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Editor's Note

Academia *noun*: Life, community, or world of teachers, schools, and education.

If the assorted interests of undergraduates on a college campus make a vibrant tapestry, their shared love for learning is the inconspicuous thread that runs through the fabric, tying us magnificently together.

But why inconspicuous? Like the mycelial network, modest and hidden beneath the soil, knowledge spreads unseen until the right conditions bring it to light—an emergence shaped by time, persistence, and the unseen forces that sustain discovery. Like this network, SPARC has grown inconspicuously, a catalyst for the expansion of undergraduate research at Michigan State University.

SPARC was born from urgency—a need for a platform that matched the ambition of undergraduate research. The story of SPARC unfolded elegantly, quite like the Fibonacci sequence. One, an idea. Two, a partnership. Three, our first team. Five, our website launched. Eight, an established identity as an RSO Now at thirteen, we are a thriving Spartan community, marking another milestone the launch of our inaugural issue! This issue is more than just a publication; it is persistence made tangible, a challenge to the status quo, and the first step in redefining how scholarship is shared.

In this issue, we present carefully curated works of exceptional student scholarship, tackling some of the world's greatest challenges– from combating mass species extinction to a critical commentary on forced sterilization in the U.S. Somehow unwittingly, a strong health sciences theme emerges as well, with papers covering genetics of rare cat diseases, gender disparities in diagnoses of AuHD, and rethinking pediatric patient education. Michigan State University's legacy as an agricultural college inspired us to root this issue in a consciousness of health and ecology. In a world where research on human and environmental health is too often censored, we raise the volume, making space for the ideas that deserve to be heard.

And so, if we are to return to our metaphor– SPARC is the frame that firmly holds and proudly displays the colorful tapestry that we are as students. The vibrant threads are now seen and celebrated.

To learning and beyond,

Veona Cutinho & Om Nair
Editors-in-Chief

Destiny Kanning

Human Biology And Korean Studies • Class of 2024

As an emergency department clinician with over four years of experience, Destiny has witnessed firsthand the impact of health literacy gaps on emergency care. Her passion for patient education and resource optimization stems from seeing families struggle with healthcare decisions and basic health literacy. As a first-generation and international student, she is committed to research that empowers patients in the communities with knowledge, ensuring that emergency resources remain accessible for those in critical need, while pushing for education as the bridge to better healthcare outcomes.

Rethinking patient education in the overutilization of pediatric emergency medicine

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Abstract

Overutilization of pediatric emergency departments (EDs) for non-emergent issues burdens healthcare systems, inflating costs and reducing access to urgent care. This study evaluated the impact of targeted educational interventions on mitigating these challenges. Data from over 2,000 patients across Michigan revealed an average cost of $1,233 per non-emergent visit, totaling approximately $369,900 during the 18-month study period. Interventions—including brochures, workshops, and a ”traffic light” system for healthcare navigation—improved patient understanding of healthcare options by 68% (t-test, p = 0.1383). Results demonstrate the effectiveness of tailored reeducation programs in reducing ED overutilization and enhancing pediatric healthcare outcomes.

Introduction

The Centers for Disease Control and Prevention (CDC) estimates that 7.5 to 10.5 million annual emergency department visits in the United States are attributed to non-emergent pediatric health concerns (CDC, 2021). These visits significantly strain emergency services, drive up healthcare costs, and reduce timely access for critically ill patients. In Michigan alone, non-emergent pediatric ED visits account for approximately 17.3% of total emergency visits annually, costing hospitals an estimated $56.4 million per year (Michigan Health & Hospital Association, 2023).

A key contributing factor to this issue is the lack of health literacy among caregivers regarding appropriate healthcare pathways. Studies show that many parents struggle to differentiate between emergency, urgent, and primary care services, leading to avoidable ED utilization (Sartini et al., 2022). This research seeks to assess these decision-making patterns and evaluate the impact of targeted educational interventions—such as a structured ”traffic light” system and community-based reeducation programs—on reducing non-urgent ED visits.

At the local level, healthcare institutions across Michigan, including Sparrow Health Systems and McLaren Greater Lansing, have reported challenges in managing high volumes of non-emergent pediatric cases. The increasing demand for emergency services has led to longer wait times, provider burnout, and financial strain on hospital systems. This study aims to provide an evidence-based model for improving patient decision-making, enhancing access to appropriate care, and optimizing emergency healthcare resource allocation.

Objective

This study evaluates the effectiveness of educational interventions, such as multilingual brochures, structured reeducation workshops, and a culturally tailored ”traffic light” system, in reducing the overutilization of emergency departments (EDs) for non-emergent pediatric health concerns while assessing the prevalence and patterns of overutilization across Michigan.

Common non-emergent pediatric concerns leading to avoidable ED visits include minor colds, low-grade fevers, mild gastrointestinal issues, ear infections, and minor fractures or sprains—conditions that could be managed in primary care or urgent care settings. However, a lack of accessible healthcare education leads many caregivers to seek emergency care unnecessarily, placing strain on ED resources and increasing wait times for critical cases.

This study investigates changes in patient awareness and decision-making through a mixed-methods approach, including pre- and post-intervention surveys, statistical analysis of utilization trends, and qualitative assessments of patient perceptions of care options. Additionally, the study explores demographic factors, such as socioeconomic status, insurance coverage, and access to primary care providers, that contribute to ED overutilization and identifies critical gaps in healthcare accessibility.

By addressing these factors, this research aims to improve healthcare literacy, empower families with informed healthcare decision-making skills, and optimize emergency department resource allocation across Michigan.

Literature Review

Patient education is recognized as a key strategy for addressing inefficiencies in healthcare, particularly in underserved communities (NIH, 2021). A lack of accessible, culturally competent healthcare education and widespread misinformation about appropriate healthcare services contribute significantly to ED overutilization. Sartini et al. (2022) demonstrated that tailored educational interventions can reduce non-emergent visits by up to 30%, reinforcing the role of structured patient education in improving healthcare resource allocation. Similarly, Johnson et al. (2023) found that in-person reeducation programs significantly enhance patient comprehension compared to digital resources, particularly among populations with lower health literacy levels.

At the state level, institutions like McLaren Greater Lansing and Sparrow Health Systems have implemented community-based initiatives to improve healthcare awareness. For example, Sparrow Health Systems has integrated targeted patient discharge education in emergency departments to help families navigate follow-up care, while McLaren Greater Lansing has collaborated with local primary care providers to promote alternative care options for minor illnesses. However, despite these efforts, a standardized, consistently evaluated model for statewide patient education remains lacking (Dover et al., 2022).

This study builds on national models—such as the Urgent Care Association’s patient education programs, which have demonstrated success in reducing ED strain—while addressing the unique challenges faced by Michigan’s healthcare system. These challenges include:

1. **High rates of Medicaid enrollment:** Michigan has a higher-than-average percentage of Medicaid-insured patients, who, due to difficulty accessing primary care providers and long wait times for appointments, often resort to ED visits for non-emergent conditions (Michigan Health Policy Institute, 2023).

2. **Disparities in rural vs. urban healthcare access:** While urban centers like Detroit and Grand Rapids have large hospital networks, rural areas across Michigan struggle with healthcare provider shortages, leading to limited urgent care availability and increased reliance on emergency departments (MDHHS, 2022).

3. **Cultural and linguistic barriers:** Michigan’s diverse population includes a growing number of non-English-speaking residents, particularly in urban centers like Lansing and

Dearborn, where language barriers can hinder patient understanding of healthcare navigation and alternative treatment options (CDC, 2021).

By incorporating culturally tailored, multilingual, and community-integrated educational interventions, this research aims to develop a scalable, evidence-based approach to reducing ED overutilization and improving healthcare literacy across Michigan.

Methodology

Data Collection

Timeframe:	October 28, 2022 – April 27, 2024
Locations:	Sparrow Health Systems McLaren Greater Lansing UofM Health West C.S. Mott Children's Hospital Helen DeVos Children's Hospital
Sample Size:	2,000+ patients for emergency department utilization analysis 520+ patients for access and reeducation surveys

Survey Analysis

Quantitative data were analyzed using R-Studio and Excel. Surveys assessed patient awareness, utilization patterns, and understanding of primary care versus emergency care. Data points included baseline knowledge, post-intervention comprehension, and utilization behaviors.

Statistical Approach

Data triangulation and t-tests were conducted to evaluate pre- and post-intervention understanding. This statistical improvement was corroborated by survey data indicating shifts in patient decision-making patterns post-intervention.

Sample Intervention

The traffic light system is a visual and straightforward approach designed to educate patients and families about appropriate healthcare resource utilization. It categorizes medical concerns into three levels of urgency:

- **Green:** Non-urgent issues suitable for primary care providers, such as minor colds or routine checkups.
- **Yellow:** Semi-urgent conditions that can often be addressed in urgent care clinics, including minor injuries or moderate flu symptoms.
- **Red:** Emergencies requiring immediate attention in an emergency department, such as severe chest pain, difficulty breathing, or serious injuries.

This intervention was delivered via pamphlets, digital resources, and community workshops to simplify decision-making and reduce unnecessary ED visits.

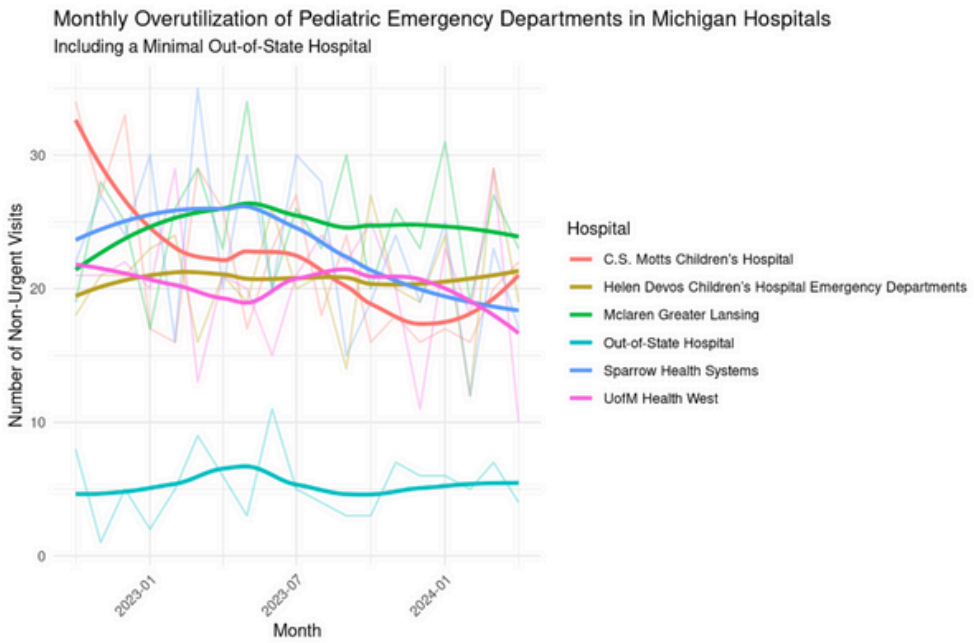

Fig 1. Line graph with Gom-Lines of patients seen in various local emergency departments between October 2022 and April 2024.

Results

Data demonstrates steady values of non-emergent utilization of emergency services in developed communities throughout the State of Michigan. A steady rate of non-emergent visits was observed across local EDs, with an average of 20.67 non-emergent visits per month at each institution,

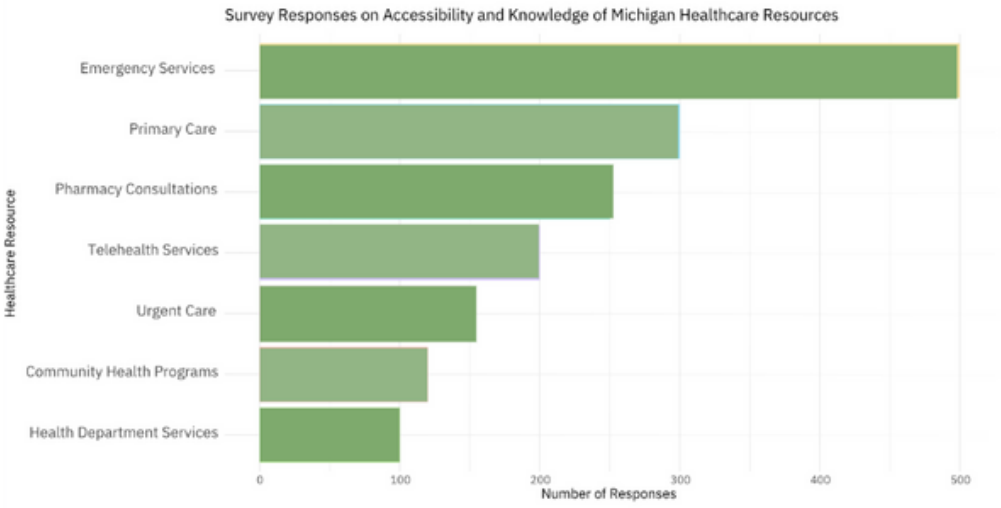

Fig 2. Key areas of miseducation and lack of services

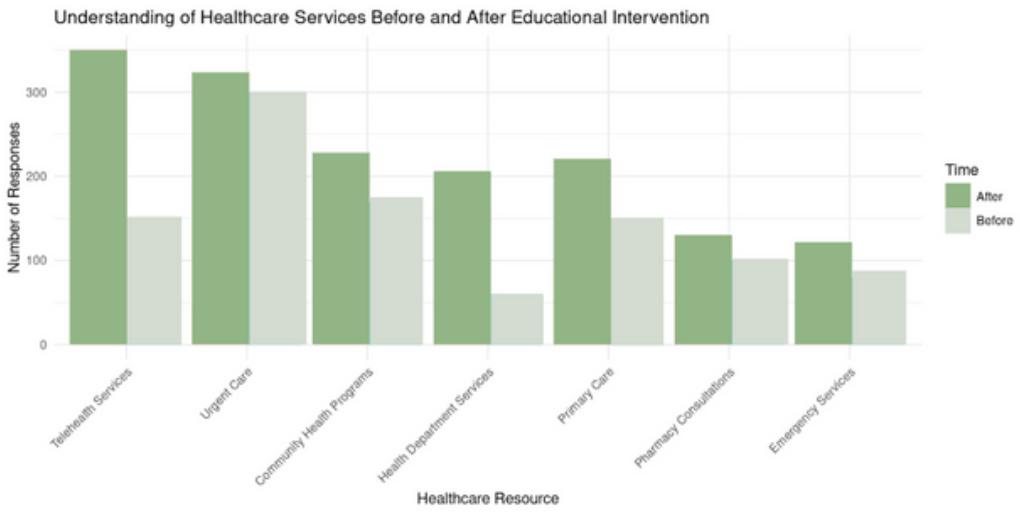

Fig 3. Histogram displaying efficacy of traffic light reeducation measures.

totaling 124 patients across the study period. Data emphasizes the need for adequate patient education and long-term care.

The histogram of intervention efficacy highlighted key improvements in patient understanding, particularly regarding primary care utilization and urgent care options. However, there was still limited awareness of urgent care and community health resources.

Furthermore, Figure 3 highlights the ”traffic light” intervention, which led to a 68% increase in awareness of healthcare options, with significant improvements in decision-making patterns as indicated by post-intervention surveys.

Analysis

The findings highlight the significant burden of non-emergent pediatric visits on emergency services and underscore the potential for educational interventions to mitigate these challenges. Statistical analysis revealed key demographic trends in overutilization.

Minority groups, urban residents, parents with lower educational attainment, and single-parent households were identified as populations more likely to overutilize emergency services (CDC, 2021). Insurance coverage, or the lack thereof, was also a major factor, with Medicaid patients representing 38% of non-emergent visits. The financial impact of these visits was substantial, with an average cost of $1,233 per non-emergent visit, resulting in approximately $369,900 in costs across the study period. Statistical analysis using t-tests revealed an increase in patient understanding after the intervention, with a t-value of 1.98 and a p-value of 0.1383. Although the p-value does not reach conventional statistical significance (typically p ¡ 0.05), this suggests a positive trend toward more informed decision-making, warranting further investigation and refinement of educational strategies. Further analysis indicates that the most significant reductions in non-emergent visits occurred in districts with the highest levels of intervention and outreach. These results suggest that community-specific educational programs can have a measurable effect on healthcare utilization patterns, particularly when paired with tailored, in-person reeducation efforts.

Discussion

Three main interventions were tested:

- *Informational Brochures:* Distributed at pediatric clinics and schools, these brochures improved parental understanding of healthcare pathways, with a 45% increase in awareness.

- *In-Person Workshops:* Conducted in collaboration with community centers, these workshops showed a 68% increase in knowledge retention, with participants reporting greater confidence in decision-making.

- *Digital Outreach:* Social media campaigns increased interaction rates by 120%, although follow-up surveys showed lower retention compared to in-person sessions.

In-person workshops were the most effective intervention, particularly when tailored to local demographic needs. These workshops reduced non-emergent pediatric visits by 27% over six months.

Proposed Intervention for Our Community:

Given the local demographics and healthcare accessibility challenges, we recommend implementing bilingual in-person workshops at community centers and schools. These sessions should include partnerships with trusted local organizations to enhance education and build community trust.

Conclusion

This study highlights the role of targeted educational interventions in reducing the overutilization of pediatric emergency departments. The 68% increase in awareness following the 'traffic light' intervention demonstrates the potential of such programs to improve healthcare decision-making. Statistical analysis (t-test, $p = 0.1383$) indicates positive trends in informed decision-making, even though further evaluation is needed to achieve statistical significance.

While further evaluation is needed to achieve statistical significance, the study underscores the importance of collaboration between healthcare systems and community organizations to address patient education gaps. By empowering patients to make better-informed decisions, these efforts can reduce healthcare costs and improve outcomes for families statewide.

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Amanda Schadler

Psychology and
Neuroscience • Class of 2027

Women are significantly less likely to be diagnosed AuHD, meaning they could be struggling without receiving support or knowing why. This can be detrimental to their mental health and well-being, which is why this topic is so important to Amanda. Making diagnosis more accessible doesn't erase the gender bias or solve all of these women's struggles, but a diagnosis does grant access to the few accommodations available as well as a better understanding of oneself, which will, in turn, improve these women's overall quality of life.

Late Diagnosis of Autism and ADHD in Adult Women: A Literature Review

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Abstract

Gender bias in research and clinical practice prevents many women from receiving a joint diagnosis of autism and ADHD (AuDHD) until later in adulthood. This literature review provides insight into the process of late diagnosis of AuDHD in women and the impact diagnosis has on their life. Research was obtained from the PsycINFO database. Thirteen journal articles published between 2021-2024 met the criteria to be included and were subjected to in-depth narrative analysis. Results indicated common themes in the experiences of late diagnosed adult women including frustration with lack of support pre- and post-diagnosis, skewed understandings and reinforcement of autism/ADHD stereotypes, and gender-biased diagnostic criteria. Implications for future research are discussed and include expanding sample diversity and incorporating AuDHD voices into all stages of research.

Introduction

According to the DSM-5-TR, autism spectrum disorder (ASD) is characterized by "deficits in social communication" and "restricted, repetitive patterns of behavior, interests, or activities" (American Psychiatric Association [APA], 2022). The condition is most often diagnosed in white male children, although it can appear in people of all genders and races (APA, 2022). Meanwhile, attention-deficit/hyperactivity disorder (ADHD) is characterized by patterns of inattentiveness, hyperactivity, and impulsivity with three main subtypes including inattentive, hyperactive-impulsive, and combined, which features symptoms from both of the previous subtypes (APA, 2022). Similar to autism, ADHD is most commonly diagnosed in young white males. Interestingly, there is a high co-occurrence of autism and ADHD, which led to the creation of a joint diagnosis of the two conditions in 2013; many people in the neurodivergent community now refer to this as 'AuDHD' (Craddock, 2024).

However, there is currently a massive gender bias in research and clinical practice that prevents many women from receiving this joint diagnosis of AuDHD (Craddock, 2024; French et al., 2024). As a result, many women aren't diagnosed until later in adulthood, which can have a huge impact on their overall well-being. Thus, in this narrative review, I wanted to explore the process of late diagnosis of AuDHD in women and analyze gender differences in symptom presentation, potential barriers to diagnosis, and the effect late diagnosis has on their life and well-being.

Methods

I conducted my research using the PsycINFO database with access provided by Michigan State University. In my key search terms, I needed to include three main topic areas: some terms to

represent autism and ADHD, some terms to represent women/the gender bias, and some terms to represent the process of late diagnosis. The key terms went through many revisions including removing terms such as "Asperger's" and "adult diagnosis" due to irrelevant or no change in results. The asterisk was included in terms such as "autis*" to account for different variations of the term (e.g. autistic, autism) and to search for both the plural and singular versions of terms such as with "female*". Terms were revised to the following:

> ("autis*" OR "ADHD" OR "attention deficit hyperactivity disorder" OR "AuDHD" OR "neurodiver*") AND ("women" OR "gender bias" OR "female*") AND ("diagnos* process" OR "late diagnos*")

These terms were entered into the PsycINFO database. Using the advanced search features, I specified to search for the terms in the abstracts of journal articles, and I refined the search to the last five years to include only recent data. Sources were excluded if they examined only caregiver or professional opinions of AuDHD women without including AuDHD voices, if the topic was not about late diagnosis or the diagnostic process for adult women, if autism or ADHD was not the main focus, and if the study explored autism/ADHD in young children as opposed to adult women (no hard age cutoff, but general age requirement of 18+). Due to a lack of research on the joint diagnosis of AuDHD, studies were not excluded for focusing solely on autism or on ADHD as long as they met the rest of the inclusion criteria.

Results

Results are split up into three groups of studies with a focus on a joint diagnosis of AuDHD, a sole focus on autism, and a sole focus on ADHD. Many similar themes were found throughout all three sections, which are later discussed in the conclusion section.

Experiences of AuDHD Women: A Joint Diagnosis of Autism and ADHD

Craddock (2024) conducted an analysis of email interviews with six late diagnosed AuDHD women exploring their experience with late diagnosis and how their identity as a woman related to their neurodivergent identity of AuDHD. In terms of symptom presentation, women generally presented with more internalized symptoms than most men and were significantly more likely to mask (hide) their AuADHD traits in an effort to appear neurotypical or non-AuDHD (Craddock, 2024). This may be one of the reasons why AuDHD is often unnoticed in women as the official diagnostic criteria places a stronger emphasis on externalized symptoms that are more common in men. Interestingly, some women also noted that their symptoms of autism and ADHD tend to "cancel each other out" (Craddock, 2024). For example, autism is characterized by repetitive behaviors that may help one maintain a sense of organization and routine, but given the inattentive nature of ADHD, women may struggle to maintain said routine. As symptoms cancel out, they become less noticeable, which creates a barrier leading to later recognition and diagnosis in life.

When speaking of their experiences with the results of late diagnosis, the women in the Craddock (2024) study shared many common themes, with the stand out being a lack of post-diagnosis support. Many women shared that they were given medication to treat their ADHD symptoms and were then shoved to the side with few options for therapy or other social support. While medication may improve symptom severity for some women, others may not benefit from medication at all. Therapy and workplace accommodations would likely also be helpful, however these weren't available for many women (Craddock, 2024). Additionally, getting post-diagnosis support relies on receiving an official diagnosis in the first place. It's common knowledge among researchers that diagnosis isn't accessible for everyone due to cost of diagnosis, poor insurance coverage, length of waitlists, biased clinicians, etc. (Craddock, 2024; Cook et al., 2024; Morgan et al., 2023). While self-diagnosis is becoming more common and valid in the neurodivergent

community, it has yet to be widely accepted (Cook et al., 2024), posing challenges in ensuring all AuDHD women receive equal support.

Holding semi-structured interviews with late diagnosed AuDHD adults, French et al., (2024) shared similar themes to that of Craddock (2024) with an additional emphasis on timing of diagnosis. While an AuDHD diagnosis comes as a relief to many in helping them better understand themselves or providing them access to accommodations, some may view an AuDHD diagnosis as a burden with a large focus on "what could have been" if they were diagnosed earlier in life (French et al., 2024). This suggests a need for pre-diagnosis support to help prepare AuDHD women for the emotional transition of receiving a diagnosis. If the timing is wrong and a woman isn't mentally prepared, it's possible that a late diagnosis may do more harm than benefit, which is important to note given that a lot of research only focuses on the ways an AuDHD diagnosis can improve one's life.

Experiences of Autistic Women

Conducting a post-hoc analysis of 20+ years of diagnostic data in the state of North Carolina, Harrop et al. (2024) highlighted some of the biggest disparities in autism diagnosis between men and women. As established, women are 38% more likely to be late diagnosed in adulthood, receiving their diagnosis an average of two years later than men (Harrop et al., 2024). Interestingly, the ratio of men to women who are diagnosed has decreased over time, likely due to the larger sum of research on autistic women that is available today. Even with this decrease, however, there remains a significant gap between rates of diagnosis for men and women (Harrop et al., 2024).

While clinicians' understanding of autism in women may have increased, in a qualitative study using photovoice methodology, Cage et al. (2024) noted that the "incongruence between diagnostic tools and female presentation" is still a major barrier to adult women receiving an autism diagnosis. Many women cited struggles with finishing the Autism Questionnaire (AQ), in particular being stuck on the wording of "significant impairment" (Cage et al., 2024). After being overlooked their whole life, women diagnosed autistic in adulthood may be used to coping with their symptoms and not view them as an 'impairment.' While it's true that many women seek diagnosis after some sort of breaking point in their life when the demands of life exceed their capacity (Cage et al., 2024), this isn't the case for everyone: some women may simply want to better understand themselves. Thus, the wording of 'impairment' may cause women to self-report lower AQ scores which could cloud a clinician's judgement of whether their patient is autistic. Given that both the diagnostic criteria and the AQ were created in response to research done on white males, it's natural that women's presentation of autism may not align with these measures. These findings indicate a need to redesign diagnostic criteria and diagnostic tools with the female phenotype of autism in mind.

Masking is another common barrier to the diagnostic process as explored by Seers et al. (2022) using a feminist disability lens in qualitative interviews with late diagnosed autistic women. A natural and subconscious action for most women, masking is often used as a way to avoid rejection or stigmatization in society (Seers et al., 2022). Given that this makes autistic traits less noticeable, masking makes it harder for clinicians to assess for autism. For example, making eye contact is one way many women mask, and since avoidance of eye contact is listed in the DSM as an example of a social deficit (APA, 2022), this may cause a clinician to believe the woman isn't autistic. Females often mask significantly more than males, and since the diagnostic criteria was created based on male presentation, many clinicians don't naturally look for signs of masking during assessment, preventing many women from being diagnosed (Seers et al., 2022). Murphy et al. (2022) reinforced many of these struggles with masking through qualitative interviews with women seeking an autism diagnosis. Another theme that emerged from this study was the importance of women understanding and being prepared for the actual process of a diagnostic evaluation. This may include researching different clinicians to find ones that specialize in late

diagnosis or writing out a list of all the reasons that they believe they're autistic for self- and provider-validation (Murphy et al., 2022). Given that women often self-report more autistic traits than clinicians do (Murphy et al., 2022), this list could be extremely helpful in describing some autistic tendencies that may be masked during the assessment period.

Another option, as Cook et al. (2024) pointed out, would be for clinicians to have more awareness of and assess for masking; their narrative review of the autism diagnostic process highlights many areas clinicians could improve. For example, using the Camouflaging for Autistic Traits Questionnaire (CAT-Q) would be one option to test for masking in adult women and should thus be regularly administered during autism assessments (Cook et al., 2024). While clinician knowledge has improved some over time, many clinicians still lack knowledge of the gender bias and differences in symptom presentation of autistic females. Clinicians are also more likely to focus on external presentations of autism that are over-represented in most autistic questionnaires––which as previously stated, often excludes women whose symptoms tend to be more internalized (Cook et al., 2024).

These struggles make the diagnostic process stressful for women, as Harmens et al. (2021) discovered when exploring autistic women's blogs. Women who are familiar with the autism gender bias may fear being misdiagnosed, which can cause great worry about the assessment being a waste of time and money. Upon diagnosis, immense relief is a common theme for women as they finally have an explanation for why they have felt so different their entire life (Harmens et al., 2021). However, many women also go through some form of identity crisis, either fixating on why they weren't diagnosed earlier or feeling imposter syndrome over the fact that they don't perfectly align with the male-based diagnostic criteria (Harmens et al., 2021). Some women may even feel a combination of both, which would be extremely confusing for them to process. This highlights the importance of autistic online communities, where these women can share their experiences with other autistic women who understand their struggles.

Experiences of ADHD Women

With an observational study exploring timing of ADHD diagnosis in relation to co-occurring mental health diagnoses, Siddiqui et al. (2024) noted many gender disparities in ADHD presenta- tion and diagnosis. Similar to autism, the average age of ADHD diagnosis is significantly higher in women, who are often diagnosed between ages 16-28, with the average age at diagnosis being 11-22 in men (Siddiqui et al., 2024). As with autism, this may be due to the emphasis placed on externalizing symptoms. Given that women are more likely to present with the inattentive subtype, they are often ignored due to the lack of external hyperactivity they display (Siddiqui et al., 2023). Since 'hyperactive' is in the name of ADHD, it's a common stereotype that all ADHDers are the constant energy, scatter-brained, 'bouncing off the wall' type. Many people only notice external behaviors of ADHD when they cause significant problems in a workplace or school setting (Siddiqui et al., 2024), so clinicians' ignorance of the internalization of ADHD may be one of the barriers to women receiving a diagnosis.

Examining these biases in the diagnostic criteria, Morgan et al. (2023) discovered in qualitative interviews that many ADHD women are often diagnosed with anxiety, depression, or bipolar disorder before viewing ADHD as a possible diagnosis. This is likely very confusing for women as it may seem obvious to them that they have symptoms that don't align with the diagnosis they were given. After ADHD diagnosis, many women felt immense relief, but others still struggled with internalized ableism––holding themselves up to a neurotypical standard (Morgan et al., 2023). While co-occurring diagnoses such as anxiety and depression are common in ADHD, these don't explain the whole picture and certainly don't replace the need for an ADHD diagnosis.

Women in academia also receive significant pushback in the process of receiving an ADHD diagnosis (Cripe et al., 2024). As ADHD scholars Cripe et al. (2024) explained about their diagnostic experience, clinicians were hesitant to diagnose them because they all had PhDs and

thus must have been able to cope with their symptoms. In reality, some aspects of ADHD may be helpful in an academia career such as the ability to hyperfixate on information for an extended period of time. But, that does not take away from the struggles ADHD scholars face as they do their work; the women in this paper noted particular difficulties with procrastinating and feeling frustration with small changes that ended up causing significant overwhelm in their ability to work (Cripe et al., 2024). It's important to look at the whole picture of a person instead of just focusing on their achievements, which may cause clinicians to overlook the possibility of women in higher status careers having ADHD.

Similarly, ADHD scholars Bertilsdotter et al. (2023) expressed their struggles with trying to re-story ADHD in a narrative of their shared experiences. There are many harmful viewpoints that aim to pathologize ADHD such as that of a social construct or a neurodevelopmental deficit; instead, ADHD should be re-storied as a neurodivergence (Bertilsdotter et al., 2023). This implies that ADHD is merely a different way of cognitive processing as opposed to a problem that needs to be fixed. Given that many women struggle with accepting their ADHD identity, it's important to normalize differences. In any population, it's highly unlikely that everyone is going to think and process information in the same way, regardless of whether they have ADHD. This is why some people have an issue with ADHD medications as they tend to medicalize ADHD as a disease that needs to be cured with medication (Bertilsdotter et al., 2023). Interestingly, a lot of popular media does the opposite and tends to downplay ADHD as simply being scatter-brained or having a lot of energy, but as Bertilsdotter et al. (2023) describe, ADHDers face many struggles but are still human and deserve to be treated as more than just their condition.

Conclusion

This literature review was conducted with the goal of developing a better understanding of what the process of late diagnosis looks like for AuDHD women. Several common themes emerged including frustrations with the lack of support available, limited knowledge of clinicians, and male-biased diagnostic criteria.

Lack of support pre- and post-diagnosis was one of the most important themes to emerge. Many women expressed struggles with being mentally ready to accept a diagnosis and struggled with an identity crisis after receiving their diagnosis. Pondering thoughts of 'what if I was diagnosed earlier' was common, and some struggled to shed their ableist views and comparisons to neurotypical standards. That being said, diagnosis was also an immense relief for the majority of women as they finally had an explanation for why they felt ostracized in life. This suggests that while diagnosis is important in and of itself, the process could be greatly improved by offering more support to the AuDHD women. For example, clinicians could meet with women before an AuDHD assessment to explain what it means to be AuDHD and how a diagnosis might impact their life. During this, it might also be helpful to explain what the evaluation process will look like so that women can be fully prepared. Since many women noted significant levels of stress during evaluation, knowing what to expect may help ease some of their concerns. After receiving an AuDHD diagnosis, clinicians need to provide more guidance in helping AuDHD women accept their new identity. Being given an information pamphlet isn't enough. While medication may be helpful for some ADHD symptoms, most women would largely benefit from one-on-one neurodivergent affirming therapy and/or AuDHD support groups, specifically those within the AuDHD community. In areas with limited in-person support available, clinicians should also be more aware of AuDHD online communities as an alternative.

In addition to providing more support, many studies discussed the importance of clinicians developing a better understanding of the female phenotype of AuDHD. Most research supports the idea that women are more likely to present with internalizing symptoms, but many clinicians still focus on external behaviors that cause some sort of 'problem' in social settings. This means that many women aren't able to receive their diagnosis until they reach some sort of breaking point in their life when they are no longer able to cope with their symptoms, which is problematic.

Clinicians should be focusing on providing women with enough support so that they don't have to reach a breaking point in order to be heard. Masking may make it harder for clinicians to notice some of these signs, but awareness of masking is vital since the female phenotype portrays that women are significantly more likely to mask their symptoms than men and do so frequently. Given how difficult it is for many women to get a diagnostic appointment in the first place, they shouldn't have to worry about clinician ignorance once there. Increasing clinicians' knowledge of female symptom presentation and masking will likely increase the chance that women are able to be diagnosed earlier in life.

Finally, gender bias in diagnostic criteria and questionnaires was another major theme to emerge from research, which may be counteracted by increased clinician understanding. Since the diagnostic criteria and many other diagnostic tools were created based on research done on white male children, many AuDHD women don't fit well within traditional measures. The fact that most women present with internalized symptoms whereas many of these measures place a strong emphasis on externalized symptoms that cause a 'problem' for others is a massive barrier to diagnosis. While it may be difficult to completely change the diagnostic criteria, clinicians can enter an assessment with the female phenotype in mind. Simply knowing to look for more internalized symptom presentations may help more women get diagnosed. Additionally, clinicians can be selective about which questionnaires they choose to use and how much emphasis they place on questionnaire results. Incorporating a combination of self-report questionnaires, clinical interviews, familial/friend observations, etc. is important to get a full picture of the person and increase diagnostic accuracy.

Limitations and Suggestions for Future Research

While this literature review spoke in great depth about the gender bias against AuDHD women, there are other gender identities outside of the binary who are still excluded from current research. For example, only a couple studies included non-binary people in their samples, and none of the studies included transgender people. Since all gender identities can potentially be autistic/ADHDers, and given the fact that different gender identities often show different symptom presentations (as proven with the female phenotype that differs from the traditional male presentation of AuDHD), it's vital that future research explores a wider variety of gender identities outside the binary.

Similar to the gender bias in AuDHD, there is also a massive racial bias present in research. The majority of current research examines the presentation and experiences of a predominantly white sample when exploring AuDHD. People of other races and ethnicities are just as likely to be AuDHDers, even if they're significantly less likely to be diagnosed and studied (like women). This is a major limitation of most existing research, so in the future, research needs to be done on how autism/ADHD presents in people who aren't white. Forming a general phenotype of symptom presentation––similar to that of women––would be beneficial for increasing clinicians' understanding and ability to provide support.

Another limitation of current research is that most researchers look at autism or ADHD individually as opposed to a combined diagnosis. While it's true that not everyone who is autistic is also going to have ADHD, there is a high rate of co-occurring diagnosis between autism and ADHD, so much so that the neurodivergent community coined the combined term 'AuDHD' to refer to a joint diagnosis––but this term has yet to become popularized in the field of academia (Craddock, 2024). Future research needs to do a better job of taking a joint AuDHD diagnosis into consideration to establish any differences in symptom presentation and the resulting implications for diagnosis and support/treatment.

Finally, future research needs to include neurodivergent voices in all stages of research, not just as participants. While there are many neurodivergent researchers starting to emerge, this usually only includes a small population of upper-middle class white people and is not representative of the neurodivergent community as a whole. In many ways, the neurodivergent community is ahead of researchers when it comes to knowledge of autism and ADHD, so it

would be beneficial to include them in the planning process. For example, as previously stated, the neurodivergent community created the term 'AuDHD' to refer to a joint autism/ADHD diagnosis, and the community also had a better understanding of different gendered symptom presentations before the female phenotypes of autism/ADHD were widely accepted in research. Furthermore, there is still a significant sum of research that aims to find the cause and cure for autism/ADHD, despite the majority of the neurodivergent community stating that they don't want a cure (Craddock, 2024). Since research is aiming to help neurodivergent people, it's crucial that researchers take neurodivergent opinions into account.

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Katherine Sundeen

Women's & Gender Studies and Music • Class of 2024

Katherine is passionate about public policy, law, and social justice. Her research on the legacy of Buck v. Bell was driven by a commitment to understanding the modern legal climate and its impact on human rights. Exploring this case and its lasting implications reinforced her interest in studying law, particularly reproductive health and disability rights. She hopes to continue examining how the law affects marginalized communities and plans to pursue a law degree to engage with these critical issues.

Forced Sterilization in the United States: The Legacy of *Buck v. Bell*

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Abstract

The United States' history with forced sterilization is a dark chapter that continues to impact contemporary legal and social frameworks. From its roots in the eugenics movement to its disproportionate effects on marginalized communities (especially women of color), sterilization practices have been justified in various ways over the years, all with the underlying goal of controlling who gets to reproduce and who does not.

In this article, I explore the history of forced sterilization in the United States through the lens of culture, focusing on the racial and economic factors that influenced its justifications, its practice, and the legal ramifications that continue to shape policies today. I argue that the institutionalization of forced sterilization through landmark legal cases, particularly Buck v. Bell, is deeply intertwined with the rise of the eugenics movement. This connection has shaped how the U.S. government and medical professionals have historically interacted with people deemed "undesirable" by society. I emphasize that, despite the official end of eugenics-based policies, forced sterilization practices continued well into the 21st century, with reports of sterilizations in immigrant detention centers and among other vulnerable populations. I suggest that we continue to examine contemporary legal cases and renew conversations surrounding the legacy of Buck v. Bell through the lens of modern-day ethics of sterilization and the rights of incarcerated people.

Introduction and Historical Context

The early 20th century marked the rise of the eugenics movement in the United States, which sought to improve the human race through selective (thus, exclusionary) reproductive processes. This movement was closely tied to social and racial hierarchies, with proponents of eugenics arguing that sterilization could prevent the transmission of traits deemed "undesirable". During the time, eugenics was gaining traction in intellectual communities and was supported by many leading scientists and policymakers. Margaret Sanger, a pioneer of the birth control movement, recognized the potential of birth control as a tool for policing the reproductive choices of "undesirable" populations. Sanger believed that birth control could be a means to improve the gene pool, particularly by preventing the reproduction of those she labeled "feeble-minded".

In 1924, Virginia passed the Eugenical Sterilization Act, which gave state authorities the power to sterilize individuals deemed "unfit" to reproduce, including those labeled "feeble-minded". This law was grounded in eugenic principles; certain traits, such as low intelligence, criminal behavior, and poverty, were hereditary and it was thus the responsibility of the state to intervene to prevent the transmission of these traits. As a result, many individuals (most of whom were poor, disabled, and from marginalized communities) were sterilized against their will with little or no legal recourse.

In 1927, the United States Supreme Court heard Buck v. Bell, a case that many identify as the catalyst for forced sterilization throughout the United States, as it legitimized early eugenic sterilization procedures. In the case, the plaintiff, Carrie Bell, was deemed "feeble-minded" by the psychiatrist at the facility she was institutionalized in and was ordered to be sterilized. She was the daughter of a woman in the same institution and the mother of a daughter also labeled as "feeble-minded". The legal challenge was not against the sterilization procedure itself, but rather against the constitutionality of the Virginia Eugenical Sterilization Act and the violation of Bell's rights under the 14th Amendment, which guaranteed equal protection under the law and due process. The Court ruled in favor of the state, with Justice Oliver Wendell Holmes infamously stating "three generations of imbeciles are enough" and "it is better for all of the world if instead of waiting to execute degenerate offspring for crime, or to let them starve for their imbecility, society can prevent those who are manifestly unfit from continuing their kind".

Shifting Justifications for Forced Sterilization

In its early years, forced sterilization was justified primarily through eugenics, framed as a means of protecting the human race by eliminating certain "undesirable" traits. The decades following, however, saw an increase in the institutionalization of marginalized individuals; this led to a shift in conversation, ultimately resulting in the justification for forced sterilization to shift towards the protection of vulnerable women, particularly those institutionalized.

In 1942, the U.S. Supreme Court heard Skinner v. Oklahoma, which marked a turning point in the legal conversation surrounding forced sterilization. The Court rejected eugenic sterilization as a legitimate state goal and recognized that procreation was a basic civil right. In the case, Skinner had been arrested twice for theft and finally for armed robbery, which made him a convicted felon under Oklahoma law and he was thus sentenced to a term of imprisonment at a penal institution. During this stay, proceedings were brought to forcibly sterilize him and he referred to the 14th Amendment in his defense. Despite this ruling, sterilization continued throughout the United States, specifically targeting women of color and those on welfare.

In the 1950s and 1960s, sterilization practices grew increasingly motivated by race, with Black women disproportionately affected, particularly in the South (Stern, 2020). There was now a perception that low-income, minority families placed a large burden on the welfare system. In North Carolina, 7600 individuals were sterilized, many of whom were Black women. Between 1950 and 1966, Black women were sterilized at rates more than three times higher than white women. This practice was rooted in the belief that Black women were unfit to parent and in the broad perception of poverty justifying reproductive control.

In Alabama, the case of the Relf sisters highlighted the coercive and misleading nature of sterilizations. In Relf v. Weinberger, the young girls were sterilized after their mother unknowingly signed consent forms, believing she was consenting only to birth control shots. After the case's litigation began making its way through the courts, its exposure led to the requirement that doctors obtain "informed consent" prior to performing any sterilization procedures. It was not until 1976 that the Department of Health, Education, and Welfare finally created programs to protect minority women; they implemented safeguards such as an age requirement of at least 21 years old, a mental competence requirement, and a 72-hour waiting period. As tubal ligation became a more popular form of birth control, however, federally funded family-planning programs began subsidizing this cost. These programs targeted people of color and often coerced them into sterilization under false pretenses, such as with the (false) information that tubal ligation could be reversed after five years.

Although the practice of forced sterilization declined after Skinner v. Oklahoma, the legal and social framework established by Buck v. Bell continues to influence rulings and policies across the United States. What began with eugenics-based justifications evolved into moral and racial arguments, and the legacy of forced sterilization endures in various forms.

Sterilization in Contemporary Contexts: Immigration Detention Centers

The effects of forced sterilization continue to manifest in contemporary practices, particularly in prisons and immigration detention centers. In her article "Not Just ICE: Forced Sterilization in the United States" (2021), Emily Medosch examines the allegations against Immigration and Customs Enforcement (ICE) for forcibly sterilizing detainees under their care. Medosch highlights the introduction of tubal ligation as a sterilization method, particularly its prevalence among non-English speaking women. This practice, both then and now, serves as a form of medical coercion that exploits vulnerable women in emotional and physical distress.

The ongoing consequences of forced sterilization's legacy remain evident even in the 21st century. Women detained in ICE facilities have testified that they received contradictory explanations regarding the procedures they were undergoing, creating an environment of minimal accountability. This violates fundamental human rights, yet it persists because it is largely hidden from the public eye. While sterilization is not as widespread as it once was, these testimonies reveal recurring ideologies of targeting and policing the reproduction of women of color. This emphasizes the importance of examining the legal implications of forced sterilization through a modern lens. It also serves as a stark reminder that the legal legacy of Buck v. Bell continues to disproportionately harm marginalized communities, especially women of color.

Conclusion

The history of forced sterilization in the United States reveals a deeply troubling pattern of exploitation and violence against marginalized groups, particularly women of color. From its eugenics-driven roots to the contemporary practices still visible in immigrant detention centers, forced sterilization has evolved but continues to disproportionately affect vulnerable populations. Landmark legal cases like Buck v. Bell institutionalized sterilization, creating the legal framework scripts that would persist for decades.

As we continue to witness instances of medical coercion in today's immigration detention centers, it is clear that the legacy of Buck v. Bell still persists. While sterilization practices may not be as widespread as in the past, the targeting of women of color and vulnerable populations remains prevalent. The need for accountability, transparency, and protections against forced sterilization is more pressing than ever. It is imperative that we confront the historical and contemporary implications of these practices to safeguard reproductive rights and bodily autonomy, especially for those who are most vulnerable.

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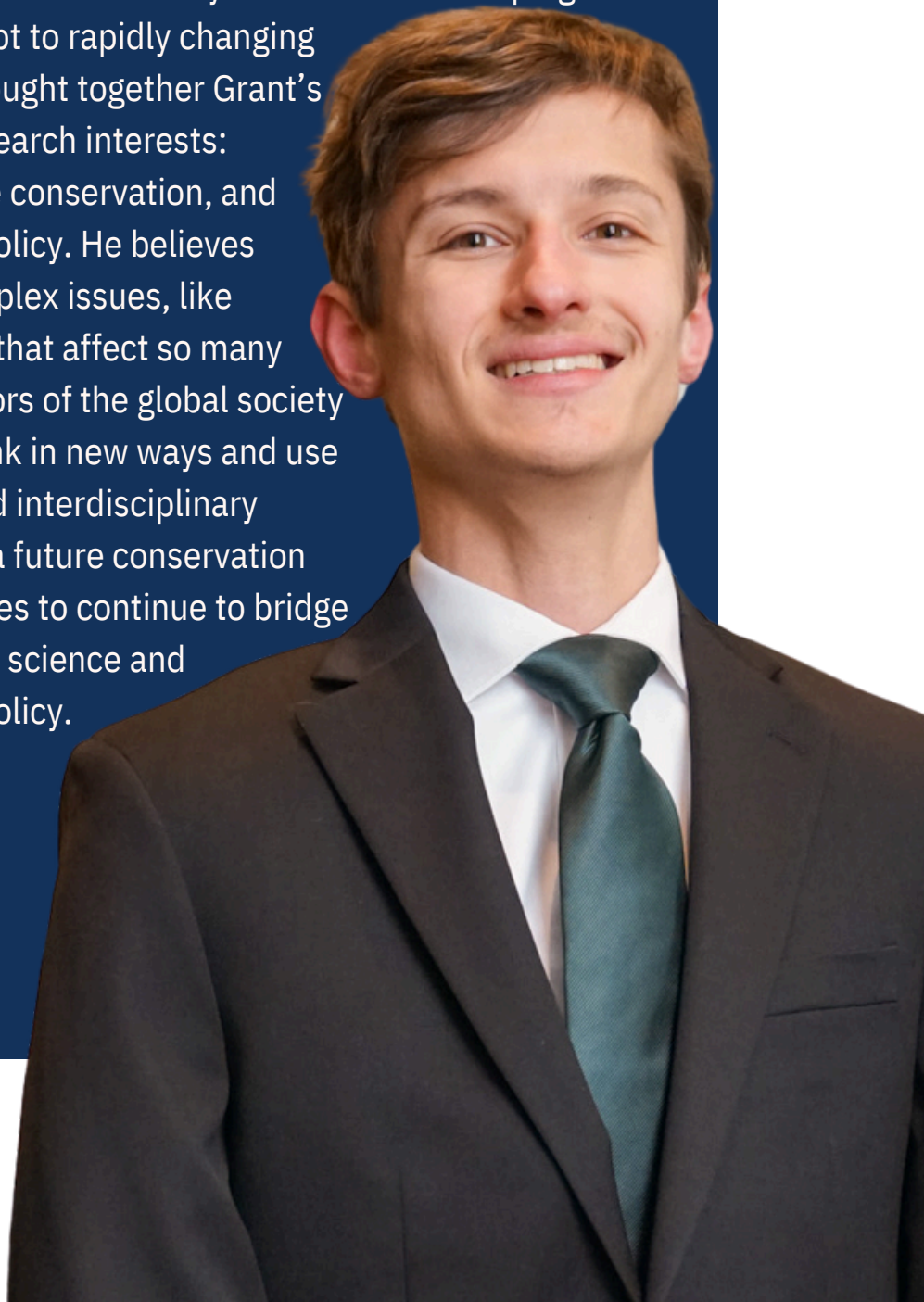
Zoology and Integrative Biology • Class of 2025

Investigating the role of hybridization in helping ecosystems adapt to rapidly changing environments bought together Grant's three driving research interests: genetics, wildlife conservation, and environmental policy. He believes that solving complex issues, like climate change, that affect so many people and sectors of the global society require us to think in new ways and use collaborative and interdisciplinary approaches. As a future conservation scientist, he hopes to continue to bridge the gap between science and environmental policy.



Hybridizing Hope: Hybridization as a Viable Method to Combat Mass Extinction in a Dynamic Environment

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Abstract

Historically, conservation managers and policymakers disregarded the hybridization of endangered species within their species (intraspecific) or between different species (interspecific) as a viable conservation strategy. Many believed that both processes produced non-viable offspring and decreased the fitness or ability of local populations of the target species to survive, a process called outbreeding depression. However, in an era of rapid climate change, hybridization confers vital genetic diversity and subsequent adaptive potential to populations who are struggling from inbreeding depression (or the loss of genetic diversity and fixation of deleterious mutations due to interrelated mating). This paper centers around the debate of whether hybridization should be prevented to preserve the adaptations in local populations or encouraged to preserve the ecological niche of the target species using scientific journal articles published between the years 2007 and 2023. This paper presents the debate over whether hybridization should be prevented to preserve local adaptations or encouraged to maintain the ecological niche of the target species, drawing on literature from the past two decades. Recent genetic studies from various species on intraspecific and interspecific hybridization events have shown that the effects of outbreeding may be significantly less detrimental than previously thought. Therefore, hybridization, if monitored correctly with recent advances in genetic and genomic technologies, could be used to maximize the survival of threatened species as their ranges continue to shift due to the onset of global climate change.

Introduction

Anthropogenic, or human-induced, impacts on the environment have resulted in the acceleration of habitat degradation, fragmentation, and destruction. Many species around the world are unable to adapt to the worsening of climatic extremes, with extinction rates reported to be between 100 and 1000 times greater than predicted pre-human background levels (De Vos et al. 2015).

Decreases in the population size of any species can present significant challenges for their natural recovery, even in instances where degraded habitat is restored. The main barrier to natural recovery in small populations is inbreeding depression: a loss of adaptive potential and overall fitness in populations where interbreeding occurs between closely related individuals (Edmands, 2007). To combat this issue, conservation biologists proposed the idea of genetic rescue through intraspecific hybridization, a process that introduces individuals from outside populations of a species into a threatened local population to encourage an increase in genetic diversity (Zecherle et al., 2021). However, these introductions, either from implementation by conservation managers or the migration of species due to climate change, can dilute genetic

adaptations that local populations have evolved to help them survive, a process called outbreeding depression (Edmands, 2007).

Therefore, there is widespread disagreement among biologists and conservation managers about whether inbreeding depression or outbreeding depression poses a bigger challenge to threatened populations (Houde et al., 2011; Todesco et al., 2016). **Modern technologies, especially in genetic and genomic sciences, are a vital tool to answer this question with a diversity of subject taxa and ecosystems. As more data emerges from species that are targeted for genetic rescue or that interbreed with individuals of closely related species from novel range overlapping, it is clear that hybridization is effective in acute population recovery and expands adaptive potential in threatened species.** In an era of climatic uncertainty, allowing for the hybridization of endangered species and managing their recovery as hybrids could prove to be important in maintaining the ecological integrity of the world's most vulnerable ecosystems.

The Case Against Hybridization

Early perspectives rejected both intraspecific and interspecific hybridization as viable conservation strategies because conservation managers expressed caution about the effects of outbreeding depression, historically detrimental to populations of multiple native taxa (Draper et al., 2021). Early conservation initiatives performed intraspecific hybridization by introducing individuals from different geographic locations to supplement a threatened local population. Managers used changes in fitness to monitor the success of local populations after the introduction of outside individuals, which produced negative fitness outcomes in early generations (Barmentlo et al., 2018; Fredrickson et al., 2007; Huff et al., 2011). Three of these reintroduction projects encompassed a variety of taxa (sculpin, primrose, and Mexican wolves) and all showed that breeding pairs consisting of individuals of different subpopulations produced offspring with significantly lower fitness at phenotypic markers compared to breeding pairs composed of individuals of the same subpopulation (Barmentlo et al., 2018; Fredrickson et al., 2007; Huff et al., 2011). For example, Mexican wolf breeding pairs from different subpopulations experienced lower levels of pup survival, a lower number of pups per litter, and a lower number of litters compared to breeding pairs from the same subpopulation (Fredrickson et al., 2007; Figure 1). Also, sculpin offspring produced from parents of different geographic

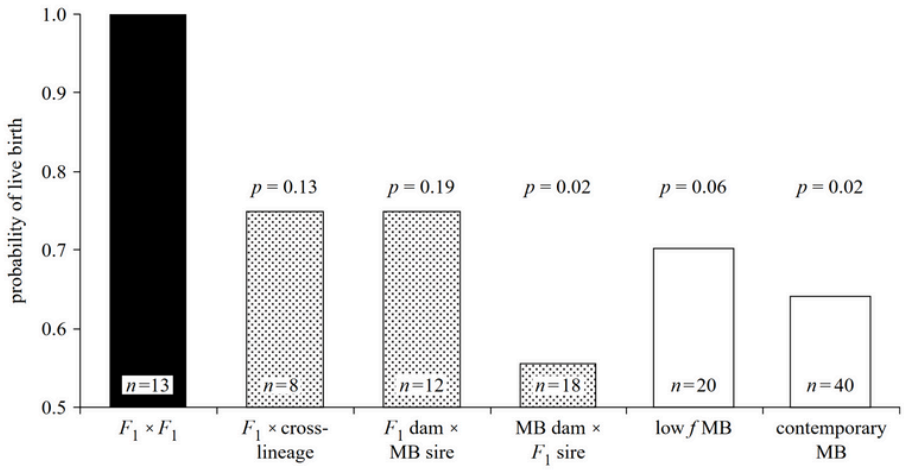

Fig 1. Probability of live birth among Mexican wolf breeding pairs from the same subpopulation (black bar) and breeding pairs from different subpopulations (grey bars) (Fredrickson et al., 2007).

subpopulations were significantly shorter, lighter, and slower growing than those from parents of the same geographic subpopulation (Huff et al., 2011). As shown by these studies, early intraspecific hybridization projects resulted in decreases in fitness across multiple taxa, calling the viability of hybridization in conservation management into question.

While these examples provide evidence supporting early reservations around the mainstream use of hybridization as a conservation strategy, they have temporal limitations that may inflate the effects of outbreeding. When subpopulations of the same species interbreed for the first time, genetic adaptations that each subpopulation has for survival are lost due to outbreeding depression (Houde et al., 2011). However, normal levels of fitness are eventually restored due to the natural selection of adaptively beneficial genes (Houde et al., 2011). This process occurs for multiple generations after the initial introduction, which is longer than the duration of many experiments on the effects of outbreeding in wild populations (Chan et al., 2019). Therefore, early hybridization programs indicate that outbreeding depression is a risk in the translocation of subpopulations into novel ranges, but further research into its long-term effects is needed to characterize the ability of hybridization to rescue species of conservation concern further into the future.

The Viability of Hybridization as a Conservation Strategy

Recent advances in genetic and genomic technologies present a clearer picture of how both intraspecific and interspecific hybridization events have contributed to the evolutionary history of many species and rescued some modern species from rapid declines due to environmental pressures. The first important development arising from the use of modern genetic technologies in hybridization studies is that outbreeding depression can be minimized through the introgression of genetically suitable subpopulations, which can be determined through microsatellite and single nucleotide polymorphism analyses (Weeks et al., 2017). Based on these analyses, subpopulations of mountain pygmy possums across Australia were selected and introduced to a threatened subpopulation, leading to a significant increase in fitness and population size, even in the F1 generation (Weeks et al., 2017). This example highlights the impact of genetic monitoring on the success of controlled hybridization projects for species conservation, thus providing clarity on how these hybridizations may be replicated by managers working with different taxa. When individuals are chosen for hybridization because of their genetic suitability, they have a disproportionately higher impact on the survival and fitness of future generations than do random additions of individuals or the preservation of standing variation for adaptive potential (Hufbauer et al. 2015).

Modern genetic and genomic technologies have also illuminated the evolutionary history of many species, some of which have undergone significant hybridization events to survive changes in environmental conditions. A study of different plant species in New Zealand detailed extensive hybridization among different species in the genus Pachycladon immediately following the end of the Last Glacial Maximum. This hybridization event provided each species with the adaptive potential to improve their defenses against predators and pathogens that were much more prevalent when the climate warmed (Becker et al., 2013). This type of rapid adaptive radiation was also the origin of the vast array of African cichlid species in Lake Victoria, as hybrid offspring interbred with one another to form unique genetic variations in coloration which are vital to their survival in varying states of water quality in the lake basin (Meier et al., 2017). These discoveries point to the long history of adaptations that are introduced between wild populations in times of environmental variability, a process that can be accelerated by the novel introduction of species either through climate change-induced migrations or translocation programs coordinated by conservation managers.

In the current era of climate change and anthropogenic impacts on the environment, both intraspecific and interspecific hybridization events continue to rescue several species from the

brink of extinction. In Scandinavia, one immigrant male gray wolf breeding with a female in a local population resulted in temporary increases in population size and offspring fitness compared to contributions from other individuals in the pack which was severely inbred due to anthropogenic barriers and habitat degradation (Å˚ kesson et al., 2016). Similar to the evolutionary history of plants in New Zealand, the climate change-induced spread of diseases like feline immunodeficiency virus (FIV) in degraded environments resulted in a strong degree of introgression between the Scottish wildcat and domestic cats in Scotland. Even though a sharp population decline occurred in Scottish wildcats during this time, due to deaths from FIV and the effects of outbreeding depression with domestic cats, surviving hybrid Scottish wildcats retained the major histocompatibility complex (MHC) of domestic cats that helps their immune system respond effectively to FIV infection (Howard-McCombe et al., 2023). Therefore, since the Scottish wildcat population declined rapidly at the onset of the FIV outbreak, it is unlikely that the population would have been able to acquire immunity to FIV through random mutations of its standing genetic variation, making hybridization a lifeline for species to acquire such adaptations. Hybridization also conferred intermediate levels of immunity to a flatworm infection and a bacterial infection in Atlantic salmon that did not previously show any immunity to these infections (Klemme et al., 2021). Hence, increased disease transmission and habitat degradation can have exceedingly more rapid impacts on wild populations than their current standing genetic variation can account for through beneficial random mutations. This is especially true for threatened and fragmented populations in which standing genetic variation is very low. By facilitating the hybridization of subpopulations and even closely related species, managers can help species adapt to these conditions more efficiently by speeding up the evolutionary process and rescuing declining populations of species that are vital to ecosystem function.

Possible Management Obstacles

Even if hybridization efforts become mainstream in conservation management, legal challenges stand in the way of their implementation, particularly in cases of interspecific hybridization. Both in North America and internationally, many of the major legal protections for threatened and endangered species were created at a time when the prevailing theories viewed hybridization as a threat to the survival of native populations (Draper et al., 2021). As a result, hybridization is either explicitly part of criteria that prohibit conservation programs from obtaining further funding for the conservation of a species or ignored entirely in legislation. For example, the International Union for Conservation of Nature Red List, which determines the demographic status of many species across the world, describes a species as extinct if all individuals of the species are hybrids with other species (Garnett et al., 2011). In addition, important North American conservation policies such as the Endangered Species Act make no mention of hybridized species, as policymakers claim that their conservation would undermine the populations of the two original parent species (Chan et al., 2019).

Current conservation policies displaying these types of biases toward species-centric management may overlook the importance of ecosystem function and resilience to variations in environmental conditions from climate change. If resources are focused on the conservation of individual species that have decreased fitness in this new environmental regime, conservation initiatives will be less effective than if the same number of resources were focused on hybrids that have increased adaptive potential from introgression. By acknowledging adaptively successful hybrids in conservation management initiatives, conservationists can encourage a shift in the legal motivation towards sustaining species populations in a way that best supports the health of their respective ecosystems, responding to the pressures of climate change on ecosystems around the world more accurately.

Conclusions and Future Steps

While outbreeding depression remains a concern for hybridized populations, recent reintroduction projects and genetic studies of evolutionary history suggest that populations can be successfully genetically rescued from extinction after hybridizing with closely related species or individuals from different geographic subpopulations. Hybridization can become the only viable option for populations to adapt quickly enough to changing environmental pressures as shown by the Scottish wildcat and Scandanavian gray wolf examples presented in this paper, signifying its importance as a conservation strategy to increase survival in severely threatened populations (Å˚ kesson et al., 2016; Howard-McCombe et al., 2023). In addition, legal statutes regarding the protection of threatened species should be altered to accommodate for the continued conservation of target species while their populations recover, even if they are hybridized (Chan et al., 2019; Draper et al., 2021).

Future research is needed regarding the level of genetic similarity required for successful hybridization both within and between species of conservation concern, the long-term consequences of outbreeding depression in reintroduction projects, and which species should be prioritized for these projects, as they require a significant number of resources to implement (Edmands, 2007; Zecherle et al., 2021). With targets identified, hybridization can serve as a beacon of hope for threatened species, especially in ecosystems where rapid adaptations to climate change and anthropogenic degradation are required for long-term survival.

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Brianna Yi

Animal Science • Class of 2025

Brianna Yi is a senior majoring in Animal Science, and she aspires to become a veterinary surgeon. Her passion for animal welfare grew while working as a Professorial Assistant for Dr. Jacquelyn Jacobs, where she contributed to research on shelter dog behavior. This experience, coupled with her interests in genetics, inspired Brianna to write literature reviews on canine and feline genetic diseases. Through her work, she aims to raise awareness of these conditions and promote responsible pet ownership and thoughtful consideration when choosing specific breeds.

Feline Polycystic Kidney Disease in the Domestic Cat

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Abstract

Polycystic kidney disease (PKD) is a hereditary condition that affects a variety of mammals, including humans and felines. Feline polycystic kidney disease (FPKD) has become one of the most common feline genetic diseases, with higher rates of diagnoses being seen among certain breeds, such as the Persian cat. The significant sign of this disease is the formation and growth of fluid-filled cysts on the kidney and can include other organs, such as the liver or pancreas. Without awareness and rigorous tracking of genetic carriers, cats will continue to be born with and succumb to FPKD, eventually resulting in kidney failure. Additionally, cats with FPKD are theorized to be ideal models for human PKD. Therefore, by understanding the feline condition, it is hoped that human PKD research can also progress (Lyons, L., et al. 2004.). There is currently no cure for this disease; however, dietary and lifestyle changes are used to increase quality of life and comfort. Understanding this disease and its mechanisms is crucial to decreasing the number of affected felines (Schirrer, L., et al. 2021.).

Introduction

Feline polycystic kidney disease (FPKD) is a genetic disorder characterized by the development and progressive growth of cysts on the kidneys. These cysts eventually lead to renal dysfunction and kidney failure. This condition is most commonly seen in Persian cats, making it a significant concern for breeders and owners especially due to the autosomal dominance. To manage the disease and improve quality of life, early detection is crucial. This paper explores the genetic causes, progression, diagnosis, and management of FPKD, as well as its implications on cat breeding.

Genetic Causes

The cause of feline polycystic kidney disease has been linked to the autosomal dominant transmission of a mutated PKD1 gene (Lyons, L., et al. 2004.). The normal PKD1 gene encodes protein polycystin-1, which covers the membrane of the kidney and aids in molecular interactions with proteins, fats, and other cellular components. Mutated PKD1 originates from insertions or deletions of base pairs, resulting in incomplete and nonfunctional polycystin-1. The cyst-causing mechanisms of the mutation are currently unknown. However, the prevalent hypothesis is that nonfunctional polycystin-1 disrupts normal cellular signaling. Disrupted signals subsequently cause abnormal growth and division of renal tubule cells, creating cysts on the kidney's membrane surface (National Library of Medicine, n.d.).

The autosomal dominant nature of this mutation means that only one copy of the defective gene is needed for the manifestation of PKD. A kitten born from a litter with a copy of mutated

PKD1 is guaranteed to be diagnosed with polycystic kidney disease in the future due to FPKD's complete penetrance (Schirrer, L., et al. 2021.). Because of its dominance, specific breeds such as Persians and Exotic Shorthairs have higher prevalence of polycystic kidney disease due to the frequency of mutated PKD1 within these populations as a result of breeding practices. In a French study, 41.8% of Persians and 39.1% of Exotic Shorthairs carried mutated PKD1 (Barthez, P., Begon, P. 2003.).

Progression of Feline PKD

Feline polycystic disease is a progressive condition. At birth, affected kittens may already display cysts on their kidney but appear to be asymptomatic. Cases differ, however, and a confirmed diagnosis can be given as early as 6 months of age. Most clinical signs and symptoms of FPKD are recognized in adulthood at around 7 years old (Cornell Feline Health Center. n.d.). This is a challenge of FPKD, as late diagnosis reduces available treatment options. As the cat ages, the cysts on the kidney begin to grow and disturb normal biological functions due to healthy tissue being replaced by cystic growth. Signs are synonymous to normal kidney disease; specifically, an increase in thirst and urination, loss of appetite, weight loss, vomiting, and lethargy are common indicators of decreased kidney function. During a physical exam, the veterinarian may also be able to see the kidney's outline while the cat is lying on its back (Cornell Feline Health Center. n.d.).

Unfortunately, most symptoms appear when the kidney has already suffered severe damage. Approximately 60-70% of kidney function is lost by the time FPKD is diagnosed in a cat (Barthez, P., Begon, P. 2003.). In the final stages of PKD, the cysts continue to grow and renal failure – as well as uremia – are inevitable. Chronic kidney disease (CKD) is often diagnosed alongside the final stages of PKD. Severe CKD is characterized by mouth ulcers, poor fur, bad breath, and lethargy (Weir, M., et al. n.d.).

Methods of Diagnosis

Testing for FPKD can be done through ultrasound or genetic testing. Genetic testing is conducted with either blood or saliva samples to identify mutated PKD1 in the genome. When tested against the definitive diagnostic method of ultrasounds, genetic testing showed accurate and similar results. Undergoing genetic screening for a cat may also reveal the cat as a carrier of mutated FPKD (Bonazzi, M., et al. 2008.). Kittens that have not yet been weaned are tested through a blood sample as the milk of the queen can give inaccurate results in a saliva test. Genetic screening is highly recommended for cats prone to FPKD, such as Persians (International Cat Care. 2018.). However, genetic testing still remains as a work in progress, and is a costly and novel technology in many veterinary clinics (Lyons, L. 2010.).

An ultrasound is an alternative diagnostic test for cats who have not undergone genetic screening to search for the presence of kidney cysts before more severe clinical signs appear. It is also used to definitively diagnose FPKD. Specifically, B-mode ultrasonography yields high quality images of kidney size and shape, as well as the size of the cysts present on the kidney's surface. Cysts at least 2 mm in size can be detected through this method (Debruyn, K., et al. 2012.). Ultrasound also serves as a reliable method of tracking cyst growth and formation after a FPKD diagnosis.

Management and Prevention

FPKD currently remains as an incurable condition. However, proper management can preserve kidney function and provide as much comfort as possible for the affected cat. One such

management strategy is dietary changes. Veterinarians recommend a low protein and phosphorus diet since it reduces the load the kidney must undertake to process the nutrients in food. Diets such as these minimize the kidney's waste production, ultimately increasing longevity. High blood pressure may also result from decreased kidney function, so it may be necessary for a cat to be prescribed blood pressure medications (Quimby, M. 2015.). Fluid therapies are also effective in the management of FPKD (Cornell Feline Health Center. n.d.). Additional fluids aid in preventing dehydration, especially if chronic kidney disease is diagnosed in addition to FPKD. Subcutaneous fluids may also improve the cat's appetite and minimize constipation (Polzin, D. 2013.).

Prevention heavily relies on breeders genetically testing their cats for the PKD1 mutation if the cat breed is susceptible to FPKD. As the PKD1 mutation is autosomal dominant, cats should be tested before being considered for breeding purposes. This ensures that the PKD1 mutation will not be passed down over generations with the goal of eventually drastically decreasing the number of PKD1 cats in the general population (Cornell Feline Health Center. n.d.).

Conclusion

Feline polycystic disease is an incurable, progressive disease that results from the dominant genetic mutation of the PKD1 gene. Certain breeds are more susceptible than others, such as Persians. Testing a susceptible cat early through a genetic test is highly recommended so that management of the disease can begin as soon as possible. Additionally, it is crucial that breeders genetically test their cats prior to breeding to prevent litters that carry the mutation. Despite the disease not having a cure, being aware of early signs and following a variety of management strategies can aid in providing an FPKD cat with comfort and aid in extending its lifespan.

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Through the lens

The cover image showcases a mushroom, captured in a focus-stacked macro photograph. Spotted along the path to Michigan State University's main library, the mushroom would not stay upright, making it difficult to photograph in its natural orientation. To achieve a clear and stable composition, we carefully positioned it upside down and later mirrored the image in post-processing. This composition was a collaborative effort, with Nityaansh and Khadija, fellow members of SPARC, assisting in arranging the scene.

The background features a gradient of green hues, subtly evoking the colors associated with the MSU Spartans. Mushrooms have long fascinated scientists and storytellers alike, emerging overnight in unexpected places and forming vast underground networks that sustain ecosystems. As a journal cover, the mushroom symbolizes nature's hidden complexity and the deeper connections that drive discovery.

- Fatih Imamoglu

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-Team SPARC

Top Row: Dora Lei, Nityaansh Parekh, Braq Abdulmajeed, Fatih Görkem Imamoğlu, Lowell Monis, Khadija Bilaspurwala, Eva Guanlao

Bottom Row: Katherine Sundeen, Om Nair, Veona Cutinho, Nick Feys, Jaini Gandhi (Not pictured: Sasha Palmkoeck)

Photo by Fatih Imamoglu