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The CROW

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The CROW

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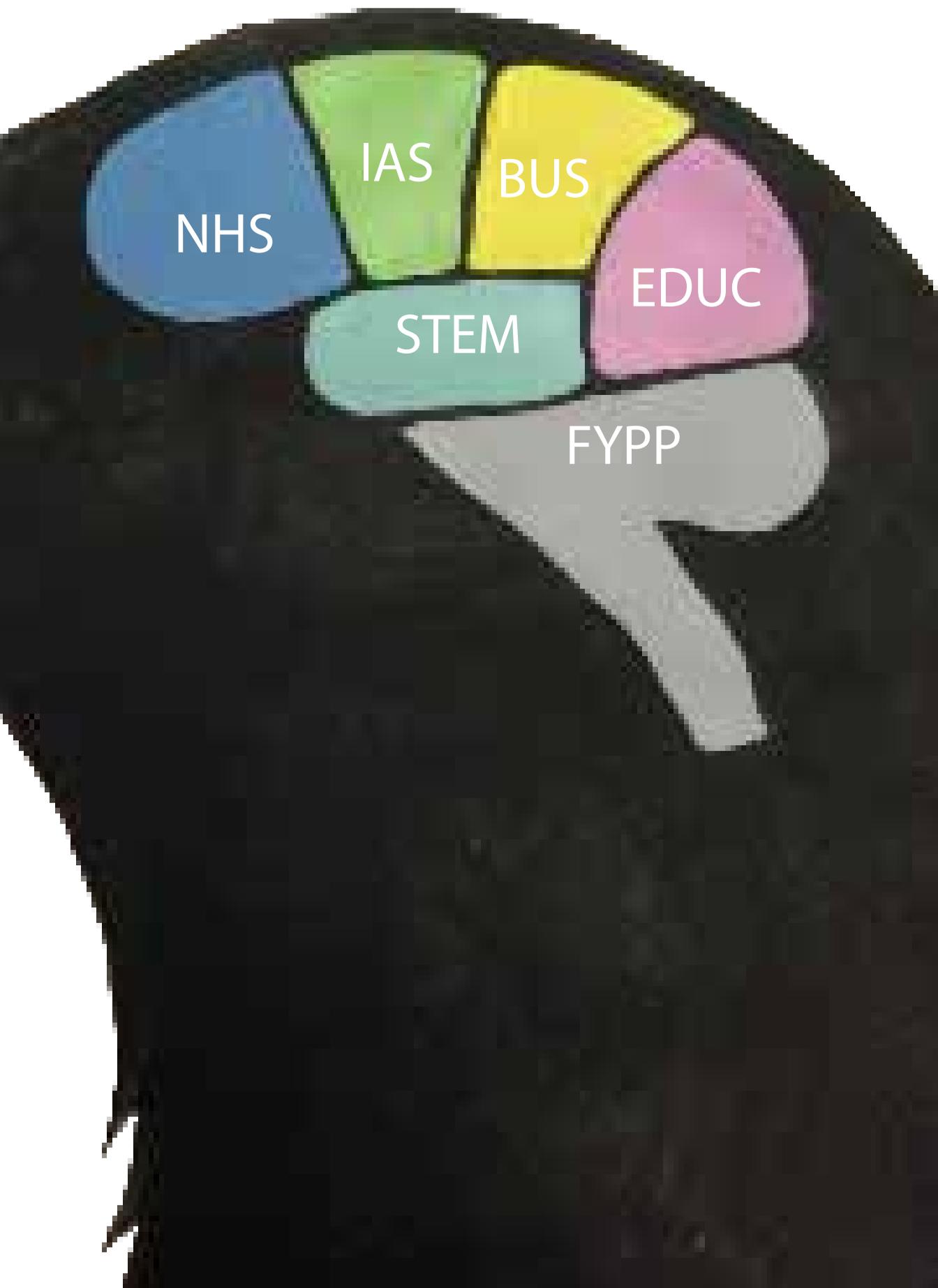
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LETTER FROM THE EDITORS

The CROW at the University of Washington Bothell provides students with a platform to showcase research investigations they have conducted, analyzed, and synthesized on their own. As a reader, you will discover a myriad of topics ranging from Science and Technology to the Interdisciplinary Arts and a few in between. The multiple submission types and various writing styles featured in the Campus Research and Observational Writings should spark any reader's interest. Beginning in this year's publication *The CROW* features a new submission type, Researched Argumentative Essays. This submission type has been a wonderful addition to the journal and has allowed for new ideas and aspects of research writing to be included. The act of conducting research is proven to be highly impactful to learning practices that engage students outside of the classroom setting and allow them to think more critically about the topics they wish to discover. Having their work published will forever encapsulate and preserve their work while also transforming it into a powerful tool which may be used by the next academics who seek new ideas. By taking this monumental and often daunting step of subjecting their work to be reviewed and critiqued by their peers, the authors featured in this journal have progressed towards becoming contributors to the academic discourse of their particular field of study. The Editorial Board was overjoyed and worked tirelessly in reviewing all the incredible submissions this year. The selection process was undertaken with extreme thoughtfulness, sensitivity, and recognition of the hard work each of the students put into their papers. We want to praise all the students for the hard work they put into their research and everyone who submitted their work for review. We also want to thank the faculty and staff mentors who foster students' passions and talents, while working with them to become published researchers.



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THE LEGACY OF COLONIALISM

Molly Herbert

ABSTRACT:

In pre-colonial India, the legal system was defined by two characteristics: legal pluralism and a customary nature of governance. After becoming subject to British rule in 1858, India's legal development became inextricably linked to England's, with ramifications lasting to the present day. This new Anglo-Hindu legal system wholly dismantled India's pre-existing laws, replacing them with a homogenized system based primarily on western ideology. This essay examines the development and reformation of laws regarding women's rights from pre-colonial to present day India, focusing primarily on eighteenth to twentieth century British rule. Specifically this paper focuses on the evolution of three areas of laws in India, all arising under nineteenth century colonialism and with marked similarities to reforms in English law: the first area concerns changes to laws regarding questions of agency, including age of consent and marital duties; the second concerns crimes of sexual violence and corresponding punishments; and the third regards changes to laws regulating the sex trade and prostitution. Additionally, this paper traces these reforms historically, referencing cases of historical value and modern court decisions which cite those cases.

Next, this essay examines the actors involved in the development of the Indian legal system under British rule; the British administrators and elite Indian men who played the most direct role in the country's development, the Indian women whose rights were dictated and constrained within these laws, and the British feminists whose limited understandings of the struggles faced by Indian women often undermined meaningful social progress. In a discussion of these areas of law and related changes to Indian society, I explore the ways in which the British administration, over the course of their nearly four-century involvement, operated under the guise of moral enlightenment and protection of women to consolidate their power. These findings cast doubt on the assertion that reforms to women's rights during this period were primarily enacted to protect Indian women from misogynistic practices. While some outcomes of India's colonial legal reform benefited women, more often it simply codified pre-existing patriarchal practices or introduced new ones all together.

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HOW CONCUSSION FREQUENCY IS GREATER IN COLLEGIATE ATHLETES THAN ADOLESCENT ATHLETES

Atif Mahmood Bhatti

ABSTRACT: Multiple studies have examined concussion frequency in athletes of all levels of play. Younger athletes are not immune to suffering this head injury that can have detrimental effects on how the brain functions. Numerous athletes in the age group of 13-23 year olds suffer extreme situations such as paralysis or even death after sustaining a concussion while playing a sport (Golomb, Grayson, Kralik, McLendon, 2016). Some studies have demonstrated that the prevalence of concussions is greater in youth athletes, whereas other studies seem to indicate that concussions are more persistent in collegiate and professional athletes. The aim of this study was to analyze previously published data on athletes ranging from the high school to the collegiate level and determine if concussion occurrence was greater in collegiate athletes than in adolescent athletes, or any athlete between 13-18 years of age. Based on my analysis, the concussion abundance in the tested adolescent athletes was 3.7% and the occurrence in the collegiate athletes was over twice as much at about 7.5%. This data demonstrates that concussion frequency in collegiate athletes is indeed greater than the adolescent athletes' frequency. Information such as this can open possibilities to having more intense research on concussion frequency in collegiate athletes as well as improving the concussion protocol that is already in place.

KEYWORDS: Concussion, frequency, adolescent, collegiate

Introduction

Concussions, which are blows to the head that cause brain-altering injuries, have become an increasingly topical issue in today's society. Although concussions can occur to anybody, the profile of this serious brain injury has risen primarily in the world of sports and an absolute solution has not been discovered. In this literature review, the difference in concussion frequencies between differently aged athletes was examined. It is critical to further develop an understanding of concussions because the issue is becoming more of a presence in adolescent and collegiate athletes. In fact, a 60% increase in concussion occurrence was noted from the years 2007 to 2014 in athletes ranging from 10 to 19 years of age. (Feeley, Rugg, Senter, Sing, Zhang, 2016).

Multiple studies that examine concussion

frequencies in high school and college athletes have been done. According to one study in which over 8,000 athletes from high school and collegiate levels participated, nearly 400 of the athletes received a concussion while playing a sport (Marshall et al. 2015). However, this particular study did not compare and contrast any potential differences in concussion frequencies between the adolescent and collegiate players that were examined and studied. To address this issue, the data collected from my research will focus on four different studies from within the last two years to examine differences in concussion frequencies between adolescent and collegiate athletes.

Methods

To determine how concussion frequencies vary amongst adolescent and college athletes,

I searched key word combinations such as “concussion AND adolescent” and “concussion AND collegiate” on a database called PubMed. These specific key word combinations were used in the hopes that the database would provide the most pertinent information regarding concussion occurrence in both adolescent athletes and collegiate athletes. After receiving excessive results, filters were applied to only feature any work or projects that were done within the last decade. Doing this provided the most up-to-date information about concussions in sports while keeping the focus primarily on college and adolescent athletes. The results that were assessed and kept had ideal sample sizes of athletes, as well as a range of both female and male athletes in various sports. The minimum requirement in terms of sample size was 1,000 athletes. Also, research that included tables, graphs, or any other sort of figures in the writing was favored because those tools already had the information presented in numerical and clear ways.

Results

The results for concussion frequency came out to be 3.7% for the adolescent athletes and 7.5% for the collegiate athletes (See Table 1 and Graph 1). Although the difference in concussion frequency between the two groups was noticeable, it is important to note the differences in the sample sizes of both concussions and number of athletes. The adolescent group featured more athletes in the studies but fewer concussions were reported. Conversely, the collegiate group had a smaller sample size of

athletes to work with, but a greater frequency of concussions was present. Ultimately, this data demonstrated that concussions are more common in collegiate athletes than adolescent athletes.

Discussion

Analyzing the Data

Data was extracted from the four studies featured in Table 1 and Figure 1. Dompier et al. (2015) and Reeser et al.(2015) both directly compared adolescent concussion occurrence to collegiate concussion occurrence, while Currie et al. (2016) and Zuckerman et al. (2015) each focused their attention on adolescent and collegiate athletes respectively. For the purposes of this particular analysis of the data, athletes were only separated based on whether they were an adolescent or collegiate athlete, not based on their sport or gender. Also, no more than one concussion was counted for one athlete, meaning that multiple concussions per the same athlete would not count as different occurrences. For each of the four studies, the number of adolescent athletes and adolescent concussions were calculated and the same was done for the collegiate athletes. After this, the totals for number of concussions and athletes for both the adolescent and collegiate categories were combined, the percentage for each group was calculated, and the two values were compared with each other to see which one was greater.

Table 1. Calculated percentages of each source’s statistics for adolescent and college concussion-to-number-of-athlete ratio and calculated percentages of each age group’s total number of concussions and athletes based on the information the sources provided.

Source	# of Concussions (Adolescent)	# of Athletes (Adolescent)	Frequency % (Adolescent)	# of Concussions (Collegiate)	# of Athletes (Collegiate)	Frequency % (Collegiate)
Dompier et al. (2015)	412	16,049	2.6%	111	4,305	2.6%
Reeser et al. (2015)	23	1,574	1.5%	25	2,490	1.0%
Currie et al. (2016)	245	777	31.5%	No Data	No Data	No Data
Zuckerman et al. (2015)	No Data	No Data	No Data	888	6,932	12.8%
Total for athlete # and concussion #	680	18,400	3.7%	1024	13,727	7.5%

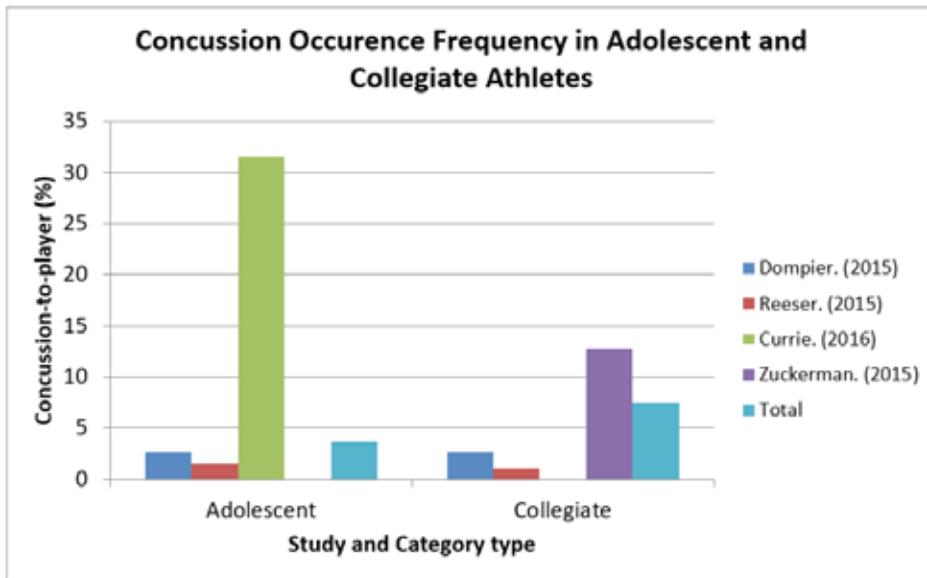


Figure 1. Calculated percentages of each source's statistics for adolescent and collegiate concussion-to-number-of-athlete ratio and calculated percentages of each age group's total number of concussions and athletes.

Limitations of the Study

In terms of the analysis done in this study of the concussion frequency differences in the adolescent and collegiate athletes, there were some limitations. For instance, there were 5,000 more adolescent athletes than collegiate athletes featured. The results of this study may have been more indicative of the differences in concussion frequency between the two age groups if the sample sizes were more similar to each other. Another example of a limitation is the fact that age was the only distinguishing factor between the athletes; gender and sport was disregarded in my analysis.

The Research Field's Future Direction

In such a relatively new research field such as this particular one on concussions, the emphasis has been placed on the understanding of concussions and potential prevention methods. Helmets are viewed as equipment that can help in concussion prevention, particularly for younger athletes who play contact sports such as football and hockey. For instance, one study tested 35 different helmet models and gave them ratings based on their performance over multiple impact tests (Allen, 2016). Some

particular helmets performed sufficiently for most of the time, while others were adequate sometimes. The issue here is that these results do not definitively demonstrate that any particular helmet will always protect the athlete completely and constantly.

When studying concussions in younger athletes in the future, researchers should look very closely at whether or not athletes of a certain sport are more prone to concussions, or if gender has any correlation with concussion frequency. Future studies should have identical or near-identical sample sizes when comparing two different groups to each other. Additionally, the literature review conducted in this paper only focused on the difference in whether the athletes were adolescent or collegiate. Seeing these two groups be further broken down based on the sport type or gender of the athletes could tell a lot about which factor is a bigger contributor to concussion frequency over another factor. Having a better understanding of the differences in concussion frequency between different groups of athletes may identify the pathway to solving this concussion epidemic in the future.

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EXTREME ADAPTATIONS IN CETACEANS: DEEP DIVING BEHAVIOR AND PHYSIOLOGY

Allison Thomas, Alexander Richards, Clinton Foriska, Ryan Mayer

Author Note

Literature reviews are a tool used by the scientific community to gather and present current information on a particular topic of interest. The goal of this project was to provide well supported information from professional sources in the field of Cetology. All scientific claims and experimental information contained within this document were derived from outside sources. Various resources, to include the university library and research databases, were used to gather reference material cited within this document. As members of the scientific community, we hope that this information can be used to educate others and further demystify the behavior and physiology of deep diving mammals.

ABSTRACT: The term cetacean refers to a unique group of oxygen breathing aquatic mammals, more commonly these species are known as porpoises, whales and dolphins. Around 88 species are classified within this category. The evolutionary history accepted by the general scientific community suggests that cetaceans may have evolved from quadruped type land animals that lived millions of years in the past. Most modern cetaceans exhibit similar physiological traits between species. Examples of this include: modified nostrils (blowholes), slender bodies, smooth skin and extensive thermal insulation. Of these characteristics, one of the most crucial to aquatic survival is an effective respiratory system. Since cetaceans all intake oxygen directly from the air, they must resurface to expel carbon dioxide and intake oxygen to fuel metabolism. Naturally speaking, the more effectively cetaceans can hold their breath, the better chance they have of evading predators and searching for food. As such, extreme adaptations like deep diving behavior have allowed consecutive generations of these creatures to feed and reproduce exceptionally well. It is important to note that the term “deep diving” does not necessarily represent physical depth but rather time spent below surface. This extreme adaptation is not singular and works through the regulation of many different bodily processes. Some examples of these include: Elastic arteries, respiratory physiology, gas regulation, myoglobin, blood circulation, and metabolism.

Keywords: cetacean, whale, adaptation, deep-diving, ecology, behavior, physiology

Deep diving Cetaceans are found in almost all non-landlocked aquatic regions throughout the world (IWC, 2016). A majority of deep diving species live in waters of the Pacific and Atlantic Oceans. The deepest diving cetacean is known as Cuvier’s beaked whale (*Ziphius cavirostris*). Coastal species such as the killer whale (*Orcinus orca*) typically prefer shallower regions of the arctic. Some species translocate to many different ecological regions, like the Blue Whale (*Balaenoptera musculus*)

and Humpback whale (*Megaptera novaeangliae*) which make seasonal migrations to breed. Remaining subsurface, migrating, rearing young, and feeding produce a serious challenge for cetaceans. An exceptional amount of energy is expended to sustain deep diving behavior. Cetaceans are among the largest known mammals on earth, and require a substantial amount of food and space in order to live.

Reproductive Strategies

Deep diving cetaceans are isoporous, meaning they can give birth several times during their lives but often with single calves. In order to better understand how different organisms reproduce, ecologists have developed classifications known as selection strategies. Almost all mammals, including humans and cetaceans, follow K type selection strategy (Cain et. Al, 2014). This strategy is often referred to as “opportunistic” strategy. Under this classification, organisms typically have very few offspring. This allows the majority of nutrients and protection to be applied to a single calf. Opportunistic strategy usually results in a high chance of offspring surviving to maturity. For cetaceans, a gestation or pregnancy period is typically around a year.

Many deep diving cetaceans travel in migratory pods. Which mean that whales contribute and interact with several ecological communities stretching over thousands of miles (Braithwaite et. Al, 2015). One of the most notable examples of this is the Humpback whale. During winter months Humpback whales travel thousands of miles south to the Hawaiian Islands in order to give birth. In the summer months, they travel with their newborns north to the more frigid waters near Alaska. The total trip is over 6000 miles long, the longest of any migratory mammal. There are many theories why whales make the grueling trip year-round. Marine scientists hypothesize that food abundance and climate are the main factors. More recently, evidence suggests that this is a risk assessment by the species to avoid calf predation by killer whales (Corkeron & Connor, 1999).

Ecological Role

Cetaceans are involved in a wide variety of ecological interactions including predator prey relationships, migration behavior, nutrient distribution, and symbiotic facilitation. Whales in particular are often referred to as “ecosystem engineers” due to their significant impact on

aquatic communities (Roman, 2014). Sediment upheaval from the ocean floor is incredibly beneficial to underwater communities, especially bottom feeding organisms and foragers.

Whale excrement, otherwise known as fecal plumes, help to redistribute nutrients over huge areas and several oceanic communities. Many different organisms, including phytoplankton and oceanic bacteria, utilize these delivery systems to gather much needed nutrients (Roman, 2014) .

Another ecological role whales serve occurs after death is when a carcass falls to the seafloor, referred to as a “whale fall”. Whale falls provide massive inputs of organic matter into the seafloor biome, providing enough food energy for detritivores to last for decades (Smith, & Baco, 2003). According to Smith and Baco, whale falls are relatively common on the seafloor, potentially acting as food stepping stones for isolated deep sea communities that occur in areas such as hydrothermal vents.

Behavioral Ecology and Adaptive Evolution

Deep diving itself is a behavioral adaptation to find food in areas of the water column that are otherwise inaccessible to other oxygen breathing mammals (Cain et al., 2014). Accessing new depths allowed for a new niche to be utilized by marine mammals. Cetacean communities are made up of “pods” that can include many individual whales and offspring. Aside from local migrations from the surface to the deeper feeding columns, many species of whale utilize long distance migration from feeding grounds to calving grounds (Braithwaite et al., 2015). Migration is a very interesting adaptation because of how dangerous long distance travel through the open ocean is for any organism. There is a very distinct cost and benefit that affects cetaceans ability to feed, reproduce, and survive. Whales migrate to find food-rich areas of ocean in the lower latitudes during summer months, and to rear calves in tropical waters that are safer

during the winter months when food is scarcer. (Kennedy et al., 2013). Whales need to build up substantial fat to last through the winter calving period. Natural selection is causing adaptive evolution in whales by favoring individuals that are successful at feeding and rearing calves.

Symbiotic Influence

Deep diving whales such as the Humpback Whale (*Megaptera novaeangliae*) are subject to commensalism type interactions in the form of barnacles (*Coronulidae*) on their outer skin. The whales essentially provide a mobile buffet for barnacle species to feed. This also greatly increases the breeding range of the hitchhiking marine life. Whale carcasses, or “whale falls” also provide a food source for an abundance of marine life (Fujiwara et al., 2010). Observations have shown that this food source has a huge impact on the organisms that scour the ocean floor. Once settled to the bottom and colonized, the whale carcass can support communities for years at a time.

Predator/Prey Relationships

Cetacean whales can be separated into two distinct categories: toothed whales and baleen whales. Baleen whales eat small krill sized prey by the thousands by gulping large amounts of water then slowly filtering the water out through the baleen plates. Toothed whales are usually faster hunters as their prey is much larger and quicker than that of baleen whales. Toothed whale prey includes; squid, fish, sharks, seals and even other whales. Diets range by species distribution and seasonal abundance. Cetaceans greatly vary in size, with the largest being the Blue whale (*Balaenoptera musculus*) known for reaching over 200+ tons (WWF, n.d.). These species require a huge amount of nutrition to dive, travel, and raise young. Some estimates include over one ton of food (2000lbs) is ingested per day. Deep diving species like the sperm whales feed exclusively at specific depths and

are considered a top predator and one of the few species able to effectively consume large squid.

Adaptation Summary

Cetaceans have lived exclusively in the water for over 53 million years. After the transition from terrestrial to aquatic life, whales went through a series of adaptations that distinguish themselves among deep-sea diversity: (1) Distal airways that are reinforced by cartilage allows for the movement of oxygen from the alveoli to the bronchi during lung compression. (2) The ability to completely collapse the lung prevents the uptake of nitrogen into their bloodstream, preventing decompression sickness. (3) Adaptive changes in the cardiovascular systems in response to hypoxic conditions known as dramatic bradycardia, which is the lowering of the heart rate. To achieve normal function at great depths, blood flow is reduced by selectively constricting blood flow to non-essential areas such as the skin, muscle and gastrointestinal system. Blood flow is instead redirected to the central nervous system and the heart by a process called selective peripheral vasoconstriction. (4) High concentrations of hemoglobin and hematocrit in cetaceans' circulatory system allow for increased oxygen storage for extended dive duration. (5) Elastic arteries regulate circulatory pressure at extreme depths. (6) The ability to withstand high concentrations of myoglobin allows cetaceans to dive to extreme depths. (7) Unique muscle characteristics provide additional ATP production for optimum locomotion. (8) Behavioral tendencies drive adaptive evolution in whales for food foraging and reproductive success.

Reinforced Airways

Diving to extreme depths can distort distal airways and cause tissue compression. The lungs of some cetaceans are capable of completely collapsing to avoid compression damage. However, the distal airways are reinforced by cartilage to allow for the movement of oxygen from the alveoli to the bronchi during lung compression.

sion (Bostrom et al., 2008). Without this reinforcement, compression would constrict blood flow within the alveoli and also prevent airflow from leaving the alveoli during dives.

Alveolar Collapse

The role of the lungs are to take the oxygen from the air and transfer it to the red blood cells. Once the oxygen is carried through the bloodstream oxygen is exchanged for CO₂ And the lungs aid in removing the CO₂ waste by exhalation. Different cetaceans use different strategies to manage gas exchange. For example, bottlenose dolphins can take a quick single breath of air and dive to depths of 100m without collapsing their lungs. On the other hand, larger cetaceans such as sperm whales, remain on the surface for longer periods of time and ventilate several times to replenish oxygen storage (Piscitelli, 2010). Once the sperm whale's oxygen levels are replenished, they completely collapse their lungs before submerging. The ability to completely collapse the lung prevents the uptake of nitrogen into their bloodstream. This adaptation prevents decompression sickness when the sperm whale resurfaces from extreme depths. Since deep divers do not rely on their lungs for oxygen storage, oxygen is stored in the muscle and blood.

Cardiovascular System

The ability to keep supplying oxygen to muscles is crucial for subsurface traveling. Cetaceans are unique in the fact that they can store large amounts of oxygen in their circulatory system, upwards of ~75%. In comparison humans are limited to only about ~35% oxygen storage (Bostrom et al., 2008). Cetaceans have uniquely adapted to hypoxic conditions by balancing cardiac responses during underwater exercise.(Williams et al. 2015) found that bradycardia and tachycardia were inversely correlated with depth and exercise. The study found that the heart rate of deep-drivers decreased with increased depth and locomotion switches from actively swimming to a slower glide-like

movement. Oppositely, heart rate and locomotion increased as depth decreased. The behavioral response is not completely understood, however, blood flow is reduced by selectively constricting blood flow to non-essential areas such as the skin, muscle, and gastrointestinal systems. Blood flow is instead redirected to the central nervous system and the heart by a process called selective peripheral vasoconstriction (Williams et al., 2015). This adaptation allows for extended dive times at minimal metabolic cost.

Elastic Arteries

Deep diving cetaceans such as seals and pinnipeds have developed what's known as elastic arteries or aortic ballooning. In Mammalia, the aorta acts by supplying oxygen to the rest of the circulatory system. The seal aortas are unique in the fact that they are extremely flexible but also more rigid to contend with pressure fluctuations (Joyce, 2016). This means the circulatory pressure can be regulated at extreme depths and continue to fuel the muscles and organs with oxygen.

Metabolism

Cetaceans have large energetic requirements that are essential for success in their ecosystem. However, when they are deep diving their energy expenditures must decrease. One adaptation that aids in this process is by having a lower metabolic rate, which will then lower the rate of using the stored oxygen (Roos, 2016). To survive during deep dives and for long periods of time, metabolism is decreased so that oxygen consumption needs are also decreased. This adaptation allows for deep divers to be more efficient with their oxygen-rich blood which is then shunted to vital organs by way of selective peripheral vasoconstriction (iron and oxygen binding protein in the muscle tissues of vertebrates.)

Myoglobin

The single evolution of the protein myoglobin (Mb) has given cetaceans a major adaptation for

the ability to swim at such deep depths. Because of this the large sperm whales can dive for about an hour at one kilometer deep. Increasing in the length of dive requires 10-20 times higher Mb concentration, which is mostly found in their skeletal muscles. About half of the whale's oxygen levels are also found in their skeletal muscles. Holm et al. (2015) found a direct relationship between Mb concentrations and oxygen storage. High concentrations of myoglobin found in humans result in the clumping of the myoglobin, which leads to illnesses such as Alzheimer's and diabetes. Whales on the other hand adapted to surviving with exceedingly high concentrations of myoglobin and use it to maximize their oxygen carrying capacity. Researchers (Mirceta et al, 2013) found that the myoglobin in whales are positively charged. The positively charged myoglobin molecules repel each other and do not stick and clump together. Thus, creating an environment within the cells of muscle tissue that are adaptable tolerant to support high concentrations of myoglobin, which allows for extended dive duration under hypoxic conditions.

Muscle Characteristics/ Muscle Type Trade-offs

There is a vast amount of different muscle adaptations for deep diving whales, due to the sheer complexity and number of muscle systems a single organism may possess. This number is then multiplied by the number of different species possessing muscle adaptations based on factors such as depth of dive and dive time. One of the ways scientists are comparing the various adaptations is by comparing the fiber-type composition of muscles. (Sierra, 2015.) Type I fibers are slow type fibers that have high potential for ATP production in aerobic (high oxygen) environments. Type II fibers are fast twitch and have high potential for ATP production in anaerobic (low oxygen) environments. Skeletal muscles of whales are composed of both types, yet the ratio of fiber type present fluctuates based on whether the species is a deep-diving or shallow-diving

whale. Deep-divers have higher ratios of type II fibers to be able to effectively produce energy in low oxygen environments.

The ratio of muscle fibers serves as a good example of a trade-off in locomotor performance. Orcas are quick hunters and have more Type I fibers for sustained endurance (high oxygen) locomotion in chasing prey. They have less ability to conserve their blood oxygen for long duration deep dives because of the ratio of muscle type fibers favors Type I, which have high ATP yield in aerobic environments. (Sierra, 2015)

Species Conservation and Human Impact

The history of humans hunting marine mammals can be traced all the way back to ~2,000 BCE (Society, N. G. 2012). Whale meat, seals, and other pinnipeds have been a staple diet of worldwide indigenous tribes for thousands of years. In the past few centuries, the demand for oil derived from harvested whales has pushed many species toward endangerment. Sperm whales were exclusively hunted for the waxy substance, spermaceti, for which the species is named. Spermaceti is found in the upper part of the mammal's head above the nasal cavity. Prior to electricity, spermaceti oil was commonly burned for heat and light. In the mid part of the 20th century whale populations had been reduced to near unsustainable levels by the fishing industry.

Overfishing and climate change have been a long-standing threat to the deep diving community. Whales are often targeted for human consumption and harvested for food and blubber. Although, this is not as common in the 21st century due to federal protection.

The Marine Mammal Protection Act (MMPA) of 1972 banned the hunting of marine mammals in U.S. waters, closely followed by the U.S. Endangered Species Act of 1973 (ESA). Since the passing of legislation over 45 years ago, population rates have slowly increased. Modern impacts on whale populations can be attributed

to increased oceanic traffic. International shipping and commercial whale watching continue to threat migration patterns and breeding behaviors of deep diving species (Blair et al., 2016). The application of audio tracking buoys and Unmanned Aerial Systems (UAS) technology has been a critical asset to cetacean preservation (Nowacek et al., 2016). The UAS provides less costly research approaches and allows for larger conservation coverage. These techniques allow scientists to observe whales without endangering themselves in often hazardous ocean conditions, while simultaneously reducing the invasiveness of research by reducing boat motor sound and boat/whale collision risk. As new research techniques continue to emerge, the future of cetacean preservation looks promising.

Although, deep diving populations seem to be on the rise. according to statistics by the International Whaling Commission (IWC) published as recently as 2016. Whaling is still practiced in many parts of the world, to include many coastal areas in Japan and the remote communities of the arctic.

Conclusion

Due to increasing demands on species fitness, cetaceans adapted behaviorally and morphologically to survive. Many millennia have passed in order for mammals to develop deep diving behaviors and morphology. The ocean's severe environment has forced ancestral species of cetaceans to exhibit many of the aforementioned adaptations in order to successfully feed and reproduce. These adaptations are expansive and continually subject to challenging environmental pressures. The ability to effectively breathe underwater requires the synchrony of several physical and behavioral adaptations. Abnormally reinforced airways help cetacean lungs to collapse while efficiently directing blood and oxygen into the alveoli. Alveolar collapse prevents uptake of nitrogen in the circulatory system, assisting in the ability to use stored oxygen while diving. Additionally, an improved cardiovascular system supports hypoxic conditions

and improved muscle characteristics make for a more capable anatomy. These are but a few of the many ways cetaceans have evolved into successful aquatic organisms. Cetaceans play a key role in many ecological processes and help contribute to a diverse underwater community. Many preventable external factors are causing harm to these incredible mammals. It is the responsibility of the scientific community and citizen alike to assist in the preservation of these masters of the deep for generations to come.

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PHYSICAL EXERCISE AS TREATMENT FOR DEPRESSION IN GERIATRIC PSYCHIATRIC PATIENTS

Rebecca Rodrigues

ABSTRACT: This paper examines the relationship between physical exercise and depressive symptoms in geriatric psychiatric patients, and how physical exercise can be used to treat depression in these patients. Studies were conducted that led to the conclusion that physical exercise is successful in treating depressive symptoms most effectively in the elderly demographic. This paper includes research from Carneiro et al, Carter et al, Heinzl et al, the New York State Office of Mental Health (OMH), Rapp, and Rosenbaum et al. These reports demonstrate the ways in which physical exercise is beneficial in combatting depressive symptoms and disorders in patients over the age of 60.

Many methods of treatment have been developed with the purpose of treating depressive symptoms in patients of differing demographics. Included among them are medication, psychotherapy, and homeopathic and natural remedies. Another proven treatment is physical exercise, which can be combined with other treatments to further reduce depressive symptoms. According to Heinzl, Lawrence, Kallies, Rapp, and Heissel (2015), physical exercise is associated with increased levels of oxygen and lower cortisol levels in the brain, which results in higher cognitive functioning and fewer depressive symptoms, primarily in patients over the age of 60.

Literature Review

While physical exercise has been known to alleviate depressive symptoms, it has been determined that this decrease in symptoms is dependent not only on the type of exercise performed, but also on duration and intensity of the exercise. Carter et al. (2015, pp. 2-12) explores the correlation between physical exercise and depressive symptoms in children age 7 to 17. It was found that the effects of exercise on depressive symptoms were insignificant in children.

While general physical exercise in adults results in an increase in self-esteem and self-worth, a decrease in anxiety and depressive symptoms, and an overall improved mood. The same study discovered that this is not the case in adolescents and adults under age 60, unless exercise is performed in a specific manner. Some participants were prescribed a level of intensity for physical exercise, and others could choose the intensity level that they preferred. This study concluded that the types of exercise performed impacts the effects on depressed mood. The participants that exercised at their preferred intensity level yielded a greater reduction in depressive symptoms than those exercising at the prescribed intensity level. Furthermore, the effects of physical exercise in this demographic were not evident until at least six months after the intervention began (2015, pp. 2-12). This could be evidence of changes occurring in the brain as people age, suggesting that those under the age of 60 are less susceptible to depressive symptoms, have lower cortisol levels, and have higher cognitive functioning than those over the age of 60. The ability to perform the desired exercise at a preferred intensity level is something that is more likely to be a possibility at a younger age. As the body ages, participating in high intensity exercises for

extended periods of time becomes more physically challenging or harmful due to frail bones, loss of endurance and flexibility, resulting in more injuries. By having a prescribed exercise and intensity level, those over the age of 60 can benefit from relatively intense physical exercise, without the risk of injury or discomfort associated with higher exertion.

Depression is the most common mental health condition in geriatric patients for a multitude of reasons including the physical and mental challenges of aging. Compared to younger patients (those under the age of 60), there is a vast difference in level of independence, socialization, mobility, memory, cognitive functioning, and physical capabilities, which together lead to a depressive state. It is evident that while exercise based treatments for depressive symptoms can be moderately successfully implemented in adolescents and young adults, they are significantly more successful in older patients, over the age of 60. According to Heinzel et al., depression is the most common psychiatric condition among patients over the age of 60, and is best treated, in terms of exercise-based interventions, with specific types of activities performed in regulated circumstances (2015). It could be that this increased prevalence of depression with age is correlated to a loss of ability and physical functioning. Younger generations are less depressed because they are able to be more active and fit, and mood changes can result with a decreased activity level. By reintroducing physical exercise, these mood changes can be reversed by implementing a previously lost sense of ability, independence, strength, and overall well-being.

In the study detailed in Heinzel et al.'s report, various types of exercise plans were tested in geriatric patients over the age of 60. These included aerobic exercise, resistance training, and other alternative exercises, specifically tai chi and qi gong (2015). While each of these did have a positive effect on depressive symptoms, it was reported that the most effective cases included a combination of alternative exercises. Heinzel et al. commented that this is likely due to the

meditative nature of these exercises, which is also said to improve mental health and reduce depressive symptoms (2015). It is widely accepted that meditation is an effective means by which to treat and combat depressive symptoms and disorders, so in combining it with a physical exercise, the benefits the individual may experience increase. Another aspect of this study was the setting in which the exercise-based intervention took place. Some participants were given a home-based exercise plan and others were in a supervised group exercise plan. It was found that the group exercise participants had more success in decreasing depressive symptoms because socialization is a "natural antidepressant" (Heinzel et al., 2015). Isolation has shown to increase or even feed depressive symptoms, thereby worsening its negative effects. By adding socialization to the practice of meditative exercise, there can be even more benefits in combatting depressive symptoms because it is being targeted from every angle. In conclusion, Heinzel et al. reported that alternative group exercise under supervision had the greatest impact on the mental health and reduction of depression in geriatric psychiatric patients for this very reason (2015).

Physical exercise influences other bodily systems, such as brain functioning, which may serve as a preventative measure against other previously mentioned ailments due to aging that can result in depression. The condition of the body can affect the state of the brain, and vice versa. Detailed in a 2016 report by Rosenbaum et al., is a study on the link between physical exercise and cardiometabolic disease, which increases a person's risk of diabetes, heart disease, or stroke. According to the New York State Office of Mental Health (OMH), some lifestyle changes that reduce this risk include weight loss, healthy diet, and regular exercise (2009). While some antipsychotic medications, such as Olanzapine, Quetiapine, Chlorpromazine, and Thioridazine, have been effective in treating depression, they also put geriatric patients at higher risk for cardiometabolic disease

(OMH, 2009). Cardiometabolic disease is more likely to occur in older adults, making it challenging to treat these psychological conditions with medication. This makes physical exercise a safer alternative than medication for depression. Physical exercise is sufficient in treating not only depression, but also other mental disorders, such as schizophrenia, anxiety, and PTSD (Rosenbaum et al., 2016). This validates OMH's statement that there is a risk associated with the use of antipsychotic medications and physical health. A sedentary lifestyle not only puts people at risk for physical health conditions, such as cardiometabolic disorder and its comorbidities, but also depression, which the treatment of is complicated by the risks of medication. This leaves physical exercise as a safe treatment option that can improve both physical and mental health. It increases socialization and physical fitness, and decreases depressive symptoms and cardiometabolic risk factors.

Neurotransmitter levels are another cause of depressive symptoms, and these can be altered through physical exercise and increased oxygenation that comes with exercise. A study done by Carneiro et al. (2015, pp. 117-122) reported that low neurotransmitter levels, such as epinephrine, dopamine, and norepinephrine, have been linked to depressive symptoms. The report also states that participation in physical exercise can increase neurotransmitter levels, resulting in a reduction of depressive symptoms. Carneiro et al. (2015) found that the most effective way to alter the levels of these neurotransmitters and reduce depressive symptoms was to perform 40-50 minutes of exercise three times a week, for at least sixteen weeks. Because these neurotransmitters are present and can be altered in patients of all ages, physical exercise can aid in lessening depressive symptoms even in geriatric patients. In addition to decreasing depressive symptoms, implementing exercise plans in geriatric psychiatric patients has an array of other benefits which further promote mental health. Physical exercise can alleviate the fear and risk of falling as physical strength and balance are gained, and

can also encourage the older adult patients to be more independent as they age, rather than losing their independence, which can also lead to depression (Rapp, 2015).

Discussion

While implementing physical exercise interventions in the geriatric psychiatric setting can be cost-effective, relatively risk-free, and highly successful in treating depression, it does come with challenges. According to Rapp in a 2015 report, these challenges can include: the presence of disability in patients, access to equipment and resources in facilities, multi-morbidity of conditions in patients which complicates the possibility of exercise-based treatment, a lack of awareness that physical exercise can be effective in treating a variety of conditions, the lack of acceptance society has for mental disorders, and the possible bias of therapists on the effectiveness of the physical exercise-based treatment in geriatrics (p.147).

If a patient has a disability or a comorbid condition, it physically becomes more challenging and dangerous, if not impossible, for them to participate in a physical exercise program. That said, there are other ways for a disabled patient to be active through modifying exercises. For example, they may still be capable of exercising in a seated position or even lying down. Also, many facilities do not have the equipment needed, such as exercise mats, cardio machines, or resources, such as a certified fitness trainer. These amenities would add an expense to the facility that could potentially be helpful for the patients, but detrimental from a business and finance standpoint. However, it is a possibility that by implementing a fitness program into the facility, they may save money in other areas, such as mental health care. Another key way that this treatment for depression is challenging is that many practitioners are unaware of just how beneficial physical exercise can be for elderly patients. They are often regarded as frail, but that does not need to be the case. They can

be both physically and mentally strong, as well as healthy through exercise if they are given the opportunity.

These challenges are things that can be overcome once it is recognized that physical exercise is a highly beneficial, and relatively risk-free activity to those of all ages, including those over the age of 60, in treating and preventing mental disorders and depressive symptoms. The first step in implementing such a helpful program is to get healthcare providers on board through education. By teaching them exactly how supervised group physical exercise combined with socialization can help their patients maintain their health and youth longer, there would be much support of exercise programs for geriatric patients.

Conclusion

Physical exercise can be highly beneficial to both physical and mental health in psychiatric patients of all ages, yet the success rate in treating depression with exercise is higher in geriatrics than it is in adolescents and younger adults. The most effective exercise-based treatment program in geriatrics would be participating in meditative and moderately aerobic exercises three to five times per week, for at least sixteen weeks. According to these studies, implementing alternative exercises into geriatric psychiatry can result in less depressive symptoms in patients with comparatively few risks and more cost-effectiveness than typical treatments. Participating in physical exercise enhances both the physical and mental health state of depressed patients in a natural way, by altering brain chemistry and providing socialization, and is effective in treating depressive symptoms, either in addition to or in place of medication and other psychotherapy interventions.

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GENETIC PREDISPOSITION TO GENERALIZED ANXIETY DISORDER

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ABSTRACT: Generalized Anxiety Disorder (GAD) is a subset of anxiety disorders and recently has been investigated by researchers worldwide due to a potential genetic predisposition. Researchers have consulted a variety of potential factors that could lead an individual to develop GAD, including familial structures, peer stimulus, age, living/schooling environments, and genetics. Of all of these factors, a genetic predisposition is the one factor that can be observed globally. This paper is an extensive literary review from international researchers looking at the potential for a genetic predisposition to GAD. This paper identifies a serotonin transporter gene polymorphism (5-HTTLPR) as the genetic variant which is thought to predispose an individual to GAD. Finally, this paper looks at how identifying this genetic predisposition can lead to advancements in medicine and therapy and ultimately lead to curbing the amount of diagnosable cases of GAD worldwide.

Introduction

Within the field of psychology, researchers seek to find what might predispose someone to GAD. Both environmental and biological factors have been investigated in search of an answer. However, when taking into account all of the contradicting data claiming to know the greatest risk factors for GAD, the most compelling data backed with minimally debated research is a genetic predisposition. This literature review walks through worldwide evidence on the genetic variation identified as the potential predictor of GAD; also providing background on the variation and an explanation as to why it is thought to be a predictor. Additionally, alternative views are presented to show the breadth of information about GAD and the vast variety in potential influencers in the development of this mental illness. This research is important to know because when a genetic predisposition can be identified, prevention plans can be put in place in order to deter an individual from developing a diagnosable case of GAD. Furthermore,

side effects of medications used to treat GAD can be predicted if the genetic predisposition of one person matches that of another.

KEYWORDS: Generalized Anxiety Disorder (GAD), Serotonin Transporter Gene Polymorphism (5-HTTLPR), Anxiety Sensitivity (AS), Stressful Life Event (SLE).

Review of Literature

Researchers have investigated a specific serotonin transporter gene polymorphism (5-HTTLPR) and observed how this polymorphism, when found at high levels in the body, makes people more anxiety sensitive (Stein, Schork, & Gelernter 2007). Anxiety sensitivity (AS) is when a person is at greater risk for developing GAD after experiencing a Stressful Life Event (SLE). SLEs are the precipitating event of this mental illness but only with the preexistence of high levels of 5-HTTLPR. The presence of high levels of 5-HTTLPR is found through blood sampling (Hemmings et al., 2015). This par-

ticular genetic variation contains a long L allele and a short S allele (HUGO Gene Nomenclature Committee [HGNC], 2017, 2017).

Even though studies indicate higher levels of 5-HTTLPR predisposes a person to GAD, a specific haplotype (another word for polymorphism) called the L-G haplotype must be found within the variation in order to make this statement accurate. This haplotype, unlike other ones found in the body, can “be found cross-culturally” (Hemmings et al., 2015). This is significant because many disorders are thought to be products of culture and manifest within a particular context; examples of this being both bulimia and ataques de nervios, a term used in Spanish-speaking countries, primarily Puerto Rico, for a person going through a nervous breakdown but here is actually a diagnosable mental illness (Oltmanns & Emery, 2015). Research has shown the presence of the L-G haplotype at high levels will make people more likely to develop GAD, and people who develop GAD across all cultures have shown high levels of the L-G haplotype (Hemmings et al., 2015).

Research has looked closely at the correlation between 5-HTTLPR and SLEs, particularly in regards to child maltreatment. When a child has higher levels of 5-HTTLPR and lives in a abusive or neglectful environment, GAD is likely to develop (Stein et al. 2007). Additionally, Stein et al. (2007) discovered that when two or more individuals have comparable levels of 5-HTTLPR, they will react to antidepressant medications in a similar way. The study showed multiple pairs of patients with comparable levels of 5-HTTLPR. These patients were given identical doses of antidepressant medications and found both positive and negative reaction were the same within each patient pair. This finding has led to more accurate antidepressant medication prescriptions and less negative effects on behalf of the patient. Now patients can rely on the results from previous patients and know what to expect when taking new medications instead of the old method of trial and error.

Another study (Hettema, Neale, & Kendler, 2001) investigated for common environmental and/or biological features to Obsessive Compulsive Disorder (OCD), GAD, panic disorders, and specific phobias within different sets of twins. This study was a meta-analysis and sought to observe similarities in findings in a variety of studies all looking to find what causes these disorders. The similarities found among patients OCD and specific phobias were determined to not be statistically significant. And, of all the disorders studied, GAD had the highest heritability rate with a 32% between monozygotic (MZ) twins. This finding led to the conclusion that genetics were the primary cause in the high prevalence rates of GAD and other anxiety disorders within MZ twin populations. This statistic was particularly important in male populations. In MZ male twins, the environment that the twins grew up in had virtually no effect on whether or not there was the development of GAD, however, in MZ female twins, the prevalence of GAD was highly correlated not only to 5-HTTLPR but also to shared environments. The study came to the conclusion that genetics were the most prominent feature in GADs, especially in male MZ twin populations with environmental factors following suit in terms of importance.

While most disorders are culturally bound, it is important to note 5-HTTLPR is a cross-cultural gene. In a study conducted in South Africa of “young, colored, tribal males” (Hemmings et al., 2015) the presence of 5-HTTLPR was found to be almost identical to that of people in the United States. This study revealed people in this small tribe with high levels of 5-HTTLPR were not only predisposed to have GAD, but had higher levels of AS and thus, when confronted with stressful life events, it could be predicted whether the individuals would develop GAD just by looking at the presence of 5-HTTLPR in their blood. Similarly to studies that have taken place in the United States, this study was also specific in looking for the L-G haplotype, which was found in DNA when drawing blood sam-

References

ples from the men. And, similar to other studies cited above, when at elevated levels, was used as a predictor for GAD with relative accuracy.

However, a study conducted by Schinka, Busch, & Robinchaux-Keene (2004), looked at the results of twenty six previous studies, all specifically looking for the genetic variance in GAD and other anxiety disorders. This study concluded there is little statistical evidence to support 5-HTTLPR variations predispose someone to GAD, stating all evidence in support of a genetic predisposition to GAD is false. However, it is important to note while this study deemed the results of previous studies to be statistically insignificant, the study still found strong correlations between 5-HTTLPR and AS.

Conclusion

The identification of 5-HTTLPR as a genetic indicator for Generalized Anxiety Disorder has furthered the field of anxiety research and has paved the way for further investigation into how to curb the diagnoses of anxiety disorders. Due to the identification of this genetic variation, prevention plans are being created for individuals prior to experiencing a Stressful Life Event, meaning an individual can have the psychological skills to handle a Stressful Life Event and not have it trigger Anxiety Sensitivity into the development of Generalized Anxiety Disorder. The identification of this genetic variation has also lead to investigation by other researchers at potential co-occurring disorders such as mood disorders and eating disorders, however, this research is far from conclusive. The identification of this variation has opened the door to a new way of studying anxiety and has provided insights into how to prevent the spread of diagnosable mental illnesses.

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GLOBALIZATION OF CLINICAL DRUG TRIALS AND FAILURE TO REGULATE

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ABSTRACT: United States' pharmaceutical companies often test their drugs in developing nations through the use of contract research organizations. Despite established ethical guidelines, questions arise of whether research in developing nations can be considered ethical. These questions surround the practice of using placebos, acquiring informed consent, and ensuring voluntary participation. Ethical guidelines such as the Belmont Report, the International Conference on Harmonisation, and the Declaration of Helsinki, outline important measures to promote ethical research, but they are rarely enforceable. In order to ensure ethical practices are being followed among drug trials, The Declaration of Helsinki must become enforceable and be recognized as the standard for ethical research in developing nations by United States' agencies and research institutions.

According to the Department of Commerce, the United States is the world's largest market for pharmaceuticals and is the leader in biopharmaceutical research. United States' firms carry out the majority of the world's development and hold the majority of rights on new medicines (Select USA, 2016). Yet, drug research within the United States has shifted, through the use of contract research organizations, to developing nations (Thiers, 2008). In the United States, great effort is placed on assuring ethical treatment of research subjects, but standards of ethical research vary among developing nations. This has caused ethical concerns regarding the use of placebos, informed consent, and voluntary participation among globalized clinical trials. Regulatory documents including the Belmont Report, the International Conference on Harmonisation, and the Declaration of Helsinki, outlining ethical guidelines for clinical trials, have been put in place, but are not universal and rarely enforceable. In an effort to create ethical guidelines for international research, the Declaration of Helsinki was put in place by the World Health Organization and is by far the most comprehensive of current regulatory documents. Despite efforts to promote ethical research, globalized clinical drug trials cannot overcome these ethical dilemmas until

the Declaration of Helsinki becomes enforceable and is recognized by United States research institutions and agencies.

The Shift of Clinical Trials to Developing Nations

Testing drugs for safety requires an extensive research process. For instance, the Food and Drug Administration (FDA) requires four phases of testing on human subjects. In Phase I, the drug is tested on healthy individuals for safety. In Phase II, the drug is tested on mostly healthy and a few sufferers of the disease of interest. Phase III involves the recruitment of a large number of individuals, who have the disease of interest and tests the drug's efficacy. During Phase IV, the drug is licensed for use but is closely monitored (Okanta, 2014). As the number of drugs produced rises, the number of clinical research participants in the United States decreases. Since 2002, the number of active FDA-regulated researchers, based outside the United States, has grown by fifteen percent annually, whereas the number of U.S.-based researchers has declined by five percent (Glickman et al., 2009). One study conducted by Glickman et al. (2009) found one-third of phase three clinical trials were being conducted

outside the United States.

This decline is partly due to the number of drugs each American is exposed to. Drug companies cannot test their drug on an individual who has been regularly exposed to medications, such as the average American, because it will cast doubt on the drug's ability to perform its intended purpose (Glickman et al., 2009). Due to a lack of research participants in the United States, drug companies have expanded their research past the United States border. (Petryna, 2005).

Another causal factor for globalized American research is the increase in clinical regulations in the United States making research costly. The added costs to clinical research has depleted government funds and placed a burden on researchers in the United States. As a result, American pharmaceutical companies have moved their clinical trials outside of the United States where trials are less costly. For instance, research in India at a first rate academic medical center is one-tenth the cost of running a trial in the United States (Glickman et al., 2009). Due to the various regulations by the U.S., the international community, and developing nations on human research, drug companies turn to contract research organizations to carry out their trials abroad.

When a drug company is ready to test their drug in a developing nation, they seek out a contract research organization (CRO). These organizations specialize in international clinical drug trials. They are responsible for finding a location, a population, and the health care professionals who will carry out the study. They are also responsible for knowing the local regulations for human research, the international regulations, and those of the United States. CROs are able to fill clinical trials quickly in places where treatments are limited and disease is prevalent. (Petryna, 2005) Globalization of clinical drug research and the use of CROs have raised ethical questions regarding the use of placebos, informed consent, and voluntary participation.

Ethical Implications of Globalized Research

Placebos

When conducting randomized experimental trials, it is common practice to use a placebo for the control group, but this is only ethical if there is no existing treatment (Angell, 1997). It is also standard practice, and more ethical, to use an existing drug as the control, if one exists. This ensures the control group is still getting treatment while acting as a control for the experimental group, yet this method has repeatedly been ignored because results are not as credible as that of a control-placebo study (Glickman et al., 2009).

Particularly in the 1990s, the use of placebos was in question due to HIV research in Africa. In 1994, American drug companies were testing their HIV drug, AZT, on pregnant women and using placebos for the control group. These drugs were designed to prevent the transmission of HIV from the mother to the fetus. At that time, existing HIV drugs were being used in the United States, yet researchers chose to use placebos over these existing drugs (Petryna, 2005). Both FDA and National Institute of Health officials supported the use of placebos to create greater confidence in the research results (Glickman et al., 2009). This created concern over the ethicality of using placebos and created a need for regulations specifically addressing placebos.

Informed Consent

Another ethical concern regarding the globalization of clinical drug trials, is the reliability of informed consent when language and cultural barriers are in place. For consent to be informed, the participant must know all the risks associated with the clinical trial and must be informed of their right to end their participation in the study at any time. This is difficult in developing nations where there may be barriers such as literacy, education levels, and cultural differences. The researcher may explain details of the study, but this is not always a good indica-

for the participant understands the information. Another difficulty with informed consent is the inferiority some research subjects may feel. Researchers are often seen as superior due to their educational background and their ability to offer lifesaving treatments. This may deter participants from asking questions or exercising their right to end their participation at any time during the study. In this case, consent is not truly informed (Angell, 1998).

Voluntary Participation

The expansion of research to the developing world has raised questions of whether participation is truly voluntary. Cases of individuals' involvement in research studies without their knowledge have led to strict guidelines in the United States over voluntary participation in research. These include caps on how much participants can be compensated for their participation (Belmont Report, 1979). If compensation is too high, it becomes impossible to decline participation in clinical trials. Institutional review boards in the United States screen studies for high compensation, but many globalized clinical trials are not screened at all or in this way. In some studies, participants are given incentives greater than their annual income and the study is their only opportunity to get medical treatment (Glickman et al., 2009). This creates a situation where participation in the study is not actually considered voluntary.

In some cases, participants are not even aware they are a part of a study. In 2008, the Center for Research on Multinational Corporations released a document of the detrimental results from globalized clinical trials in the 1990s and 2000s. Studies included participants from Uganda, India, and others who experienced adverse effects, and even death, who were not aware they were given experimental drugs. Even after these adverse effects were noted, most trials were allowed to continue (Kelly, 2013). The ethical implications of cases like these are staggering and clearly represent a need for ethical regulatory guidelines.

Current Regulatory Guidelines

The Belmont Report

The Belmont report outlines three basic principles for ethical research including respect for persons, beneficence, and justice. These principles represent informed consent, assessing risks and benefits, and the protection of vulnerable populations when selecting research subjects. While this document is the standard for scientific research using human subjects in the United States, it is not always enforceable.

According to the Department of Health and Human Services, the Belmont Report does not make recommendations for how it should be enforced, but is meant to be the standard adopted by institutional review boards and government agencies (Belmont Report, 1979). This becomes increasingly difficult in developing nations where research is not subjected to review boards. In a study by Glickman et al. (2009), only 56% of the 670 researchers surveyed in developing nations reported their research had been reviewed by an institutional review board. Another strategy for enforcing these regulations involves strict publishing guidelines. Medical journals make application of these guidelines a requirement for publishing, but many researchers employed by CROs from developing nations, are not aware of these guidelines and do not wish to publish (Glickman et al., 2009). For these reasons, the Belmont Report is not always applicable to globalized clinical trials.

The International Conference of Harmonisation

The International Conference of Harmonisation (ICH), which included representatives from Europe, the U.S., and Japan, put a set of guidelines for international research in place in 1990. The guidelines focus on the safety of the drug itself, the manufacturing process, and streamlining drug approval among nations. Although necessary, the ICH does not address ethical concerns regarding the selection of participants or the protection of the vulnerable (Singh, 2015).

The Declaration of Helsinki

The Declaration of Helsinki, developed by the World Medical Association, is the most comprehensive and detailed as it is aimed toward protecting research subjects in developing nations. It includes ethical principles outlined in the Belmont Report, but also adds a specific provision that every drug trial participant is entitled to the best medical care and treatment available at the end of the study. It also requires all clinical trials be subjected to an ethics committee. Finally, the Declaration of Helsinki forbids the use of placebos if existing drugs are available, but just as the Belmont Report is not always enforceable, neither is Helsinki. (World Medical Association, 2013)

Conclusions and Call to Action

The Declaration of Helsinki is a starting point for turning the tide toward ethical international research. Globalized research has the potential to spread advanced medical treatments to those who need them all across the globe, but serious changes must occur for this potential to be realized, including clear expectations that researchers conform to these guidelines in order to market their drugs or publish their research. This would require a regulatory institution with the power to enforce regulations.

The tragic abuse of research subjects throughout history has created a strong case for regulations on research. In an effort to promote ethical research, various guidelines have been prepared including the Belmont Report, the International Conference of Harmonisation, and the Declaration of Helsinki. Despite these guidelines, ethical issues surrounding the use of placebos, informed consent, and voluntary participation have occurred because these documents are not always enforceable or recognized by all nations. In order for globalized clinical trials to meet these ethical standards, the Declaration of Helsinki must become universal and enforceable. This would require a regulatory institution with the specific intent of regulating international re-

search and drug trials. In the meantime, there must be a push for U.S. agencies to accept the Declaration of Helsinki as the standard and required regulation for international drug trials. There must also be accountability through the publishing of clinical trials and their results conducted in all nations. This would not only provide the public access to how research participants are treated, but would also make medical research open for everyone, the developing world included, to benefit from.

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THE EFFICACY OF WOMEN'S HEALTH RESOURCES IN DEVELOPING COUNTRIES

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ABSTRACT: The lack of access to health and family planning resources for women in impoverished countries has been recognized as a major barrier to national growth. Not only are equality and full reproductive agency for women inherent characteristics of a more developed nation, but other factors also largely depend on the well-being of female populations. When women are given access to family planning education, they tend to choose to prioritize the financial security of their families over sheer procreation. This goes on to benefit communities and nations as women's rights are restored, individuals invest more in regional economies, and the overuse of limited resources is slowed. It is important to highlight that providing access to family planning and contraception in this argument is not equivalent to enforcing the use of that contraception. Rather, providing these resources is a response to a large contraceptive need - women who themselves desire to use contraception but do not have access to it. There has been great success in women's health programs such as The Maternal and Child Health and Family Planning Program in Bangladesh, which is attributed with having decreased the fertility rate from 5 to 2.2 children per woman on average. Although there have been great recorded successes in meeting contraceptive need, resources are still extremely limited and some countries also face staunch sociocultural barriers.

Introduction

In recent years, the UN has set eliminating extreme poverty as its primary goal. This comes in light of a global population that has become increasingly aware of how fast the world around us is changing for the better – obviating the issues still being faced. The UN recognizes that there are an estimated 836 million people still living in extreme poverty, and that the gross majority of these people live in “small, fragile, and conflict-affected countries” (UN, 2015). These impoverished countries (primarily in Asia and Africa) make up a majority of the developing world, and the UN has set its goal for these regions to aid in their progression. Sustainable populations are defined to be those that allow for equal and adequate resources (such as jobs and land) to be supplied to all members of the population. Sustainable populations can fluctuate in size, but growth and decline should still allow for sufficient access to resources for all people. Growth of a country is often character-

ized by a sustainable economy, widely available health resources, and equality between genders. Not only are these factors interdependent, they also have significant reliance on the health and education of women. Although a seemingly uninvolved matter, the well-being of a country's female populations is actually incredibly dependent on economic factors, because the lack of access to education and health resources specifically can result in dangerous and unintended pregnancies that contribute greatly to unsustainable populations, defined by high concentrations of youth (Crenshaw, 1997). This is to disprove that women's rights are an afterthought or luxury that comes with being a developed country, but rather an essential and inherent right that sustainable growth hinges on. Exponentially increasing populations in impoverished regions can often lead to the stunting of regional economy (Easton, 2014) and the overuse of limited resources (FAO). Although the interdependency of these issues results in their ramping intensity, it is also key to their resolution. Solutions set in place to provide health and family planning

resources for women will then also relieve some of the pressure caused by the resulting economic complications of large populations that result from unmet contraceptive need. In order to resolve issues that are characteristic of developing countries and catalyze their growth, it is essential to heavily increase the amount of and access to health education resources for women.

Health in the Context of Women's Rights

It has been frequently documented that the status of women in a country is correlated with that country's level of development. However, it is important to define which characteristic is the causal one. It is not that women reap benefits as a nation progresses, but rather the fair treatment of women that catalyzes such growth. In fact, it has been estimated that "losses in [national] achievement" such as academic or economic achievement "due to gender inequality range from 17%-85%" (UN). The same study also found that countries with greater disparities between the treatment of men and women had similarly "unequal distribution of human development" – referring to large, youth-dependent populations (UN). The fair treatment of women is hinged particularly on access to general education and availability of health resources such as contraception (WHO). This is not to say that solely access to health care is equivalent to gender equality, but it is an important facet of it. Other expressions of equality are similarly important human rights – and are inherently deserved by the same women discussed – but this argument aims to focus on the result of meeting women's health and health education needs. Allowing women to express and act on their own reproductive agency is key to the upward mobility of impoverished countries. When discussing the increased distribution of contraceptives in developing nations, it is necessary to clarify that it is presented first as an option for women to control their own maternal health, but even further as part of the general education that they deserve. The United Nations Girl's Education

Initiative (UNGEI) has found that women in developing countries most strongly seek education above any other resources or amenities. It was also found that women who received general education were more prone to seek careers and higher education. Additionally, they are more likely to want smaller families and delay having children. The UNGEI has estimated that "one year of female schooling would reduce fertility by ten percent" (2016), further supporting the notion that the development of a nation by way of shifting priorities away from procreation and towards gender equality begins by educating women and restoring their reproductive agency. Empowering women by giving them the tools to make their own decisions about family life and their own maternal health is necessary before national development can occur.

Unmet Contraceptive Need and Health Resources

The current state of women's health is not favorable, but has certainly been seeing improvement. The specific concentrations of women's health as key to population growth include meeting contraceptive need, and providing family planning options. Women with unmet contraceptive need are defined to be women who themselves desire contraception, but either have no access to it, or cannot afford it – of which the United States Agency for International Development currently estimates includes 225 million women and girls worldwide (Schivone, 2016). Because most of this need is concentrated in rural regions of developing countries with limited medical resources, it creates a seriously dangerous environment for mothers. Not only would meeting contraceptive need avert "70,000 maternal deaths", but it would also prevent "52 million unintended pregnancies overall" (Schivone, 2016, p.171). These unintended pregnancies are dangerous for several reasons. They endanger women who give birth in unsafe conditions, and are problematic for families who cannot financially support more children. However, the

gravity of these repercussions is beginning to be realized. In the years between 2000 and 2015, the number of women using contraceptives in developing countries has nearly doubled thanks to the increase of health workers (Davis, 2012). An example of a particularly beneficial resource is health extension workers – women who often walk up to eight hours a day to reach women with an unmet need. These women provide contraceptive options and health education to people who want these resources in rural communities – who are recorded to have the most difficulty getting access to family planning resources (Davis, 2012). Although this kind of resource has been wildly beneficial, it is still incredibly limited due to a lack of trained workers, and thus its potential for success has yet to be reached.

Another resource that has seen great success in other parts of the world is family planning centers. These centers provide education for women and their families, and have been shown to help women make their own educated decisions about the size of their families (Rosling, 2014). However, due to geographic factors, there are far too few of these centers, and women lack the transportation to reach them (Jackson, 2016). Even if a woman can manage to make the trip out, the options she is offered can still be extremely limited and expensive. For families that currently use contraception, it takes somewhere from 5-10% of their household income (Davis, 2012). Health extension workers and family planning centers are the kind of resources that could potentially help fulfill women's contraceptive needs, giving them the tools to express their own reproductive agency.

As more resources for women are made available in developing countries, the potential for women's empowerment to slow the growth of poverty becomes clearer. Of the 4 billion people expected to be born into the world by the end of the century, 90% will be born in impoverished countries. Although a portion of this statistic is due to a cultural trend for a larger family size, a problematically large portion is the result of

unmet contraceptive need and a lack of education and family planning resources (Rosling, 2014). Arguments to provide women with the tools to control their own reproductive health should take no issue with larger family sizes if that is the will of the mother. Rather, it is mothers who wish to control the number of children they have but do not have the resources to do so that require action to be taken. Sub-Saharan Africa suffers particularly from unmet need – their population is expected to increase by 125% over the next 34 years (Schivone, 2016).

For some countries that have embraced the benefits of women's health resources, the situation is not so dire. Bangladesh has been seeing the rise of a new generation of women that educate others about contraception and family planning. Women in smaller Bangladeshi communities have found great success in holding community meetings, where topics of discussion include sex education and maternal health (Davis, 2012). These community meetings are incredibly popular, which exemplifies how urgent the want for education is among these populations of women. The biggest achievement in Bangladesh has been the implementation of The Maternal and Child Health and Family Planning Program (MCH-FP) in 1977. Its establishment provided women in "designated 'treatment' villages with home delivery of contraceptive supplies, follow-up services, and general advice" (Joshi, 2013, p. 149). Over the course of the program more services were added and expanded to reach more regions, and by 1996, the fertility rate of Bangladesh had decreased by 17%, as women received more education (Joshi, 2013). By 2015, the average number of children born per woman dropped from 5 to about 2.2 (Rosling, 2014). This is a very significant figure, because if mothers have just two children, effectively replacing just themselves and the father, the population does not grow or decline, which gives impoverished nations a chance to heal (Freeman, 2013). This amount of progress is entirely due simply to liberating women's reproductive agency, and clearly shows how pop-

ulation dynamics respond to slowing birth rates. This kind of impact on the projected world population prevents economic stunting that unsustainable populations cause, but importantly, it does so by returning the right to control fertility to individual women.

Economic Response to Unsustainable Populations

Large populations put serious economic stress on families in developing countries. For families living outside of major cities, the primary source of income is farming. Farming families will save up money to purchase items that allow them to produce more products, which then allows them to earn more money. A family may, for instance, save up for a bicycle that allows them to carry more of their crop to market faster than before when they had to walk (Rosling, 2014). However, this cycle gets interrupted when populations grow unsustainably. There is only so much land for families to grow crops on, so more people are restricted from expanding their businesses and thereby their familial economic standing is stunted (Rosling, 2104). A study comparing population dynamics and economic development noted that “high fertility and rapid growth ... are detrimental to [economic] development” (Crenshaw, 1997, p. 980). This is important because it recognizes the danger of youth-concentrated populations that result from unmet contraceptive need. Using population dynamics to evaluate a correlation with economic development allows for the analysis of not only low or high relative populations, it also takes into account age distribution. The type of population that developing countries undergoing unsustainable growth are made up of are characterized by heavily concentrated younger populations and sparse older populations. This is a sign that parents are having more children than were in their original families, graphically explaining the trend towards larger populations. Age distributions are particularly useful because although two populations may

have the same current population, the age trend will show whether the population is growing or declining – and this is what leads to different outlooks for economic development. The same study found that populations that are more youth-dependent have a more negative effect on the region’s economy than populations which have smaller youth populations. Although it may be argued that increased birth rates allow for a larger workforce to produce more wealth, this statistic shows that this claim is not necessarily true since high concentrations of child populations were found to be related to lower economic development due to limited resources and job availability (Crenshaw, 1997). Educated women are more likely to choose to have smaller families, but without contraceptive options, populations grow increasingly concentrated younger generations that hinder economic growth and the overall development of a country.

Emerging Social Trends

The effect of specific population demographics is beginning to be more realized by local families in these youth-dependent countries. Part of the reason Bangladesh has had such great success in decreasing the rate of unintended pregnancies and overall fertility rate has been due to the education of men as well as women. Women often face pressure by their husbands to bear more children unwillingly, particularly if the mother has not had a son (Libbus, 1997). Fathers have begun to understand what benefits a small family size can have. In one two-child family interviewed, the father stated that he would rather have a small family so that their income is sufficient to provide his children with a comfortable life; if he had more children, he would not be able to provide them all with the same life (Rosling, 2014). This same family has also particularly benefitted from the area’s new health resources for women, as the mother of the family now works as a health extension worker. In fact, programs like MCH-FP have opened up many new jobs – particularly for women.

With more women providing a secondary income for their families, not only do they help improve their family's economic standing, but it also has an interesting effect on family size. When women in families begin to work, they set aside having children until they feel they are economically stable enough to provide for them (Snopkowski, 2016). Prioritizing income stability over bearing more children again leads to a decrease in the projected population growth as women gain more control, and the restraints that are characteristic of overpopulation are loosened further. It is an important step in achieving the gender equality that is distinctive of national growth that women have the tools and education to make decisions about their priorities. Based on these observations, the education and empowerment of women has a clear ability to reduce poverty that is worsened by high rates of unintended births.

Although many countries have begun to prioritize contraceptive use and family planning, there are still staunch barriers to gross expansion of such resources. The most common barrier referred to by researchers is cultural or religious influence. A 1997 study of Jordanian people's beliefs about contraception evaluated how deeply rooted this impediment was (Libbus et al.). It was also set to evaluate whether this barrier was preventing access to contraception for women who themselves desire to use it, or if the women choose to have many children. To clarify, this argument finds error with a scenario that places the decision to have children in the hands of anyone but the mother, not with women wanting more children due to cultural trends. The study interviewed a sample of women (a majority of which personally used contraception) and their husbands to determine how involved culture was in their decision to use or avoid contraception. Overall, the study concluded that "the social and economic value of children in combination with cultural and reli-

gious norms have contributed to the limited use of contraception" (Libbus et al., 1997, p. 87). Jordan is predominantly Muslim, and although Muslim religious texts do not specify a position on contraceptive use, 50% of "husbands interviewed felt that family size should be left up to God"; this is compared to an average of 6.85% of women who hold the same belief (Libbus, 1997, p. 87). The social value of children seemed to be particularly engrained into decisions about family planning – decisions that were mostly controlled by the men and elders of households. Jordanian culture places particular value on sons, as they are considered to provide "physical security" as well as "political strength and social prestige" of a family (Libbus, 1997, p. 86). Many mothers feel immense pressure from family members to have a lot of children because many Muslim cultures believe that "procreation is the primary goal of marriage" (Libbus, 1997, p. 86). Mothers who have already had two children feel less of this pressure, unless the two children they have are female.¹ Nevertheless, there is a new trend emerging that leans away from prioritizing procreation, and towards increasing time spent nurturing the children that a couple already has. This trend is led by younger women who object to other cultural practices that they have found oppressive. It is trends like these that show how much women desire to make decisions for themselves about bearing children, and that when their authority is embraced, fertility rates decline. It is essential to overcoming oppressive facets of culture or religion that this call to meet the health requirements of women is answered. Women in developing countries rightfully demand access to health education and contraceptive tools, and it is meeting this demand that results in progress towards gender equality and sustainable upward mobility of a nation.

¹This alludes to a disadvantage of providing more family planning because it opens up an opportunity for sex-selective abortions that further perpetuate gender imbalances and have other highly destructive ramifications. This debate is discussed further elsewhere (Hesketh, 2011).

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DESERTIFICATION OF NORTH AFRICA AND THE DESERTION OF ITS REFUGEES

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ABSTRACT: There were 20 million new climate refugees in 2008. There are 17 million people fleeing desertification right now. 60-75 million people in the North African region of the Sahara-Sahel desert region face displacement due to desertification. Climate change is causing desertification via droughts and temperature increases at levels never before seen. The United States must act: it should set a precedent of accepting climate change refugees, providing funds for United Nations Conventions, and become party to the International Criminal Court. The Sahara-Sahel is suffering and the international community is turning a blind-eye to their pain.

Introduction

Research Question

How can the United States adopt a unilateral response to address both the lack of refugee status and support for climate change refugees facing desertification in Northern Africa?

Research Methodology

The research method in this paper is also the format of how the paper is organized. The initial focus was on gathering data on the human rights violation and the statistics on the populations that are being affected by desertification. This research then opened up into a wider research lens, gathering information on all of the relevant international conventions and policies. Once this international scene was researched, the focus turned to how the United States was involved, eventually leading to the addition of the European Union's involvement, due to their proximity to the issue.

Limitations of Research

There are several limitations to the research of this paper. A Global focus on climate change is a relatively new direction of international policy, so the amount of available history of climate data or policy impact is limited. Additionally, the displacement of people in North Africa is in-

credibly understudied. The world, thus far, has seemingly turned a blind eye to the encroachment of the Sahara-Sahel zone due to a historical lack of voice and underrepresentation of the North African community on the global stage. This lack of discourse is explainable within the context of historical colonization. The colonial powers in Europe do not acknowledge a situation in which they are faced with the task of assuming responsibility for millions of displaced people. Providing aid for the climate change problem of desertification is an acknowledgement of the irreparable loss and damage that is occurring to the local environment of the Sahara-Sahel region. After a research trip to Washington D.C., the Norwegian Ambassador to the United States of America, Kåre R. Aas, was quoted as saying “[the] moral obligation [to displacement from climate change] due to oil production [is] not discussed.” This statement reveals additional limitation resulting from the hypocrisy of the United States and Europe. Nearly all of these states are party to the conventions on desertification and climate change, but are still major polluters, do not want to acknowledge their responsibility to the people climate change is displacing (Environmental Protection Agency, n.d.).

Definitions

Asylum-Seeker: An individual fleeing their

home and applying for temporary protected status, also known as sanctuary status, which is the right to be recognized as a refugee and receive legal protection and material assistance; an asylum seeker must demonstrate that their fear of persecution in their home country is well-founded (United Nations High Commissioner for Refugees, 2016).

Climate adaptation: A preventative measure made through investment of capital and political will towards transforming a social or economic base to a base in which climate change is less harmful. For example, switching to a crop that grows better in higher temperatures in areas facing desertification.

Climate loss and damage: Damage that has been done to the climate, on different levels of magnitude, that are irreparable; this cannot be made resilient or adapted to as the base climate has been destroyed.

Climate mitigation: Describes a community's ability to survive given differing levels of damage to their local climate.

Climate resiliency: Used to describe a general level of resistance to the damages of climate change; preparedness of a region to survive given changes to their climate.

Counter-desertification: For the purpose of this paper, this term will describe an aggregation of climate adaptation, climate mitigation, and climate resiliency policies.

Desertification: The United Nations Convention on Desertification defines desertification as "land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities ("What is Desertification," 2017).

Refugee: Someone who has been forced to flee his or her country because of persecution, war, or violence; a refugee has a well-founded fear of persecution for reasons of race, religion, nationality, political opinion or membership in a particular social group (United Nations High Commissioner for Refugees, 2016).

Risk-multiplier: For the context of this paper, this term is used to describe climate change and

desertification as a baseline cause that increases the severity of internal strife and conflict.

Sahara Desert: An arid zone that encompasses almost the entire African continent north of the Sahel Desert (Peel & Allman Gritzner, 2016).

Sahara-Sahel: For the purposes of this paper, the Sahel Desert and Sahara Desert will be lumped together into a zone of severe aridness called the Sahara-Sahel Zone, as it is a region heavily interconnected on the issue of desertification.

Sahel Desert: A semi-arid transitional zone between the Saharan desert in the North and the tropical region of Central Africa, it spans laterally from the Atlantic Ocean to Sudan (Editors of Encyclopedia Britannica, 2010).

Overview of the Problem

Refugee Mechanisms

"We don't have, in international law, or any kind of mechanisms to allow people to enter a State against the will of the State, unless they're refugees." - The Special Rapporteur on the Human Rights of Migrants, François Crépeau (Randall, 2014).

Refugee status is the only way fleeing individuals can gain access to territory during the extreme circumstances. As stated by the 1951 Convention on Refugees: the only way a person can legally become a refugee is if they are fleeing a well-founded fear of persecution due to their race, religion, nationality, membership of a social group, or their political opinion (Guterres, 2011). This framework provides no room for the tens of millions of people who are fleeing their homes due to climate change (United Nations Convention to Combat Desertification [UNCCD], 2016b).

As per Karen Grisez of Friend and Frank, the alternative to the refugee mechanism is the in-person asylum-seeking process. In the United States, any individual fleeing a well-founded fear of persecution can apply for temporary protected status (TPS). The United Nations refers

to this same concept as sanctuary status. This mechanism is distinctly different from the refugee process, because individuals, generally, are already physically in a nation like the United States when they apply for TPS. The refugee mechanism is, generally, used in vetting processes that happen outside of the United States, rather than the customs process which happens when individuals apply for TPS within a nation's territory. Individuals leaving their homes due to desertification are left with no other option than to travel to a state with a safer climate and apply for protection for reasons of persecution, rather than the primary driver of desertification. This is, of course, an issue because it means that displaced populations have to travel illegally to a host nation, rather than moving legally to a safer place.

The refugee mechanism is the ideal protocol for large movements of displaced people. There are conventions that create frameworks for their protection, with some level of precedent for large movement of refugees fleeing persecution, which increases the chances of a successful relocation. The asylum-seeking/TPS process is a bandage rather than a concrete solution. It shoe-horns displaced people into certain social groups because they have to find a 'well-founded' fear of persecution, such as their race or social group status, when such a fear may not be the cause for their flight. The criterion of persecution ignores displacement due to climate change.

Displacement Figures and Desertification

In 2008, a United Nations study showed that there were 20 million new refugees from climate change in that year alone (Barnes, 2013). By 2050, there could be close to 200 million climate change refugees (Barnes, 2013). The most disastrous and understudied issues of climate change refugees are the tens of millions of people living on the margins of the Sahara-Sahel, dealing with the encroachment of desertification from drought (UNCCD, 2016b). There is an expected 40% reduction in freshwater availability in nations on the Northern border of the

Sahara-Sahel (Radhouane, 2013). Already, on the Southern border of the desert, in Chad, they recorded only 135 mm of rainfall, compared to 350 mm of rainfall in 1950 (Rehrl, 2009). This lack of rainfall and decrease in freshwater is being coupled with increases in average temperature. By 2050, south of the Mediterranean, warm afternoons will be as hot as 114 degrees Fahrenheit, (Max Planck Institute for Chemistry, 2016). Both of the above factors will result and is currently resulting in massive land degradation, causing desertification.

The Office of the United Nations High Commissioner for Refugees estimate, alongside corresponding reports, that there are currently up to 17 million people globally who have fled desertification (Warner, 2009). Currently, there are 135 million people who are at severe risk of displacement due to desertification (Warner, 2009). There are no reports that have set out to specifically record how many of these millions of people are at-risk in Northern Africa. The Africa Action Summit has roughly estimated that there are 60 million people at risk from displacement due to desertification (UNCCD, 2016b). The United Nations has published a report stating that at least 75 million people in Africa will be affected by water scarcity, and that Sub-Saharan Africa is the most prone for displacement due to water scarcity (United States Department of Economic and Social Affairs [USDESA], 2014).

Human Rights Violations

The core of the issue in this situation is the denial of several rights specified in the Universal Declaration of Human Rights. While the UDHR itself is non-legally binding, it provides a theoretical moral obligation for later conventions and specific legal frameworks. Since there are no international frameworks for those fleeing desertification, they are left only with the grand concepts to drive the creation of later legal framework. The first violation comes from Article 3: a human's life is in danger when there is no fresh water and lethal heat waves (UN General Assembly, 1948). Additionally, deserti-

fication is a risk-multiplier, causing the destabilization of states and societies, leading to deadly conflict, like the civil war in Syria. The second article being violated is Article 25: a standard of living is not adequate to meet the criteria of human dignity when the land around them is unlivable (UN General Assembly, 1948).

These violations are essential to understand because they paint the policy and legal argument of what is happening and why it is wrong. In terms of displacement due to desertification, it is critical to understand the lack of any binding legal framework that protects individuals directly from displacement. There are conventions to address water insecurity, violent unrest, but they are missing the destruction of millions of people's way of life. What is at stake is not necessarily instant death for tens of millions of people, but a massive wave of destabilization as their culture and societal norms have their rug pulled out from underneath them; so to speak, their homeland is becoming uninhabitable desert.

Classification Issues from Insufficient Mechanisms

The tens of millions of individuals being displaced by desertification are being wrongly classified as economic migrants (UNCCD, 2016b). First, this classification is due to the fact that there is no proper legal term for these afflicted individuals. Because there is no proper legal classification, they cannot claim refugee status due to habitability-destroying drought in their homeland. Secondly, it is in the best interests of powerful states around the world to ignore this issue of misclassification. This issue will be expanded upon during the stakeholder analysis, but it can be generalized as states not wanting to accept more refugees, or alternatively not seen as rejecting more refugees. Finally, the international community is focused, not without reason, on the humanitarian crisis in Syria from the civil war. Unfortunately, one of the main issues of the Syrian Civil War is being ignored, which was a record-setting drought directly be-

fore the demonstrations in cities across the state (Weinthal, 2015). This has led to a situation where Syrian War Refugees are masking other displacement concerns, as Europe's attention is focused on them, rather than the tens of millions at severe risk of displacement in North Africa.

Current International Policy Statures and Effects

There is no desire by the influential states of the United Nations to create a refugee mechanism for those seeking to leave areas affected by desertification. However, there is a policy framework put into place by the United Nations Convention on Combating Desertification. This framework is called the 10-Year Plan, and has four objectives for the UNCCD: reduce the negative impacts of affected populations, reduce negative impacts of affected ecosystems, create global benefits, and mobilize resources between national and international actors (United Nations Convention to Combat Desertification [UNCCD], 2016a). The 10-Year Plan hopes to accomplish these strategic objectives by advocacy and awareness, a revised policy framework, increase in scientific knowledge, capacity-building, and to increase financial and technology sharing. The 10-Year Plan was created "after a decade of implementation, it is recognized that limiting factors have prevented optimal deployment of the Convention" (UNCCD, 2016a). Essentially, it was a response to an ineffective initial convention, but has suffered from the same fate, except for two positive differences. The plan does not have sufficient financial resources or organizational cooperation. It did, however, mention the people who are being displaced by desertification, "growing numbers of environmental refugees and migrants shedding new light on the impacts of poverty and environmental degradation" but left this component entirely out of the effective language of the 10-Year Plan (UNCCD, 2016a). Secondly, the 10-Year Plan extended the lifespan of the Global Mechanism, which is a framework that connects development partners to climate projects in ar-

eas facing desertification.

In contrast to the failure of an international convention, the Africa Action Summit met for the first time during the United Nations Framework Convention on Climate Change COP22 summit meeting in Marrakesh, November 16th 2016 (“Marrakech,” 2016). This summit reaffirmed three initiatives: the Security, Stability, and Sustainability Initiative, the Great Green Wall for the Sahara and the Sahel Initiative, and the Adaptation of African Agriculture (“Marrakech,” 2016).

The Security, Stability, and Sustainability Initiative is a general affirmation and recognition of the potential for massive displacement of people affected by climate change. They note that 60 million people are at risk of displacement due to climate change (UNCCD, 2016b). The parties to the summit agree to focus on land restoration and increasing climate resiliency capabilities. This is a non-binding resolution, and has had no significant outcome, partly due to its very recent creation.

The Great Green Wall for the Sahara and the Sahel Initiative is a more robust policy framework that’s goal is to create a “7,775km [wall] from Senegal to Djibouti – the “wall” consists of a mosaic of projects implemented by countries in the region” United Nation Convention to Combat Desertification [UNCCD], 2016c). These missions, in practice, are agricultural projects that focus on re-planting of local flora, as well as tilling land with crops that are specifically tasked with growing in semi-arid environments. Those two examples encapsulate the terms climate mitigation and climate resilience, in order. Furthermore, the policy is preparing for a temperature increase of up to five degrees Celsius, which could cause population displacement of up to 60 million people (UNCCD, 2016c). This is another way of saying that the Green Wall Initiative is preparing for the impacts of desertification. In terms of its funding and partnerships, the 10-Year Plan does have some role in organization of financial resources, but its links are minimal, and mostly

operate through the creation of the Front Local Environnemental pour une Union Verte (United Nations Convention to Combat Desertification, 2013).

The Adaptation of African Agriculture is an intricate policy framework, developed by the Kingdom of Morocco, under framework guidance of the United Nations Framework Convention on Climate Change. It focuses on connecting equally distributed climate financial resources to four different types of solutions: soil management, agricultural water control, climate risk management, and capacity building solutions.

The Paris Climate Accords focuses on emission standards, which is only indirectly related to the displacement of populations due to desertification. Fortunately, for the sake of policy progress, it recognized and legally affirmed the Warsaw International Mechanism for Loss and Damage (United Nations Framework Convention on Climate Change [UNFCCC], 2013). It is a historic breakthrough that acknowledges climate change will cause irreparable loss and damage. The framework that was created focuses on advocacy and awareness of these concerns, connects stakeholders and fosters dialogue, and increases support for research on the potential loss and damage from climate change (UNFCCC, 2013).

Other Critical Conventions

The refugee convention of 1951 and the 1967 modification should be essential conventions concerning the displacement of millions of people due to desertification, but as the problem stated, current refugee mechanisms do not include climate change as a sufficient cause for refugee status. Its significance should and could be greater, but this component will be further discussed in the stakeholder analysis and in the policy recommendation. Historically speaking, the initial 1951 convention was created as an answer to the displacement of population in Europe after World War II (Guterres, 2011). The 1967 protocol expanded the convention to cover

any individual around the planet that meets the criteria for a refugee (Guterres, 2011). Again, this convention fails to protect displacements due to desertification.

The United Nations Framework Convention on Climate Change was ratified in 21st of March in 1994 (United Nations Framework Convention on Climate Change (UNFCCC, 2014). “Preventing ‘dangerous’ human interference with the climate system is the ultimate aim of the UNFCCC” (UNFCCC, 2014). It is a sister convention of the UNCCD, as they were both created by the 1992 Rio Earth Summit. Critical to the later policy recommendation, it places the onus on ‘developed’ nations to create the path towards a solution to the issues of climate change. There are three major developments that the UNFCCC has sponsored: the Kyoto Protocol, the Paris Climate Accords, and the Africa Action Summit. The Kyoto Protocol was the first international agreement, while ineffective, of setting emission standards (UNFCCC, 2014). The recent Paris Climate Accords have an optimistic framework at curbing emissions, and also critically acknowledge the Loss and Damage protocol, as stated earlier in this paper (UNFCCC, 2014). Finally, the Africa Action Summit is a committee that is held within the framework of the UNFCCC and at its summits; it is a group that has proposed similarly optimistic counter-desertification policies.

United States Policy on Climate Change Displacement

The United States already has a storied history with population displacement from climate change. In the 1930’s, the Dust Bowl caused 2.5 million people to be displaced (Reuveny, 2007). Now, of course, the desertification in areas like North Africa are not solely from poor land management, but from regular and enduring droughts. Moving forward from the 1930’s, the United States is in fact facing desertification. A 2001 report noted that there is extensive land degradation and desertification underway in the American South West (Asner, 2001). The report

utilized Imaging Spectroscopy to measure the ‘greenness’ of the region. This greenness has been steadily decreasing, which is a symptom of the historic droughts the region has been facing, such as California (Swain, 2014). These droughts are causing immense stress on water infrastructure and consequently resulting in the desertification of arable land in the American South West. There has been no noticeable population displacement due to the desertification of this region.

Nonetheless, The United States of America has practically recognized the displacement of populations due to climate change. In January of 2016, the Department of Housing and Urban Development created one billion dollars in grant money for climate resiliency projects (Robertson, 2016). One particular community attracted a great deal of attention, the Biloxi-Chitimacha-Choctaw tribe of Southern Louisiana. Their community lives on a small island that is now flooding regularly due to rising sea-levels and climate-change-enhanced storms (Robertson, 2016). They have been given a grant for climate change resilient improvements and relocation. The above, of course, is not an acknowledgment of displacement due to desertification, at least domestically. The United States does study the environmental displacement of populations due to desertification, but only as an indirect cause of migration from Mexico to the United States (Schwartz, 1994).

In summary, the United States does not acknowledge desertification as a substantial cause of population displacement. They do not have refugee mechanisms to accept environmental displacements, as they still call the few individuals they have recognized as migrants. This policy is inconsistent with the reality of dangers the nation faces from internal and external displacements of people due to desertification.

On international policy, The United States has ratified the UNCCD, but it has not created nor does it maintain an action plan, and it does not have a synergistic investment mechanism (United Nations Convention to Combat Desertifica-

tion [UNCCD], 2015). It does have a desertification monitoring system (UNCCD, 2015). The United States has also ratified the UNFCCC, but has no significant connection to desertification projects via this convention (UNFCCC, 2013). Finally, the United States has ratified the Paris Climate Accords, but its significance of its membership is at risk due to the resentment of the accords by the new Trump administration (“Donald Trump would ‘cancel’ Paris climate deal”, 2016).

Stakeholder Analysis

This section of the paper will outline the stakeholder positions of actors that have not been mentioned so far, or have not clearly had their positions developed. It will follow a general format of explaining the background of the actor, how the background connects to the issue of desertification and its refugees, with a final statement on the actor’s involvement with the policies and conventions discussed thus far.

Populations at Risk through Case-Studies

Two case-studies provide a stakeholder position for both the individual people who are facing the effects of desertification, as well as states that are suffering from similar effects of desertification. The Kingdom of Morocco provides an African stakeholder on the northern side of the Sahara-Sahel region. Conversely, the Republic of Chad provides a stakeholder of desertification on the southern side of the Sahara-Sahel region. Both have unique perspectives on the issue of displacement from desertification, and have conducted themselves differently on issues of policy.

The Kingdom of Morocco is a leader amongst the Africa Action Summit, as well as being the nation that is pioneering the counter-desertification project: Adaptation of African Agriculture. This nation is particularly prone to the effects of desertification because much of its economy is dependent on agriculture, which is itself dependent on unsustainable amounts of water use

(Karmaoui, Ifaadassan, Babqiqi, Messouli, & Khebiza, 2016). “Land classification in Morocco shows that 78 percent of the area (56,000,000 ha) is in desert and dry zones (annual average precipitation <250 mm/year)” (Karmaoui et al., 2016). Furthermore, Morocco also contains a population of over 33 million people (“Morocco,” 2016).

The Kingdom of Morocco has to be a leader on desertification because its existence is in jeopardy. The Saharan desert expands from the south east with every drought. These droughts place extensive stress on the already unsustainable amount of water usage. The majority of the Moroccan population depends on an agricultural economy that is vanishing due to the lack of fresh water and increasing temperatures. In this nation alone, there are potentially tens of millions of people who could be displaced. The Kingdom of Morocco has been utilizing funds from the Global Mechanism to fund counter-desertification projects like the Adaptation of African Agriculture. It is unlikely that these projects will halt all population displacement, they believe in the optimism of displacement prevention.

The Republic of Chad, while still being party to the UNCCD, UNFCCC, and the Africa Action Summit, has taken far less leadership on the issue of desertification. Additionally, their nation has been less innovative on the implementation of counter-desertification policies or projects. Their nation has roughly 14 million individuals, of which 11 million are located in rural regions (“Chad,” 2016). “Agriculture and livestock occupy about 73 percent of the workforce” (Food and Agriculture Organization of the United Nations [FAOUN], 2016). This section of the workforce is dependent on an average rainfall of 322 mm of rainfall per year (FAOUN, 2016). However, Chad has been experiencing historic droughts, and for the year of 2015, recorded only 135 mm of rainfall, compared to 350 mm of rainfall in 1950 (“United Refugees, 2016). Just as in Morocco, Chad faces a potential disaster of millions of displaced agricultural workers

due to the expansion of the desert and drought.

In both case-studies, the reality of impending population displacement is clear. What is less clear is the impact such displacement will have on the individual's livelihood, culture, and security. One comparison could be the nation of Syria. In the years leading up to the spark of the civil war, there was a historic drought (Weinthal, 2015). It forced ex-agricultural workers into the cities where they were confronted with unemployment, starvation, and the harsh reality of a dictatorship. The drought was one of the causes of a civil war which has spiraled out of control into the present world's worst humanitarian crisis. Armed factions splintered, allowing organizations like ISIS to take over, causing the massacre of societies like the Yazidi people (Cumming-Bruce, 2016). In Syria, livelihoods, cultures, and security have been lost, not to mention the millions of refugees who have been forced to flee. Because North African nations in the Sahara-Sahel region, like Morocco and Chad, have such a high dependence on agriculture, a significant loss in agricultural production would put entire economies and societies on the brink of collapse.

Europe

The European Union, as a political organization, is represented in the UN as an observer state (United Nations Regional Information Centre for Western Europe, 2007). Another component of its representation is held by whichever nation holds the EU presidency. Currently Slovakia sits as the President of the EU (European Council – Council of the European Union, 2016). On climate change issues, the EU holds itself most tightly to the Kyoto Protocol, which links them to an acknowledgement of policies limiting emissions. Such a standard does not directly link to desertification, but does indirectly link them to the UNFCCC. The UNFCCC then cooperates with the UNCCD's Global Mechanism, allowing the EU to fund FLEUVE, which generates funds for counter-desertification projects in North Africa. As a side note, for this paper

due to a criterion of relativity to desertification, the European Union will act as an umbrella for every member-state, unless they are specifically mentioned below.

France is a key European stakeholder because it held much of North Africa prior to the liberation of its colonial territories. One particularly strong link is between France and the Kingdom of Morocco. At the first Africa Action Summit, the President of France attended in support of the summits leadership by King Mohammed VI of Morocco ("Marrakech," 2016). France is a party to the UNCCD as well as to the UNFCCC, and the subsequent Kyoto Protocol and the Paris Climate Accords (Parkinson, 2015). The above agreements mean that France is an active financial partner with the Africa Action Summit and other counter-desertification policies.

Critically, though, Southern Europe, which includes France, and to a lesser extent the rest of the European Union, holds a hidden position on the issue of population displacement due to desertification. Due to past colonial connections, and many millennia of trade, many of the individuals facing desertification are going to be displaced further north into Europe, specifically the southern nations of Europe. It is in these nations' best interests to preemptively stop the issue of displacement before it leads to catastrophic population displacement. Or, at the very least, continue to ignore the gaps in legal protection of these affected populations. European societies are already buckling from the Syrian refugee crisis (Parkinson, 2015). The Syrian refugee crisis is an order of magnitude smaller than the potential tens of millions of displaced people from the Sahara-Sahel region.

The United States of America

The critical, so far undeveloped, stakeholder position of the United States is the uncertainty of Donald Trump's new administration. President Obama had a consistent record of support for the UNCCD and the UNFCCC, as well as initial support for the creation of the Paris Climate Accords (Somander, 2016). Donald Trump

has vowed to reverse President Obama's policies, calling for the removal of the United States from the Paris Climate Accords. The Heritage Foundation is expected to be one of the policy think-tanks that have the most influence on the Trump administration (Chemnick, 2016). Furthermore, the Heritage Foundation has been hard at work identifying withdrawal options out of the UNCCD and the UNFCCC, and their subsequent treaties and accords. Such a withdrawal, procedurally, would likely take more political capital than Trump is willing to spare. Nonetheless, even the thought or attempt would still deal a major blow to the support for counter-desertification projects. The tragedy, though, would be sentencing those at risk from desertification to a damned state of existence.

Regardless of the United States' official position in these international conventions and agreements, the Heritage Foundation provides some insight into the climate change policy of a Trump administration. Steven Groves, a policy analyst at the Heritage Foundation, was quoted as saying that "[American] national security issues from global warming is bullshit". Moreover, "everything caused by climate change is bullshit". The first quotation is in response to a question about the destabilization of population displacement. The second quotation is a general response on the validity of issues like desertification being caused by climate change. Overall, these quotations develop an understanding of where Trump's policies will stand on counter-desertification efforts.

Policy Recommendation

The policy recommendation will be consistent with the research question: how can the United States take unilateral foreign policy actions to address this substantially grave issue of desertification? Throughout this entire paper, the usage of the term 'refugee' to describe those who are being displaced due to desertification has been consciously avoided. The term was not used because a climate change refugee does not ex-

ist. This issue will be the first component of the unilateral policy recommendation. The second component of the recommendation will be the unilateral increase in financial support to conventions and their development groups, such as the Global Mechanism. The third component will be the necessity of signing onto the Rome Statute that established the International Criminal Court. Before any other step forward, refugee mechanisms must be addressed.

Refugee Mechanisms

"Illegal migration is not illegal, rather it is an asylum process issue" – Scott, Senior Refugee Analyst, Oxfam

There should be no such thing as an illegal refugee, so long as that person is not a war criminal. An individual fleeing their homeland because desertification has turned once arable land into uninhabitable desert is as valid of a reason for relocation, as is war and persecution. While the United States cannot solely amend the international definition of refugee, it can set the critical precedent of granting asylum to individuals based off of the reason of climate change. The fear of the slippery slope of a flood of refugees is overblown, as the United States has the capacity to handle several million refugees. If nations like Germany, that are a fraction of the total size and population of the United States can accept over one million refugees, then the United States can certainly handle many more (AFP, 2015). The issues of cultural and economic integration are valid concerns, but are separate issues from the attention of developing a solution for refugees fleeing desertification. Refocusing on refugee mechanisms, once the precedent of TPS has been set for climate refugees then an amendment can gain traction on the international stage.

The reason why Europe was heavily detailed in the stakeholder analysis is that they wield some of the most influential support within the United Nations. Furthermore, given the membership status that many EU nations have in NATO, as well as other military deals, and

trade deals, the United States could strong arm Europe into supporting the amendment of the definition of refugee. Also, this change would still be beneficial for Europe because they could have a greater level of control over the influx of refugees into their nations, rather than maintaining a system where refugees are scrambling to reach the land and many are dying along the way (International Organization for Migration, 2016).

Financial Support

A second issue that the United States can unilaterally address is the funding of the UNCCD, UNFCCC, the Global Mechanism, and the Adaptation of African Agriculture. As pointed out by Oxfam climate analyst, Sasanka Thilakasiri, there is never enough funding for development projects. The United States currently does not send any funds to the UNCCD and subsequently has no investments into the Global mechanism (UNCCD, 2015). The United States, similarly, sends very few to no funds towards the UNFCCC, or towards the Adaptation of African Agriculture. A revision of this strategy to begin to invest money into these conventions and policies would be an effective tool in improving the climate adaptation and climate resiliency in North African nations facing desertification.

While climate adaptation and resiliency have been lambasted in this paper, they are still effective strategies; we should not decide to simply abandon a third of the African continent to the Sahara-Sahel, but the reality is that many people are going to have to leave due to temperature increases that are beyond the point of return.

This funding strategy embraces a top-down and bottom-up approach. Funds sent to the overarching framework mechanisms of the UNCCD and the UNFCCC trickle funds down through the top, while direct investment into regional plans like the Adaptation of African Agriculture supports more localized plans. The two funding routes create a multi-faceted process towards reducing the effects of desertification.

Become party to the International Criminal Court

One of the inherent flaws in international agreements like the UNCCD and the UNFCCC is a lack of accountability. This is an issue that plagued the 10-Year plan of the UNCCD and the Kyoto Protocol of the UNFCCC. While the Adaptation of African Agriculture and the Paris Climate Accords look promising, they are not concrete policies. The United States should become party to the Rome Statute, which established the International Crimes Court (I.C.C.) to increase the accountability of other nations in adhering to the policies nations signed on to. While the I.C.C. has a troubled history with the continent of Africa, this is a separate issue to refugees of desertification. In fact, the United States would more than likely be focusing on nations like Europe to adhere to, hopefully, changes to the refugee definition which could include climate change as a reason for asylum. The United States' role in the I.C.C. could also be to ensure that the ratifying parties of the UNCCD and the UNFCCC are contributing funds and accepting refugees as needed. While it is essential to not become the 'world police', the United States for better or worse has a global leadership responsibility. It needs to use this leadership role to create and enhance accountability.

Limitations and Practicality of the Policy Recommendation

Given the upcoming stakeholder position of the United States under the Trump administration, the above recommendation seems futile at best. Nonetheless, given the research and analysis on the grave implications that millions of people in North Africa will encounter or are encountering, radical action is necessary. The above steps are all reasonable goals that the United States should adopt, and move about accepting them as soon as procedurally possible.

“There is nothing more un-American than being anti-refugee” – Michael Turner, legislative aid for Representative Adam Smith of Washington State

Conclusion

The Human Rights violations that refugees of desertification face are complicated and under-labeled. They are distorted not because these people are not suffering and are not going to be suffering, but rather because there is a void in protective policies that has led to the exclusion of their distress. There were 20 million new climate refugees in 2008. There are 17 million people fleeing desertification right now. There are 60-75 million potential refugees of desertification in North Africa. These are real people, not just statistics; they are children, young men and women, with families and their own life stories. Due to the limitations of researching an underrepresented region of the world, we are left mostly with estimations. One of the outcomes of this paper is to stress that these communities and regions have stories of struggle from desertification that need to be told and brought to global attention, and should not be marginalized as a number. Furthermore, a second major outcome is that the United States must take a unilateral role of leadership to mobilize other influential global players, specifically the European Union. Their proximity to this crisis places the EU in the best position to aid the millions of people that are fleeing desertification. Even without multilateral support, the United States must set a precedent of acknowledging and accepting refugees of desertification, they must pour funds into the international mechanisms that do exist, and they must stand ready to defend these international mechanisms and enforce their accountability.

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DOULA CARE FOR LOW INCOME AFRICAN AMERICAN AND LATINO MOTHERS IN A HOSPITAL SETTING

Christy Wyble

ABSTRACT: In the United States, African American and Latina women are 148% more likely than white women to experience birth complications such as cesarean sections and low birth weight babies. Implementing more support for birthing mothers during their hospital stay might decrease these outcomes. This support might be best found in a hospital based doula program that provides individual emotional and physical support to women throughout pregnancy and childbirth. This proposal will look at the current research on doulas and their positive impacts on low-income African American and Latina mothers.

Introduction

The World Health Organization currently recommends the country wide cesarean rate to be below 10%, though the United States' rate is currently at 32% (CDC, 2014). Of this frighteningly high number, low-income African American and Latina women are 148% more likely to undergo a C-section than white women (Bryant, Washington, Kuppermann, Cheng, & Caughey, 2009). High cesarean rates and low birth weight babies can lead to many other health complications for mother and baby that contribute to the dramatically high infant mortality rate in the United States (CDC, 2014). Implementing support for birthing mothers during their hospital stay might decrease their chances of having a poor birth outcome. Based on the high-risk factors for low income African American and Latino mothers, would the implementation of hospital staff doulas decrease their chances of birth complications, including cesarean-sections, low birth weight, and probability of breastfeeding? The existing research does not specify in what setting doula services could be most utilized, so this proposal will look at the role doulas play in positive birth outcomes and how their implementation might decrease negative birth outcomes for high-risk African American and Latino women.

Background

A doula is someone who provides emotional and physical support to pregnant women throughout pregnancy and childbirth. They are typically not healthcare providers and do not assist with clinical tasks, but are trained and experienced in navigating hospital systems (Simkin, 2012). Predominantly women, doulas are usually unaffiliated with hospitals or other organizations besides certification boards, and promote their services independently (Ahlemeyer & Mahon, 2015).

Most doulas are certified through DONA (Doulas of North America) International, an organization that upholds the ethics and standards of care for practicing doulas. Through DONA's training intensive, students learn how to communicate with laboring mothers, develop an understanding of the psycho-emotional experience of childbearing, and study breathing techniques, positioning, and other measures to reduce pain and enhance labor progress (Simkin, 2012). As well as attending the certification intensive, potential doulas are required to attend a breastfeeding class, read extensive materials on maternity and childbirth, and attend three births with positive evaluations from mothers and hospital staff (Simkin, 2012).

Scientific studies have found that doulas play an extremely positive role in healthy birth out

comes. In a study published in the *Journal of Perinatal Education* in 2013, Gruber et al. found that doula-assisted mothers experienced significantly higher newborn birth weights and breastfeeding rates, and experienced half as many childbirth complications than mothers without doula care (Gruber et al., 2013). An evaluation of disadvantaged women who were given the option of using a doula throughout pregnancy were significantly less likely to need a cesarean section, as well as less likely to smoke during pregnancy (Spiby et al., 2015). A 2008 study at Boston Medical Center also found doula support to significantly decrease the rate of cesareans, while increasing breastfeeding initiation rate (Mottl-Santiago et al., 2008).

Methods

Study Design

A cross-sectional design would be used to research this topic. Cross-sectional could be easily applied to mothers who recently gave birth in order to collect information about their birth outcomes and experience with a doula, which would only need to be collected once. It would be the least invasive for the mothers, who recently gave birth and do not have much time to be involved in research, as well as keeping them anonymous. It would also be the least expensive form of research, and could easily be accomplished by a single survey.

Population

This proposal will study women between the ages of 20-50 who are Latina or African American. They will have had to give birth using the services of a doula, in a hospital that has a volunteer doula program or offers free services of doulas, so that cost of using doula's services is not a variable. This research will look at this population of women, who gave birth in a hospital, in three different free doula programs in the Seattle area, University of Washington Medical Care Doula Care, Open Arms Perinatal Services, and Sea Mar Community Health.

Sampling

This research would use a purposive sampling method to conduct data about the mothers. The research would be based on women who have previously used the services of a doula while giving birth, and from Latina or African American backgrounds.

Ethical Considerations

Ethical considerations that will be accounted for are keeping the mothers anonymous. This will be easily accomplished by collecting data through a survey, so their identity is not needed. They will be providing personal information about their birth experience and their experience with a doula, they will not need to fill out a consent form. This research will need to be reviewed by the IRB (institutional review board) because the study will be collecting data from human subjects. Participation in this research will be voluntary and the mothers can choose to fill out as much of the survey as they deem appropriate.

Measures and Materials

The independent variable in this study is doula use. Women in this study will all have used the services of a free doula program in a hospital setting and will be selected based on that criterion. The dependent variable in this study will be birth outcomes. This will be measured in a survey based on if the mothers received medical interventions such as cesarean sections, forceps use, or induction. Women initiating breastfeeding will also measure birth outcomes.

Procedures and Analysis

Data will be collected by a survey using qualitative and quantitative questions. The survey will be distributed via an online survey host, which is more convenient for mothers who are busy with children, than a mail or phone survey. Mothers will be asked questions about prior to their birth, for example, if they were at risk for any complications or medical interventions as well as their age, ethnicity, annual income, and

if they had insurance or used Medicaid. They will be asked questions about their overall birth experience: did they use pain management, such as epidurals, induction, or forceps? As well as the final outcome of their birth: did it end with a cesarean section or a natural birth? They will be asked questions about the use of their doula: did the doula make them feel more empowered about their birthing experience, was the doula knowledgeable about the birthing experience, and if so, did she help you with coping measures regarding pain, fear, and breathing techniques?

Discussion

Significance & Implications

This research is important because implementing doulas into the healthcare system could dramatically decrease the need for medical interventions during birth for the women who are at the most risk of interventions: Latina and African American women. These women, according to the CDC, are almost twice as likely to lose a baby in the first year of life than a Caucasian woman (Willams, 2013). Implementation of doulas into the healthcare system could not only potentially decrease medical interventions, but could also decrease infant mortality rates.

An analysis of women who gave birth during 2011 and 2012 found that black and Latina, primarily Medicaid funded women, were twice as likely to want a doula but were unable to access one because of financial reasons (Kozhimannil et al., 2014). An analysis of birthing mothers undergoing chronic financial stress was done and found that low-income status was significantly associated with delivery of low birth weight babies (Borders, Grobman, Amsden & Holl, 2007). The most at-risk group of women, those who would benefit from a doula's services the most, do not have access to them. Furthering the research done on the benefits of doulas will encourage hospitals to adopt doula programs.

On average, giving birth in a hospital with insurance costs \$37,000, which is mainly covered by the insurance company. Giving birth

with Medicaid costs \$35,000, which is paid for by the government (Truven Health Analytics, 2013). Many women giving birth in this population use help from government assistance, in the form of Medicaid. If doulas could decrease the need for medical intervention, the overall cost of birth would be less. A study found that on average, total maternity costs were 40% lower for vaginal births when compared to cesarean births for both Medicaid and privately insured people (Truven Health Analytics, 2013). This study also found that both insured and Medicaid members paid 100% more for cesarean than vaginal births (Truven Health Analytics, 2013).

States have started to realize the tremendous cost of women giving birth in hospitals and ways they can decrease this cost, especially if they are paying for it through Medicaid. Oregon is the first state to start reimbursing women for their services as doulas, which is in the direction of doulas being covered by Medicaid ("Oregon Health Authority", 2015). The doula has to be certified through an accredited program and has to be working under the authority of a Medicaid provider ("Oregon Health Authority", 2015). The more states start to realize the savings and benefits of doulas, the more they will start on the path to reimbursement and the more women can reap the benefits of doula services.

Limitations

Using a cross-sectional study design works fairly well for gathering data for this research proposal. Some limitations from it might be not controlling all the variables. For example, women who chose to utilize the doula services at these hospitals had to self select into the group of women choosing doulas. There is no way to force a woman to use a doula during birth because it is a very personal experience. The women who chose to have a doula present might be predisposed to not use pain medication and want more of a natural birth experience which could skew the data.

Another limitation might be that the study is

only looking at three free doula programs in the Seattle area. This may lead to a smaller sample size of women of color using free doula services, as opposed to other parts of the country where there is a larger population of African American and Latina women. One last limitation is that I would be looking at three different free doula programs. Since these programs are not identical, the services they are providing could lend for different experiences for the mothers.

Future research

Doula work is an emerging area of care that is quickly spreading as women and medical providers are realizing the benefits. While a significant body of work exists on the emotional effects of doula care on the birthing mother, potential further research could be done on other positive birth outcomes associated with doulas. One of these under-researched areas is on increased doula support throughout pregnancy, not just during birth, and the positive outcomes that may be associated. Research could also be done on the benefits of a doula visiting mothers multiple times following birth, known as a post-partum doula. Both of these research topics could look at the doula's role in affecting infant mortality rates in the United States.

With regard to the previously discussed financial benefits of natural birth over caesarian sections (Truven Health Analytics, 2013), financial savings from the reduction of caesarian sections may incentivize doula care. Cost comparisons may yield pathways towards using doulas as a means of financial savings for medical institutions. As medical systems shift towards recognizing the benefits of doula care, we may see more hospitals implement doulas in the birth team, which would open doors for future research to be done on their benefits.

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ACCESS TO PHYSICAL EDUCATION IN HIGH SCHOOLS AND CHILDHOOD OBESITY

Qendresa Hasani

ABSTRACT: Childhood obesity is a major public health issue that affects adolescents all over the United States. Studies show that Americans' average weight has increased since 1970s; for ages 2 to 5 obesity has doubled and nearly tripled among youth ages 6 to 19. According to the information collected by Interlake High School representatives, it appears that IHS more than fulfills students' physical education needs because they have a robust physical education implementation program and that all high schools should provide to their students. Random sampling will be used to study Interlake High School students with a wide range of ethnicities. This research proposal will include analyzing data from the Healthy Youth Survey and the Bellevue School District. In this research proposal, the research question is: Is there a relationship between the access of physical education in high schools and childhood obesity, specifically for grades 9-12?

Introduction

Obesity is a major public health issue in adulthood and childhood. Obesity is measured by Body Mass Index (BMI), which is calculated based on a person's height and weight; a BMI of 30 or over is categorized as obese (Public Health England, 2015). Americans' average weight has increased since the 1970s and prevalence of childhood obesity has more than doubled among children ages 2 to 5 and nearly tripled among youth ages 6 to 19 (National Institutes of Health, 2013). There are many factors that lead to obesity such as easier access to unhealthy food and an inactive lifestyle with little or no physical activity (LifeSpan, 2013). However, the lack of physical education in schools contributes twice as much as the previous factors to childhood obesity (National Institute of Health, 2013). Physical education helps people be more physically and mentally active, be medically healthy, gain self-confidence, do better in schools, and be more sociable (PHIT America, n.d.). The access of physical education in high schools provides many benefits to children, including helping them maintain a healthy body weight and be able to better stay focused. From the research I have done I found that Interlake

High School is a great example of a good physical education model which promotes higher academic performance, an active lifestyle, and lower obesity rates.

Studies show that King County has a moderate percentage of obesity in high school students compared to other counties in Washington State (Healthy Youth Survey, 2012). Healthy Youth Survey (HYS) is a statewide survey that measures the health threats that lead to death, disease and public issues among adolescents in Washington State. According to the HYS data of 2010 and 2012 for grades 8, 10, and 12 show that King County had the same percentages (8%) of obesity in high school students as Seattle (8%), but relatively lower percentages than Washington State (10%) high school students. Other data from Interlake High School shows that the percentage of high schools with more than 60 minutes of physical activities per day for King County was the same as for Seattle high schools (23%), whereas Washington State had a higher percentage of physical activities in high schools (26%). In 2013, the Healthy Youth Survey shows that the King County obesity rate has increased by age, including a 10% increase for 18-24 year olds, 21% for ages 25-44, 27% for ages 45-64, and 22% for ages 65+. How-

ever, according to The Seattle Medium Newspaper (2015), in 2014, Public Health and King County school districts worked together to reduce obesity in youth by 17%. This was done by applying an obesity prevention initiative that increased healthy practices among middle and high school students. The aim was to provide communities with healthier food choices, access to public parks, recreational trails, create more sidewalks, limit the marketing of fast food and increase access to physical education in schools (The Seattle Medium Newspaper, 2015).

While there is a lot of research about the presence of physical education in high schools, there should be more research about how each high school can have a successful implementation of physical education. For example, Interlake High School (IHS) in Bellevue is of particular interest because of its physical education implementation. Its enrollment is very large, 1503 students as of the 2014-2015 year, for grades 9-12 (Interlake, 2015). Data will be provided regarding obesity rates and presence of physical education (PE) in Interlake High School later in this paper. In this research proposal, the research question is: Is there a relationship between the access of physical education in high schools and childhood obesity, specifically for grades 9-12? The hypothesis is that high schools that lack physical education are more likely to have higher rates of obesity.

Background

Providing requirements for physical education in high schools helps reduce the prevalence of childhood obesity. According to the PE department representatives, Melissa Leibole and Christina Madden, IHS provides a lot of outdoor facilities for its students such as a grass football field, baseball and softball fields, seven tennis courts, and three indoor gyms. (Interlake, 2015). These representatives mentioned that ninth graders are required to do approximately 22 hours of PE per month. In addition, 10-12 graders can take PE electives, such as weight

training, personal fitness, racquet sports, and basketball. Furthermore, data was provided about the obesity rates of 9-12 graders at IHS from the Healthy Youth Survey. In 2014, the obesity rate of children in grades 9-10 was 5%, compared to the statewide student rate at 11%. And students in grades 11-12 had a rate of 9% compared to the statewide student obesity rate of 11%. As a result, this data demonstrates that students at IHS are positively affected by physical education. This is a move in a positive direction. If more physical education is implemented in schools, the students will be more active, will have a higher academic performance, and have lower rates of obesity.

More PE in schools leads to decreased obesity rates and higher academic performance. Tonetti, Fabbri, Filardi, Martoni, and Natale (2015) explain the association between overweight students and poor academic performance in high school. This study intended to determine whether sleep quality, sleep duration, socio-economic status or BMI affected students' grades. In this study, thirty-seven high school students from the United States participated; their BMI was measured as well as their quality and duration of sleep by using actigraphic recordings. School performance was measured based on the grade of the final exam that students took. A higher grade meant higher school performance. The results showed that BMI was the only negative predictor of grades. Obesity and poor academic performance are related because obese children are more likely to have a sedentary lifestyle while watching television, among other factors (Harvard T.H.Chan, n.d.). Tonetti et al., continue that when children performed poorly on the final exam, there might be other factors that would affect performance such as family income, race, sex, parents' education level, and job status. IHS was ranked the fifth school in the state based on SAT scores for 2010-2012, which it may have been affected by high investment in physical education (Sung, 2015).

If healthier food choices are provided in schools, students will be more active, will be

healthier, and have lower rates of obesity. Story, Nannery, and Schwartz (2009) explained that there is access to unhealthy foods in schools such as vending machines, local stores, and school lunch programs. This study examined the presence of foods, snacks, drinks that contain high amounts of sugar and fat, and the duration of physical education in all high schools in the United States. The results show that in all high schools, the availability of unhealthy foods, snacks, and drinks that contain high amounts of fats, sugars, and energy is higher than the availability of fruits and vegetables. Moreover, Story et al. (2009) suggest that in most schools there is not enough time for physical education, and little access to high-nutrient foods and healthy drinks. Also, since there is easy access to energy drinks, drinking water is neglected. Although there is a lot of unhealthy food consumption, the presence of physical education and activities in schools are able to balance the issue of obesity.

Research demonstrates providing requirements for physical education in all high schools helps to reduce the prevalence of childhood obesity. Kahan and McKenzie (2015) note that the quality of physical education programs in schools helps students develop their skills, concepts, and dispositions needed to be physically active for life. Additionally, in order for physical education to increase, students' energy expenditure in physical education class needs to be longer in duration. Other factors that may lead to obesity include unhealthy foods in schools, their parents' low income, poor neighborhoods, and the school's location. Leibole (2015) suggests that sufficient and regular physical activities not only help prevent major diseases, but also promote learning, reduce stress, depression, and improve overall wellness. Interlake's rate of obesity is lower than statewide high schools because they have a robust physical education implementation program (Leibole, 2015).

According to the information collected by IHS representatives, it appears that IHS more than fulfills students' best interests and this is what all high schools should provide to their students.

Looking at the relationship between physical education in high schools and obesity, it can be concluded that students at IHS are positively affected by physical education. On the other hand, high schools that lack yearly physical education requirements for students are more likely to be negatively affected by obesity. Also, increased availability of fruits, vegetables, whole grains, and low-fat dairy products as components of school meals may be an effective strategy to promote healthy eating behaviors among children.

Methods

Study Design

This research proposal will include analyzing data from the Healthy Youth Survey and the Bellevue School District.

Population

The target population is students enrolled in the Interlake High School, Bellevue. The study sample is 100 students, grades 9-12, ages 14 to 18.

Sampling Method

Random sampling will be used to study Interlake High School students with a wide range of ethnicities. The sampling process will include reviewing pre-existing data from the Healthy Youth Survey, asking students questions such as listing the types of food they eat every day in school, how often they eat, and whether they eat school lunch or bring their own lunch. Also, data will be retrieved regarding obesity rates from the school.

Ethical Considerations

Student participation in the study is anonymous and voluntary; there will be no harm to participants. There will be an assent form for children who are under 18 and a consent form for students' parents/ guardians. Additionally, an IRB review from the school district will be obtained.

Instruments

The most important independent variables in this study are diet and access to physical education. Diet will be measured by observing how often students eat and the type of food each student consumes during lunch time each day. Also, it will be observed whether students consume school lunch or bring their own lunch to school. The amount of physical education will be measured by observing how often students do physical activities in school and how often students visit gyms and parks. PE teachers will be asked how many students they have data for on required PE classes. The most important dependent variable in this study is BMI. The increase in BMI will be measured by getting the weight and height of each student in order to get the BMI; students with BMI over 30 will be considered as obese. The access to healthy foods will be measured by observing the quality of food in neighborhoods and asking about parents' income levels. Another important dependent variable is childhood obesity, which will be measured by asking each student their weight and height, and getting their BMI.

Procedures

Data will be collected by reviewing existing records from the Healthy Youth Survey along with a questionnaire asking students the type of foods they eat, how often they eat during the day, how often they eat vegetables, how often they have PE, and visit trails and parks. Data will be also collected by observing students from the beginning to the end of their lunch time. The timeline for this study is as follows:

- January to March 2016: Obtain IRB, conduct literature review, examine Healthy Youth Survey, prepare assent & consent forms, and survey questions.
- March to April: Observe and collect data from Interlake High School students.
- April to May: Results, analysis, write-up & disseminate data.

Dissemination: Write-up results around April 2016 and complete the poster by May 2017.

Analysis

This study will use a quantitative analysis method because there will be questionnaires used to gather information from multiple participants on their eating habits and physical activities. The questionnaires seek to ask questions such as whether students ate vegetables last week, chicken and rice, burger and fries, macaroni & cheese, number of servings of fruits or vegetables per day, etc.

Also, students' height and weight will be asked to calculate their BMI, which will be compared with the school district's data using the following formula: $\text{weight (lb)} / \text{height (in)} \times \text{height (in)} \times 703$ (BMI Formula, 2015).

Discussion

Significance & Implications

Maintaining a healthy weight is not always easy. Obesity as a major public health concern takes its toll on human life and requires research, education, implementation of cures, ameliorating care, and surgeries. The key to success is making changes in daily eating and physical activity habits that can be maintained over children's lifetime. Since high school students spend most of their time in school, this is an important opportunity to make changes to their eating and nutritional behaviors. Moreover, obesity is more than simply an individual problem; it has become a community problem, driving up health care costs and decreasing productivity (Minnesota Department of Health, 2014). Communities play a significant role in improving the health of its members by increasing healthy choices through efforts such as building proper sidewalks in neighborhoods, increasing physical education in schools, increasing access to healthy foods in schools, and in communities. Improving the nutrition standards for foods offered in competition with federally reimbursable school meals may enhance the positive effects of school meal programs on student eating behavior. Also, implementing a successful physical education program at all high schools may lead to reduced childhood obesity.

Limitations

There are some issues related to this study design, including choosing a representative sample which should represent the whole population. In addition, the sample size should be sufficiently large enough to estimate the prevalence of the conditions of interest with adequate precision. Furthermore, non-response is a particular problem affecting this study and can result in bias of the measure of outcome.

Directions for Future Research

Childhood obesity has been considered by researchers as one of the most serious public health concerns of the 21st century and with good reason. It can harm nearly every system of child's body, including, social and emotional aspects. Providing opportunities for physical education in all high schools, healthy nutrition, access to clean water, and quality medical care will help reduce the rates of childhood obesity. Based on all the information compiled, it appears that childhood obesity is negatively related with physical education, healthy nutritional behaviors, access to trails and parks, and proper sidewalks. In many ways, choosing this topic is an expression of passion for the public health field and shows a desire to help reduce obesity rates in young children. Having the opportunity to be involved in this research proposal will provide the educational base needed to help people, and to understand and maneuver the policies, local laws, social customs, and other forces that might contribute to a successful reduction in childhood obesity rates. This exploratory proposal to reveal why the IHS program works can help researchers replicate its success and apply it to other high schools in King County, particularly those that have low-income students, and make it easier for those students to maintain healthy minds and bodies. Exploring in depth why the IHS program works and examining data from King County and the Healthy Youth Survey on childhood obesity, can help high schools in lower income neighborhoods benefit from IHS' success. Learning what works and apply-

ing it to schools with higher rates of obesity can help those schools reduce obesity rates among their students.

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EXPERIMENTAL APPLICATIONS OF DIFFERENTIAL SCANNING CALORIMETRY TO TEST AND CHARACTERIZE POLYMERS AT THE UNIVERSITY OF WASHINGTON BOTHELL

Kaleb Dempsey

Under the direction of John W. Bridge Ph.D. P.E.

ABSTRACT: Differential Scanning Calorimetry (DSC) is used for analyzing the thermal properties of polymeric materials used in many engineering applications. The data produced by DSC generates a heat flow curve that reflects the amount of energy required to heat a sample per degree Celsius over time, and heat capacities can be calculated. In addition to comparing enthalpies (Δh) for different materials, DSC is also a powerful tool to determine other important material characteristics such as melting temperatures (T_m), thermal glass transition temperatures (T_g), degree of crystallinity, and environmental oxidation. Also, the use of DSC coupled with other analytical techniques, such as Fourier Transform Infrared Spectroscopy (FTIR), Gas Chromatography (GC), and Nuclear Magnetic Resonance (NMR) spectroscopy, gives insight to changes in material molecular composition. This paper describes several projects at the University of Washington Bothell where DSC was effectively utilized to evaluate actual industrial and sports applications of various polymers with the goal of understanding their respective thermal properties. The hands-on experience facilitates making connections with material science concepts learned in-class, and emphasizes the importance of material selection that engineers are involved with throughout their careers. Projects discussed involve degradation mechanisms in hydrocarbon-based binders used in sport track surfaces, analysis of premature cracking and failure of polyurethane molded covers used in electrical transformer housings, determination of an unknown polymer used in high temperature fluid filtration systems, and comparisons of poly vinyl-acetate adhesives used in composite materials.

Introduction

Differential Scanning Calorimetry (DSC) is a useful tool in analyzing chemical and thermal properties of polymeric materials against a reference sample. A polymer is defined as a compound of high molecular weight in which the structure is composed of small repeating chains (Callister, 2014). Generally, these chains consist of hydrocarbons with additional side groups of other atoms known as impurities. An example of an impurity is an oxygen or chlorine atom bonded to a small chain of hydrocarbons. Between chemical structure and various impurities, different physical properties of polymers exist. Such properties include strength,

hardness, and thermal behavior. Polymers are classified into two categories when the thermal behaviors of polymers are considered: thermoplastics and thermosets. Thermoplastics exhibit linear chains of hydrocarbons that soften under heating whereas thermosets show cross-linked chains that maintain rigidity under heating (Callister, 2014). Understanding polymeric structure helps identify and characterize a sample by its structure, which is related to its crystallinity, a state in which periodic and repeating atomic arrangement is achieved by molecular chain alignment. However, to characterize a polymer's properties, appropriate analytical techniques are required, such as the use of a DSC. A DSC machine (Figure 1) works by measur-

ing the amount of heat flow through a sample directly in conjunction with a feedback loop to maintain a set temperature. The power required to maintain a specific temperature is recorded against a reference sample in the DSC (Perkin Elmer, 2013). The measurements taken by the DSC machine create a thermal profile of a given sample by recording either energy absorbed or released versus change in temperature or time, respectively. In the generated curve from the DSC endothermic peaks often result such as the one shown at 30 °C for the n-octadecane sample in the DSC scan shown in Figure 2. These endothermic peaks are produced because the sample at that heating point requires more energy input from the DSC to retain the same temperature between the sample and reference sample (Perkin Elmer, 2013). From this profile created at the end of each experimental run, the following properties can be attained:

- heat capacity
- enthalpy (Δh - the internal energy of the material)
- melting temperatures (T_m - the temperature at which a solid phase transitions to the liquid phase)
- thermal glass transition temperatures (T_g the temperature at which a non-crystalline polymer transforms from a super cooled liquid into a rigid glass)
- percent crystallinity

From these tests, various polymer characteristics can be determined such as oxidative degradation over time (Callister, 2014). Another advantage of the DSC is the short time required for analyses with average experimental run times ranging between 10 and 60 minutes depending on test specifications. The information provided by DSC helps to understand how different materials may change over time or give insight into process history. Additionally, polymers can be identified, characterized, and compared with one another. When coupled with other analytical techniques such as Fourier Transform Infrared Spectroscopy (FTIR), Gas Chromatography (GC) and Nuclear Magnetic Resonance (NMR)

spectroscopy, greater insight into changes in materials molecular composition can be inferred.

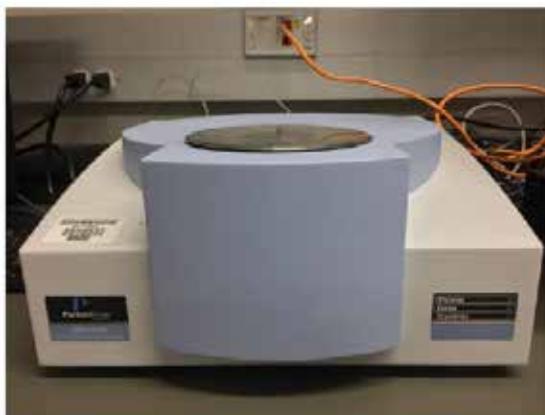


Figure 1: A Perkin Elmer Differential Scanning Calorimeter (DSC) 6000 used at University of Washington Bothell (UWB).

The University of Washington Bothell (UWB) Materials Testing and Characterization Lab (MTCL) began in January 2015 testing multiple polymers using our DSC machine. This paper provides four examples of how the DSC is used in the MTCL and involve; 1) phase changes and oxidative degradation in hydrocarbon-based binders used in sport track surfaces, 2) pre-mature cracking of polyurethane molded covers used in electrical transformer housings, 3) the determination of an unknown polymer used in high-temperature fluid filtration systems, and 4) comparisons of poly vinyl-acetates (PVA) used as a resin in a composite material. The techniques used involve creating a thermal profile of energy absorbed versus rise in temperature and then determining each sample's Δh , T_m , or T_g . Conclusions were drawn after determining each material's thermal properties over multiple DSC runs.

Materials and Experimental Methods

The DSC machine used was a Perkin Elmer DSC6000 with power compensation under nitrogen flow (20 mL/min) and Intracooler SP that allows cooling down to -70 °C. For all DSC projects, approximately 10±1.0 mg samples are placed into a small aluminum

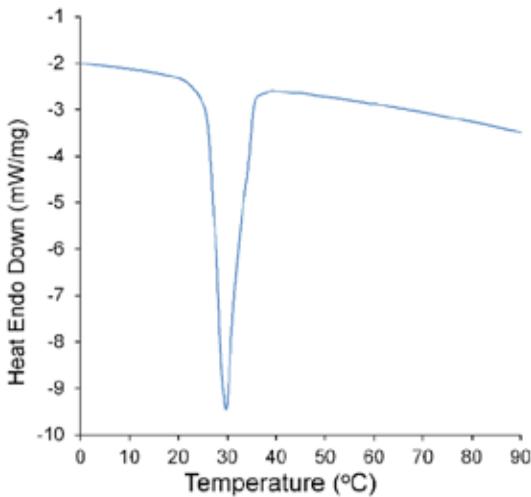


Figure 2: DSC Scan of n-Octadecane wax with an endotherm pointing downwards at 30°C.

sample pan. The sample pan with a press-fitted lid (using a crimping device) is placed into the furnace section of the DSC machine (Figure 3).



Figure 3: Placement of the aluminum sample pan into the furnace of Perkin Elmer DSC 6000 against a reference pan.

Test parameters are then entered into the DSC's operating program called Pyris Manager. Typical parameters entered are the samples mass, desired heating and cooling ranges, and the duration of holding at specified temperature(s). The length of each test is dependent on each step added to the program and the temperature difference between heating and cooling. In a typical test, a sample is heated or cooled at 10 degrees Celsius per minute. Additionally, the sample is held at a desired temperature for at least one to two minutes between heating and cooling cycles to ensure a uniform temperature throughout the sample. Upon completion of a run at a desired temperature range, a generated curve of Heat Flow (mW) vs. Temperature (°C) with the endotherms pointing downwards is produced (Figure 2). Furthermore, the data can be normalized by dividing the Heat Flow by its mass

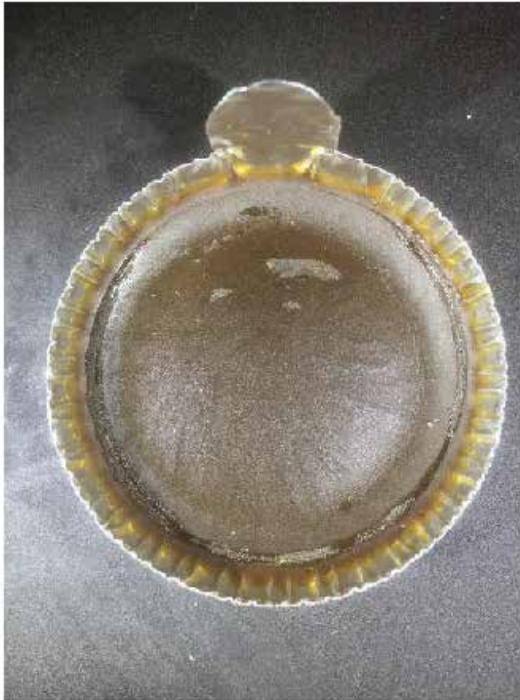
to compare between DSC runs. From this generated graph, the enthalpy (Δh), thermal glass transition temperature (T_g), and melting point (T_m) can then be determined in accordance to the American Society of Testing and Materials (ASTM) standards and specifications.

Oxidative Degradation in Hydrocarbon-Based Binders Used in Equine Sport Track Surfaces

DSC use at UW Bothell began with testing hydrocarbon-based binders used in equine sport track surfaces. These surfaces consist of granular composites made from sand, polymer fiber, rubber, and a high-oil paraffin wax binder. An extracted sample of the binder as well as a typical racetrack surface, before and after oxidation, can be seen in Figures 4 and 5. The aim of this ongoing investigation was to analyze the hydrocarbon-based binder to help determine and quantify oxidative degradation of the binder that holds the granular composite material together. It is hypothesized that binder degradation leads to reduced performance of the track surface over time. Over 50 DSC runs of this material have been completed with samples taken over a seven-year period from one thoroughbred horse racetrack. This test was conducted in accordance with ASTM Standard D4419 (ASTM D4419, 2005) and D7414 (ASTM D7414, 2009). After each test method was performed, only the heat flow from the last heating cycle was analyzed. All data was normalized, the enthalpies were calculated, and the transition temperatures were recorded using the intersection of tangents on the slopes of the endothermic peaks pointing downward.

Test Method Applied

1. Heat from 30 °C to 94 C at 10 °C/min
2. Cool From 94 °C to -30 C at 10 °C/min
3. Hold Temperature for 2 min at -30 °C/min
4. Heat from -30 °C to 94 C at 10 °C/min



Premature Cracking of Polyurethane Molded Covers Used in Electrical Transformer Housings

This project involved analyzing the material in an attempt to understand the premature cracking of a polyurethane molded cover used in electrical transformer housings (Figure 6). This material is subject to outdoor environmental exposure. Failure in the original specimen was reported to be occurring near a mounting point of the molded cover. It is to be noted that the area of failure was not tested due to insufficient data on the material. In this experiment, initial interest was in finding the thermal glass transition temperature (T_g) value of the polyurethane as well as the melting characteristics. Changing T_g and melting points can indicate chemical changes to the polymeric structure over time. The aim of this investigation was to determine if the polyurethane cover was the best choice of material for this outdoor applica-

Figure 4: An example of hydrocarbon-based binder used in equine sport track surfaces produced from Soxhlet extraction.

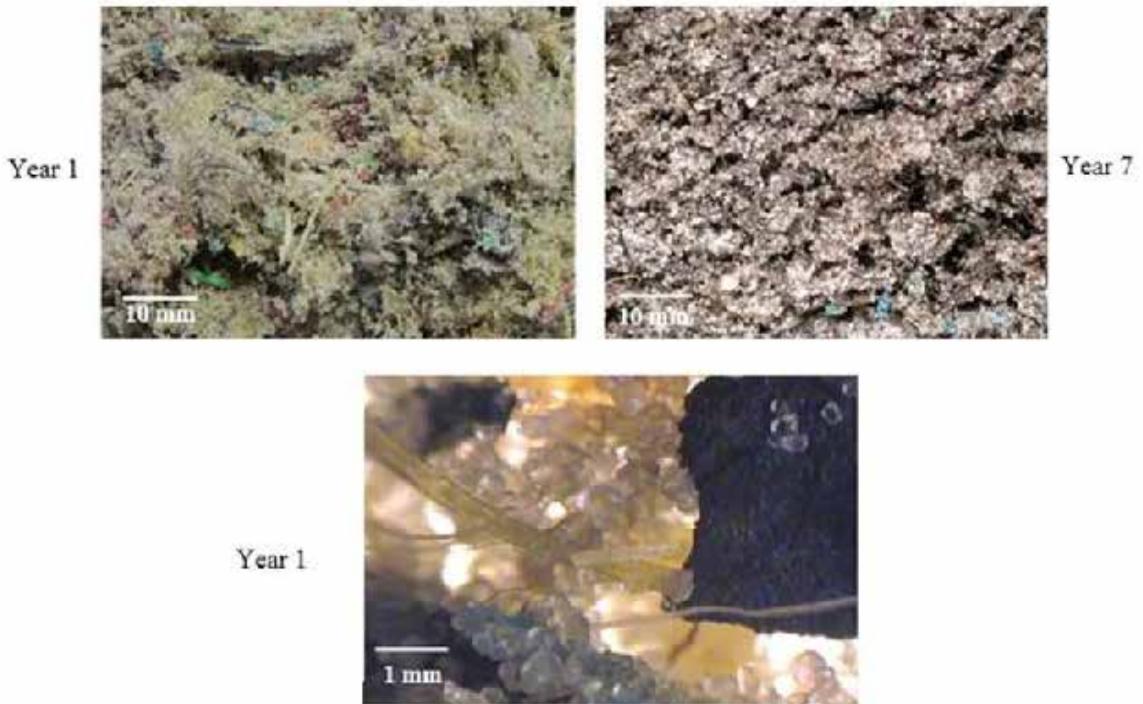


Figure 5: Photos of hydrocarbon-based binder coated track material taken from Year 1 and Year 7 surface (same track). Silica sand particles are mixed with binder, polypropylene fibers and rubber (black) particles. The darker appearance of the Year 7 sample is attributed to binder oxidation over time. A thin layer of binder covers all components and can cause local clumping of sand particles as seen in the lower magnified photo [8].

tion. Each sample was extracted with a surgical razor blade from the sample show in Figure 6 by shaving off an approximately 10 mg mass sample. There was no specific test specification called out for this application. Only one increasing heating run was involved in each sample run.

Test Method Applied:

1. Heat from -20 °C to 120 °C at 10 C/min
2. Calculate transition temperatures and melting enthalpy



Figure 6: A sample of the polyurethane molded cover used in electrical transformer housings.

Determination and Characterization of an Unknown Polymer Used in High-Temperature Fluid Filtration Systems

This project involved the identification of an unknown polymer used in high-temperature fluid filtration systems (Figure 7). The goal for this project was to determine the melting point temperature (T_m) value and compare with known values of adhesives used in similar high temperature fluid filtration applications. Each sample was prepared by cutting the adhesive used as the base of the filter membrane. The remaining fibers on the adhesive were carefully extracted by further cutting and filing. Once all fibers were successfully removed from a strip of adhesive, approximately 10 mg samples were cut and placed into the aluminum sample pans. All runs performed on the material were performed in accordance to the ASTM D3148

specification (ASTM D3148, 2003).

Test Method Applied:

1. Heat from 120 °C to 250 °C at 10 °C/min
2. Hold for 5 min at 250 °C
3. Cool from 250 °C to 120 °C at 10 /min
4. Hold for 5 min at 120 °C
5. Heat from 120 °C to 250 °C at 10 °C/min



Figure 7: The unknown polymer in filter membrane. The membrane fibers were removed with a file to analyze the unknown polymer in the DSC.

Poly Vinyl-Acetate Polymer Comparisons

This last example involved comparisons of three separate poly vinyl-acetate adhesives that showed various degrees of ductility (Figure 8). This was accomplished by determining the thermal glass transition temperature T_g of each sample. The goal was to determine differences in the three materials, and if a potential replacement material possessed a suitable T_g and adequate thermal characteristics for the given application. The T_g values were determined from the DSC by deducing the midpoint temperature per ASTM Standard E1356 (ASTM E1356, 2008). Each sample was prepared by cutting an approximately 10 mg sample and placing them into the aluminum sample pans.

Test Method Applied:

1. Cool from 20 °C to -20 °C at 10 °C/min
2. Hold for 1 min at -20 °C
3. Heat from -20 °C to 60 C at 10 °C/min



Figure 8: Oven Cured 7g Samples. Samples 1-3 are laid out from left to right. Sample 1 was bent over to show ease of deformation. Samples 2 and 3 show cracking and were brittle.

Results and Discussion

The Oxidative Degradation in Hydrocarbon-Based Binders Used in Equine Sport Track Surfaces Results

Figure 9 below shows two DSC curves of the wax binder extracted from the same thoroughbred horse racetrack but 6 years apart. This hydrocarbon-based binder is used in many equine sport track surfaces and is suspected to degrade over time. Note per Figure 9 that during the first year when the surface was first installed, the binder melting enthalpy was found to be 7.7 Joules per gram (J/g), the first transition temperature 23.5 °C, and the second transition temperature 63 °C. Six years later, after exposure to factors such as racing, track harrowing, and weather, the enthalpy decreased 34% to 5.1 J/g suggesting a decrease in crystallinity over time. It is also worth noting that the second temperature transition peak at approximately 63°C fades away over the seven-year period. This second transition region correlates to higher molecular weight hydrocarbon-based molecules that have higher melting temperatures (Bridge, 2015) In conjunction with other analytical testing methods such as gas chromatography, the results are consistent with decreasing crystallinity as hydrocarbon chains scission (Bridge, 2016). Testing at UW Bothell

enabled the hypothesis that oxidation is the primary degradation mechanism in the composite binder and is most likely due to ultra violet (UV) radiation. Future testing will be conducted after artificially exposing a first-year stockpile of the hydrocarbon-based binder with UV radiation to mimic the effects of accelerated weathering.

The Premature Cracking of Polyurethane Molded Covers Used in Electrical Transformer Housings Results

As shown on the DSC scan in Figure 10, the thermal glass transition temperature was approximately 29.2 °C. Thus, temperatures greater than 29.2°C will result in changes to the polyurethane's mechanical properties, such as unexpected softening, which can result in reduced load-carrying capability or reduced sealing performance which would be of a concern in an outside environment. Other concerns are related to ductility or lack of, different coefficients of expansion, and accelerated aging. Additional failure considerations that DSC can help detect in this application include incomplete mixing of the polymer components, incomplete curing, or both during manufacturing.

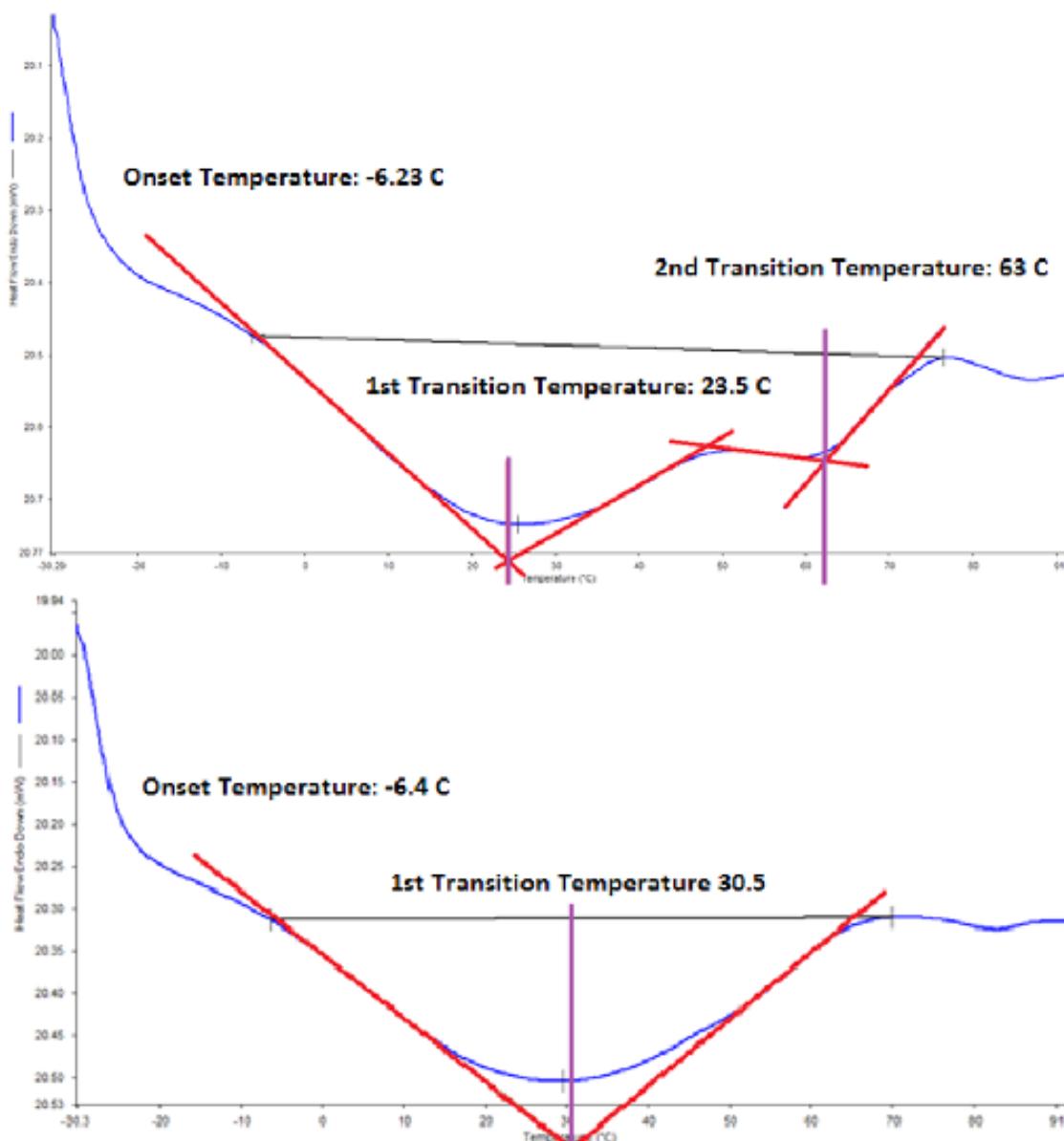


Figure 9: Comparison of DSC curves of wax binder extracted from same track surface of year 1 (top) vs. year 7 (bottom).

Section 3.3 Determination and Characterization of an Unknown Polymer Used in High Temperature Fluid Filtration Systems Results

As shown in Figure 11, the melting point temperature (T_m) was found to be 164.7 °C. This melting point value was compared against known values of adhesives used in similar high temperature fluid filtration applications. Polyamide resins have different thermal prop-

erties depending on the monomers used in the formation of the polymer. Melting points can range from between 150 and 240 °C based on the carbon chain lengths and amide functional groups (CRC, 1978). When coupled with Fourier transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA) the unknown polymer was confirmed to be a polyamide.

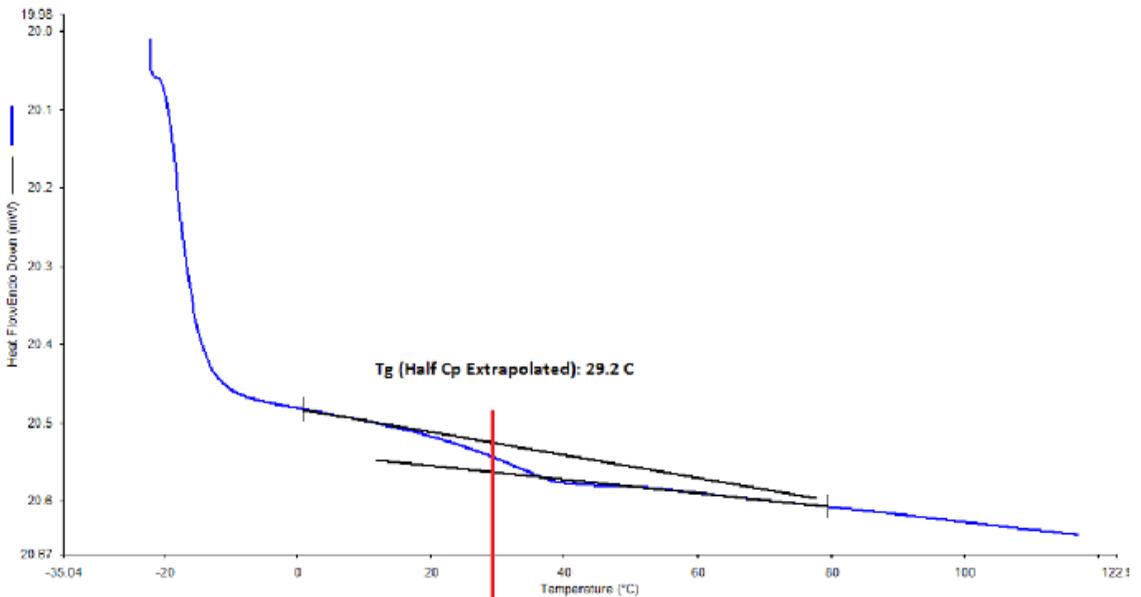


Figure 10: The Differential Scanning Calorimetry curve generated after performing a run on the polyurethane molded cover used in electrical transformer housings.

Poly Vinyl-Acetate Comparison Results

In Figure 12 that follows, the differences in thermal glass transition temperature (T_g) values of three poly vinyl-acetate samples are shown. The T_g values were 12.71 °C, 21.56 °C, and 21.55 °C respectively. Sample 1 showed a clear difference in T_g when compared to the other two. The result of Sample 1 having a T_g value lower than room temperature was expected due to the easy deformability of the material as evident in Figure 8. Samples 2 and 3 were observed to be brittle at room temperature. After coupling the DSC runs with FTIR, it was concluded that at moderate temperatures, the tested poly-vinyl acetates will show differences in performance and affect the stability of each in their given application.

Conclusions

Differential Scanning Calorimetry is powerful analytical tool used to examine the thermal properties of polymeric materials found in a myriad of engineering materials. The thermal information provided from the generated heat flow curves of a test sample allow for a material's properties to be characterized and or

compared. These properties can include glass transition temperatures, melting points, and melting enthalpies as shown in each of the four application examples of the DSC. When used in conjunction with other analytical techniques such as Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography (GC), useful mechanical and thermal performance of polymeric materials may be attained. The hands-on testing of polymers used in real-world applications provides valuable experience for undergraduate students who will find themselves working with similar materials in their engineering careers. These experiences will also aid them when selecting engineering plastics with optimized mechanical properties for specific applications.

Acknowledgement

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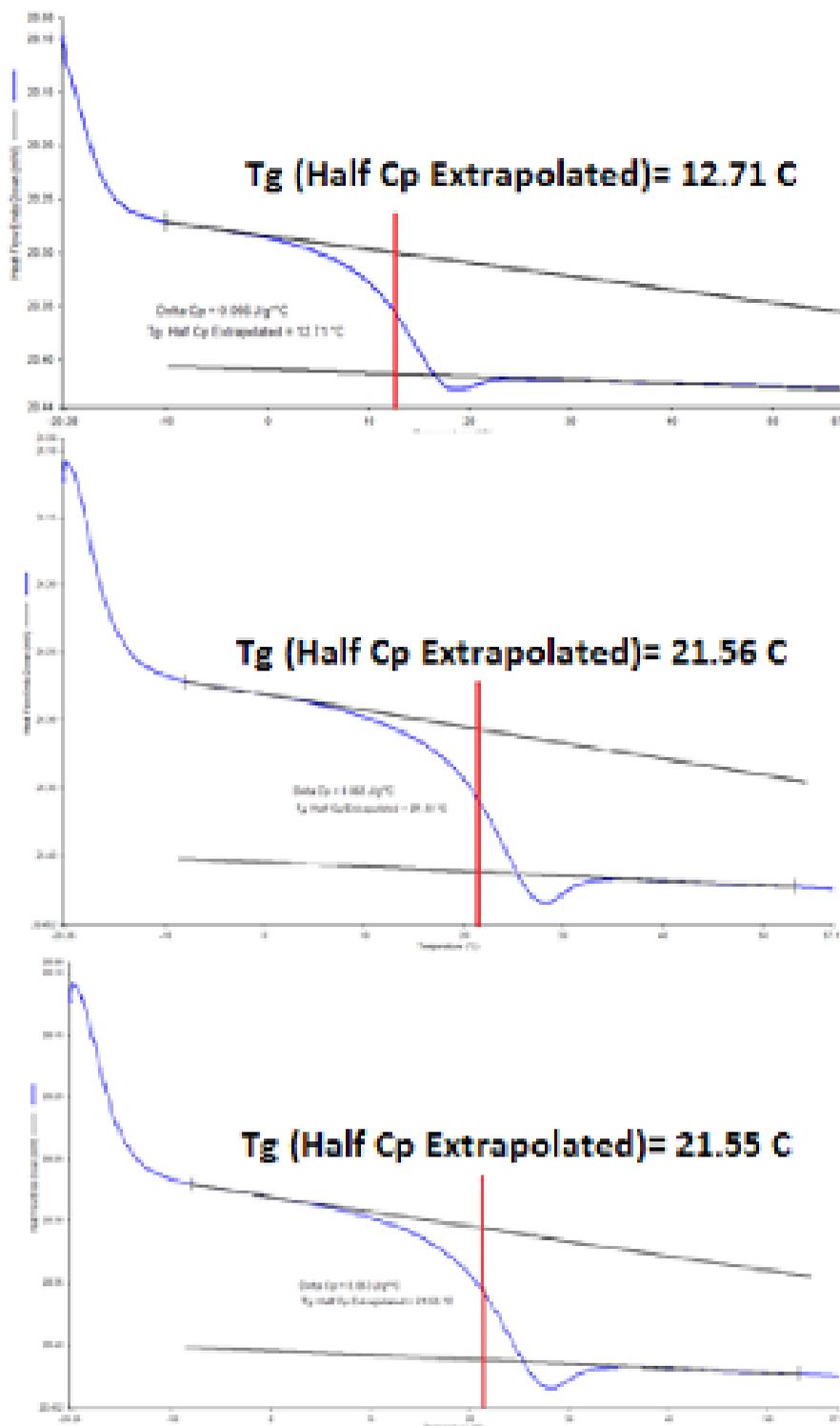


Figure 12: The DSC-analyzed Scanning Calorimetry curves generated for Sample 1 (Top), Sample 2 (Middle), Sample 3 (Bottom) of the Poly-Vinyl Acetate. The vertical line created from the Temperature axis represents the T_g value of each sample.

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INDOOR AGRICULTURAL TECHNOLOGIES: AN INTRODUCTION TO THE FUTURE OF SUSTAINABLE FARMING

Gerald J. MacKenzie

ABSTRACT: Indoor agriculture provides a framework to address the need for new, innovative solutions to feed the planet's exponentially growing population. This investigation assesses the advantages and future prospects of indoor agricultural technologies as a sustainable alternative to traditional farming. A hybrid approach of academic literature review and exploration of indoor farming culture is used to provide a comprehensive scope of indoor agriculture. Cost-benefit analysis is utilized to examine potential economic advantages of hydroponic gardening systems and Light Emitting Diodes (LEDs). Advancements in artificial lighting technologies, a dwindling global water supply, and unpredictable weather patterns prompted by climate change, signals a promising prospective future for indoor farming.

Introduction

The human population is expected to reach 9.6 billion by 2050, creating a desperate need for new forms of sustainable agriculture (World Resources Institute 2014). Industrial agriculture is one of the largest contributors to environmental degradation and greenhouse gas emissions (Blanco et al., 2014). Climate change and environmental pollution creates an unpredictable set of variables that are difficult to navigate with traditional agriculture. New adaptive techniques will be necessary to mitigate undesirable farming conditions and environmental degradation.

New specialty forms of produce will emerge on the market. Indoor, hydroponically grown produce will become a niche market for wealthy consumers. Filtered and recirculated water is going to be preferred by consumers over the polluted soils of traditional agriculture. The air intake will be scrubbed by carbon filters, removing many of the pollutants circulating the atmosphere. Hydro-organic nutrient inputs will flourish as a new form of plant fertilizer for small-scale and high-end hydroponics gardeners.

While lighting technology advances, indoor gardening will become progressively efficient. Instead of dedicating large plots of land to agriculture, indoor gardening can provide a stacked multi-level system that conserves acreage. This system could be used in multiple stories of a building, or vertical stacking systems with many layers of lights in a single room. Light emitting diodes (LEDs) are quickly replacing traditional indoor high intensity discharge lamps used for indoor horticulture (Wojciechowska, Długosz-Grochowska, Kolton & Zupnik, 2015). LED lighting allows farmers to optimize their lighting intensities and spectrums to achieve maximum photosynthesis rates for various cultivars (Gerovac & Craver, 2016).

Indoor agriculture is emerging as a distinct subset of farming techniques, technology, and culture. Current indoor agriculture technology, techniques, and information has set the framework for the future of sustainable farming. Exploring contemporary indoor gardening solutions is a necessary step for securing a sustainable future in both urban and industrial agriculture.

The following components of indoor agriculture will be investigated:

- Market-driven knowledge versus academic research, as it pertains to indoor agriculture.
- Cost-benefit analysis of various agricultural lighting technologies.
- Advantages of recirculating hydroponics and aeroponics systems.
- Site visit of successful, functioning, indoor farm.
- Interview with successful Urban Farming Specialists at Microsoft.

Methods

Much of the information pertaining to indoor agricultural technology is market driven and resides outside of academia, which prompted a hybrid approach to literature analysis and research. This involved consulting both academic and community-based contributions. Many contributors are accomplished academics, though they tend to submit articles to informal publications, blogs, and magazines (Maximum Yield 2017). This paper takes an Environmental Studies approach to understanding the culture of indoor farming, how the industry has developed, and how it can be applied to improve large-scale agriculture.

Cost-benefit analysis was conducted to compare and contrast various lighting technologies, namely high pressure sodium (high intensity discharge) lamps and light-emitting diodes (LED). Calculations were made with consideration to cost of electricity, lumens per watt, spectrum efficiency, maintenance fees, and air-conditioning. Agricultural lighting efficiency is an essential component to profitability.

A site visit was conducted at Microsoft's Urban Farm in Redmond, WA. I was given a comprehensive, informational tour of two indoor farming facilities. This tour was conducted by two of their lead Urban Farming Specialists and was followed by an interview consisting of roughly nine questions with intermittent con-

versation and follow-up questions. The site visit and interview was a valuable method of gathering information from specialists with hands on experience designing, facilitating, and configuring a medium-large scale indoor farm.

Limitations

Academic sources are quite limited because many industry standard practices have yet to be investigated or have only very recently been researched. For example, hydrogen peroxide in hydroponics systems is very commonly used to prevent root rot but does not appear to have been formally studied in academia until 2016 (Bosmans, et al. 2016). This suggests that academic research pertaining to indoor gardening techniques is behind market driven and community-based contributions.

Cost-benefit analysis is subjective to local weather conditions, cost of electricity, scale of facility, room dimensions, and desired outcome. It is difficult to create an analysis that will hold true in any given scenario. An assumption is made that the facility in question is a medium to large scale farm of at least 20,000 watts of electricity.

Researching particular agricultural products and indoor gardening techniques was a particularly daunting task. Indoor gardening products often have extremely competitive niches that rapidly evolve. Due to these brisk changes, it is unrealistic to determine which products and techniques work best by consulting academic research. Indoor growers collectively decipher which techniques and products are most effective through anecdotal experience, monitoring tools, online message boards, and recently, social media. Aside from this approach not being academic research, a large portion of indoor gardeners are cannabis growers, effectively dominating the indoor agriculture market. Cannabis growers look for qualitative traits that food crop growers may not value, such as trichome production.

The limitations all suggest an increased need

in indoor agricultural research, though this need is mainly necessitated by the advancements in market driven technologies and techniques. A great deal of academic research could be conducted in order to validate or invalidate commonly held beliefs in indoor agriculture culture.

Results

Light Emitting Diodes (LEDs) vs High Intensity Discharge Lamps (HIDs)

Utilizing LEDs instead of HID lighting systems is not only more energy efficient, but more economical as well. The most common industry standards in artificial greenhouse lighting are the HID lamps, High Pressure Sodium (HPS) and Metal Halide. HPS lamps last a maximum of 20,000 hours and Metal Halide 10,000 hours, whereas LEDs have a lifespan of 100,000 hours (Yeh, Naichia, and Jen-Ping Chung 2009). HPS and Metal Halide lamps gradually diminish in lumen output over time. To ensure HID lamps are running at optimal efficiency, bulbs must be replaced at least once per year but ideally every 6 months. Assuming these were changed once a year, that would only give HID bulbs a shelf life of 6,570 hours, costing \$50-100 USD per bulb. LEDs run much cooler than HPS lamps, putting out approximately half as much heat. This not only eliminates a costly need for air conditioning, it allows the lamps to be closer to the plant, enabling it to absorb a higher amount of lumens.

As far as general lighting systems go, HPS is fairly efficient at roughly 100 lumens per watt. LEDs have reached over 300 lumens per watt in lab settings (Cree 2016). Factoring luminous efficiency (lumens per watt) is somewhat important for considering which lighting systems to use. This is not, however, the deciding factor for determining efficiency of horticultural lighting systems. Plants do not heavily utilize a full light spectrum, allowing LEDs to enhance specific wavelengths for more efficient optimization (Darko et al., 2014).

HID lighting systems do outperform LEDs in one important department, and that is initial

setup cost. A high end LED system, with equivalent output to a 1,000 watt HID system, would cost roughly \$1700. A high end 1,000 watt HID system would cost roughly \$500. Assuming the cost of power is \$.10 per Kilowatt/Hour, which is roughly the cost of power in the Greater Seattle Area, an 18 hour day under HID would cost \$1.80 per light. If there were 20 HID lamps running, it would cost \$36 per day or \$1,080 per month. An equivalent LED light would only require 60% of the power a HID system draws, saving \$432 each month or \$5,184 per year. It would also save an additional \$1,500 per year in bulbs. If the LEDs were only used for 5 years or 32,850 hours, that would be a total savings of \$33,420 [(\$5184+\$1500)*5 years]. One of the hidden fees of indoor gardening is air conditioning. Depending on outdoor temperatures, the baseline for air conditioning per 1,000 watt bulbs is 4,000 BTUs (in some areas much higher).

$$1W = 3.412141633\text{BTU/hr.}$$

$$4,000\text{BTU} \div 3.412141633 = 1172.284280733 \text{ watts.}$$

$$1172.284280733 \times 20 = 23,445.68561466 \text{ watts.}$$

It is difficult to determine how long the air conditioner will run per day because it is subjective to weather, season, and room. Cooling a room running HIDs can be quite costly.

LEDs are more costly to set up initially, but in the long run they are less expensive, more energy efficient, and environmentally friendly than HID lights. This technology is projected to advance to further maximize these benefits, making LEDs a primary candidate for artificial grow lighting.

LED vs the Sun

LEDs may not be able to compete with the sun in regards to energy efficiency but growing with the sun alone is not necessarily more economically efficient. A study conducted on multiple *Mentha* species showed up to four times higher essential oil production with LED lighting in comparison to field and greenhouse conditions (Sabzalian et al., 2014). The same study showed

higher growth and flower production rate in lentil and basil plants compared greenhouse conditions. These plants also finished more quickly than those in greenhouse conditions.

Implementing LEDs can also be much more space efficient than traditional agriculture. This is especially important in regards to urban farming. An indoor farming operation called Mirai in Japan was able to achieve an increased spatial efficiency of roughly 100 times that of traditional agriculture (Kellner, 2014). Utilizing indoor spaces as opposed to sun exposure opens up new opportunities for urban agriculture, reducing food miles (transportation of food), and increased land use efficiency.

Recirculating Irrigation Systems

As the population increases, an ever increasing amount of water is needed to divert to agricultural irrigation, a sector that accounts for 69% of global water withdrawal (FAO, 2012). This will inevitably result in a conflict between environmental processes and access to water resources. Recirculating irrigation systems like hydroponics and aeroponics can drastically reduce water use for irrigation in addition to improved crops yields. In a study conducted in Yuma, Arizona, hydroponically grown lettuce yielded 11 ± 1.7 times more produce than conventional agriculture and the amount of water used was over five times less L/kg/y (yield to water use ratio) (Barbosa et al., 2015). Other benefits include reduction of soil degradation, eutrophication, and improved waterway preservation. Integrating recirculating irrigation systems reduces water consumption, environmental degradation, and is more economically efficient than traditional agriculture.

Site Visit

I visited two indoor agriculture facilities at Microsoft in Redmond, WA and met with the two Urban Farming Specialists (UFS1 and UFS2) that worked on the projects. As I sat down with them, the UFS2 asked me what the one thing I would like to take away from the visit would

be. I responded by indicating that aside from a short interview, I would like advice as to which lighting technology is the most efficient. They both seemed to think the answer was subjective to the plant being grown. Suggesting that leafy greens would do better with LED lights and plasma lights would be better for fruiting plants. They did not like their particular plasma lighting system, however. We commenced to the tour of urban farms.

The first site they took me to was an aeroponic lettuce garden. It was a pyramid style aeroponics system under plasma lighting in a public setting. When they took me into their reservoir room I was surprised to find that they used a hydro-organic base nutrient, Pure Blend Pro by Botanicare. Microsoft reports the garden uses “up to 90 percent less water than a standard field-grown lettuce crop” (Microsoft 2015). This garden may not have been energy efficient, but it was an effective conceptual demonstration of hydroponic water efficiency. After visiting the lettuce garden, I was taken to a different building where their microgreens were grown. The room had 15 types of microgreens in an automated watering system with 100% organic nutrient inputs. The water pooled into each tray of microgreens, slowly being absorbed by the roots and medium. Most of the water in the tray was being absorbed by the microgreens, but they also had an overflow drainage system. Because of the standing water they occasionally had issues with root rot. Since the microgreens life cycle is only 20 days, they did not find treating root rot to be necessary, especially since it wasn’t a widespread issue. The room was arranged with multiple levels/stacks of T5 lighting systems. Most of the lighting was T5 fluorescent panels with occasional LED replacements. UFS1 mentioned that LEDs are much more cost efficient to replace in T5 panels as opposed to simply purchasing an LED system. They did not need fans in the room because of the powerful HVAC and high level of ambient CO₂. The microgreens facility was an excellent demonstration of a space efficient urban farm with organic inputs.

After visiting the microgreens room they took me into their sanitation room. This was a room they washed out all their trays and gardening materials, similar to a dishwashing station in a kitchen. Sanitation was stressed as incredibly important to the entire process.

After the tour of the site, I did a sit down interview with UFS1 and UFS2. The inspiration was for this garden was Mark Freeman, the Director of Global Dining at Microsoft, wanting an “ingredient revolution.” His interest in indoor growing was sparked by going to gardening conventions. The garden was meant to represent innovation, the future of food, and was partly a marketing strategy. Aesthetics and conceptual appeal was meant to lure stakeholder buy in, and without these appeals the garden would not have been implemented. Both interviewees suggested that it wasn’t important what’s actually going on, more what they think is going on. 80% is stakeholder managed. Making things look perfect is a priority. UFS1 mentioned that things that happen in permaculture could not happen in public spaces because they need to look presentable.

Growing microgreens was estimated to be half the cost of simply purchasing them. Microgreens are high value and don’t store well, making them more practical to grow. Lettuce was a different story. Most of Microsoft’s lettuce is purchased and is much cheaper to buy from farms. The plasma grow acts as an art installation, but produces 30 pounds of lettuce per pyramid. The main purpose of the plasma grow is stakeholder buy in and sparking conversation.

I asked them about plasma lighting as it compared to other lighting technologies. UFS2 remarked that plasma lighting is “cool” but the technology is underdeveloped. Bulb performance was also problematic. They replaced bulbs the day of the interview and one already went out. They theorized that plasma has better potential for fruiting crops and LEDs would be better for leafy greens. Plasma bulbs were meant to last for a full year but on that particular day there was an instance of six hour bulb

life. The bulbs are made of quartz and have a lower amount of safer mercury than HPS bulbs. The systems they were using had recurring bulb outages, which are likely a symptom of poor manufacturing, coupled with new technology. The interviewees stated that Plasma and LED lights have different applications. LEDs can be closer to plants, whereas plasma lights are too light intense for close proximity. LED is better for stacks of leafy greens. Plasma is better for fruiting crops. Plasma has UV that helps promote the growth of certain resins. They thought that LED technology was more developed than Light-emitting Plasma and likely more practical to utilize. The following LED systems were recommended:

ILLUMITEX - NEOSOL DS - 520 WATTS:
\$1,829.73 shipped

This system is equivalent to a 1,000 watt HPS system. It is dimmable down to 10% of it’s full output, which may be useful for smaller plants. It also keeps its light intensity fairly consistent when raised, whereas many systems lose a considerable amount of lumens as they increase in distance from the plants. This is a generally well reviewed system and this brand was also recommended by UFS1.

Fluence SPYDRx Plus 685W LED Grow
Light: \$1500.00 (Or best offer)

This is another popular choice for high end LED systems. It focuses more on providing a full spectrum output of light. It pays respects to important photoreceptors outside 700 and 400 nanometers, as opposed to primarily boosting Chlorophyll A and B absorption ranges. Recommended to be used six inches from plant canopy. The wavelengths are designed for specific photomorphogenic responses, photoperiodic signals, chlorophyll A and B absorption, xanthophyll carotenoid pigments, and anthocyanin accumulation. Projected lifetime of 100,000 hours.

Some final thoughts and points made by the interviewees:

- Some plants may need low amounts of the light spectrum outside red and blue kelvins, necessitating full spectrum lighting.
- Before accepting advice or hiring consultant, look at their previous or current work to make sure they've worked with large-scale operations.
- It is more difficult to design systems that work for long periods of time.
- Experience is everything. There are a lot of people who say they know what they're doing but simply lack hands on or large-scale experience.
- Smaller designs are not always scalable.

Discussion

The technology and techniques of indoor farming have already been developed and utilized, they simply aren't present in mainstream agriculture. Cost-weight analysis of indoor agriculture versus traditional industrial agriculture is complicated to analyze, making it difficult for farmers to see the advantages of indoor agriculture. Creating artificial environments may also be more complicated and intricate than industrial agriculture, adding an element of risk to pursuing an indoor farming endeavor. One of the primary issues of indoor agriculture, as it relates to developing countries and sustainability, is that these facilities are quite costly to set up when compared to traditional agriculture. Technology is currently available to implement sustainable indoor agriculture on a large scale, but initial setup fees are much higher than current industrial agricultural models.

Conclusion

Traditional agriculture is one the primary contributors to environmental degradation, greatly necessitating new approaches to farming techniques. Investing in indoor agriculture is not merely an economic investment that will pay off over time, it is also an investment in the future

of sustainable farming that can provide a cutting edge model for other establishments to follow. As this technology becomes more sophisticated, artificial lighting and recirculating irrigation systems will become progressively feasible.

LED lightings and recirculating irrigation systems are powerful steps towards implementing a futuristic model of indoor, urban agriculture. LED technologies have shown to provide clear advantages over HID systems regarding energy efficiency, space efficiency, heat output, and light spectrum optimization. Recirculating irrigation systems can drastically improve yield while simultaneously reducing water consumption. If LED lighting systems and recirculating irrigation systems enter mainstream agriculture it would reduce various aspects environmental degradation, creating a more sustainable future for the exponentially growing human population.

Projected population growth cannot be sustained by traditional agriculture. New farming techniques need to be explored and utilized to meet the future global carrying capacity of humans. Current indoor garden culture has provided a powerful framework for implementing the future of sustainable farming.

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FOURIER TRANSFORM INFRARED (FTIR) SPECTROSCOPY FOR MATERIAL CHARACTERIZATION AT THE UNIVERSITY OF WASHINGTON BOTHELL

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ABSTRACT: Fourier Transform Infrared (FTIR) Spectroscopy is a powerful material analysis technique that can be used to help solve engineering problems. It can be used alone as a quick material characterization tool, as well as in complement with other techniques such as Differential Scanning Calorimetry (DSC), Gas Chromatography (GC), Nuclear Magnetic Resonance (NMR), or Raman Spectroscopy to gain the complete physical and chemical makeup of a material. The application of FTIR spectroscopy in undergraduate research at University of Washington Bothell (UW Bothell) has greatly aided in solving materials-related problems in a variety of real-world engineering problems. At the UW Bothell, FTIR techniques are being used to analyze synthetic granular composites used on horse racetracks, crumb rubber from artificial turf and rubber flooring material (RFM), and for comparative studies of polymers such as polyvinyl acetate (PVAc). Within the granular composite track surface, FTIR tests indicated oxidation degradation of the wax binder used to hold sand, polymer fiber, and rubber constituents together (Bridge, Weissaupt, Fisher, Dempsey, & Peterson, 2016). In the RFM, the FTIR spectra exhibits the presence of strong C-H and C-C bonds at approximately 2850 cm^{-1} and 915 cm^{-1} respectively. Also, shown was the presence of calcium stearate at 1600 cm^{-1} , calcite at 1400 cm^{-1} , and zinc oxide (ZnO) at 690 cm^{-1} that gives RFM its waterproofing, scratch hardness, and UV protection properties, which are especially important properties desired in the tire industry. Finally, in the comparative study of PVA, FTIR revealed that different amounts of acrylic contents in PVAc give it slightly different properties. The PVAc sample with higher acrylic content shows a peak in the FTIR spectra around 1173 cm^{-1} which is of the acrylate copolymer group. This gives PVAc “special properties”—a disruption in the crystal structure of the PVAc, making it more flexible at room temperature.

Introduction

There are many analytical tools available to the materials engineer to characterize polymeric materials in order to design the best material for an application or to solve problems with existing materials. Fourier Transform Infrared (FTIR) is arguably one of the best tools available for quick, efficient analysis of engineering polymers. FTIR is a spectroscopy technique, which involves passing an infrared light source through a sample to measure its reflec-

tance, or absorbance in the infrared spectrum. This technique produces a spectrograph, which reveals compositional information on material structure to help identify or characterize a given material sample. Figure 1 shows a typical spectrograph of a poly vinyl acetate (PVAc) glue sample taken with the Thermo-Nicolet iS50 Spectrometer with an ATR (Attenuated Total Reflectance) diamond crystal; the specific peak wave numbers and absorption strengths indicate the type of material.

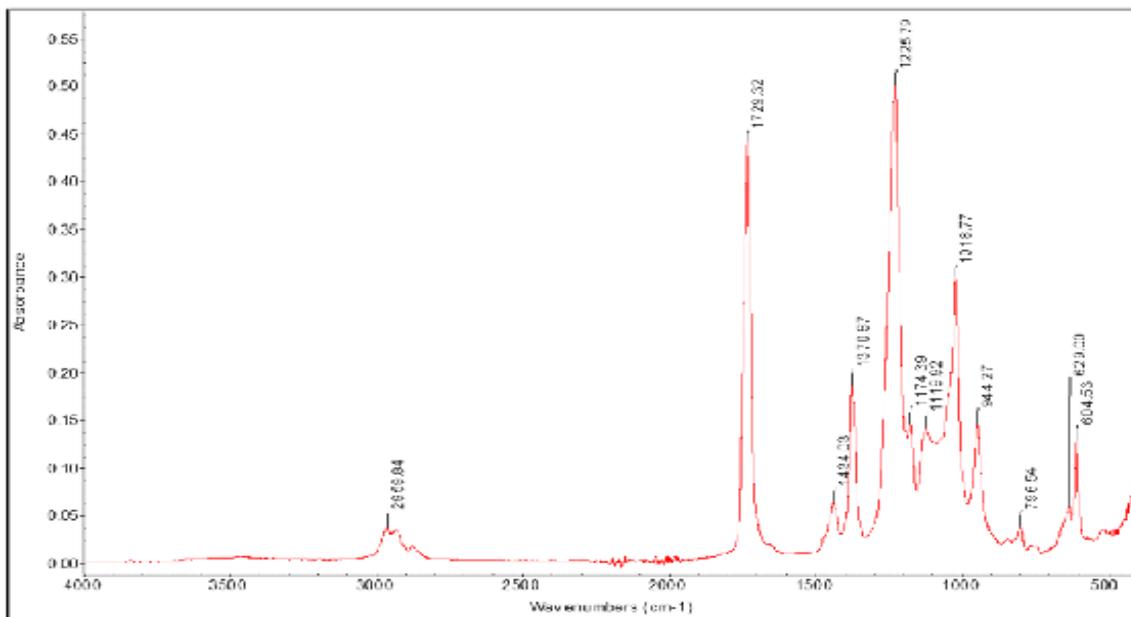


Figure 1: A spectrograph of poly vinyl-acerate (PVAc) Glue sample taken with the Thermo-Nicolet iS50 Spectrometer.

Figure 1 above is a typical FTIR spectrum of PVAc and water. It exhibits the prominent absorbance peaks, often occurring between 1800 and 500 wave numbers. Figure 2 below is a sample spectrum of a rubber flooring material obtained with the same FTIR machine but configured with a germanium crystal. The various peaks/depressions in an FTIR spectrum indicates the chemical and structural composition of a material (i.e. the material’s bonding structure and chemical nature) that gives the material its physical, mechanical, chemical, and other properties.

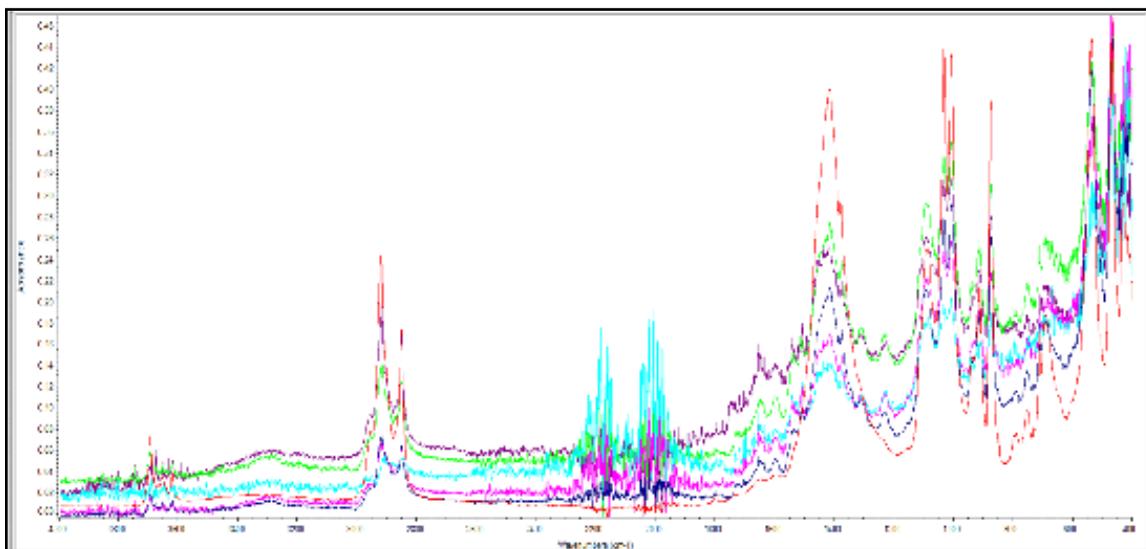


Figure 2: Sample FTIR Spectra (superimposed) of a rubber material showing various functional groups between the 400 cm-1 and 4000 cm-1 range.

Operation

In an FTIR instrument, an infrared (IR) beam is passed through the sample where part of the energy, or photons, are absorbed and part is transmitted. The transmitted IR reaches a detector, which records the intensity of the IR. The response of the detector yields information about the wavelengths being transmitted at once, which provides information about the signature of the composition of the given sample. The given signal is then digitized and processed via a computer. Finally, the various frequencies measured for the given material sample is translated into a spectrum by a Fourier transform algorithm. Every element has a distinct light wave signature and can be easily identified based on the output light pattern. The physical properties and characteristics of a molecule or substance is produced from the vibration spectra of the substance. An infrared spectrum of absorption or emission of a solid, liquid or gas is obtained in FTIR spectroscopy, and the infrared spectrum can be used as a fingerprint for identifying a substance by comparing it with the spectrum of previously recorded reference spectra (PerkinElmer, Inc., 2005). Most FTIR instruments are accompanied by software that has a spectral library or database which one can use to search for a quick match of the functional groups in a sample. However, the most useful factor in FTIR spectral interpretation is prior knowledge

of the sample or experience analyzing spectra of the material under investigation. This is something one quickly finds to be an art and it is especially true for more complex materials such as polymers and composites. Additionally, a good knowledge of chemistry is very useful and makes spectral interpretations much easier.

Application

FTIR application cuts across all phases of a product's lifecycle, from design through manufacturing to failure analysis. There are several areas where the application of FTIR analysis have proven to be very useful including material identification and verification, copolymer and blend assessment, identification of additive and quantification, contaminant identification, molecular degradation assessment and so on (Coates, 2000). FTIR has proved effective for "the characterization of polymers used as protective and consolidant treatments" (Doménech-Carbó, 2008; Chércoles Asensio, San Andrés Moya, De la Roja & Gómez, 2009; Casadio & Toniolo, 2004; Miliani et al., 2010). FTIR reflectance has also been used as a non-invasive technique for identifying pigments and organic binders in wall paintings and contemporary artworks (Rosi et al., 2009 & 2010; Vagnini et al., 2009). FTIR can be used on materials ranging from simple compounds



Figure 3: Thermo Scientific Nicolet 380 (Left) & Nicolet iS50 (Right) FTIR Spectrometers used at UW Bothell.

to complex compositions which requires careful analysis and efficient use of accompanying FTIR software libraries.

FTIR spectroscopy is used in undergraduate research and has greatly aided in solving materials-related problems in real-world engineering application and practice. This paper discusses three example projects in which FTIR techniques were utilized at the UW Bothell's Material Testing and Characterizing Lab (MTCL); 1) the oxidative analysis of the wax binder used in synthetic granular composite horse racetracks, 2) the characterization of rubber flooring material, and 3) comparative studies of three grades of Polyvinyl Acetate (PVAc).

Materials and Experimental Methods

The UW Bothell – MTCL has access to the Thermo-Nicolet 380 and iS50 FT-IR spectrometers (Figure 3) which run the OMNIC Spectra software that has an elaborate spectral library, which is useful in gaining quick insights about a material sample. For all FTIR projects an approximate sample size of $2 - 5 \pm 1.0$ mg are placed on the spectrometer crystal and clamped down.

FTIR Method Applied

1. Turn on Spectrometer and allow to warm up for an hour.
2. Clean the surface of the crystal using a Q-tip dipped in Isopropyl alcohol.
3. Open OMNIC Spectra software on computer
4. Run background test as a baseline against which the sample's spectra will be taken.
5. Place very small amount of the sample ($2-5 \pm 1.0$ mg) on the surface of the crystal and clamp down.
6. Run test via the OMNIC Spectra software.
7. Use analysis tool on the software and run spectral match by comparing sample's spectra with the spectral library of materials with known spectral signature.

All FTIR tests follow the same procedure with the only difference involving what type of sample is tested. For liquid samples the clamp is often not used. Additionally, the type of crystal selected for the given test depends on the material being tested. A diamond crystal (Figure 4) is commonly used due to its robustness and durability. Also, a germanium crystal can be used for high absorption materials such as carbon black filled rubber. The Nicolet 380 uses a diamond crystal and the Nicolet iS50 has both a diamond and a germanium crystal (Figure 5). The average test-run time for an FTIR is between 30 seconds and 1.5 minutes. The test results can be printed or emailed from the computer for further inspection.



Figure 4: Diamond crystal for the Thermo – Nicolet iS50 FTIR – ATR.



Figure 5: Germanium crystal for the Thermo- Nicolet iS50 FTIR – ATR

The Oxidative Analysis of the Wax Binder used in Synthetic Granular Composite Horse Racetracks

FTIR techniques were used to analyze a wax or polymer binder used to hold sand, polymer fiber, and rubber constituents together in horse racing synthetic surfaces (Figure 6). To study the degradation of these surfaces over time, the oil in the wax binder was extracted via Soxhlet extraction and analyzed using FTIR spectroscopy. The objective of this investigation was to analyze the wax binder to quantify and determine any oxidative degradation of this binder material that held the granular composites together. It is hypothesized that the degradation of the wax binder leads to loss in performance of the track surface over time. Several FTIR runs of the sample wax binder from the Thoroughbred horse racetrack over a period of seven-years were performed and compared. The test was performed using the diamond crystal of the Nicolet iS50 FTIR-ATR spectrometer.



Figure 6: Photo of fresh synthetic granular composite used on horse racetrack surfaces made up of silica sand particles mixed with binder (wax), polypropylene fibers and rubber (black) particles.

The Characterization of Rubber Flooring Material (RFM)

The next project involved the use of the Thermo-Nicolet iS50 FTIR spectrometer to help identify the functional groups in crumb rubber used on sports surfaces such as those in many football stadiums. Again, FTIR was hypoth-

esized to be the most efficient and effective tool for this analysis. RFM is also used as a safe and comfortable alternative to wooden and tile flooring or carpets. They are often used in places like gymnasiums, stores, and office spaces as comfortable standing pads. Safety hazards have been brought up about different rubber particles in the past because many of these materials are made from recycled car tires and the different chemical components in them raise a lot of health and safety concerns for people who are exposed to them on a regular basis (for instance, athletes). Also, over time, exposure to the elements and other factors affect their mechanical and chemical structure and may cause them to lose their properties. FTIR was therefore used to gain a quick understanding of the structural and chemical makeup of this material. Several test runs were made using the diamond crystal (Figure 4) but the spectra generated from these tests had too much signal-to-noise-ratio (SNR)—the ratio of a signal (intensity of a peak) in a spectrum to noise (random fluctuations of baseline) in the spectrum. This was due to both the crystal used and the high carbon content of the rubber material. Hence, the diamond crystal was switched out for a germanium crystal (Figure 5) which has a better working pH range and much higher refractive index of all FTIR crystal materials available.

Comparative Studies of three grades of Polyvinyl Acetate (PVAc)

This last project involved the use of the Thermo-Nicolet 380 FTIR spectrometer to analyze the structural properties of polyvinyl acetate adhesives. Three separate PVAc grades were prepared (Figure 7) and an FTIR of each sample grade was performed to compare their properties and help determine the cause of cracks and fractures. The goal of this project was to quickly test and characterize a replacement product from different grades of PVAc and determine suitability. FTIR spectra were coupled with DSC testing to analyze this material by finding the thermal glass transition temperature (T_g) and comparing

the FTIR spectra to known PVAc spectra. The spectra revealed composition information of the different grades of PVAc.

Results and Discussion

The Oxidative Analysis of the Wax Binder used in Synthetic Granular Composite Horse Racetracks

The resulting spectra from the FTIR analysis revealed an increase in oxidation peaks as the horse racetracks age to account for the deterioration in the performance of the tracks, due to the degradation of the wax binder (Bridge et al., 2016). The FTIR was extremely effective in identifying and quantifying oxidation activity. Below are the spectra from the FTIR analysis showing the spectra time series near 1700 cm⁻¹ for both the wax binder and the extracted oil for the racetrack over the period of seven years. The peak around 1730 cm⁻¹ is due to stretching of the C=O bond which results in the molecular vibration of this carbonyl group in the wax binder as shown in Figure 8 & 9.



Figure 7: Oven Cured 7g Samples. Samples 1-3 are laid out from left to right. Sample 1 has been bent over to show ease of deformation. Samples 2 and 3 show cracking.

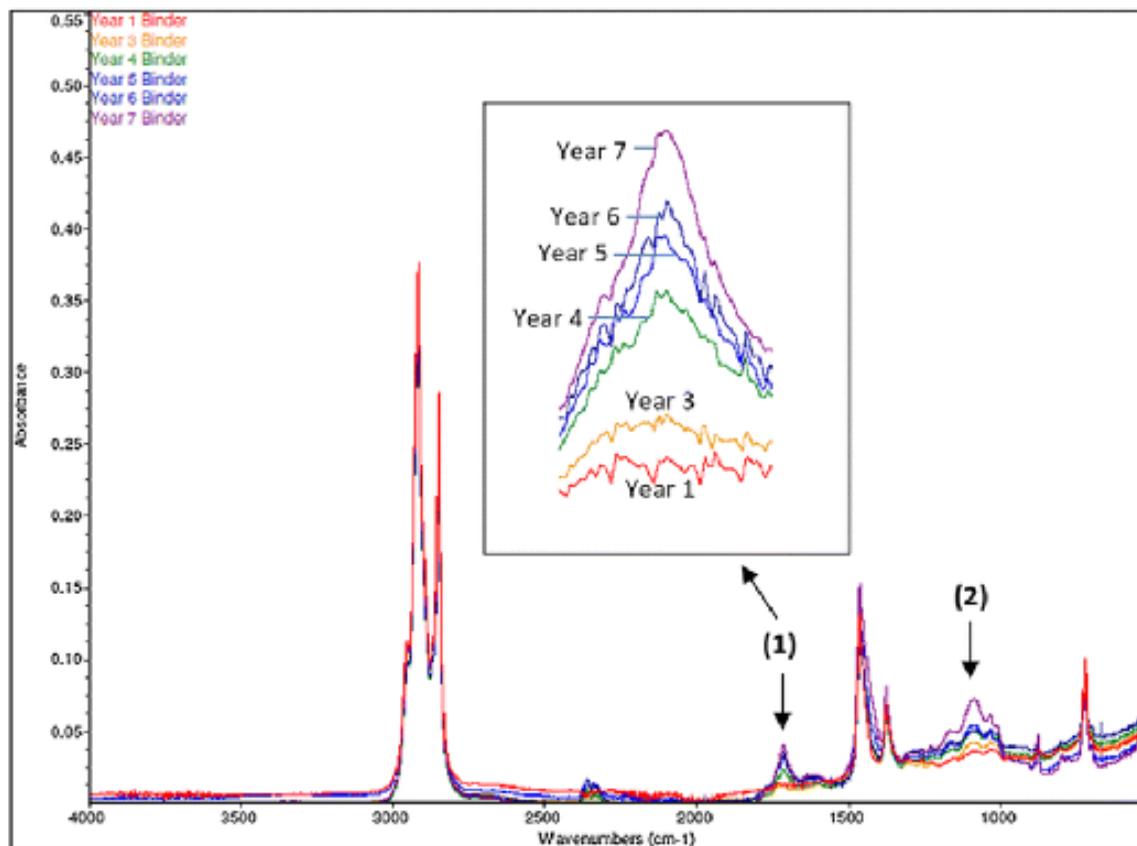


Figure 8: Binder FTIR Spectrum showing difference in spectra time series near 1700 cm⁻¹.

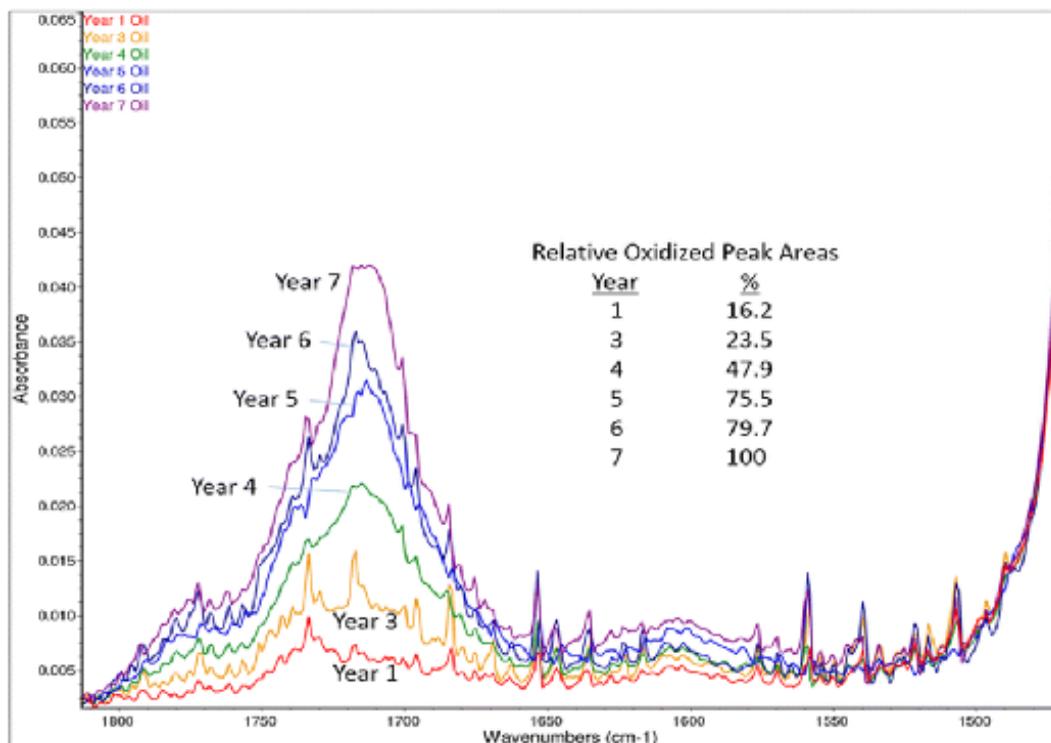


Figure 9: Expanded view of extracted oil FTIR spectrum comparing oxidative peaks in 1700 cm^{-1} region.

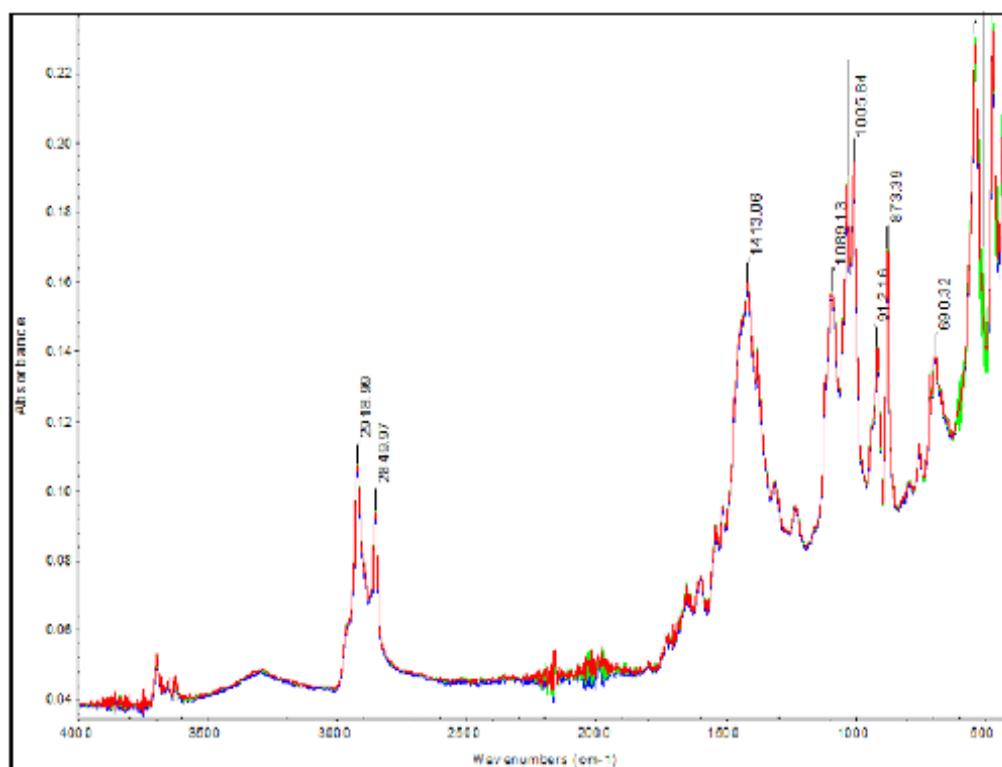


Figure 10: FTIR Spectrum of RFM taken using a germanium crystal. It shows the C-C, C-H & C-H₂ bond peaks at 915 cm^{-1} , 2850 cm^{-1} , and 3000 cm^{-1} respectively.

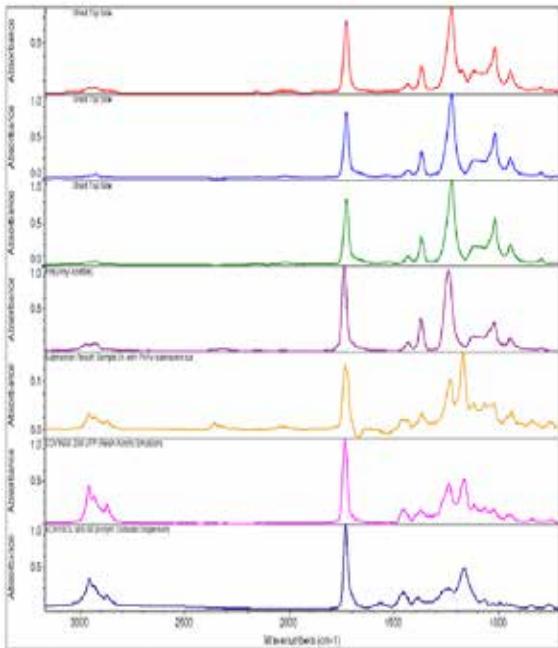


Figure 11: FTIR of Dried Samples. IR absorbance spectra of all three samples show primarily PVA. Sample 1 shows additional peak structure at 1173 cm⁻¹ due to acrylic content.

Also, the performance of FTIR testing has been complemented with DSC testing to fully characterize the degradation of granular composite material. In addition to that, Raman spectroscopy has recently been employed and will hopefully shed more light on the degradation of the granular composite components.

Characterization of Rubber Flooring Material (RFM)

From the FTIR Spectrum of RFM (Figure 10), two peaks clearly indicate the presence of the C-H and C-C bonds at approximately 2850 cm⁻¹ and 915 cm⁻¹ respectively. These single-carbon, hydrogen and oxygen bonds are very strong and makes the material non-reactive as well as give this material good bond strength in its covalent bonds. The presence of the CH₃ bond at 3000 cm⁻¹, the calcium stearate at 1600 cm⁻¹, and calcite at 1400cm⁻¹, give RFM its waterproofing and scratch hardness properties, especially important properties in tires. Also, the identified zinc oxide (ZnO) found near 690 cm⁻¹ is heavily used in the rubber industry for the vulcanization of rubber, and as a good UV protection in tires. This information is critical when comparing other RFM materials in conjunction with mechanical property tests. Below in Figure 10 is the FTIR spectra of RFM that was obtained using the germanium crystal.

Comparative Analysis of Polyvinyl Acetate (PVAc)

A comparison of the FTIR absorbance spectra after 48 hours of drying (Figure 11) reveals a peak in sample 1 around 1173 cm⁻¹ which is not present in the infrared (IR) spectra of samples 2 and 3. Further analysis of this peak showed that

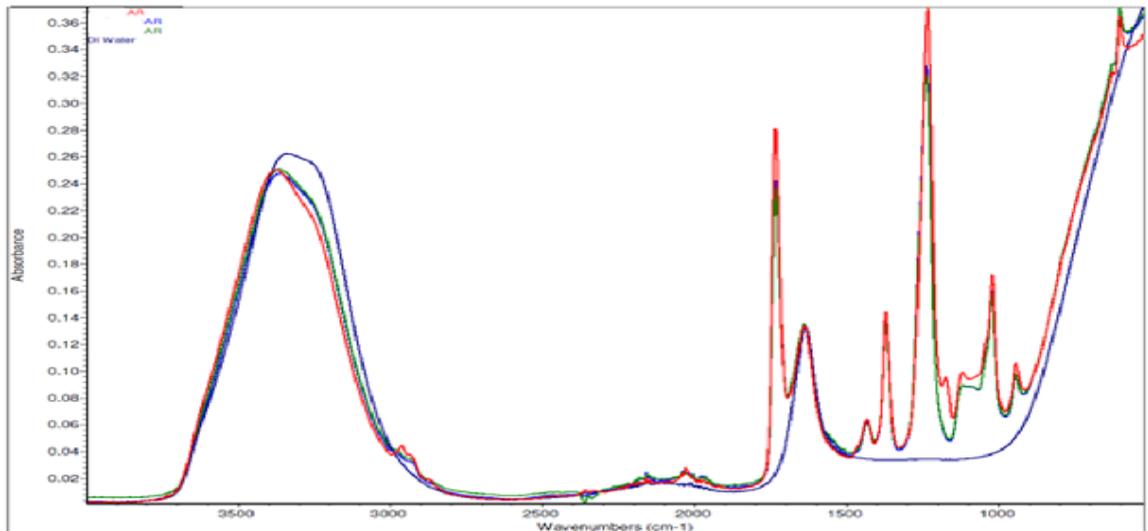


Figure 12: FTIR of as Received Samples. The wet samples show similar IR peak structure, primarily PVA and water. Sample 1 (red) shows slight differences due to acrylic content.

it is of the acrylate copolymer group. These two samples (2 & 3) show purely PVAc spectra as shown in Figure 11. Performing further examination on the three samples revealed that they are slightly viscous at room temperature (22-degree C). Sample 1 was found to be very pliable at room temperature, and can deform and stretch without breaking. Samples 2 and 3 were found to be comparatively brittle at room temperature and would crack if bent more than a few degrees (evident from image of the 3 samples in Figure 7 above). The glass transition temperature (T_g) values measured using DSC were consistent with these observations. The comparative analysis of these three samples therefore revealed that different amounts of acrylic contents in PVAc will give it slightly different properties.

Finally, the comparison of the FTIR absorbance spectra for the uncured samples prepared shows a slight difference due to acrylic contents in the samples as indicated in Figure 11 below. The different PVAc/Acrylic mixtures in the 1100 cm⁻¹ region is due to slightly different bond energies of the C-O bonds in the ester groups of each polymer. This indicates that the addition of a small amount of acrylic to PVAc gives it “special properties.” That is, the small acrylic content in PVAc disrupts the crystal structure of the PVAc, making it more flexible at room temperature as seen with the image of sample 1 in Figure 7, and evidenced in its FTIR spectrum in Figure 12 compared with that of sample 2 & 3.

Conclusion

FTIR proved to be a powerful analytical technique that has been employed to solve commonly encountered engineering problems, particularly with polymeric materials. As exhibited in the three successful projects described at UW Bothell, the use of FTIR resulted in definitive chemical analyses that resulted in immediate engineering decisions or shed light on compositional changes that affect mechanical properties. In the degradation study of the wax binder used to hold sand, polymer fiber, and rubber constitu-

ents together in synthetic horse racetrack materials, substantial oxidation was discovered - this may be contributing to the deterioration in performance of these tracks over time. FTIR also successfully identified the functional groups in a rubber flooring material (AFM); thereby aiding in correlating composition to mechanical properties. Finally, FTIR was used in a comparative study of three (3) different grades of polyvinyl acetate (PVAc) - to determine which grades were better suited for use in a given application. FTIR spectroscopy can be used as a quick analytical tool for gaining insights on material composition, and complements other techniques such as DSC, NMR, and Raman Spectroscopy. FTIR spectroscopy has therefore proven to be a very effective and useful tool for material characterization and testing at the UW Bothell Materials Testing and Characterization lab. Its application in undergraduate research at the UW Bothell MTCL has indeed aided the development of useful solutions for real world engineering problems for industry clients and partners.

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ABOUT THE STUDENT AUTHORS

Atif Bhatti is a second year-student at the University of Washington Bothell where he's majoring in Biology and minoring in Neuroscience and Chemistry. Upon graduating after Summer Quarter of 2018, Atif plans to attend medical school and practice neurological medicine in the future. Atif is an active member of UWB's Pre-Health Society and he plans on being one of the club's officers for the 2017-18 school year. In his free time, Atif enjoys volunteering at BloodWorks Northwest and spending time with his friends.

Nate Blanchard will graduate in Spring 2017 with a B.A. in Law, Economics, and Public Policy along with a minor in Human Rights. In Fall 2017 he will be advancing his public policy education within the M.A. in Policy Studies. His experiences include competing on the debate team at the University of Washington Bothell and also serving as the President of UWB's Debate Society. His passion is the study of climate change policy and the study of how to promote political advocacy of marginalized stakeholders. He hopes to one day help individuals displaced by climate change as a refugee attorney.

Luke B. Daanomah will graduate in the Spring of 2017 with a B.Sc. in Mechanical Engineering. After graduation, Luke will be headed off to NASA's Marshall's Space Flight Center in Huntsville, AL to start his career as a propulsion systems engineer. He plans to work for some years before going to graduate school for a Master's degree and hopefully a Ph D. Luke has a deep passion for undergraduate research and has led undergraduate research work since his time at Edmonds community college; and has been a student research assistant at the UW Bothell Materials Testing and Characterization Lab (MTCL) since January 2016. At the MTCL, Luke has been part of a research group that has been investigating the cause of degradation in synthetic granular composite materials used on horse race tracks, as well as other materials such as crumb rubber used on sporting surfaces. Luke is trained and checked-out on the use of analytical equipment such as Fourier Transform Infrared (FTIR) and Raman spectrometers which are utilized for material structural and chemical analysis, and supports research projects in the MCTL needing the use of such analytical tools.

Kaleb Dempsey is an undergraduate at the University of Washington Bothell enrolled in the Mechanical Engineering program and is expected to graduate in June of 2017. He has been attending college since the fall of 2010 and received an Associate in Science degree from Cascadia Community College in 2014 focusing on the natural sciences. From the beginning of 2015, he has been the Lab Coordinator and Manager for Professor John Bridge, aiding in various thermal and material characterization testing such as Differential Scanning Calorimetry (DSC), Fourier Transform Infrared Spectroscopy (FTIR), MTS tensile testing, Scanning Electron Microscopy (SEM), and Soxhlet extractions. His most recent work includes a degradation study that led to two journal papers on the thermal characterization of wax/polymer binders and the associated environmental degradation over a seven-year period for synthetic Thoroughbred horse racetracks. His current interest and focus of study is materials testing and characterization. Upon graduation, he plans on pursuing a Master's degree in Materials Science and Engineering.

Bryce C. Denis is studying at the University of Washington Bothell where his intended major is Mechanical Engineering; he is expected to graduate with the class of 2018. He has been in the college system since the September of 2014 and started studying at the University of Washington Bothell. He has been involved in undergraduate research since March of 2015, he holds the position of a lab researcher. His work from the start has been the study of degradation related to wax/

polymer binders over a seven year period for synthetic Thoroughbred horse racetracks. During testing he worked on the FTIR machine and NMR machine to observe the effects of age on the wax/polymer binder. On top of being involved in Undergraduate Research he also holds the position of a Resident Advisor in the on campus housing. Upon Graduation, he plans to search for a job in the Mechanical Engineering or Material Science field.

Clinton Foriska. I will graduate from UW Bothell in Winter 2018 with a Bachelor's of Science in Biology and a minor in Chemistry. I am a US Army combat veteran and retired from the military in 2014. I am interested in pursuing a medical degree and hope to work for the Veteran Administration where I would continue to serve our nations heroes who suffered post war traumas with an emphasis on rural and underprivileged communities. I enjoy being part of the UW Bothell community where I strive for success.

Samantha Frati graduated from UWB in December 2016 with a Bachelor of Arts in Health Studies. She will attend Liberty University School of Law in the fall of 2017 as a Juris Doctor candidate. Through her coursework and undergraduate research at UWB, Samantha developed interests in bioethics, health law, and policy. She hopes to pursue those interest while in law school and complete a dual Juris Doctor/Master of Public Policy degree. After law school, she plans to use her education to work in legislation and health policy.

Qendresa Hasani will graduate in Spring 2017 with a Bachelors of Arts in Health Studies. Upon graduation, she plans to attend Graduate School to study Pharmacy. Qendresa is passionate about improving health literacy of individuals and populations. Her interests include public health, health advocacy, and pharmacy. She participated in health research, teaching assistant, parent volunteer, and health scholar. Over the past six years, her work, coursework, and volunteer experience have allowed her to sharpen these skills and to work across a number of health settings, including: hospitals, schools, pharmacy, and non-profits. She values teamwork and community-engaged methods, and enjoys collaborating with community partners to plan health education activities and resources. She is happy to have the opportunity to be involved in research and be published to expand her experiences on campus. In addition, Qendresa is happy to work with community groups and health professionals to create effective health education modules and plans that support people to adopt healthy behaviors and address social determinants.

Molly Herbert is a senior and will be graduating with a Bachelor's of Arts from the School of Interdisciplinary Arts and Sciences in Law, Economics & Public Policy, and Global Studies with a minor in Human Rights. Throughout her undergraduate career, Molly has conducted numerous independent research primarily in the fields of law or economics, culminating in her senior thesis.

Gerald MacKenzie is an Environmental Studies major at UW Bothell. He is currently researching fungal endophytes in aeroponic gardening systems in the Sarah Simonds Green Conservatory. Gerald is very passionate about future prospects of indoor agriculture, particularly pertaining to organic hydroponic inputs and LED technology.

Ryan Mayer will graduate in 2018 with a Bachelor's of Science in Environmental Science: Conservation Restoration Ecology. He plans to next attend graduate school studying Environmental Policy, with the intent of eventually becoming an un-corruptable public servant. He believes in the Greek concept of phronesis. A type practical wisdom, specializing in the ability to know how or when to act virtuously, while simultaneously inspiring virtue and excellence in others.

Molly Miller will graduate Cum Laude in June 2017 with a Bachelor of Arts in Community Psychology. Her interest in a genetic predisposition to Generalized Anxiety Disorder (GAD) have led her to work in three different research labs in the realm of clinical psychology, including her current position at the Dorsey Lab under Dr. Shannon Dorsey researching dissemination and implementation. She has presented at two symposia and will be presenting at the University of Washington, Seattle campus Undergraduate Symposium this May on the findings of this paper. She plans on working as a research coordinator in the realm of Clinical Psychology with hopes of entering into a PhD program for Clinical Psychology and Neuroscience where she can further research a genetic predisposition to GAD.

Alexander Richards will graduate in Fall with a Bachelor of Science in Biology. He is a veteran of the Army branch of the U.S. armed forces. Currently his educational interests are focused toward water preservation and Marine Mammal Physiology. He hopes to enroll as a graduate student for the 2018 school year and peruse his PhD in a related Biology program.

Rebecca Rodrigues will graduate in Fall 2017 with a Bachelor of Arts in Community Psychology. Upon graduating, she will attend graduate school to continue her studies in psychology. She plans to work in the public school system to improve education for physically and mentally disabled children.

Neele Thom is a sophomore majoring in Biology at UW Bothell. Currently, she works as a peer consultant in the Writing and Communication Center, and studies as an undergraduate in a research lab at UW Medical School in the hematology department. She plans to go to graduate school after earning her B.S. to study molecular and cellular biology to continue learning at the forefront of biological knowledge. Although she primarily enjoys studying science, she has a passion for engaging in global health topics and is excited to use that passion to contribute to The CROW this year.

Allison Thomas is a senior at UW Bothell and will graduate in the spring of 2018 with a B.S. in Biology, along with a minor in Chemistry and Neuroscience. She holds an A.A.S. degree in Fashion Design from Seattle Central Community and an A.A. degree from North Seattle College. Allison enjoys chemistry and research. After graduation, she plans to pursue Pharmaceutical Sciences, with future work in drug development.

Christy Wyble will graduate in Summer 2017 with a Bachelors of Arts in Health Studies. Her interests are in food quality & availability, herbal medicine, and public health. After finishing her degree she hopes to get her masters in Public Health in maternal-child health care or in Naturopathic Medicine. She is a trained doula and wishes to further pursue advocacy work for the doula world, providing safer care for all birthing mothers.

ABOUT THE EDITORS

Anaistasia Gray will graduate in Summer 2017 with a Bachelors of Arts in Health Studies. Upon graduation, she plans to attend Graduate School to study Public Health. Her experiences as a Certified Nursing Assistant and volunteering with organizations addressing health care access have driven her passion for researching inequities in health care. She believes solutions to aid underserved populations are rooted in understanding various communities, thought processes, and disciplines. She feels her work in journal drafting and editing makes her contributions to the CROW an exciting way to guide others to publish their work and make the interdisciplinary connections necessary to progress in healthcare.

Julianne Korn will graduate in Spring 2017 with a Bachelor of Arts in Health Studies and a Minor in Education & Society. Her experiences so far have included internships with the Hope Heart Institute in Community Health Education and Public Health – Seattle & King County in Chronic Disease & Injury Prevention. Her passions include working with children around education and food access, as well as making changes to impact health disparities in her communities. Julianne has always enjoyed writing and research, and is excited to expand her experiences on campus through working with The CROW.

Katelyn Oppengard is a first year graduate student in the MFA Creative Writing and Poetics program at UW Bothell. Her undergraduate degrees are in English Literature and Creative Writing from California State University, Long Beach. Although much of her current work is focused in creating poetry, her background specializes in research of Early Modern English playwrights and Bloomsbury literature. Continuing her undergraduate passion of working with students' writing, Katelyn works as a peer consultant at UWB's on-campus Writing and Communication Center. She is excited to use her skills as a writer and tutor in this new environment of The CROW's editorial board.

Anna Perry will graduate in Spring 2017 from the School of Nursing and Health Studies with a B.A. in Health Studies. Her interests in study range from community advocacy, social justice, and gender equality. In the future, Anna has hopes to take these interests and use the knowledge gained to help heal victims of violence by defending vulnerable populations and inspiring families to live in unity. Working on the CROW is a great opportunity that will motivate Anna to explore a new horizon of work as well as strengthen the various skills she has developed over the years at UWB. Her work in the health field, often as an active listener and support giver, will play an important role as an editorial board member of the crow as she strives to give a voice to anyone looking to get published.

Anna-Marie Rinaldi will graduate in the Spring of 2017 with a B.A. in Health Studies and a minor in Policy Studies. Upon graduating, Anna will enter the workforce where she hopes to gain real-world knowledge of the Healthcare field. She plans to work for some years before going to graduate school for a Masters in Health Administration. Before working on The CROW Anna had taken part in undergraduate research on campus that focused on Adolescent and Immigrant Health. Working on undergraduate research led her interests in The CROW, because she wanted to take part in examining final research papers. Anna believes that as an editor of The CROW she can not only bring her unique ideas, but will also learn creative ways to collaborate with other students as well as the entire editorial board.

Jenny Sims is a senior at UW Bothell and will graduate in the spring of 2017 with a B.A. in Health Studies. She currently holds an A.A. degree from Shoreline Community College and plans to pursue graduate school in the near future. Jenny's health and science interests are varied, but she is particularly drawn to studying the social determinants of health and how they affect a person's mental health and their quality of life. She hopes to find a career that will allow her to combine her interests in public health, social work, and global studies. Jenny is excited to be part of The CROW editorial board and looks forward to honing her own writing skills while learning how to help others improve theirs.

Henry Welch will graduate in Spring 2017 with a B.A. in Community Psychology from the school of Interdisciplinary Arts & Sciences. His experience as a Peer Consultant at the Writing and Communication Center will help him in collaborating with students on their submissions. He is interested in science, research, and the production of knowledge. The CROW provides a unique opportunity to be a part of that process with his peers. He is excited to take part, and learn about the research being done on our campus.

Victoria Wettmarshausen has a B.A. in English Literature from Hamburg University and will graduate in Spring 2017 from the University of Washington Bothell with a Master of Arts in Cultural Studies. Her interests in the program include literature and poetry, globalization, feminism, and utopia. She works as a Peer Consultant and Graduate Student Liaison at the Writing and Communication Center and just started a publishing internship. She is an editor on the CROW and hopes to go on into publishing after her graduation.

Additional Board Members:

Gabby Alvarado

Sara Alzeer