

University of Washington Bothell

# The CROW

Campus Research and Observational Writings

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*The CROW*

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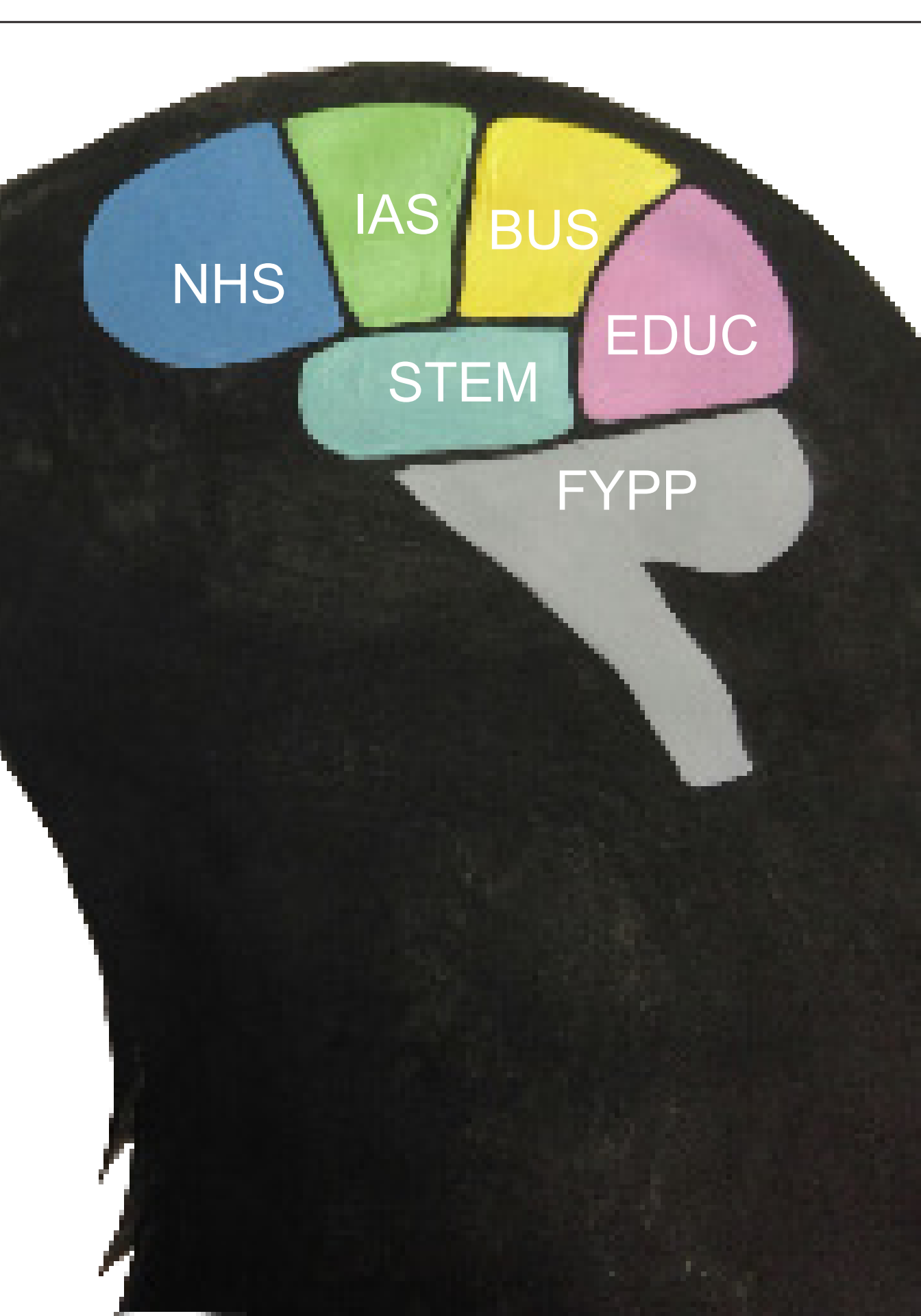
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## LETTER FROM THE EDITORS

*The CROW highlights the incredible dedication of students at the University of Washington Bothell to conduct and compose their own research endeavors. As the reader, you will discover a myriad of topics ranging from the biological sciences to the interdisciplinary arts, as well as issues pertaining to our own campus. The multiple submission types and diverse writing styles will spark the interest of any reader. The act of conducting research proves to be a highly impactful learning practice thoroughly promoted through the University. Research engages students outside of the classroom setting, allows them to think critically about the topics they desire to explore, and to practice producing knowledge for themselves and others. Having their work published will forever preserve their work, while also transforming it into a powerful tool to be used by the next generation of academics seeking 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 to have the opportunity to review all of the incredible submissions this year. The selection process was undertaken with extreme thoughtfulness and sensitivity for the fascinating and well written submissions we received. We thank and praise all of the students for the hard work they put into their research and to everyone who submitted their work. We also thank the faculty and staff mentors who foster students' passions and talents. In this volume we proudly present the work of a growing research community.*



NHS

IAS

BUS

EDUC

STEM

FYPP



# UW BOTHELL COMMUTER CRISIS

Alexa Russo

*ABSTRACT: This paper is a feasibility study analyzing the proposed potential solutions to the UW Bothell commuter crisis, including increased alternative transportation options, building new parking structures and lots, and a shuttle system to transport students to and from a lot off campus. By examining this important campus issue, this paper sheds light on the drawbacks to the proposed solutions that have been assessed by administration, namely environmental implications, community impacts, and cost impacts. The results of this study determined that the options on the table currently all have numerous benefits and drawbacks, and although building a parking structure might seem to be the simplest option for solving the parking issues on campus, the impacts of this action are numerous and could have many detrimental consequences, putting us further away from our climate neutrality goals.*

## Introduction

## Problem

From 2010-2017, UW Bothell faced a population growth (in full-time equivalent, FTE) of roughly 48% (Lundquist, 2017). In this time, parking on campus became an increasingly challenging issue, as the majority of the campus community commuted to campus by car each day, which created a matter of increased volume on the parking lots. An overwhelming amount of the campus population believed that there was not adequate parking on campus to support such a large populace (Figure 1) (Sanderson, 2017). The lack of parking on campus detracted from the experience of the campus for users, and also produced negative impacts for the surrounding community. To address the problems, the campus administration considered several options to improve the parking capacity of the campus. This paper analyzes the current and future state of the alternative solutions to this issue, identifies the environmental impacts, costs, and feasibility perspectives that must be considered, and evaluates the proposed solutions to these considerations.

The deficiency of campus parking posed many issues for the campus community, including demands on time, increased stress, as well as the associated environmental impacts. Students, staff, and faculty alike have experienced being late to their on-campus commitments due to the amount of time that it took for them to find a place to park. This created a major concern for stakeholders due to the ripple effect that these impacts had on the academic environment, as it detracted from the quality of the academic experience. Faculty expressed frustration; they were unable to enforce attendance and tardiness policies while their students were consistently late to class, missing important concepts, lectures, and discussions. Students have also taken to leaving classes early to make it to job or family commitments on time, because at peak times it takes just as long to leave campus as it does to enter. Overall, the quality of the educational experience on campus is not what it could or should be, in part due to the parking problems that this campus faces.

The campus parking problem is responsible for environmental problems which include increased greenhouse gas emissions produced by circling the parking lot and idling while waiting for a parking spot to open. As the largest greenhouse gas emitting category for UW Bothell, commuting to campus puts a strain on fulfilling our climate neutrality commitment, and contributes to climate change. Particulate matter and other gasses from these emissions also create air quality concerns, which must be addressed for the overall health of our community. In addition, more cars traveling to campus has led to more leaks of hazardous fluids and shedding of heavy metals from tires and brake pads, both of which contribute to water pollution in our watershed.

### **Statement of Research Objectives**

The objective of this study is to examine the potential solutions to the campus parking issue through analyzing the feasibility of each option, as well as their environmental impacts. The original premise behind this research project was to quantify the environmental impacts of idling in the parking lot while waiting for a parking space to open, as well as propose a campus shuttle system to offset this impact. This latter objective became outdated when the Truly Express shuttle system was put into place during the data collection process. Gathering enough data to actually quantify the environmental impacts also proved to be very difficult. Consequently, the objectives of this project have shifted. This paper looks at the current state of transportation and parking options on campus from a user perspective, addresses the constraints that the alternative transportation modes face, as well as evaluates the feasibility

of the proposed solutions through cost, community, and environment analyses. Specifically, this paper focuses on the results from the Commuter Services Survey conducted during spring 2017 and a Student Transportation Survey designed for this project.

### **Research Description & Methods**

This paper uses two main data sources, the first of which was collected by UW Bothell Commuter Services as an online voluntary survey (Sanderson, 2007). This ten question survey was administered from March 31-April 8 to students, staff and faculty and advertised through their various communications channels by the administration at UW Bothell. The survey garnered 1,607 responses. This data was then analyzed in the Catalyst Survey software and provided by the administrator of the survey, Nicole Sanderson. A copy of the survey instrument is reproduced in Appendix 1.

The second data source was two versions of one survey, “The Student Transportation Survey” (varying in questions and format) generated for this research project. The first survey contained 7 questions, where the other was broken down by days of the week and had 4 questions per day. The survey was distributed to students in Statistics, Introduction to Sustainable Practices, as well as Environmental Monitoring Practicum taught in winter quarter 2016 and spring quarter 2017. Students completed the surveys on a voluntary basis or for course credit, and 124 responses were received in total between the two survey types. A copy of these survey instruments is reproduced in Appendix 2.

This paper also evaluates the impacts



and considerations listed in the Campus Master Plan, an official institutional document outlining the developmental goals and guidelines for both UW Bothell and Cascadia College over a 20-year span to address the future growth of this campus (Arntz, 2017).

## Results

### Current State of Campus Parking

The Campus Master Plan outlines in the Transportation Discipline Report, that current parking utilization on campus is roughly 90 percent during peak periods; an unsustainable amount for the projected population growth to take place in the near future (Arntz, 2017). This document also confirms that adjacent streets have faced spill-over from the campus, either due to lack of being able to find a spot to park, or potentially due to the high cost of parking on campus (Arntz, , 20172017). Consequently, the surrounding community, including neighborhoods, businesses and the downtown area have faced a shortage of available patron parking due to campus parking overflow (Arntz, 2017). The Commuter Services Survey found that the majority of respondents believed that parking on campus is inadequate (Figure 1), 13% of surveyors said that they parked off campus because of this (Sanderson, 2017). The survey also found that 61% of surveyors attributed the inability to find parking on campus as a cause of them being late to class (Sanderson, 2017).

### Transportation Options To and From Campus

The most common transportation options to and from UW Bothell at its present state include driving, biking, walking, bussing, and carpooling. Of the 1,607 people who

answered the Commuter Services Survey, 14% of people claimed to take the bus to school, 3.8% either walk, bike, skateboard, or Segway, where 61% of people drive as their main means of transport. The results of the Commuter Services Survey are supported by the results of the Student Transportation Survey generated for this research project. Figure 2 demonstrates that the majority of students take personal vehicles to campus each day, as opposed to alternative transportation options.

Within the suburban setting which UW Bothell is located, it is no question that dependencies on cars become much greater than in more urban settings (Balsas, 2002); and with the increase in population that the Bothell area has seen in recent years, and the intensification of traffic on all major roads, highways, and freeways, many seek other options to get them to and from where they need to go.

### Constraints on Increased Public Transportation Modes

Public transportation has been utilized at a mere 14% rate to get to campus, and according to the Student Transportation Survey, increased use of public transportation seems to be the simplest way to alleviate the parking challenges on campus. The Commuter Services Survey gathered information about why people have not chosen to use public transportation to get to campus; some believed that the current public transportation options have not adequately satisfied the needs of the typical UW Bothell student, and as a result these options have not been used to their full potential (Arntz, 2017). The main complaints of public transportation seem to be convenience, as well as various time constraints that commuters face. Over 55%

of surveyed people from the Commuter Services Survey stated that public transportation is not quick or convenient enough for use as their main means of commuting to campus; many also claimed that the distance from their residence to campus is too far for public transit to be manageable for their use (Sanderson, 2017). The Student Transportation Survey backs up these findings, concluding that 24% of people said that they need their car immediately for other varying reasons before or after class. Some of the most common reasons for this need were work and family commitments; making public transportation very inconvenient or impossible (Figure 3).

### **Options for Addressing Campus Parking Space Scarcity**

One possibility discussed by campus administrators and seen as the most direct fix, was to build another new parking structure. However, parking structure construction costs a good deal of money and most of that cost is passed on to users via increased parking fees. Roughly one-third of those surveyed argue against this option, claiming that they might not be willing to pay increased fees (Sanderson, 2017). The other solution put into action by campus stakeholders was the creation of a shuttle system, the Truly Express, which transported commuters from a parking lot off-campus to campus and back. This option included the lease of an off-campus lot, located at the Seattle Times building, with a shuttle that ran every ten minutes during operating hours (7am-11pm Monday through Thursday). The shuttle was scheduled to run through the fall and winter quarters, but not during spring quarter when enrollment dips and parking is more available (Sanderson, 2017).

Although support has been provided to improve alternative transportation options such as biking and bussing, the constraints of time, convenience, availability, and distance associated with these other transportation sources make them insufficient to meet demand if deployed on their own. Therefore, it is imperative that UW Bothell considers options to increase parking capacity of the parking lots, particularly due to the overwhelming preference for the campus community to commute via personal cars and the anticipated growth of the campus, expected to increase by 2,900 FTE by 2021 (Office of Planning and Budgeting, 2017).

### **Discussion**

Given the current state of campus growth and existing infrastructure, the parking situation is unsustainable as a means of supporting the campus population. The administration at UW Bothell and Cascadia College have explored options to address the predicament, all with their benefits and drawbacks. Administration from both institutions have explored the creation of a new parking garage and the implementation of the campus shuttle system. While a parking garage would create the amount of additional spaces needed to support the demand, parking structures cost a lot of money and have environmental impacts, such as ecological habitat fragmentation and surface runoff pollution. The Truly Express has also provided more parking spaces, however cost and time constraints might be a deterrence for users.

### **Impacts of Building a New Parking Garage**

The Campus Master Plan outlines multiple scenarios to address the parking issue on

campus, which include options varying from taking no action at all, to building an additional parking garage. The proposed new parking structure would increase the amount of parking stalls from 2,272 to 4,200; an increase of 1,928 parking stalls (Arntz, 2017). There are many factors and concerns involved with the building of a new parking structure, including cost, space planning, environmental impacts, increased traffic congestion in the neighboring area and other impacts on neighboring homes.

### **Cost Impacts**

The impacts of these actions have been noted by the Master Planning Committee in the Campus Master Plan. The cost of creating a new parking garage on campus could be roughly between \$45,000 and \$50,000 per stall, if not more, meaning that an increase in parking fees would need to be enforced to cover this cost (Guerrero, 2017). Because parking structures are supposed to be self-sustaining, state funds may not be used in order to build a new parking structure, therefore the revenue from selling parking permits at a higher premium is the only way to cover the cost of a new parking garage. The Commuter Services Survey identified that cost is a limiting factor for students, and many are not willing to front the cost for such an expense (Sanderson, 2017).

### **Community Impacts**

Neighbors worry that a new parking garage would be a detriment to their property values due to light pollution seeping into their homes, increased pollution, increased noise, and poor aesthetics (Arntz, 2017). They also fear that the increased price of parking permits would further encourage students to park for free off-campus, creating a heightened issue of parking available on the

neighboring byways (Arntz, 2017).

### **Environmental Impacts**

Increased impervious surfaces from the construction of a new parking structure on campus will inherently create increased surface runoff of low quality into the wetland and North Creek (Arntz, 2017). North Creek is a tributary to the greater Puget Sound; therefore, these concerns do not simply impact local conditions, but affect the larger region. As a Salmon Safe Certified campus, we must also consider the impacts that this drainage could have on salmon populations that spawn in North Creek, potentially creating challenges for the recertification of the university. Administrators, however, do not perceive this as an issue due to their plans to implement additional stormwater mitigation measures (Arntz, 2017). Depending on its placement, building a new parking structure could cause fragmentation and disruption of habitats, the displacement of native species, and destruction of ecosystem functions that are vital to the health of our region due to the tree removal that will be necessary to create enough space for the structure. Removal of these trees is an ecological disservice to this campus through loss of carbon sequestration, air filtration, water infiltration, shade, and aesthetic appeal that many in the campus community cherish.

While the construction of a new parking garage on campus would potentially have damaging impacts to the environment, it is important to note that the process of looking for a parking spot does have its own environmental costs, which may be alleviated through an increased number of parking spots or the use of the shuttle system. When cars are looking for parking

spots, they have to drive very slowly, frequently decelerate and accelerate, and oftentimes idle in place for long periods of time, from 5 minutes to upwards of 30 minutes. Studies suggest that lower speeds have higher emissions rates, due to the necessity of more gas to gain power to accelerate, and emissions from queued vehicles have a higher emissions rate than those that are free flowing. If drivers have the ability to find parking spots more quickly and efficiently, they will spend less time at low speeds, therefore the overall emissions per car should decrease (Lenner et al., 1983; Tong et al., 2000; Arntz, 2017).

Population increase on our campus is guaranteed to create an increase in overall greenhouse gasses, due to the emissions coming from the large amount of cars travelling in and out of campus. (Arntz, 2017; Levofsky et al., 2011).

This will increase the amount of air pollution on the campus, as car exhaust emits carbon monoxide (a known direct toxin), nitrogen oxide, benzene, and other toxic gasses to the air through the combustion process (Levofsky et al.; Gaffney et al. 2009).

### **Viability of Off-Campus Parking and Shuttle System**

A majority of students from the Student Transportation survey (n = 68) claimed that they have been late to class due to issues finding parking, with 27% claiming that it has taken them 11 minutes or above to find a parking spot, which led us to question whether a shuttle system would be more time effective and eliminate this issue. The dispute that folks might have with the shuttle model is that the cost of the permit to park in this lot will be the same as parking on campus. Even though use of the shuttle

was free of cost, students would be unlikely to park in a less convenient location off-campus if they do not receive a financial break to offset the sacrifice of proximity to their vehicles (Arntz, 2017).

The other possible deterrent of this option would be the time users would spend waiting for the shuttle to transport them to and from campus, which might not actually save them much time. A study done by the University of North Dakota showed that people were unwilling to wait more than 10 minutes for a bus or shuttle to pick them up (Scott et al, 2011). The Commuter Services survey results showed that roughly 35% of surveyors claimed that they would be likely to use this service, where 50.12% said it was unlikely that they would use this option (Figure 4).

### **Shuttle System Case Studies**

Western Washington University uses their quarterly Student Transportation Fee to provide their students with multiple alternative transportation options to get to and from campus. For a small fee of \$26.25 per quarter, students are provided bus passes and shuttle service as well as access to Zipcar service. This shuttle system only runs at night, to safely transport students to locations along the route. This shuttle runs to and from an off-campus site on Monday through Saturday from 11 pm to 3am, and Sunday from 9pm to 2am. The incentive for use of this sustainable transportation package is that for a small price to pay, students are given multiple safe alternatives to get around campus, while promoting the use of alternative transportation on campus (Western Washington University, 2017).

Universities, such as UCLA, University of North Dakota and UT at Austin also use their own shuttle system to transport

students throughout campus, as well as to off-site locations. The UT Austin shuttle system is known to be one of the oldest and most expansive shuttle systems in the nation (Juarez, 2011). After piloting a fraternity-run shuttle, their success led to a shuttle bus system implemented campus-wide, and has been immensely successful ever since (Juarez, 2011). For a \$2.00 mandatory transportation fee per semester, students are offered rides on all shuttle bus system services (Juarez, 2011). This “universal coverage” funding model has proven to be the most effective strategy for covering costs, because of the low cost-per-ride, as well as the coverage of overhead costs related to running the system (Juarez, 2011). This also creates more of an opportunity to make this system successful, because there is more incentive for students to use the shuttle system when they have already paid for it in their student fees. This funding model is something that should be considered if the Truly Express were found to be a successful solution, upon expansion of the system plans.

It is important to bear in mind that the previous shuttle system model is present on a much larger scale than the Truly Express, as the UT Austin population is thirteen times larger than UW Bothell’s (Juarez, 2011). This also differs from our own shuttle system, due to the fact that it transports users to various locations surrounding their campus, not just to their cars and back. As a successful shuttle system model, this structure can show university administrators the benefit of creating a more university-driven transportation route. This would cater to the diverse needs of commuter students, which could potentially eliminate the quantity of cars on the lots. This would also

be beneficial for the environment because it increases the frequency of high-occupancy vehicle trips, reducing the overall number of cars on the road (Juarez, 2011).

The University of North Dakota (UND) conducted a study which looked at the success of their shuttle systems, including student satisfaction. The UND shuttle system is comprised of multiple shuttle service options, each varying in their degree of success; one of these options was eliminated entirely in 2008 due to low ridership (Scott et al., 2011) Each of the options have many stops across the campus, and they also have a similar service option as Western Washington University, with a night service shuttle option. These systems have had reported challenges, including funding, ridership amounts, maintenance of vehicles, as well as scheduling (Scott et al., 2011).

UND has a high percentage of students commuting from off-campus to classes each day, therefore they found that pricing parking permits such that it incentivizes the use of the shuttle system has helped increase ridership amounts (Scott et al.). Their campus shuttle system was found to be in the top five most frequently used modes of transportation, however they saw a net decrease in ride use of 21% between 2006 and 2010 (Scott et al., 2011). Roughly half of those surveyed said they used the shuttle service; those that didn’t use this service claimed that convenience was a barrier for using the shuttle. The majority of surveyed said that 10 minutes was the longest they would wait for a shuttle, and that weather and timeliness were significant considerations when looking into this alternative transportation option (Scott et al., 2011). Although there were incentives

and benefits to riding the shuttle, this shuttle program turned out to not be a very successful model.

When considering whether or not the Truly Express shuttle will be successful, we must look at the cost-to-benefit ratio. The same University of North Dakota study found that students claimed that there was little benefit to using the shuttle system when they were still forced to pay for parking, which could be a factor in the success of the Truly Express shuttle system (Scott et al. 2011). As discovered, the time-convenience ratio is also an important factor for students when considering the success of the Truly Express.

### **Conclusion**

With the implementation of the shuttle system starting in fall 2017, we have yet to determine whether or not the shuttle system is a feasible solution to our parking problem. There are both pros and cons to this system, including environmental and cost impacts, as well as potential time savings and decreased traffic congestion on campus. Since cost is such a strong variable to the campus community, it is fair to speculate that incentivizing the use of the shuttle system through decreasing costs could create more draw to use this option over parking on campus. We do know that the cost of a parking garage or surface lot would reach a hand into the pockets of our students, staff, and faculty, which might be a barrier to this option.

We could expect to see negative environmental implications associated with the construction of additional parking lots and structures, although the Campus Master Plan has proposed to use mitigation

and replacement measures to address the increased runoff and removal of trees that we could face.

The campus continues to grow in population year by year and the majority of the campus community commutes to campus by driving single occupancy vehicles. The survey results show that this expansion has created a strain on the amount of parking available on campus. The options that the administrators are currently exploring are not sufficient enough to properly manage this issue, due to the implications that they each might have on the environment, the space around us, and people's wallets. The simple fact that the state funds may not be spent to address this issue, even when it impacts the surrounding community is unfair. Students are frustrated, and as this study has shown, too many are unwilling to pay the high price of a new parking structure. Further investigation to determine the success of the newly implemented shuttle system is necessary to supplement this paper, as is an expansion on alternative options to this growing campus transportation crisis.

## Appendix 1: Commuter Services Survey

Distributed March 31-April 8 2017 by UW Bothell Commuter Services

What institution are you primarily affiliated with?

- a. UW Bothell
- b. Cascadia College

What best describes you?

- a. Dual enrolled high school student (Running Start Student)
- b. Adult Basic Education Student
- c. Undergraduate Student
- d. Graduate Student
- e. Full Time Faculty
- f. Part Time Faculty
- g. Full Time Staff
- h. Part Time Staff
- i. Other:

Please indicate how much you agree with the following statement: "Parking availability on campus is adequate."

- a. Strongly agree
- b. Somewhat agree
- c. Neither agree nor disagree
- d. Somewhat disagree
- e. Strongly disagree

What is your primary method of commuting to and from campus?

- a. Take the bus
- b. Drive myself
- c. Drive with others
- d. Have someone drop me off
- e. Walk, bike, skateboard, or Segway
- f. Other:

If you don't take the bus to campus, what is the primary reason? Select as many that apply.

- a. Taking the bus doesn't fit into my schedule, i.e. takes too long, and doesn't run often enough.
- b. I prefer having the flexibility of my own vehicle.
- c. I don't like using public transit
- d. Not applicable – I ride the bus
- e. Other:

If you drive to campus, where do you park your car?

- a. On campus – includes UWB owned spots at UWBX and UWBB
- b. Commercial parking
- c. In the neighborhood
- d. Not applicable – I don't drive to campus

If you park off campus, what is the primary reason you do so?

- a. I can't find parking on campus
- b. Campus parking is too expensive
- c. Not applicable
- d. Other:

If you purchase your parking pass on a day-to-day basis what is the primary reason you do so?

- a. I generally don't drive myself to campus, so it's cheaper to pay on a day-to-day basis rather than buying a quarterly permit.
- b. I don't know why; it's just what I do
- c. By the time I finalized my class schedule and was comfortable committing to purchasing a quarter permit, it was cheaper to continue paying for parking day by day.
- d. I didn't realize I had the option of a quarterly permit and by the time I realized the savings potential, it was cheaper to continue paying for parking day by day.
- e. Not applicable
- f. Other:

We are considering leasing a parking lot off campus and providing a shuttle service that would take 10 minutes to get to/from campus and would run every 15 minutes from 7AM to 11PM, Monday through Thursday. You would need a regular permit to park in the lot, but the shuttle would be free. How likely would you be to park in the off campus lot and use the shuttle?

- a. Very likely
- b. Somewhat likely
- c. Neither likely nor unlikely
- d. Somewhat unlikely
- e. Very unlikely

In order to provide more parking on campus we will need to increase parking fees to pay for parking facilities. The more parking spaces we create, the more it will cost. Given this fact, which of these statements best describes your preference:

- a. Cost is most important to me: I want it to be easier to park, but minimizing parking rate increases is the most important thing to me.
- b. A balance between cost and convenience is important to me: I'd like it to be easier to find a place to park, and I am willing to pay somewhat more, but not much more.
- c. Convenience is what is important to me: I'm willing to pay more for parking if I know I will be able to find a space to park when I get to campus This would not impact me since I do not drive to campus.

Please share any additional comments you have.

## Appendix 2: Student Commuter Survey "The Student Transportation Survey"

### Version 1: distributed Statistics and Environmental Monitoring Practicum during winter quarter 2016.

\*This survey is based off of the average day, please answer based off of what you do most often

1. Do you drive to campus? (circle one):  
Yes / No

2. Do you carpool? Yes / No if so, how many people are in your carpool?  
\_\_\_\_\_

3. If you drive, why do you drive instead of taking alternative transportation?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. If you drive, on average, how long do you think it takes you to find parking (from the time you arrive in the parking lot until you put your car in park? \_\_\_\_\_

5. If you drive, what kind of car do you drive? \_\_\_\_\_  
\_\_\_\_\_

6. If you do not drive, how do you get to campus (circle) walk / bike / bus / other

7. What days do you have class? \_\_\_\_\_  
\_\_\_\_\_

8. What times do your classes start? \_\_\_\_\_  
\_\_\_\_\_

9. Have you ever been late for a class due to parking? (Circle one) Yes / No



**Version 2: distributed to Introduction to Sustainable Practices during spring quarter 2017.**

1. Did you come to campus today? (Circle one): Yes / No

2. Did you Drive (circle one): Yes / No

3. What time did you enter campus?  
\_\_\_\_\_

4. What time did you park your car?  
\_\_\_\_\_

5. What kind of car do you drive?

Make of Car/Truck:  
\_\_\_\_\_

Model of Car/Truck:  
\_\_\_\_\_

Year of Car/Truck:  
\_\_\_\_\_

6. Did you carpool? Yes / No

7. If you drove, why did you drive instead of taking alternative transportation?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

8. If you did not drive, how did you get to campus (circle) walk / bike / bus / other

9. If you did not drive, how long did it take you to get to campus? \_\_\_\_\_

10. What days do you have class?  
\_\_\_\_\_

11. What times do your classes start?  
\_\_\_\_\_

12. Have you ever been late for a class due to parking? (Circle one) Yes / No

13. Rate your stress level: (Circle one)

1 2 3 4 5 6 7 8 9 10

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# EVIDENCE THAT THE SABER-TOOTH DID NOT INCREASE THE LIFESPAN OF THE CARNIVORA SPECIES

Sydney Beaumont

*ABSTRACT: There are many extant species from the Carnivora order, however, none of them are considered saber-toothed. It is examples like this that contribute to the mystery of extinction and speciation. To evaluate this example and to see if there is a correlation between having saber-teeth and their extinction, the hypothesis tested is that non-saber-toothed species of Carnivora on average survived longer than saber-toothed species. Using the data from the Paleobiology Database, all species and genera from the order of Carnivora were downloaded. The average lifespan of saber-toothed and non-saber-toothed species were compared. The results indicated there was a statistical significance between the average lifespans and that the research hypothesis was supported. On average non-saber-toothed species existed longer than saber-toothed species of Carnivora. Reasons include the lack of evidence indicating the usefulness of the saber-tooth over the smaller and stronger conical tooth.*

## Introduction

The saber-tooth is an elongated canine tooth with a feature assumed to be useful in killing prey. It is a question as to why there are no extant saber-toothed Carnivora. This paper compares the average lifespan of saber-toothed and non-saber-toothed Carnivora species and uses the previous studies to evaluate why there may be a difference. The saber-toothed species existed primarily in North America and Asia (Van Valkenburgh, 2007). The first of the saber-toothed species, Nimravids, existed from the Eocene through the Miocene, and then the saber-toothed felids took over from the Miocene until the major Pleistocene extinction (Meachen-Samuels, 2011). While the order of Carnivora continued following this major extinction event, it was the end of the saber-tooth for Carnivora species. It is important to understand how evolution occurs and to evaluate extinction events. From studying extinction researchers can better understand global ecology across time

(Raup, 1991). It is assumed that extinction or evolution occurs if that species was in some way inferior as a natural process for adaptation (Raup, 1991). So, what contributed to the saber-toothed Carnivora species extinction and why?

In this paper, the hypothesis tested was that on average, the age of non-saber-toothed Carnivora species exceeded saber-toothed species. The results will provide a direction for discussion of why saber-toothed Carnivora species no longer exists.

## Materials and Methods

The data was downloaded from the Paleobiology Database on 19 October 2017 using the Order name "Carnivora". All the data provided by the Paleobiology Database was downloaded and winnowed to focus only on genus and species. The average lifespan of each species was calculated using the excel average function of the maximum and minimum ages of the fossils. Data was then differentiated based on the species

containing saber-teeth or conical teeth. Identifying which species contained saber-teeth was done by referencing Sabretoothed Carnivores and the Killing of Large Prey by K. Anderson, et al. (2011). Once data was organized, the average age for each sample (saber-toothed and non-saber-toothed) was calculated as well as the standard deviation. A level of significance was placed at 0.05 as this test is not high risk. A p-value was calculated within Excel using a one-tailed t-test. The one-tailed test was used because the hypothesis states the non-saber-toothed species average lifespan will exceed saber-toothed species. From here, the graph for the mean age with error bars set to the standard deviation was created as shown in Figure 1.

### Results

The one-tailed t-test was used because the research hypothesis predicted non-saber-toothed Carnivora species to have a higher

average age than saber-toothed species. The test performed supports the research hypothesis that species of non-saber-toothed Carnivora survived longer than saber-toothed Carnivora. The data analysis provided a p-value of 0.04. This result indicates that the possibility of getting these results by random chance if the statistical null hypothesis is .04; therefore, the research hypothesis is accepted. Figure 1 shows the one-tailed t-test graph of average age for non-saber-toothed Carnivora species and the average age for saber-toothed Carnivora species with error bars set using the standard deviation for the data. According to the data, the mean age for non-saber-toothed Carnivora was 5.68 million years compared to the mean age for saber-toothed Carnivora being 4.95 million years.



**Figure 1:** The difference in average age of non-saber-toothed Carnivora species versus saber-toothed Carnivora species is statistically significant.

## Discussion

Based on the results of the one-tailed t-test, the research hypothesis is accepted that on average, non-saber-toothed Carnivora species had a longer lifespan than saber-toothed Carnivora species. While saber-teeth seem highly useful, they don't appear to be advantageous.

### Hunting

Saber teeth were used for catching prey and assisting with a quick take down and are rather fragile (Meachen-Samuels 2011). According to Meachen-Samuels (2011), the round conical canines of extant cat species are used for a choke-hold method of killing prey (Meachen-Samuels, 2011). Their shorter, more compact tooth can withstand forces in all directions while the saber-tooth was subject to breaking (Meachen-Samuels, 2011). This is supportive for why being a saber-tooth species did not ensure a longer lifespan. There was an idea tested that the upper body and forelimbs of the saber-toothed Carnivora had larger and stronger forelimbs in order to pin their prey (Meachen-Samuels, 2011). The results of this test did not support the idea that the forelimbs and saber-teeth were directly correlated. Meachen-Samuels (2011) suggests that the stronger upper body and forelimbs were likely a secondary adaptation due to the fragility of the saber teeth (Meachen-Samuels, 2011). Although there was a risk for breakage, the saber-teeth allowed the animal to increase their hunting range from the ability to take on larger prey relative to their body size (Van Valkenburgh, 2007). However, there is thought this may have contributed to their extinction (Antón, 2013). Due to the most recent major extinction event, the ice age

of the Pleistocene, the food source for the saber-toothed Carnivora species died giving an advantage to non-saber-toothed Carnivora (Antón, 2013). This provides further evidence why non-saber-toothed Carnivora species survived longer than saber-toothed species.

### Morphology

Dental features in animals can tell you a lot about the diet of the organism. They also allow you to assume the ecological niche for the species (Holliday and Steppan, 2003). Due to the elongated canines, it was imperative for the saber-toothed Carnivora to open their mouths wider (Van Valkenburgh, 2007). It was discovered that the anatomy of the skulls for these species were adjusted in comparison to present day cat-like Carnivora to accommodate their saber-teeth (Van Valkenburgh, 2007). The anatomical differences suggest that they could open their mouths larger, but they had a weaker bite (Van Valkenburgh, 2007). From the weakened bite and the increased size of teeth of the saber-tooth Carnivora came disadvantages to the saber-teeth, including a loss in biomechanical efficiency for the muscle systems and fragility of the teeth (Van Valkenburgh, 2007). This provides another example of what could have contributed to the shorter lifespan of the saber-toothed Carnivora species.

### Limitations and future work

In comparison, less saber-toothed species of the order Carnivora existed than non-saber-toothed based on the Paleobiology database. Alternative results for this would be to focus on why non-saber-toothed species survived a longer time rather than why saber-tooth species survived a shorter time.

Because there are no extant saber-toothed species of Carnivora, the Paleobiology database was used to conduct this research which made the research dependent on the fossil record, creating a limitation on the sample size. While it would be more useful to have a larger sample size to increase the accuracy of the study and to gain more understanding on why saber-toothed Carnivora species on average did not survive as long as non-saber-toothed species, this is not an option. The only conclusion that can be made from this research is that the saber-teeth were not as advantageous as assumed and the more compact, smaller conical canines prove to be more useful for these carnivores.

### Acknowledgements

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# BATS MAY HAVE ORIGINATED IN THE WESTERN HEMISPHERE

Zachary Weldon

*ABSTRACT: Although bats (order Chiroptera) make up one of the largest extant groups of mammals, second only to rodents, their location of origin remains a mystery. The fossil record of any genetically linked group of species can be a valuable tool to determine the location of origination of that group, and from there serve as a foundation towards further study of that group. This paper describes an analysis of the bat fossil record made to narrow the location of origination for bats to either the Western Hemisphere or the Eastern Hemisphere. The average age of fossils found within the Western Hemisphere was found to be greater than the average age of fossils found in the Eastern Hemisphere (27.66 million years old vs. 17.99 million years old respectively;  $p < 0.001$ ). This result would indicate that bats most likely originated in the Western Hemisphere. However, the poor quality of the bat fossil record has limited the data available which could potentially affect the accuracy of the analysis.*

*Keywords: Bats, Western Hemisphere, Eastern Hemisphere, Origin, Fossil Record*

## Introduction

Bats, order chiroptera, make up one of the largest groups of extant animals. They can be found in nearly all different habitats and environs across the Earth, and have been one of the most successful mammalian orders since their origin (Gunnell & Simmons, 2005). Given their wide dispersal and diverse abundance, they are of great importance to ecosystems the world over. To understand bats and their evolution is to understand a great portion of the evolution of mammals.

Gunnell & Simmons (2005) report that the location of bat origination remains unknown. While some of the oldest fossils on record have come from North America (Gunnell & Simmons, 2005) some molecular evidence has pointed towards an Eastern Hemisphere origination (Gunnell et al., 2017). Additionally, genetic studies have been used to create additional potential evolutionary trees for bats. For example, using genetic information Teeling et al.

(2005) has argued for a possible origination in North America while Eick et al. (2005) argues for an African origination. While molecular studies are a valid and rich alternative approach to the study of bat origins, studies based upon bat fossil evidence is still of major importance as fossils are the only direct physical evidence that can display the expanding geographic range and increase in bat species over time (Eiting, 2009).

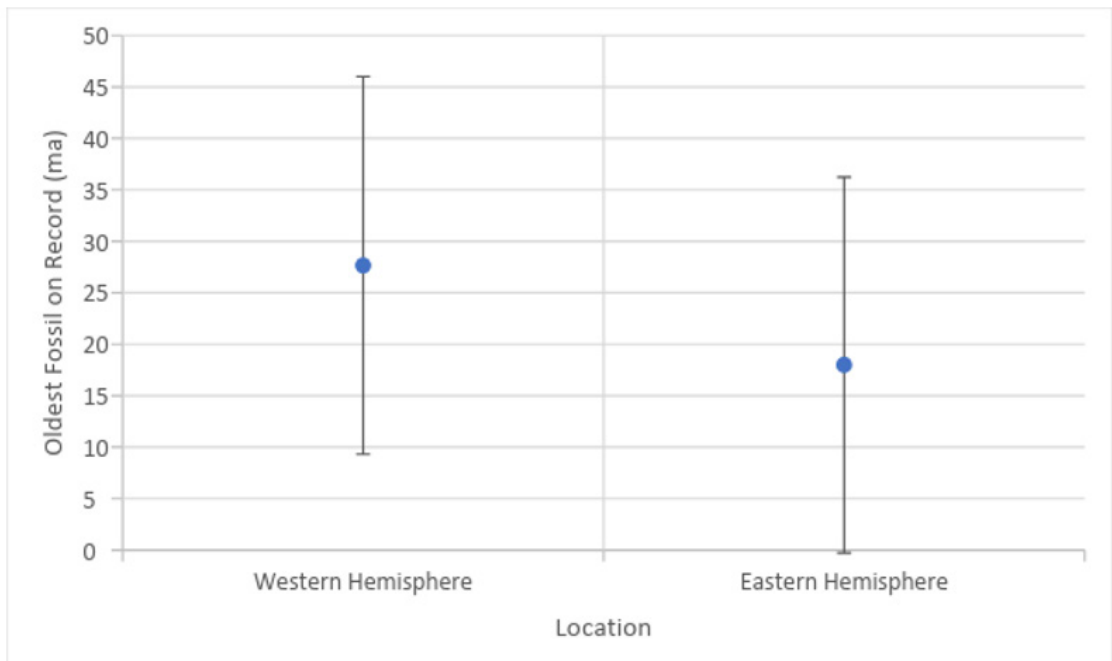
Paleobiologic data was used in this study to test the hypothesis that bats originated in the Eastern Hemisphere. It was predicted that the oldest fossils on record would not only be found in the Eastern Hemisphere, but that most of the oldest fossils would be found in the Eastern Hemisphere. This would imply that bats first appeared within the Eastern Hemisphere before they diversified and extended their influence nearly world-wide. To test this hypothesis, a comparison of the mean ages of Eastern Hemisphere and Western Hemisphere fossils was performed.

### Materials and Methods

The data for this research was downloaded from the Paleobiology Database on 21 October 2017, using chiroptera as the only taxon to include. This data was exported as a Microsoft Excel file. The data encompassed all chiroptera fossils present in the database along with the locations they were found. The geographic information included the latitude and their furthest identified taxonomic rank and name. The oldest fossils were found in both the Western Hemisphere and Eastern Hemisphere and dated 56.8 million years ago (mya) to the early Eocene while the most modern fossils were dated to the current epoch at 0.0117 mya and found

in the Eastern Hemisphere.

Fossils were divided into two categories; Eastern Hemisphere and Western Hemisphere. To do this, all fossils found at a longitude of -40 or lower (more West) were treated as Western Hemisphere fossils, and any longitude greater (more East) than -40 as Eastern Hemisphere fossils. The dependent variable is the age of the fossils, in mya. The prediction was that the average age of the Eastern Hemisphere fossils will be statistically greater (that is, older) than the average of the age of fossils found in the Western Hemisphere. To test this, a one-tailed t-test with a significance level of  $\alpha=0.05$  was used. Analyses were conducted in Microsoft Excel.



**Figure 1.** The differing ages of the known fossils of bats found in the Western and Eastern Hemispheres. Statistical error is shown through error bars. The mean age of Western Hemisphere Chiroptera fossils was higher than the mean age of Eastern Hemisphere Chiroptera fossils. The standard error of the mean for Western Hemisphere fossils is 18.26, and the standard error of the mean for Eastern Hemisphere fossils is also 18.26. P-value = 0.0006



## Results

A one-tailed t-test was performed to determine if there is a significant statistical difference between the mean ages of the oldest known bat fossils found in the Western and Eastern Hemispheres respectively. The t-test gave a p-value  $< 0.001$  which indicates the chance of getting the results obtained by coincidence or random chance is quite low, and that the null hypothesis, because there is no difference between the means of fossil ages, must be rejected. The mean age of the fossils found in the Western Hemisphere was found to be 27.66 mya with a standard deviation of 18.26 mya. The mean of the age of the fossils found in the Eastern Hemisphere was 17.99 mya with a standard deviation of 18.26 mya. Although a significant difference was found between the two means, the research hypothesis that the mean age of the fossils in the Eastern Hemisphere would be older than those in the Western Hemisphere could not be accepted. This is because the mean age of the fossils found in the Western Hemisphere is greater. Instead, the data indicates that the fossils found in the Western Hemisphere are older than those in the Eastern Hemisphere. Figure 1 displays the ages of the oldest known bat fossils found in the Western and Eastern Hemispheres respectively.

## Discussion

As the mean age of Western Hemisphere Chiroptera fossils was shown to be significantly different than the mean age of Eastern Hemisphere Chiroptera fossils, the null hypothesis must be rejected. However, the mean age of fossils in the Western Hemisphere was found to be 9.67 mya older than the mean age of the fossils in the Eastern Hemisphere. This means the research

hypothesis that placed the mean age of the fossils found in the Eastern Hemisphere to be older must also be rejected. Instead, the mean age of the fossils found in the Western Hemisphere are greater than those found in the Eastern Hemisphere.

If the location of origination for bats was within the Western Hemisphere, we would expect the oldest bat fossils would be deposited in the Western Hemisphere where the earliest ancestors lived. We would also expect that as the earlier ancestors have had more time to deposit fossils, their location would have a greater number of older fossils. This conclusion is compatible with the findings made by the analysis of the available fossil data.

The oldest bat fossil on record was found in Wyoming by Simmons et al. (2008) and was dated to the early Eocene. This would seem to also imply origins in North America. However, other fossils from the early Eocene also appear in the Eastern Hemisphere (Gunnell & Simmons, 2005). This could point to an ancestor that was able to diversify before the separation of the Eastern Hemisphere from the Western Hemisphere. Since as Hamilton et al. (2012) described, bats from the Western Hemisphere may occasionally be found in parts of the Eastern Hemisphere, it is also possible that very early migration may have occurred.

The data gathered would imply that bats originated in the Western Hemisphere and spread out from there to eventually encompass much of the world. The relative closeness in the mean age of Western Hemisphere fossils to the mean age of Eastern Hemisphere fossils (less than 10 mya) would also seem to imply a rapid diversification after origination, which is

supported by Gunnell et al. (2017) when they reported on the appearance of many fossils representing differentiated groups of bats early in their evolutionary history.

### **Future Work and Limitations**

Although all the available fossil data was used in the statistical analysis, it is possible that there are missing fossils or data from species that were not preserved that could alter the results. The fossil record for bats is highly incomplete, with much lower completeness estimates than the fossil records of other comparable groups (Eiting & Gunnell, 2009). Genetic sampling from extant bats still indicates an origination in the Western Hemisphere (Teeling et al., 2005) and this data is independent of the fossil record.

A large statistical error was present through the analysis. This is troublesome, especially as the statistical error is larger than the mean age of Eastern Hemisphere fossils. This would signify that the difference in age between fossils found in both the Eastern Hemisphere and Western Hemisphere is large, and that the ages do not tend to be close to their individual means. This assessment is conclusive with the data used in this study, as the 157 fossils available had ages ranging from 0.0117 mya to 56.8 mya with no clear common age. A greater sampling of bat fossils would likely lower the standard deviation and return a more reliable statistic.

While the results of the statistical test imply origination of bats in the Western Hemisphere, the data is not definitive. If a greater amount of bat fossils were to be unearthed and accurately dated, it would be possible to more accurately predict the region of origination for bats with greater accuracy. As concluded by Eiting &

Gunnell (2009), historically under-sampled regions should be targeted for examination. Currently, fossil sampling of bats is poor due to less than ideal circumstances such as the nature of bat skeletons (Gunnell & Simmons, 2005). Rather than use the poor fossil record, many studies have instead looked at the molecular genetics of bats to relate them to each other and to map their ancestry (Ammerman & Hillis 1992, Teeling et al., 2005, Almeida et al., 2011). Although this method does not provide physical proof it can provide significant genetic evidence. Ideally, a combination of new fossil evidence along with greater genetic evidence via greater taxonomic sampling would be the way forward to discovering more information about this diverse and important mammalian order.

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# Cephalopod Evolution and the Increase in Size Across the Mesozoic Periods

## Madasair Zubair

*ABSTRACT: By looking at a species' change in morphology, which is their shape and size, throughout time, it is possible to learn about the environmental conditions they lived in and what effect they had on them. Specific elements that can play a role in the change of size are extinction events, environmental responses, divergent/speciation occurrences, and adaptations to an ecosystem. In this research paper, cephalopod widths have been examined to see if they have undergone a noticeable change in size throughout the three Mesozoic periods, Jurassic, Triassic, and Cretaceous. The result of this research is that the cephalopods have gone through significant changes in size between every period in the Mesozoic. It is suggested that this increase in size was a response to elements in the environment such as the Marine Mesozoic Revolution, the C/T extinction event, and other evolutionary factors.*

### Keywords

Size, Cephalopod, Mesozoic, Evolution, Environment, Pressure

### Introduction

Many factors place an evolutionary influence on size. Ecological events such as the introduction of new species or a change in an environment can play a role in the cephalopod's evolutionary development. Cephalopods, mollusks that are part of the class Cephalopoda such as cuttlefishes, ammonites, or squids, were chosen for this research since there is a huge diversity of cephalopods in various shape and sizes. This paper focused on cephalopod samples from Europe; having numerous coasts close to the ocean, this would mean Europe is likely to carry an abundance of data. The span of time examined in this research will be throughout the Mesozoic when Cephalopods are recorded to have the most diversity in size within their fossil record.

What jump-started this evolutionary change in size was the Mesozoic Marine Revolution (Tanner et al., 2017). Happening

early in the Mesozoic, this revolution was a series of events where cephalopods contested with marine vertebrates (mostly predators). Throughout the revolution, many shelled cephalopods ended up being preyed upon. Cephalopods that survived the challenges presented during the Revolution would adapt, survive, and diversify into modern cephalopods. After the Revolution, diversions among Cephalopod and differing environmental pressures led to the formation of several orders (Strugnell et al., 2006) and diversification of Cephalopod Morphology. (Lindgren et al 2012). The Cenomanian/Turonian Extinction Event (also known as the C/T event or the C/T Interval) that occurred towards the end the Mesozoic would have also drastically altered the earth's environment and climate, forcing cephalopods to undergo another intense stage of change, forcing them to adapt to the new conditions in their current environment at the time, or migrate to a new one if they

could not adapt (Yacobucci, 2017). These would likely result in cephalopods adapting to different conditions, which in turn would cause them to change in size, as an evolutionary response.

This paper tests the hypothesis that over the course of the Mesozoic Era the species in the class Cephalopoda would have gone through a significant change in size from the beginning of the Triassic to the end of the Cretaceous. The importance of this data is that it will help clarify how marine life evolves, as size is a trait that changes with environmental factors or diversification.

### Materials and Methods

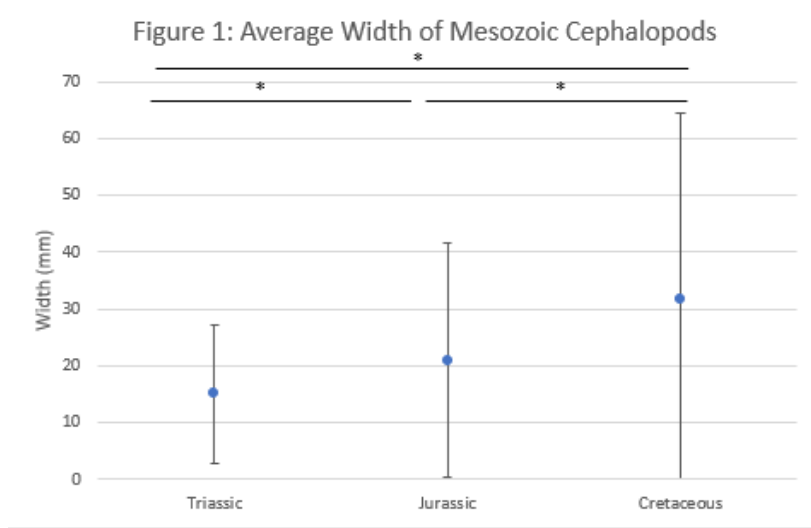
This data was collected from the fossil works database on October 28, 2017, through restricting the region to Europe, restricting class that was studied as a cephalopod, restricting the time interval to the entire Mesozoic, and setting the measurements as the width (provided in millimeters). Data from periods outside of the Mesozoic were excluded. The data was reorganized into displaying the periods of the Mesozoic (Jurassic, Triassic, and Cretaceous) and the mean width. The statistical test used was ANOVA since the data used three categorical variables – the periods of the Mesozoic - with one categorical variable - width in millimeters. The program used to narrow down, collect the data analysis, and make calculations was 2016 Microsoft Excel. I used an ANOVA test, with a P-Value of zero, a level of significance of 0.05. A statistical significance 0.05 since this was a low-risk study and greater level of significance would be unnecessary.

### Results

My hypothesis was that over the course of the Mesozoic Era, the species in the class Cephalopoda would have gone through a significant change in size from the beginning of the Triassic to the end of the Cretaceous. Thus, the research hypothesis is accepted because there are significant differences in size between all three periods according to Figure 1. Table 1 indicates that average cephalopod widths for the Triassic, Jurassic, and Cretaceous were 15.09193 mm, 20.98029 mm, and 31.83559 mm. The standard deviations were 12.1891, 20.65792, 32.55768 for the Triassic, Jurassic, and Cretaceous respectively, represented by the error bars. Figure 3 indicates via one-tailed T-tests that relationships between all three periods,  $5.3E-61$  for Triassic-Jurassic,  $8.52E-145$  for Triassic-Cretaceous,  $5.4E-56$  for Jurassic-Cretaceous are all showing signs of being significantly different. As the P-value is zero and thus is significantly less than all the T-test results, the null hypothesis of there being no significant differences from the Triassic to the Cretaceous is rejected.

### Discussion

The hypothesis is accepted because it is shown that between every period of the Mesozoic, cephalopods were showing to go through an increase in sizes between every period according to Figure 1 and the t-tests in Table 2. Table 1 illustrates that cephalopods increased to roughly 5 mm between the Triassic and Jurassic and by roughly 11 mm between the Jurassic and Cretaceous. Because these results indicate significant changes in sizes happened between every period, it's presumed some environmental factors played a role in the



**Figure 1:** Mean width of recorded Cephalopods throughout the Mesozoic era. ANVOA reveals Width differences between the ages are significant. ( $P < 0.001$ ) Significant differences between periods, post hoc T-test values (for Triassic-Cretaceous, Jurassic-Cretaceous, and Triassic-Jurassic comparisons are  $< 0.001$ ) A statistical significance 0.05 was used since this was a low-risk study.

**Table 1: Width Data for Mesozoic Periods**

Period	Mean Width of Cephalopods (mm)	Standard Deviation	Number of Cephalopods Examined
Triassic	15.09193 mm	12.1891	6089
Jurassic	20.98029 mm	20.65792	4217
Cretaceous	31.83559 mm	32.55768	2923

evolution of cephalopod size during the Mesozoic Era.

Environmental factors will often push cephalopods to evolve in a certain way. Due to having gone through “selective pressures,” cephalopods during the Mesozoic would have gone through a convergent evolution and correlated evolution, the former being one where cephalopods develop similar organisms not related to them, with the latter being where they develop traits based on environmental responses. Thus,

**Table 2: T-Tests for Significant Differences**

Periods	T-test
Triassic - Jurassic	5.36609E-61
Triassic - Cretaceous	8.5208E-145
Jurassic - Cretaceous	5.39984E-56

there would be significant changes in their morphology (Lindgren et al., 2012). These changes would include but are not limited to having harder shells or stronger muscles. The Marine Mesozoic Revolution would have also played a large part in advancing this where predatory vertebrates were easily preying on them. It was heavily described as the rivalry between predators and prey to see which could out-evolve the other (Tanner et al., 2017). Thus, Cephalopods

would continue to evolve into having defenses like a stronger, bigger, more protective body. This can be illustrated with a gradual increase in size throughout the Mesozoic.

The Cenomanian/Turonian extinction event, life-changing for all life on earth event that occurred around the mid-Cretaceous, would have further pushed this change. With the rising sea level, global greenhouse effects occurring, and the extinction of species, environments and ecosystems would have through a major reorganization. The C/T interval brought so much change that cephalopod diversity significantly increased in areas coastal areas but are said to, during the Turonian, decrease speciation in open-ocean (Yacobucci 2017). Considering that different environmental pressures have changed cephalopod morphology in various ways, Cephalopods may have increased in size (likely through speciation) to fit the conditions of a post-C/T Interval world.

Research in Xavier et al., (2015) suggests that cephalopods are subjugated to similar conditions as they were back in the Mesozoic era – global warming and rising sea level - and many more human-made challenges like overfishing and ocean acidification through dumping chemicals and waste into the ocean. These challenges would bring long-term pressures to entire ecosystems (especially at the coastal ecosystems) that cephalopods live in. The research also noted that studying cephalopod shape and size would be a valuable addition in helping modern-day research since it helps scientists understand the environmental conditions they lived in back in the Mesozoic and the conditions they live in now. While granting that cephalopods sizes increased throughout the Mesozoic, man-made pressures are

showing to increase the pressure for cephalopods to adapt (Xavier et al., 2015). Thus, it could be inferred that size is affected as a part of evolutionary responses and species diversification in response to environmental pressures.

Alternate explanations for the data could be that genetic mutation, where new genes are introduced to a species, or evolutionary divergences, how a species' evolutions branch off into different paths like a family tree, could have given larger-sized Mesozoic cephalopods a competitive advantage over smaller-sized ones. In an instance where a group of larger sized cephalopods and common smaller sized cephalopods contest for food, the larger ones would be able to catch more and reproduce more than the smaller ones. During Paleozoic Era, there has been evidence of Cephalopoda taxa within dividing into several orders, with some continuing to diverging into the late Mesozoic/early Cenozoic as evidenced by their fossils, while others remain incomplete and unclear. (Strugnell et al., 2006). The cephalopods that successfully diverged throughout the Mesozoic may have been bigger cephalopods, while smaller ones would go extinct.

Another alternative explanation is that it was noted that towards the end of the Cretaceous period there was an increase in speciation in coastal areas in a post C/T world (Yacobucci, 2017). With Europe also having many coastal areas the continent could be considered a haven for Cephalopods, or certain types of large cephalopods, to thrive and evolve. However, this does not speak for Cephalopods in areas outside of Europe that may have evolved differently (i.e. decreased in size).



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The stakes of this data suggest that long-term changes to the environment will affect how a species developed and survives, as well as what kind of species they will evolve into. Living in a world affected by global warming and going through a change like Mesozoic Marine Revolution and the C/T extinction event, it is necessary to look out for what kind of world the future holds for creatures on earth who will be caught once again and be forced to evolve in new conditions or die.

### Limitations and Future Work

Certain biases that may have happened over the course of this research are that the only cephalopods examined were in Europe; cephalopods sizes in other parts of the world may be very different. The fossil record, while an extremely useful resource, cannot catalog every known cephalopod. Further experimentation in this area could focus on cephalopod occurrences throughout the Mesozoic, analyzing species sizes between Mesozoic ages rather than periods, research on convergent and correlated evolutionary traits in niche ecosystems, and analyzing the C-T interval and the Mesozoic Marine Revolution.

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## **Appendix**

The supplemental raw data for this research can be accessed via the UWB CROW website at: <https://thecrowuwb.wordpress.com/>

# AMMONOIDEA: AN EXCEPTION TO THE TEMPERATURE SIZE RULE

Megdalena Brooks

*ABSTRACT: A phenomenon exists where the size of animals living in colder regions are larger than those living in warmer regions. Scientists call this phenomenon the temperature size rule. Although there is no conclusive explanation for why the temperature size rule occurs there is much research that has been done on it and some studies have found exceptions to the rule. This study looks at whether ammonoids, an extinct subclass of cephalopods, are an exception to the rule because they had unique growth patterns and evolved rapidly. A linear regression was run using width as the dependent variable and paleolatitude as the independent variable. The null hypothesis, which supports my prediction, was not rejected because of a large p-value and a small  $r^2$  value. Because of the lack of relationship between the two variables, as well as other factors, I conclude that ammonoids are an exception to the temperature size rule. Future studies should look at specific ammonoid species and explore more variables such as depth.*

*Keywords: Temperature Size Rule, Latitude, Ammonoidea, Exception*

## Introduction

The temperature size rule (TSR) is a widespread phenomenon where the size of adult animals living in colder regions are larger than those living in warmer regions; average animal size increases as temperature decreases (Walters & Hassall, 2006). When it was first discovered in 1847, the rule was thought to apply to endotherms, warm blooded animals, because of a resistance to heat loss (Walters & Hassall 2006). However, about 80% of ectotherms, cold blooded animals, also followed this trend (Walters & Hassall, 2006). As widespread as it is there is no current explanation for why the TSR happens (Walters & Hassall, 2006). Among many possible explanations, one study found a tentative working hypothesis where temperature variation caused changes in diet which led to variations in size (Lee et al., 2015), and another found that size may be influenced by predation patterns

at different temperatures (Manyak-Davis et al., 2013). Current databases allow for more extensive research, but many of these studies analyzing the TSR were conducted with regards to only one or two organisms. Consequently, there is still no conclusive explanation that applies to all species. In fact, some scientists believe there is no one reason for why it happens (Kingsolver et al., 2007).

Even though individual studies analyzed one or two organisms at a time, over the years a wide range of species have been studied with regard to the TSR. These organisms include grasshoppers (Walters & Hassall, 2006), pulmonate snails (Arendt, 2015), fish (Rijn et al., 2017), and other ectotherms. In these studies, some exceptions to the TSR have been found including aquatic ectotherms (Atkinson, 1995). By analyzing these exceptions to the TSR, and finding new exceptions to the rule, new information about its cause(s) may be found which is

why it is important to search for new species that may be exceptions to the rule.

Cephalopods are a very diverse class of marine animals that includes squids, octopuses, and nautiloids, which look like octopuses with curved shells covering most of their body. Some species of common Cephalopods were studied in one project and seem to follow the TSR (Rosa et al., 2012). However, one extinct subspecies of Cephalopod has not been studied and may be an exception to TSR. Ammonoids were marine animals with soft bodies and external shells similar to current day nautiloids (Moriya, 2015). Studies concerning ammonoid ecology are ongoing, but there is evidence that they lived near the ocean floor and ate aquatic organisms such as plankton (Moriya, 2015). Their spiral shells, which grew throughout their entire life and contained chambers, are thought to have helped the animals regulate their buoyancy (Arai & Wani, 2012). Because their shells grew along with their bodies, ammonoid size is easily measured using their shells (Arai & Wani, 2012). Ammonoid growth was done in four steps, and the characteristics caused by this growth vary greatly between ammonoid species (Arai & Wani, 2012). This implies that their growth is independent of patterns such as the TSR. Also, ammonoids evolved rapidly (Moriya, 2015). If ammonoids were diverse and able to adapt quickly to their environment, then whatever factor, or group of factors, influence the TSR may not have applied to them. Thus, I suggest that ammonoids may not follow the TSR because of their unique growth methods and rapid evolution.

My hypothesis is that ammonoids, as a subclass, are an exception to the TSR. In this research project, I predict that ammonoids

will not follow the common trendline of the TSR, showing that they are an exception to the rule. If ammonoids are an exception to the rule, then more research into their species may help provide other explanations for why the TSR occurs. According to the Paleobiology Database, the most occurrences for the subclass Ammonoidea are from the Cretaceous Period (PBDB, 2017), so this study will focus on the subclass Ammonoidea from the Cretaceous period.

### Materials and Methods

Data on species, age, and location were downloaded from the Paleobiology Database on October 18th, 2017 using the parameters Ammonoidea and Cretaceous. Occurrences that slightly overlapped the Jurassic were included to ensure all Cretaceous occurrences were accounted for. Data on shell width were downloaded from fossilworks.org on October 25th, 2017 and added to the occurrence data. The absolute value of the midpoint of latitudinal range was used to represent temperature since it indicates distance from the equator.

The accompanying file shows the three columns which were used to run the statistical test. A linear regression was run in Excel using width as the dependent variable and latitudinal range as the independent variable. The significance level was chosen as  $\alpha = 0.05$ . For the linear regression, my research hypothesis was that the relationship between ammonoid size and latitude would be negative rather than the positive relationship shown by the TSR. My null hypothesis was that there would be no relationship at all between the two variables.

## Results

The linear regression generated a p-value of 0.1 which means that my results had a 10% chance of being random, and an  $R^2$  value of 0.003 which means that the difference in latitude is only responsible for 0.3% of the variation in size. Thus, I failed to reject my null hypothesis that there is no significant relationship between temperature and size and subsequently rejected my research hypothesis that the relationship would be a negative slope. This statistical test supported my prediction that ammonoids are an exception to the TSR; there is no significant relationship between ammonoid size and latitudinal range. Figure 1 shows my graph of the data for size and latitude along with a linear trend line. This

almost horizontal trend line illustrates that there is no relationship between size and latitude.

## Discussion

In my results, the p-value was very large and the  $R^2$  value was very small, causing me to accept my null-hypothesis. Because I did not reject my null hypothesis, I concluded that ammonoids are an exception to the TSR. If ammonoids had followed the TSR, I would have seen a steeply positive slope, showing a relationship where size decreased the closer it got to the equator. As shown in Figure 1 and explained in the Results section, I did not get these results; the linear regression I ran showed a trend line with a slope of 0.0029, which is almost completely

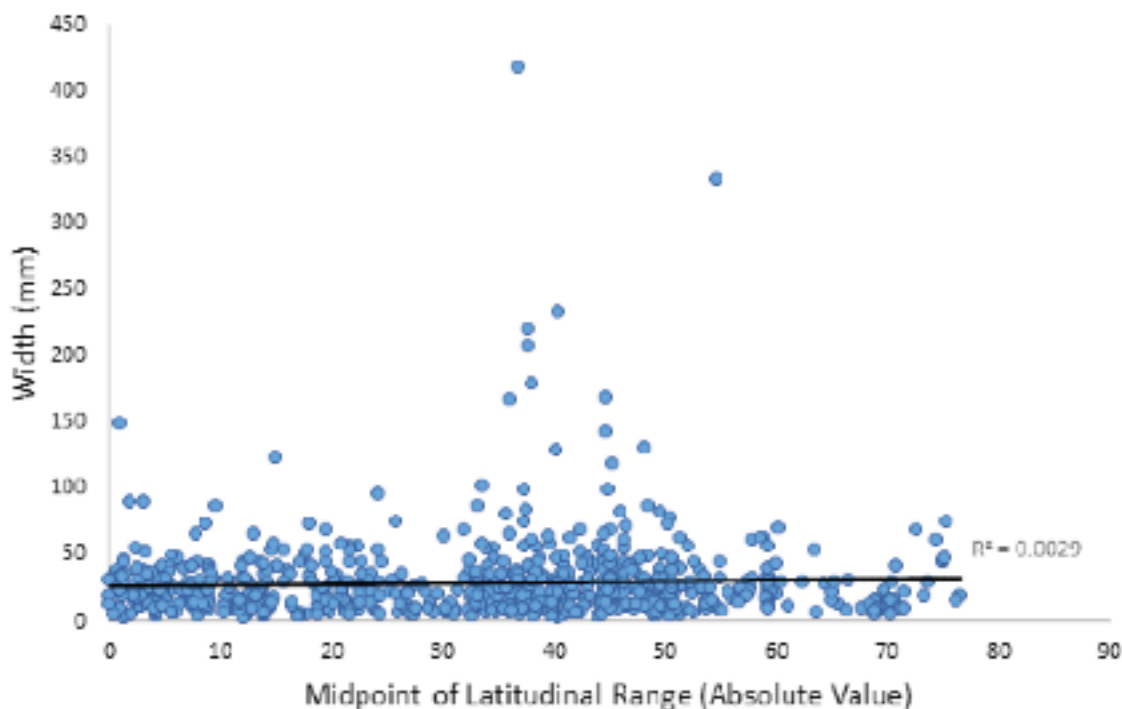


Figure 1. Lack of significant correlation between width (mm) of Ammonoidea shells and the midpoint of their latitudinal range (absolute value). (Linear regression,  $P = 0.1$ , and  $R^2 = 0.003$ ).

flat. Because the results show no significant relationship, positive or negative, between latitudinal range and size, ammonoids must be totally independent of the TSR and exceptions to the rule.

If we take into account differences in ocean circulation during the Cretaceous Period, it is even more impressive that there is no relationship between latitude and size. According to one study, during the Cretaceous Period, strong ocean currents greatly influenced where species were located and wide circulation patterns caused a severe differentiation between temperate and arctic waters (Gordon, 1973). I would expect my results to have an even steeper positive trend line if ammonoids followed the TSR because the severe difference between warm and cold water should have caused a dramatic difference in shell size. As seen from the results, that is not the case, which all the more supports ammonoids being an exception to the TSR.

As I explained in the Materials and Methods section, I represented temperature using the paleolatitude of the occurrences. I used latitude to portray water temperature because it seemed like a straightforward way of representing it and had been used in other studies (Rosa et al., 2012). In fact, Bergmann's Rule, another version of the TSR, compares body size to latitude (Angilletta & Dunham, 2003). Nevertheless, latitude might not be the best representation of water temperature when analyzing aquatic organisms because aquatic environments are impacted by many factors such as the weather, sea level, atmospheric temperature (Yin, 1988), and depth. Depth has major implications for the size of the animals. In fact, Rosa et al. states that, in general, the deeper

the animal, the larger its size (Rosa et al., 2012). When latitude has been used in other studies to represent water temperature the studies occurred in shallower environments (Rosa et al., 2012), but my study included fossils from every depth. Depth has even bigger implications for ammonoids because many species of Ammonoidea are bottom dwelling animals (Moriya, 2015). This possible misrepresentation of temperature may have impacted my results and should be considered when analyzing my data.

Another related matter I would like to bring up is the outlying occurrences shown in Figure 1. Between 30 and 60 degrees, especially around 40 degrees, there are a number of occurrences that are far above the average size. It would appear that a large number of ammonoid occurrences that are from temperate regions are larger than those in tropic and polar regions. If this is true, then ammonoids definitely do not follow the TSR.

### **Limitations and Future Work**

Future studies should take into account more factors than just latitude in representing water temperature when considering ammonoids. Also, rather than generalizing the data and using each species once, future studies should analyze ammonoid species individually to see if there are trends in some species and not in others. I think that future studies should additionally include other measurements of size. I included width as a representation of shell size, but height and length could be added to provide a more accurate representation of size. Lastly, research should be done by dividing the latitude of ammonoid occurrences into different bins rather than using latitude as a continuous variable. They should look

into whether ammonoids are actually larger in temperate regions, or whether there is a difference in size between the Northern and Southern hemispheres.

### Acknowledgements

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# FEMALE STEREOTYPING IN VAMPIRE FICTION

Amman Nega

*ABSTRACT: This essay focuses on how negative stereotypes in the media can affect people's behaviors towards the groups targeted in these films or books. More specifically, how vampire fiction portrays females as psychotic and by showing that they have nothing else to offer besides their bodies. The media can be highly influential and may even shape our understanding of the world and what we believe everyone's role in the world is. Therefore, analyzing vampire fiction and their portrayal of their female characters is crucial in understanding why we may treat women in a less dignified manner compared to men. My paper provides evidence to prove that even subconsciously, men may treat women as if they aren't as qualified for a job as their male colleagues. Looking at the source of where we obtain this information of what typical female behavior should be and figuring out how we can alter it in the books we read and the films we watch, will be essential in moving our society closer to reaching gender equality.*

The fight for gender equality is a major issue that has always been present. More specifically, women have never received the same level of respect as men in the US and looking at the representation of the two genders in the media, it is not hard to see why. "The Girl with the Hungry Eyes" (1949) by Fritz Leiber highlights this issue when looking at the portrayal of females. This vampire tale centers on a vampire disguised as a model who uses her sexuality to get what she wants: the blood of her dates. Her behavior throughout the story certainly is not something that could be described as ground-breaking for female characters. From Dusk till Dawn (1996) directed by Robert Rodriguez similarly objectifies women but adds an element of fear to them. This action horror film is about two robbers who find themselves trapped in a strip club filled with vampires eager to feed on them. Dissecting these pieces, I believe is crucial in determining why men may behave a certain way towards women. The media helps shape our perceptions of

the world and people around us, so we must be aware of films and books that portray women in a negative light. I wish to argue that female vampires are seductive and dangerous, as shown in "The Girl with the Hungry Eyes" and From Dusk till Dawn, perpetuating the stereotypes that females are crazy and obsessive in relationships and lack much depth besides showing you what is under their shirts. The way women are portrayed in these narratives affect how we behave towards them, and moving away from the misogynistic ways of vampire fiction could help inspire social change in the future.

I'll begin my discussion on the issues of female stereotyping with the short story "The Girl with the Hungry Eyes", specifically, the issue that female vampires flaunt their sexuality to fulfill their selfish desires. The story is narrated by a photographer named Dave who finds himself working with a model, and soon finds out that she is not as gorgeous and innocent as she may seem. He realizes that any man who is around her ends

up dead the next day and he could be next if he does not stay away. Due to her increasing fame as a model, she finds it easy to seduce men, as evident by one man she meets whose reaction Dave described as, “A crazy dream had come to life for him” (Leiber 346). The “crazy dream” for the man shows how desirable she was; he was infatuated with her and ended up being another victim of her desires. The stereotypes of female vampires in “The Girl with the Hungry Eyes” sends a message that women are selfish and even scary when in a relationship with men. While at a dark park with the vampire, Dave observes that, “wherever she came from, whatever shaped her, she’s the quintessence of the horror behind the bright billboard. She’s the smile that tricks you into throwing away your money and your life” (Leiber 347). Normally, one would not describe a smile as a trick, unless someone is deceiving another person, which seems likely based on the vampires’ intentions of wanting to drink his blood. This shows us that she is manipulative by using her smile, which could be a way of saying she is highly seductive to get what she wants from men, whether that be power or their very lives. Dave’s comments on how manipulative she can be only worsens the stereotype passed around between men that women are crazy or can become mentally unstable around their boyfriends. She is a serious threat to his life, and this central character’s shift from charming and sweet to blood thirsty killer does not help to prove the stereotype of women being psychotic in relationships wrong.

The film *From Dusk till Dawn* is a perfect example of women in vampire fiction being treated as sex objects. This black comedy/horror film revolves around bank robbers

Seth and Richie. The two men force a family to take them to a strip club known as the Titty Twister where they will meet their contact. However, when the sun goes down the employees at the strip club turn into vampires, and now the family and bank robbers must try to escape. A significant scene in the film shows Richie watching one of the strippers dance when she becomes fixated on his hand which is covered in blood after getting shot earlier during the robbery. Suddenly, she reveals herself to be a vampire and bites Richie. Before we learn that she is a vampire, we see various sexualized shots of her dancing on stage. We first see a close-up shot of her dancing with a snake wrapped around her body while a band plays music that talks about “knocking on the devil’s door” (From Dusk till Dawn). This shot with the snake is mostly used to show her at her sexiest as the snake slowly moves around her body and legs, while the music is foreshadowing the impending doom for the guests. Following this, is a medium shot of the stripper and Richie as she pours wine down her leg and lets the drink flow into Richie’s mouth. At this point she has seduced him enough for Richie to lower his guard and while he was distracted, she bites him and turns him into a vampire. This connects to the idea of females being mischievous as she gains power over him by using her body. The message this sends to viewers, particularly men, could potentially be alarming. Seeing how Richie is enjoying this interaction with the stripper could be telling men to treat women like eye candy. Even when the woman ends up attacking him, it is shown to be more horrific than empowering for women, as she is clearly the villain who wants to feed on human blood. Down to the setting of the

scene being in a strip club, director Robert Rodriguez is showing men that women are only good for their body and that if they are not careful the women can also be very vicious and dangerous. This film does not try to be subtle in its sexualization of female vampires when looking at the woman at the strip club and could present a problem to female viewers as well.

How does stereotyping women in vampire fiction affect the way women are treated in the real world? Understanding stereotypes of women and why they can be damaging to them is necessary for analyzing females in vampire fiction. In “How Does Gender Bias Really Affect Women in the Workplace?” by Christine Rho, describes a study conducted by Yale University where it was found that women who talked a lot were seen by colleagues and especially by people in power as domineering and overly assertive compared to men who spoke a similar amount. Another study was done that looked at job reviews for both men and women. Not only was it found that women received more criticism in these reviews than men, but this criticism usually included feedback such as needing to tone it down and be less aggressive. Rho’s article in summary, shows how even when men and women behave the same way, people are more likely to be intimidated by the women and view their behavior as unacceptable. The negative response to women being assertive at work could possibly be caused by the way those same people have been taught to view women because of reading/watching vampire fiction’s portrayal of women. Tying this into “The Girl with the Hungry Eyes” and *From Dusk till Dawn*, we see both female vampires that I have analyzed act in ways similar to how women in Rho’s article are

perceived to act at work. When you see *The Girl* try to manipulate her way into getting what she wants as a model or the stripper that goes from seductive to a rampaging killer in Rodriguez’s film, it is easy to see why men are intimidated by women being in a position of power or showing confidence at work. Whether it is in vampire fiction or from real-world examples, the way we talk and depict different groups of people may subtly affect how they behave. Female vampires are victims of stereotyping that has type casted them as sexual predators who are only appealing when they are pleasing men by showing off their bodies. “The Girl with the Hungry Eyes” shows a vampire who uses her position as a model to seduce and feed on unassuming men. *From Dusk till Dawn* does not stray far from these stereotypes, featuring a villainous vampire who takes up a job as a stripper by day, and a bloody thirsty killer by night. Over time, not much has changed when it comes to the representation of women in vampire fiction. In the future, we should be mindful about how portrayals of women can influence viewers and respond accordingly. Stereotypes are prevalent in all types of media and vampire fiction is no different. As mentioned in Rho’s article, stereotypes can alter how people treat women, so we must fight to prevent negative stereotypes from being reinforced in today’s media.

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# HEALTH CARE ACCESS FOR LOW-INCOME CHILDREN

Thy Tran

*ABSTRACT: Numerous of studies have identified over 3.5 million children are uninsured in the U.S due to barriers of income, cost of insurance, and confusion about the insurance process. It is vital for children to obtain a regular source of health care as they are experiencing the crucial developmental stages of their young lives. Financial barriers are the most profound answer in many studies conducted yet little is researched about its effect on access to primary care for low-income children in Snohomish County Washington. The study will investigate the obstacles low-income children face when trying to acquire needed health services. There are local reports about health care access among adults but less is known about children; this study aims to fill the gap regarding information about how poverty affects children and their struggles to receive health care. This study also takes a look at why children who are eligible for government assistance programs remains uninsured and how we can improve the programs to better support low-income children across the U.S.*

## Introduction

Children are delicate, vulnerable, and innocent; they require protection and guidance through the most crucial developmental stage of their lives. They need primary care to ensure their wellbeing and live a healthy life (Newacheck, Stoddard, Hughes & Pearl, 1998). Currently, low-income children face the barrier of limited access to health care due to their family's financial situation. The United States still has an alarmingly high rate of uninsured children. There are approximately 3.6 million uninsured children in the U.S, with many of them qualifying for government insurance coverage but have been dropped for various reasons (Pham, 2017). Many uninsured children live in states that decided against Medicaid expansion, leading them to fall into a coverage gap where their household incomes are above Medicaid eligibility limits but falls far below the Marketplace premium tax credits (Artiga & Ubri, 2017). The risk of being uninsured was higher

for children in single-parent homes, older adolescents, minorities, and children in low-income households (Newacheck, Brindis, Cart, Marchi & Irwin, 1999). President Trump's proposed budget for 2019 plans to cut funding for essential programs such as Medicaid and SNAP (Supplemental Nutrition Assistance Program) (Children's Defense Fund, 2018). If the proposals are approved, it will adversely impact the most vulnerable group: low-income children who rely on the assistance.

Having adequate health insurance is an important factor in children receiving a regular source of health care. It was reported that 79% of uninsured children had a regular source of health-service care while 97% of children did with private insurance (Vital and Health Statistics, 1997). Also, children encounter a variety of health conditions through developmental stages that put them at risk for injuries and illnesses (Healthcare and Children, n.d.). During this early stage, routine primary care can provide opportunities for practitioners to identify and treat

health problems that can affect children's physical, emotional, cognitive and behavioral growth (Healthcare and Children, n.d.). In the U.S, 1.2 million children were unable to receive needed health service and 2.1 million children had to delay getting medical care due to the expensive cost of the needed service (CDC Vital and Health Statistics, 2012).

Acquiring health insurance for low-income children has been addressed through the decades by Medicaid, The Affordable Care Act, and many other programs. Even with these programs, there is an enormous amount of low-income children in the U.S without insurance coverage. There are an abundance of questions that remain to be explored and discussed. My research question is how does poverty affect access to primary health care for low-income children in Snohomish County, Washington? I hypothesize that poverty will limit the access to primary health care greatly for low-income children in Snohomish County, Washington. It will be measured by percent of emergency department visits as regular source of care, percent of children with a primary care provider, as well as years spent with a healthcare professional. The study will examine the challenges low-income children experience when trying to obtain health services, public insurance programs accessibility, and why children who are eligible for public insurance remain uninsured. It will strive to accumulate data about the percentage of uninsured low-income children in Snohomish County, Washington in order to establish effective interventions to address the issue at hand.

## Background

With being a low-income family, financial barriers are not a new subject. In the U.S, health insurance is not free. The United States has a market justice concept healthcare system where individuals are primarily responsible for their own health coverage. The first step to achieve health care access is to obtain health insurance, which many low-income children are not able to do because it is too expensive. One research study investigated and analyzed what effect health insurance coverage had on children's access to primary care by using the National Health Interview Survey of 1993-1994 (Newacheck et al, 1998). When families with uninsured children were surveyed with the question of why they do not have health insurance, almost three out of four families stated that expensive cost was the reason for their lack of insurance (Newacheck et al, 1998). As mentioned above, private practices best efficiently provide health care in the U.S but, the findings of Newacheck et al.'s (1998), stated children in low-income families are unable to afford private practice prices. Similarly, DeVoe, Graham, Angier, Baez & Krois (2008) suggested that absence of health insurance was the most common predictor of unmet health needs.

The results reported major concerns of families were expensive cost of having insurance, health insurance instability, and lack of access despite having health insurance (DeVoe et al, 2008). When comparing insured children versus uninsured children, uninsured children were more likely to have unmet health-related needs such as prescriptions and medical care (DeVoe et al, 2008). The Alliance for Health Reform reported the same finding of uninsured children are much more likely to have

unmet health needs than insured children. Most uninsured children were forced to do without medical care due to high cost (Alliance for Health Reform, n.d.) Another study showed that over 72% of children delayed or did not receive needed health services due to the expensive cost and that absence of health coverage was the number one response to why children did not have a regular source of health care (Flores, Lin, Walker, Lee, Currie, Allgeyer & Massey, 2017). Related to DeVoe et al.'s (2008) findings, the top unmet health services were dental and medical care (Flores et al., 2017).

In order to meet health needs of children, the U.S Maternal and Child Health Bureau recommended that health care visits are vital for children during their developmental stage (CDC Vital and Health Statistics, 1997). In the U.S, there are 1.44 fewer deaths per 10,000 people and a 2.5% decrease in infant mortality with just one primary care doctor in the community (Starfield, 2011). A study in Australia suggested that having primary care is related to lower hospitalization rates due to good care provided by the primary care doctor (Starfield, 2011). A similar study in Canada reported the same results; places with more primary care providers had more use of preventive care which led to a decrease of hospital visits among children from birth to eighteen years old (Starfield, 2011). Philips Jr. and Bazemore (2010) proposed related results, those with a regular source of primary care had fewer emergency visits and hospital admissions since they received treatment before serious conditions occurred. Specifically, for low-income people, having access to primary care is linked to better health, a lower mortality rate, and complete immunization (Philips Jr. et al, 2010). Primary care

has been shown to provide a wide variety of benefits for individuals therefore it is important for vulnerable children to have better access to it.

Through the decades, many public programs were implemented to help poor Americans obtain basic medical care. Despite these new programs, 24% of low-income children remain uninsured (Salsberry, 2003). It was found that SCHIP-eligible children were not enrolled because parents thought they had too high of an income to qualify or they found the process to be too complicated (Salsberry, 2003). A study reported similar results that the four main responses of why parents chose to forego public insurance: 1) confusion about the insurance process and information, 2) difficulties obtaining insurance, 3) restricted number of provider opportunities, and 4) coverage gaps and services that are not covered by the insurance (DeVoe, Westfall, Crocker, Eigner, Selph, Bunce & Wallace, 2012). Both studies showed how being eligible for public insurance does not guarantee coverage and that our current healthcare system limits access for low-income children. However, Swartz (n.d.) claimed that poor children are a population that are focused on more than poor childless adults. The government views medical access for children as a good investment because healthier individuals have shown to be productive citizens (Swartz, n.d.). Alker (2015) reported similar results; the rate of uninsured children decreased to 6% in 2014. With SCHIP, Medicaid, and the Affordable Care Act, there are many options for affordable coverage plans for children. Since the ACA was instated, Nevada went from 15% of children uninsured to 10% in one year (Alker, 2015).

Snohomish County Human Services (2016) reported statistics regarding only low-income adults and their lack of health coverage. Medicaid expanded for adults leading to increased coverage for medical and dental services (Snohomish County Human Services, 2016). It was also reported that one-quarter of adults interviewed do not have a regular source of health care (Snohomish County Human Services, 2016). Less is known about the lack of health care access for low-income children. This study is designed to fill the gap regarding information about the access of health care for low-income children in Snohomish County and how the public insurance system can improve access for the population.

## Methods

### Study Design

This study will use a longitudinal design. This design will include prospective data gathering, which allows for better evaluation of the effect of poverty on health care access for children over a period of time. Specifically, this design will be a cohort study. It will help the researchers examine specific subpopulations (low-income children) as they change over time. Also, it enables researchers to see what happens to attitudes of the specific cohorts over a period of time.

### Participants

This study will be recruiting 500 participants. There will be two cohorts: low-income children and non low-income children. To determine whether a child is “low-income” or not, the study will use the FPL (Federal Poverty Level). Children in households who are at or below the poverty level will be considered “low-income” while those who

are above the poverty level are “non low-income”. Background information consisting of household income and insurance type will be provided by parents or legal guardians. The age range for the participants will be birth - 18 years old. The study is using a local sample within Snohomish County. With the lack of information regarding health care amongst low-income children in Snohomish County, that is the reason for the focus on this specific population.

### Sampling Method and Process

The sampling method will be purposive sampling. To recruit the sample population, flyers and posters will be posted at local public schools, daycares, and parks in Snohomish County. There will be advertisements in the Snohomish County Tribune and ParentMap Magazine. Parents of children who are interested in the study will have to fill out a questionnaire. Questionnaires will be attached to the flyers, newspapers and magazines and need to be turned in via mail or e-mail. The questionnaire will include questions about household size, household income, and child’s age. All forms of advertisement and the questionnaire will be available in English, Spanish, Vietnamese, Korean, Chinese, and Tagalog. According to the Statistical Atlas (n.d.), those are the most prevalent languages within Snohomish County.

### Ethical Considerations

Since the participants in this study are children, consent from parents and legal guardians will need to be obtained. The informed assent and HIPAA forms will be issued in order to collect data about the child’s health insurance coverage and needed health services. Also, this study will be reviewed by the IRB from the Snohomish County Health



Department to ensure that the study will be ethical. With longitudinal designs, information about participants cannot be kept anonymous but will remain confidential. Participants will be informed about freedom of choice and any potential physical or mental harm. Researchers will not put the participants in any harmful conditions or act in disrespectful manners.

### Measures

The independent variables are children who are low-income and children who are not low-income. To assess this variable, questions about household size and income will be included in the questionnaire. An important variable to take in account is whether the child has health insurance or not. Health insurance plays a big role in the type of care children receive, therefore it is a crucial confounding variable. The dependent variable is health care access. It will be measured through the percent of persons with hospital emergency department as their usual source of care, percent of persons with a regular primary care provider, and time (years) spent with a healthcare professional. For participants who have health insurance, the next question will be: "What type of insurance do you have?". Additional questions will be about thoughts on medical providers, medical facilities, locations of medical facilities, and what health services have they used within the past 5 years. For participants who do not have health insurance, the question will be: "What are the reasons on why you do not have health insurance?". Further questions will ask about past experiences of trying to obtain health insurance and what health services are currently needed. Other questions that will be addressed are about the barriers families feel they face in trying to receive

care and the challenges they experienced.

### Procedure

The data will be collected by doing face to face interviews. Face to face interviews will provide the appropriate setting to evaluate participant attitudes and there is the ability to ask clarifying follow-up questions. There will be follow-ups with participants annually for five years. The follow-ups will contain different questions depending on how their information has changed or not changed. Due to this study being explanatory research, in-depth questions regarding individuals' reasoning and behavior will be asked in order to establish a reason why a particular phenomenon occurs. Participants' attitudes such as tone of voice and facial expression will be recorded, too.

### Analysis

This study will have a qualitative analysis method. The study aims to understand the correlation between poverty and how it affects health care access for low-income children. Data gathered about the two cohorts will be compared to see if there is an association between poverty and health care access. In order to have a thorough analysis, researchers will perform data reduction, data interpretation, and data representation. In data reduction, data will be reduced from chunks in codes to help make sense of the information. Next, data interpretation will group those data "chunks" in similar categories and interpret themes that emerge from the data clusters. Lastly, data representation is where the trend or association is discovered through making sense of data.

## Discussion

### Significance and Implications

Children need to have great health care access in order to lead a healthy life. Medical care should be provided for all children regardless of their ability to pay for care. Further research in health care access amongst low-income children will provide necessary information to adjust current health assistance program or create a new program. In Snohomish County, health care for low-income children is not focused on, therefore this study will bring awareness to the county to establish a new health policy or support for the population.

### Limitations

A possible concern in this study is loss of follow-up. Loss of follow-up can affect validity of data but will be addressed in the study. Another concern is participants dropping out. Since the study is following participants for five years, there can be a change in contact information, death, or refusal to continue with the study. This concern can limit the amount of usable data. The study asks many questions about family income and health history, which can be uncomfortable for participants or can be perceived as an invasion of privacy. Participants will be notified that all questions are voluntary and the information will be kept confidential.

### Future Research

Future studies should focus on if there is difference in health care access if an individual has private or public health insurance. A similar prospective longitudinal research design can be used for the study. The study will focus on the health services used, and overall feeling about the health care they receive. The study will aim to reveal

if there is an advantage in having private or public health insurance, and if so, what the advantages are.

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# EFFECTS OF 3,4-METHYLENEDIOXYMETHAMPHETAMINE ON MEMORY IN HIGHER EDUCATION

Thi Nguyen

*ABSTRACT: MDMA is a psychoactive drug also known as ecstasy or the street name “molly”. (National Drug Intelligence Center, 2003). As the amount of raves and parties increases, the number of MDMA users are continuing to grow due to euphoria, hallucinogenic, and stimulant effects of the drug (National Drug Intelligence Center, 2003). In the first section, the author explores ways in which MDMA can affect the health of young adults at the University of Washington. Additionally, the research proposes a longitudinal experiment using a memory test to explore ways in which MDMA can affect the studies of students in higher education. This research paper will attempt to answer the question: Do college students who take MDMA have worse memory problems than those who do not?*

## Introduction

3,4-Methylenedioxymethamphetamine (MDMA) is a psychoactive drug also known as ecstasy or the street name “molly”. MDMA is a man made and illegal drug invented in early twentieth century Germany as an appetite suppressant (National Drug Intelligence Center, 2003). In 1970, the United States began using MDMA as a psychotherapeutic tool but the drug was not approved by the United States Federal Drug Administration; therefore, it did not undergo formal clinical trials (National Institute on Drug Abuse, 2006).

MDMA is mostly used at all night dance parties like raves and nightclubs and has become very popular. This drug is extremely popular for the hallucinogenic and stimulant effects (National Drug Intelligence Center, 2003). In a 2004 survey, more than 11 million people over the age of 12 used MDMA at least once in their lifetime (National Institute on Drug Abuse, 2006). MDMA affects the serotonin receptors and reduces the serotonin levels. When these receptors are affected, it could affect

negative things like aggression, mood, sexual activity, sleep, sensitivity to pain, and memory loss (Gowing et al., 2002). In addition to serotonin, MDMA can affect dopamine which can also affect movement, cognition, motivation and reward (Gowing et al., 2002).

Drugs like MDMA are attracted to cities like Seattle due to the large population of about 563,374 people in 2000, the easy access to the freeways, and popular rave dance events and clubs (Banta-Green et al., 2005). This paper will focus on college students at the University of Washington Seattle campus, ages 18 to 25 who take MDMA at raves or parties and the effects the drugs can have on students' memories. The question for my propose plan is: Do college students who take MDMA have worse memory problems than those who do not? The hypothesis is that college students who take MDMA have more memory problems than those who do not take MDMA because of the damaging brain effects.

MDMA is the third most commonly used illicit drug and causes many serious health

problems (Gowing et al., 2002). In 1995, the lifetime prevalence of ecstasy was only two percent, however in 2001, it increased to 13 percent, and is continuing to increase (Martin et al., 2005). Raves and dances were the one location where people who used MDMA were consistently and significantly affected (Banta-Green et al., 2005).

While using the dangerous drug, MDMA causes tension, involuntary teeth clenching, nausea, blurred vision, tremors, sweating, and even chills. Taking MDMA can be very dangerous since it can be mixed with many other drugs like heroin and methamphetamine which can sadly cause death (National Drug Intelligence Center, 2003). In a study, participants believed that MDMA encourages risky behaviors such as unprotected sex, and driving under the influence (Comis & Noto, 2012). While surveying people at raves, a study found that 38 percent of the users had unprotected sex, and were driving under the influence (Banta-Green et al., 2005).

Since MDMA can be found in many dance clubs, many people experience hyperthermia due to the loss of serotonin levels because of physical activity involve in dancing which causes body temperatures to lose control (Gowing et al., 2002). Hyperthermia is the most dangerous side effect along with severe adverse effects of MDMA (Shimane et al., 2013). Hyperthermia can also cause seizures, disseminated intravascular coagulation, rhabdomyolysis, renal and liver impairment (Gowing, 2002). There is evidence for causation that as body temperature rises that there is a risk in death. When someone's temperature is over 41.5 degrees Celsius, two thirds of the cases show that this can cause death (Gowing et al., 2002). Treatment of hyperthermia needs

medical attention right away because of muscles breaking down and kidney failure. However, after a single dose of ecstasy, liver damage can occur ranging from benign forms mimicking acute viral hepatitis to severe forms such as liver failure due to massive hepatic necrosis even without hyperthermia (Gowing et al., 2002).

Many users who have taken MDMA have said that stopping the use of MDMA was very difficult and they were all concerned that there would be future health problems if they continued to use MDMA (Banta-Green et al., 2005). Some long term effects of MDMA also include: insomnia, depression, headaches and muscle stiffness (Gowing et al., 2002). This is another serious problem of MDMA. This is because the drug affects the serotonin producing levels and these effects seem to be long-lasting when done on rats (MDMA, 2012). Depression and having a low mood are associated with the consumption of MDMA which can last up to a week after taking MDMA and can be even longer for those who have taken MDMA for a longer-term or a higher dosage (Gowing et al., 2002). Many people try to make MDMA "safer" by using vitamins like 5-hydroxytryptophan (5-HTP) to help with the depressant effects of MDMA (Banta-Green et al., 2005). Memory problems and lack of concentration are the most common effects and in a study, two participants with a heavy use of MDMA for a year or more, reported memory loss even after they stopped using ecstasy (Comis & Noto, 2012).

Many young adults continue to use MDMA at raves despite its negative effects. The average age of MDMA use is 21 years old and the majority of people were 18 to 21 years old (Riley et al., 2001). In Seattle, one

## Methods

of the most popular rave events is hosted by USC events who host sold out shows every month which include Freaknight, Resolution, and Paradiso and many people who attend these shows consume drugs. Recently in 2014, a young adult in Seattle died from the overdose of MDMA and people are constantly being sent to the emergency room (Kim, 2014). In a study, 24 MDMA users who had not taken the drug for two weeks, and 24 non-users who had never taken the drug, took a vocabulary test, and it was shown that the MDMA users had signs of impaired visuals and verbal memory (MDMA, 2012). With the negative effects of memory loss, and lack of concentration, students would often go back to class with these negative effects of MDMA which might possibly affect their ability to learn.

Use of MDMA has been associated with verbal memory deficits in abstinent users and recreational users (Van Wel et al., 2011). In a study, a male mouse with a high dosage of MDMA, caused persistent impairments in recall of operant alternation behavior, suggesting alterations in memory processing and reduced behavioral flexibility (Viñals et al., 2013). Using a total of 17 healthy MDMA users in a study, three different memory tests were done on the participants and it was shown that from one single dose of MDMA it produces memory impairments in all memory tasks (Van Wel et al., 2011). With the average age of MDMA users being from ages 18 to 21, and the memory impairments shown these studies, there is evidence that young adults are suffering from memory loss which could affect their ability to learn in higher education.

### Study Design

The study proposed would be a prospective longitudinal design. This design will assess the amount of MDMA students have taken and a memory test will be taken once a month for six months which will allow the research team to see the effects of MDMA on the participant's memory.

### Population

The population for this study will be 400 students from the University of Washington Seattle campus from ages 18 to 25 year olds who will take questionnaires. The questionnaires will include questions such as the number of MDMA they have taken in the past year, and how often they take MDMA. The question will split the students into two groups of students who have taken MDMA and students who have not.

### Sampling Methods and Process

The sampling method is quota sampling. This is a non-probability sampling because the groups will be split into groups of whether they have taken MDMA and whether they have not taken MDMA depending on their answers to the questionnaire. The study population will have the same proportions of individuals since there will be 200 students in each of the two groups.

Posters and flyers will be posted all around campus. The posters and flyers will include a phone number and email. The research will also be shared using social media daily and will also be shared by word of mouth. Once they have called, texted, or emailed, they will be sent with a short questionnaire about their experiences with MDMA within the last three months and from there, the student will be able to voluntarily join the research. There will be 200 students in

each group and will take a recall memory test every month for six months. Due to participant attrition, many participants may drop out during the research and therefore I will gather 50 more participants for each group.

### **Ethical Considerations**

Participation in this research study would be voluntary along with consent forms. The forms will include the proposed study design, sampling, and methods and will be reviewed for approval by the University of Washington Institutional Review Board (IRB). Personal information would be accessible to the researcher team and would be confidential to those who volunteer.

### **Measures and Variables**

The independent variable in this study would be the total of MDMA taken by the students. The amount of MDMA will be found using the questionnaire. The dependent variable in this study would be the memory test using a word list recall method. Users and non users will have a list of 20 words that would have to be memorized in 20 minutes. Some other important variables in this study are the other drugs and alcohol that is taken with MDMA like alcohol and marijuana which could play an impact on the memory test in the study. The questionnaire will ask other drugs and alcohol that is combined with MDMA during their time of use.

### **Procedures**

Researchers will go to the University of Washington Seattle campus and recruit two hundred students who will participate in a questionnaire determining whether they have ever taken MDMA within the last year and how much MDMA was taken in the last year. The questionnaire will also make

sure that the participants involved are young adults who are in a healthy condition. This will make sure that the participants from any psychotropic medication, have not had any psychiatric or neurological disorder, pregnant, or drink or smoke excessively. The participants will then take a memory recall test. This will have 20 words that the participants will need to memorize within 20 minutes. Once it has been 20 minutes, the participants will write down the words that they remember from the list of words. Each word will be half a point. The higher the points and the more words that the participants the better the score. Each of the scores will be compared by the amount of MDMA that the participants have taken. The test will be taken every month for six months along with a questionnaire to ask if the participants have taken any more MDMA within the last month of the last memory recall test.

### **Analysis**

The data collection will be a quantitative analysis using the scores from the recall memory test. The questionnaire will ask how much MDMA the participants have taken which and the researchers will then take the memory test to see if the MDMA affects their memory. The memory test will have a score from one to ten. Ten being excellent memory and one being poor memory. This study is bivariate and will have two variables which are participants who take MDMA and participants who do not, and how much MDMA participants have taken over the course of time.



## Discussion

### Significance and Implications

The significance of this study is to see how MDMA can affect a student's memory which could also affect their learning ability. The survey will allow researchers to see how much MDMA students are taking and how many students are using this drug. The data in this study will allow students and universities to be aware of the potential harm of MDMA and possibly decrease the use of MDMA in young adults or promote awareness for these young adults in higher educations.

### Concerns and Limitations

Loss of follow up would be one of the limitations for any longitudinal study. Since this study will be for six months this will mean that participants will leave voluntarily due to many reasons. Another limitation is the cost of the study, since longitudinal study are more expensive since they go for a long time and because of the number of participants involved in this study. One concern with this study is since it is a prospective, many students will not be able to remember how many times they have taken MDMA and how much MDMA they have taken over the past year.

Some confounding variables in this experiment is that MDMA is often mixed with other drugs like meth and cocaine, and buyers often do not know what they are taking most of the time. Many people who take MDMA also mix with many other drugs like alcohol or marijuana which could then affect the accuracy of the memory test. Another concern in the study is that drug dealers are measuring less MDMA in order to profit. Many participants will be taking less MDMA than what they really thought

they are taking which causes inaccurate data. Furthermore, participants who take more MDMA within the six months of the study will be excluded from the study.

### Directions for Future Research

MDMA has increased not only in Washington, but in many other states and young adults in higher education are taking this dangerous drug especially in California where electronic dance music events are popular and where many other popular events like Coachella and Electric Dance Festival is held. The study would be a longer longitudinal study in order to study the longer term of memory effects of MDMA. The future research design would also allow the researchers to control the amount of MDMA and will only MDMA without any other drugs or alcohol that will affect memory. Participants will also take pure MDMA which may have some ethical concerns. Lastly, a larger quantity of students will be studied.

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# HOMELESS CHILDREN

Hanna Ashagre

*ABSTRACT: The purpose of this study was to examine the adverse psychological effects of homelessness on children; also, to analyze how homelessness influences homeless children's behavior, school performance, social-emotional and developmental functioning. The study findings show that homelessness has a negative impact on children's psychological development. Homeless children faced many challenges when they moved to an unfamiliar environment. The frequent movement increases a feeling of insecurity and creates severe psychological distress, which might lead them to experience anxiety, depression, social stress, and hostility. Also, researchers found that homelessness interferes with the ability to learn. Lack of social support systems may result in social emotional, low self-esteem and psychological distress in children. Moreover, homelessness may create depression in both children and their families. When mother is stressed the child is negatively affected by her stress. This study suggests that it is essential to address the cause of poverty and homelessness in the life of children. In addition, it is crucial to assess new intervention that might stimulate empowerment for child personality and mother-child relationship.*

## Introduction

The number of homeless children is rising in America. Every year in the U.S there are above 1.6 million homeless children; from those children 40% of them are living in shelters (Haskett, Armstrong & Tisdale, 2016). Homelessness is described by, low socio-economic status and the lack of stable housing. An individual is considered homeless if that person lives on the street without permanent housing (Schteingart & Molnar, 1995). Homelessness is mostly influenced by the lack of financial stability in families, which stimulate children's basic learning abilities.

Homeless children who are residing in shelters face an increased risk for mental health issues, behavior problems, academic delays, chronic illness, and are more likely to experience depression and trauma. Moreover, many homeless children and their families experience different challenges.

They move continuously from one place to another place. In addition, they are criticized for their poor school performance. They are also unnoticeable in school and labeled as "shelter rats" by their teachers and schoolmates (Kim, 2013). Practical problems involved in homelessness, such as frequent changes in housing and schools, create cumulative stress in the homeless community. Furthermore, homelessness can create harmful psychological effects such as social stress, depression, and behavioral problems in children (Haskett et al., 2016). My research question is how does homelessness distort a child's psychological well-being? I hypothesized that homelessness has a negative consequence on children psychological wellbeing.

## Background

Homelessness can have negative psychological effects on individuals,

especially on children in school. The research shows that the experience of homelessness in children includes mental developmental delay, emotional risk, chronic disease and social problems due to lack of permanent housing, which negatively impacts their quality of life (Haskett et al., 2016). According to Pamela and Toro (1998), homeless children, when they moved to an unfamiliar environment from their home and faced uncertainty concerning shelter, may be more likely to experience anxiety, paranoia, psychoticism, and hostility. For example, a constant movement may make them unable to form supportive peer relationships at school. The cumulative stress of homelessness creates harmful psychological effects such as social stress, and behavioral problems in children. Rescorla et al. (1991) conducted a study which reported that more than half of children had developmental lags, anxiety, depression or learning difficulties and that half appeared to require psychiatric evaluation. The constant movement from place to place and psychological problems can negatively affect children's psychological wellbeing.

According to Kim (2013), psychological distress may result when children lose social support systems due to homelessness. Children are more likely to experience emotional and behavioral issues such as low self-esteem, bullying, and difficulty building friendships. While psychological energy is spent on survival, less energy is placed on socialization and forming relationships which can result in a feeling of isolation. In addition, a homeless child's lack of familiar routine and loss of daily contact with friends, relatives, and neighbors leads to vulnerability, anxiety, and fear. According to Sulkowski and Joyce-Beaulieu (2014), a

clinical study from 176 homeless children, 86% met diagnostic for a psychiatric disorder; the majority 53% of homeless children show disruptive behavior disorders which are categorized as conduct disorders, and about 21% have a mood disorder, which is depression and bipolar disorder. This study shows that lack of social support system creates psychological distress in homeless children, which may also lead to depression in students as well as their families.

Homelessness may create depression in both children and their families; maternal depression is a risk factor for homeless children. The mother's frustration and helplessness may make her depressed. This depression affects children's behavior and gives them anxiety and depression. Maternal depression may encompass both intra- and interpersonal processes for children; a poor parent-child relationship may result in negative effects for both mother and child (Schteingart & Molnar, 1995). When children do not get enough attention from their families, it leads them to become more stressed and may place children at risk of depressive disorder and anxiety. According to Rafferty and Shinn (1991), while the mother is stressed, frustrated, and depressed about housing or work opportunities, the child is negatively affected by her stress, and the studies also provided evidence that 66% of parents had noticed behavior change on their children after becoming homeless. The homelessness situation may make children feel more insecure, which leads to many forms of acting out behavior. According to Kilmer et al. (2012), 50% of mothers were found to have experienced depression after they became homeless; maternal depression is associated with intensiveness, negative caregiving, and emotionally detached

parenting. This study shows that homeless children may change their behavior because of the combination of homelessness, poor parent-child relationship, and maternal depression which results in psychological effects. Besides the psychological problems and acting out behavior, homelessness can negatively affect school performance.

Homelessness may also interfere with homeless children's ability to learn. According to Cutuli et al. (2013), a 2007 study by Fantuzzo and Perlaman found that through the group of 11,835 homeless students in second grade living in an urban school district show that homelessness may influence the learning of children such as the ability to read, write, and science. These homeless children did not acquire a strong educational foundation at home, and they may not have enough resources available to school supplements, such as books, or quiet places to study. Research by Sulkowski and Joyce-Beaulieu (2014) found that homelessness has been associated with low achievement in math and reading among students in a study that was conducted in a large school district from third through eighth grades. This study shows that the impact of frequent movement affects homeless children's school performance, which makes them fall behind. The stress interferes with the ability to learn because there is a lot on their mind, and they cannot focus and concentrate. Also, this problem might build up as they continue to be homeless and might prevent them from high school graduation. Besides practical and academic problems, homelessness may produce symptoms of psychological distress in children.

Researchers have also found that homelessness may increase feelings of

insecurity in children, which leads them to different forms of acting out. It is also possible that their acting-out behavior is a signal of generalized anger about their difficult life circumstances. Some homeless children may change their behavior because of social pressure and bullying at school, which leads them to become socially withdrawn. (Rafferty and Shinn, 1991). These risk factors would be even more harmful to homeless children's psychological wellbeing.

## Methods

### Study design

This research process will use a repeated cross-sectional design. The research design will include a large sample population.

### Participants and Sample Design

The intended population is homeless children who attend at Shoreline School District. These homeless groups will consist of individuals of diverse races who are currently experiencing homelessness with diagnosed anxiety and depression. The participants will be children under the age of 18. The sample size will be 500 participants. The sampling process will be non-probability sampling method, convenience design.

### Ethical Considerations

The research study will have Institutional Review Board (IRB) approval from the Shoreline School District. Participants in this study will be voluntary and anonymous. An assent form will be provided to the participant 16-18 years old, and informed consent form for participants' guardians and parents to inform them about the purpose of the study.

## Measurement/Variables

The independent variable for this study is homelessness, and the dependent variable is psychological well-being. Sub-categories of the dependent variable are maternal depression, emotional distress, and self-esteem. The questionnaires measured by short interview answer demographic and psychological questionnaires. These interview questions use qualitative design and have open-ended questions. The interview questions are developed by the researcher in order to understand the relevant experience of homelessness and psychological effects.

## Procedures

Information and data will be collected through detailed interviews of participant and survey. The study will obtain baseline information by going onsite to the school locations and interviewing the counselor. The interview will be done by talking face to face. The study to follow participants will be two days during a school week, Monday and Friday. The first step will be to contact principals of four middle schools and four high schools by email to gain access to homeless students under eighteen. This will comprise my student population. Second, the students will sign up for the study by email or text. The data will be collected using a survey online.

## Analysis

This study utilizes a combination of both qualitative and quantitative analysis. The qualitative study is an interview, and the quantitative is a survey. This study plan is to use multivariate analysis and the three variables mentioned above.

## Discussion

### Significance

Homeless children have been invisible. Nobody wants to talk about homelessness among children because it is a sensitive topic. One of the reasons might be homeless students are not comfortable talking with others in school about the fact that they are homeless. Moreover, no one is aware of their vulnerable circumstances and challenges they face. For example, in school teachers have limited information about homeless children. They are not aware of the challenge and experience homeless children bring to school. According to Kim (2013), teachers believe that homeless children were disorganized and dysfunctional. This kind of stereotypical belief and assumption may drive from lack of experience with marginalized children. Furthermore, their situation deserves more attention because children are vulnerable, and they cannot stand for themselves. Bringing awareness to homeless children should be part of professional development in school as well as in society; such as engaging with homeless children to understand their experience and raising awareness of the situation of homeless children's lives. Therefore, teachers who are aware and trained can act differently and support homeless children to be successful in school.

### Limitations

The cross-sectional design of this research has problems establishing temporal order. The sample for homeless children may not have been representative of a larger population. Also, the observed outcomes may not apply to all families of homeless children across the board. In addition, this study requires the participant to give

detailed information about their personal situation which might be uncomfortable for some of the participants.

### Future Research

It would be important for future research to establish the study process of psychological well-being of homeless children in large school districts in South Seattle. In addition, an important strategy for future research will be to use case-study methodology. A case-study methodology will explore more in-depth the circumstance of the real-life situation for homeless children. Also, it helps to understand and analyze treatment and give solutions for homeless children. Furthermore, it is necessary to study all families of homeless children and children living in the streets, so it can be helpful to address the multiple risk factor that impacts the psychological well-being of children. Also, it is essential to continue to address the issue of poverty and homelessness especially in the life of children. In addition, it is important to assess new intervention that might promote empowerment for child personality and mother-child relationship as well as social support.

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# IMMIGRATION AND HEALTHCARE POLICIES CREATING BARRIERS FOR UNDOCUMENTED HISPANIC IMMIGRANTS

Antoinette M. Smith

*ABSTRACT: Undocumented Hispanic immigrants face many healthcare disparities while living in the United States. A review of recent research shows negative impacts on mental health and physical health statuses. These negative impacts have been created by fear of deportation, lack of preventative healthcare options/insurance and negative attitudes/stereotypes perpetuated by restrictive policies that target undocumented individuals. This proposal will examine how these restrictive immigration and healthcare policies have created challenges for undocumented immigrants and their families seeking access to healthcare. This proposal will demonstrate why additional research in this area is needed to identify barriers to health care for undocumented Hispanic immigrant community members to reduce poor health outcomes.*

The health care disparity within Hispanic populations has been an increasingly relevant topic in research. The Latino population experiences higher rates of morbidity and mortality when compared to their non-Latino counterparts (Philbin, Flake, Hatzenbuehler & Hirsch, 2017). There is a higher risk of diabetes in Hispanic adults that is disproportionate to other non-Hispanic whites and Asian adults (Philbin et al., 2017). Compounding this disparity is a shifting view of undocumented Hispanic immigrants. Vargas, Sanchez and Valdez (2017) suggested there are more negative stereotypes and anti-immigrant attitudes after the 2012 election, resulting in an increase in punitive immigration policies that target undocumented Hispanics. The effects of this attitude shift can be seen in healthcare policies, as well as within the healthcare system. A recent literature review suggests that implicit racial/ethnic bias against Hispanic/Latina/Latino individuals exists amongst healthcare providers of varying levels of training, different specialties and experience (Hall et al., 2015). The long-term effects on undocumented

immigrants are yet to be seen, but they have the potential to impact health outcomes with late or lacking chronic disease diagnosis (Torres & Wahldinger, 2015).

The Patient Protection and Affordability Care Act (PPACA) excludes undocumented immigrants from obtaining health insurance through state exchange market places, creating concern among healthcare professionals of the potential to expand healthcare disparities within this group (Edward, 2014). Health insurance is considered a significant determinant of health, directly linked to health outcomes, like morbidity and mortality, among immigrants (Edward, 2014). There are immigration laws, such as Alabama HB 56, also known as the Beason-Hammon Alabama Taxpayer and Citizen Protection Act, that restrict undocumented immigrants' access to healthcare services, employment, higher education, and many other private and public benefits (Allen & McNeely, 2017). Alabama HB 56 also increases immigration enforcement (Allen & McNeely, 2017). Kline (2016) suggests that global immigrant policing initiatives

create fear among undocumented Hispanics because of its punitive nature and threat of deportation which, in turn, impacts health behaviors, such as seeking health care services. The question must then be asked: Are policy changes in both immigration and healthcare creating barriers for the Hispanic community? My hypothesis is that current healthcare and immigration policies act as barriers for undocumented Hispanic immigrants in accessing healthcare.

## **Background and Significance**

### **History**

The U.S. has a history of negative attitudes with respect to Hispanic immigrants, both documented and undocumented. The use of terms such as “illegal alien”, “illegal immigrant” and “undocumented workers” have been used interchangeably with identifiers like Hispanic or Latino/a, regardless of immigration status (Vargas et al., 2017). According to the Association of State and Territorial Health Officials (2010), the term undocumented immigrant has no federal definition, but defined an undocumented alien as “a person who enters the U.S. without legal permission or fails to leave the U.S. when their permissible time ends.” In a report from Immigration and Customs Enforcement (ICE), the leading countries of origin for removals of undocumented immigrants included Mexico, Guatemala, Honduras, and El Salvador (2017). All of these terms act to perpetuate the stereotype of the Hispanic as a burden on the country, drug trafficker, criminal and to justify exclusion from rights and benefits afforded to citizens of the U.S. (Vargas et al., 2017). These sentiments are being seen in other policies being implemented in the U.S.

### **Healthcare Coverage**

The PPACA was implemented on March 23, 2010 in an attempt to make healthcare insurance coverage more accessible, but it came at a cost to undocumented immigrants (Edward, 2014). There are exceptions within the PPACA that specifically target immigrants, allowing only documented individuals, who meet certain criteria, to be eligible to access insurance coverage but leaves undocumented individuals, or those who fall under the Deferred Action for Childhood Arrivals (DACA), ineligible for insurance coverage (Edward, 2014). With exclusion from coverage under the current PPACA, healthcare and preventative care needs will become increasingly unmet, specifically within this group (Torres & Wahldinger, 2015). Health care costs for undocumented immigrants may be covered only in circumstances of emergency care under the Personal Responsibility and Work Opportunity Reconciliation Act (Edwards, 2017). Immigration laws also act to restrict access to healthcare insurance for undocumented immigrants.

### **Omnibus Immigration Laws**

One quarter of all U.S. children are Latino and may rely heavily on publicly funded health insurance, such as Medicaid/CHIP, because of high poverty rates within the Latino/a community (Allen & McNeely, 2017). Allen and McNeely (2017) hypothesized that there would be a decrease in the number of children, with one or more undocumented parent(s), who are enrolled in public insurance programs because of the passage of restrictive omnibus legislation, but the research suggested the contrary. Findings of this research showed an increase in enrollment, likely due, at least in part, to the social movement of ethnic-

based community-based organization (CBOs) and dissemination of information to the Hispanic and immigrant communities in response to restrictive policy changes (Allen & McNeely, 2017). In contrast, there are other policy changes that have had a notable impact in the Hispanic community. Many immigration laws have come about as a means to force many undocumented Hispanics, as well as those whom are documented, out of certain states through their restrictive nature (Philbin et al., 2017). The study suggests that this type of legislation worked to create, not only structural racism, but also increased stresses that served to discourage Latinos from participating in everyday life, potentially affecting access to healthcare (Philbin et al., 2017). Arizona State Bill (SB) 1070 is an example of an immigration law that singles out Hispanic immigrants by requiring them to carry and present identification to prove legal status in the U.S. (Vargas et al., 2017). Vargas, Sanchez and Valdez (2017) also suggest that legislators in Alabama used the term “illegals” in their testimonies, related to the passage of anti-immigration legislation Alabama HB 56, to conflate immigrants and Latinos in an attempt at racialization of these distinct groups. This is taking place in a culture that already has established barriers created through negative stereotypes and stratification.

### **Racial Identity as a Barrier**

Given the current immigration and healthcare policies barring undocumented individuals from citizen rights, the idea of racial identity as a barrier the health care is supported. There are a reported 11-12 million immigrants, of both documented and undocumented status, in the US, with the majority coming from Mexico (Young &

Pebley, 2017). Studies have shown that there is already a disparity within the Hispanic immigrant population regarding access to health care (Edward, 2014). Compared to their U.S. born counterparts, immigrants are less likely to seek health care or interact with health care professionals, let alone have health insurance coverage (Edward, 2014). Undocumented immigrants suffer from social and civic exclusions that further amplify their marginalized status, when it comes to basic rights (Torres & Wahldinger, 2015). Policies and legislation, such as PPACA, and immigration laws, like Alabama HB 56, act to exacerbate existing challenges. Hall et al. (2015) discussed findings that suggested White health care providers believed that Hispanic and Latino/a patients were less likely to take personal responsibility for their own health, so were more likely to be noncompliant with recommendations for treatment. Anti-immigrant rhetoric creates a narrative that, not only demonizes undocumented immigrants by the public and politicians, but also acts to perpetuate policies that exclude individuals from services and encourages their detention and deportation (Young & Pebley, 2017). The direct effect on health and stress levels can be seen with the passage of Arizona SB 1070, after which many Spanish-speaking Latinos had worse self-reported health in comparison to their other Latino counterparts (Young & Pebley, 2017). An example of worsening health outcomes was seen in California in 1994 with the passage of Proposition 187, that barred undocumented immigrants from using public services (Young & Pebley, 2017). The number of young Latinos utilizing preventative mental health services declined and then, not long after, an increase

use of crisis centers was noted (Young & Pebley, 2017). According to Fenton, Catalano and Hargreaves (1996), there were about 40 fewer outpatient episodes at preventative mental health facilities and six and seven more episodes initiated through crisis services after the passage of the Proposition 187.

There is a positive outcome of the current anti-immigrant atmosphere. The rejection and discrimination that many Hispanic immigrants are feeling has increased political movements, civic participation, and strengthened group identity amongst Latino/as, especially youths (Vargas et al., 2017). The current environment of restrictive policies that block many undocumented Hispanic immigrants from accessing healthcare, paired with evidence from recent research, supports the need to identify areas where improvements can be made to close the gap of health care inequity.

### **Areas of Opportunity**

Much of the research suggested that restrictive policies can negatively impact Hispanic immigrants regarding health care access and potential for poor long-term health outcomes. These negative impacts included lack of access to health insurance (Edward, 2014) and negative stereotypes of Hispanic and Latino individuals, both documented and undocumented, among some White healthcare providers (Hall et al., 2015). Research indicates the need to study a variety of problematic outcomes that result from increased policing and shapes negative behaviors that have the potential to harm both health and well-being (Kline, 2016). These studies will help identify the areas in health care and policymaking where the barriers to health care access can

be lowered, if not eliminated altogether (Edward, 2014). This research will generate data that can guide mobilization of non-profit organizations, create partnerships with ethnic-based CBOs and healthcare professionals and lead to development of interventions that will help to better disseminate information to the Hispanic community that may serve to alleviate healthcare barriers for undocumented individuals.

## **Methods**

### **Study Design**

This research will be conducted using a descriptive case study design. Two small focus groups will be used to allow for more in-depth analysis of reported barriers to accessing healthcare for undocumented Hispanic immigrants that are created by restrictive healthcare and immigration policies.

### **Participants and Sampling**

This case study will include multiple cases that will focus on individuals who identify as undocumented immigrants of Hispanic ethnicity. Age range will be between 18 and 65 with equal numbers of male and female gender (self-identified), though transgender individuals will be welcome to participate. There will be two focus groups: one in Eastern Washington and one in Western Washington. Each group will have 5 participants. Because this is a vulnerable population due to immigration status, the non-probability sampling method of snowball sampling will be used to recruit participants. This will ensure a more accurate representation of our target population and increase the potential for willingness to participate in the study. Snowball sampling will be conducted within healthcare clinics

such as the Yakima Valley Farm Worker's Clinic in Eastern Washington and advocacy groups that focus on the Latinx/Chicanx community, such as El Centro de la Raza, in Western Washington. Participants may be either English or Spanish speaking.

### **Ethical Considerations**

This study will be voluntary and informed consents will be obtained from all participants. A professional interpreter will be utilized for all portions of research when obtaining, coding, and analyzing data. IRB approval will come from the higher education institution funding this research. HIPAA consent will be needed for healthcare records review and health information shared in interview. Confidentiality is essential because this is a vulnerable population related to their undocumented immigration status.

### **Measures**

This study would consider immigration status, healthcare and immigration policies, healthcare access, insurance coverage, and health status using a variety of measures. Both nominal and ordinal measurements will be included in descriptive and exploratory surveys through a questionnaire. This will be used to measure the extent of concern and health impact created by barriers to healthcare. Nominal measurement will use yes and no type questions such as "Do you go to the doctor?" or "Do you have health insurance?" A Likert-type scale will be used for ordinal measurement. Questions may include: "How do you rate your current health?" Answers may include: "Excellent", "Good", "Average", "Poor". Verbal responses during focus groups meeting will be recorded, a transcript will be made, and data obtained will be coded. Semi-

structured questions used in focus groups may include: "What do you understand about 'Obamacare'?" "Has anything stopped you from going to the doctor?" "Have immigration policies changed how much you go out into the community?". Answers will vary. Medical records will be reviewed for diagnosis, hospitalizations and level of control of disease when present, for example, diabetes management or medication compliance. This information will then be coded. Confounding variables may be prior poorly managed disease and history of noncompliance prior to the 5-year retrospective analysis of medical records as well as gaps in medical records or missing medical records.

### **Procedures**

Researchers will partner with clinics and advocacy groups to assist in recruiting participants for this study in Eastern and Western Washington. Once two focus groups have been formed, researchers will meet each group in sequential weeks. Participants will be asked to answer surveys available in both English and Spanish. Oral surveys for individuals who are unable to read and/or write can be administered by interpreters. After surveys are completed, semi-structured questions to be asked in focus group meeting with all participants with a professional interpreter present. Retrospective analysis of health records to obtain data on health status and diagnosis over last five years will be done when available. Self-reporting on health status will be utilized to supplement if gap time in healthcare records is an issue.

### **Analysis**

Qualitative and quantitative data will be gathered. Quantitative data

will be multivariate and obtained from questionnaires and medical records and then coded. Qualitative data will be obtained and coded from transcripts of recordings of focus group meeting and conversational analysis will be utilized. Questionnaire, medical records, and focus group results will be compiled and then analyzed for significant patterns that indicate areas of concern pertaining to barriers to accessing healthcare that are created by restrictive immigration and healthcare policies.

## **Discussion**

### **Significance**

There are a reported 11-12 million immigrants currently living in the United States of both documented and undocumented status with the majority hailing from Mexico (Young & Pebley, 2017). This is a significant demographic that cannot be ignored. Current healthcare and immigration policies, such as the PPACA and Alabama HB 56, act to restrict undocumented immigrants and create barriers to accessing healthcare. This research has the potential to, not only identify areas in healthcare where barriers to access can be lowered, but it can also drive more in-depth research that may help develop policymaking in the future (Edward, 2014). Ethnic-based CBOs and community healthcare providers can utilize this information, in partnership, to reach the Hispanic community with information and education to create better health outcomes amongst an already marginalized group of people.

### **Limitations**

With any case study, small sample size has the potential to make an overgeneralization of research results. In contrast, there is a

possibility to be unable to generalize to the population. This potential limitation should be addressed by recruiting participants by snowball sampling within areas that they would likely frequent. Using professional interpreters may increase the cost of the study considerably. Other limitations might include difficulty gathering participants who are willing to participate in this study due to undocumented status and possible fear of deportation. This may also hinder openness during focus group meetings. The familiarity with the researcher and other group members, who are Hispanic and Spanish-speaking, may minimize this limitation as will the partnership with organizations who have developed relationships and built trust with potential participants. The above-mentioned confounding variables of poor health care status prior to 5-year retrospective review of health records with past medication and/or health care recommendations non-compliance may be considered limitations. Finally, gaps in or missing medical records would make it difficult to conduct a thorough review and establish data for analysis.

### **Future Research**

The PPACA is relatively new, implemented in 2010 (Edward, 2014). With the possibility of changes in the current healthcare system imminent, the full extent of how impactful this may be to the overall health status of undocumented immigrants is yet to be seen. This leaves many directions in research for the future including assessing impacts on mortality and morbidity within this demographic, as well as impacts on mental health. The impacts of restrictive healthcare and immigration policies reach beyond the Washington State border and affects other undocumented immigrants outside

of the Hispanic community, so conducting research within other impacted racial/ethnic groups is essential to get a broader picture of the barriers being created by these laws.

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## ABOUT THE STUDENT AUTHORS

**Hanna Ashagre** is a senior at UW Bothell and will graduate in Fall, 2018, with a B.A in Health Studies and a minor in Health Education and Promotion. Hanna currently holds a A.A. degree from Shoreline Community College. Hanna is interested in the following areas of study: Advocacy, Psychology, Social Justice, and Research. Her areas of interest in the future include: Effects of social determinants of health and health disparities; how they impact a person's quality of life; and, find solutions for the issues. Hanna believes to find solutions for health intervention and prevention, one first needs to see the root cause of the problem.

**Sydney Beaumont** will graduate in Fall 2018 with a Bachelor of Science in Biology. Upon graduation, she plans to attend Graduate school to become a Physician Assistant. Once a Physician Assistant, Sydney hopes to contribute to her community by working with Indian Health Services giving back to her tribe, Cowlitz. Her experience includes Medical Assisting in an Obstetrics and Gynecology office as well as Urgent care. She also volunteers for Hope and Health assisting with creating reusable feminine hygiene packs for women in the villages of Tanzania. Sydney is excited to be part of The CROW and to advance her scientific writing skills for future research.

**Magdalena Brooks** will graduate Spring 2019 from UW Bothell with a Bachelor of Science degree in Environmental Science: Conservation and Restoration Ecology. She transferred to UWB from Bellevue College where she earned an Associate in Arts and Science degree. Magdalena enjoys hands-on learning and scientific research. She is excited to have experienced the peer reviewed publishing process that The CROW provides, and to share what she has learned with others.

**Thi Nguyen** will graduate with a Bachelor's in Health Studies and a minor in Diversity this June. She is interested in social justice, and enjoys working with vulnerable populations. As of now, she will be entering the work force as a Program Coordinator for a disability program. She will also be continuing education by getting her Master's in Social Work. With her degrees, she hope to start my own non-profit organization and help people in her community.

**Alexa Russo** graduated from UW Bothell in fall 2017 with a Bachelor's of Arts in Environmental Studies. Upon graduation, Alexa continued her work in the UW Bothell Sustainability Office where she manages outreach, education, communication, and metrics. Alexa is passionate about inspiring collective action through connecting people with the earth, and continues to do so in her position.



**Antoinette M. Smith** will graduate in Spring 2019 with a Bachelor of Arts degree in Health Studies with minors in both Health Education and Gender, Women, and Sexuality Studies. She plans to pursue a Master's degree in Social Work at the University of Washington, Seattle campus. Antoinette is also a graduate of Yakima Valley College, earning an Associate Degree in Nursing. She worked as a registered nurse in the field of geriatric and rehabilitation nursing as well as working as a home Hospice Nurse Case Manager in Snohomish County. She currently sits as the vice-chair on the Redmond Human Services Commission and spent two years volunteering with Friends of Youth at the Landing. Antoinette is able to achieve all these things with the support of her husband, Alex, and her 4 adult children. Working with the CROW to publish her research proposal has been an invaluable experience and one that she is thankful for having. The experience has given her a well-rounded view on the research process that will be essential for her future educational endeavors.

**Thy Tran** will graduate in June 2018 with a Bachelor of Arts in Health Studies. She plans to gain a few years of experience in the healthcare industry before pursuing graduate school for a Masters in Health Administration. Her passion for working with children in under resourced communities and experience growing up in Vietnam are what motivated her to write this journal article. Thy's other interests are health education and promotion, community health, and global health. Her ultimate personal and career goal is to help increase access to healthcare in her community and her hometown in Vietnam.

**Zachary Weldon** will graduate in Spring 2019 with a Bachelor of Science in Biology. After graduation, he plans on pursuing a career that will utilize his passion for research, and health studies. Along with biology, he also holds interests in chemistry, physics, and programming. He currently holds an A.A. degree from Cascadia College and biotechnology lab technique experience from Shoreline Community College. Zac is currently studying gut microbiomes as part of undergraduate studies. He believes that The CROW presents him with the exceptional prospect to experience the rigors and rewards of academic publishing

**Mudasir Zubair** will graduate in June 2018 from the School of Interdisciplinary Arts and Sciences with a Double-major in Media-and-Communications program and Science-Technology-and-Society program. Despite is spending most of his time studying in the relationship between technology, our environment, and people, he also interested in biology, arts, psychology, and writing. His passions include doing artwork, enjoying nature, and learning more about how technology can be potentially used to make the world a better place. He is going to enroll in the Master of Policy Studies program in Autumn 2018.

## ABOUT THE EDITORS

Sean Arrasmith will graduate in June 2018 with a Bachelor's of Arts in Health Studies. Following graduation, he plans to work toward graduate school to pursue a Master's in Epidemiology and Biostatistics. In the meantime after graduating, Sean will look for experience to reinforce his skills for later careers and for graduate school as well. Sean's interests in writing, statistics, and disease research and study presented him an opportunity to be a part of the CROW Journal Editorial Board.

Stephen Ball will graduate in Fall of 2019 with a B.A in Health Studies. He is currently working towards becoming a Physician's Assistant with a specialty in orthopedics. He is currently trying to get experience in the medical field by working as an EMT, and by establishing connections by shadowing PA's and physicians. His interests include playing sports, composing music, playing piano, and studying new research related to mental disease and illness. His interest in research led him to become an editor of the CROW, where he hopes to continue learning and growing as both a student and member of the community.

Brandee Badgett is a third year undergraduate pursuing a bachelors of arts in Health Studies and a minor in Chemistry. Her experience has included being part of the Veterans Life Initiative Task Force, The Chancellor's Advisory Committee for Students, volunteering and working full time in retail. Upon graduation, She plans to attend a medical school to study to become a general surgeon. Her interests include medicine, helping others, and film. She is thrilled to be apart of the CROW and is looking forward to helping others publish their own work.

Daniel Bilyard will graduate in June 2018 with a Bachelor of Arts in Health Studies. Upon graduation, he plans to attend Graduate School to study to become a Physician Assistant. His experiences as a Medic in the United States Army and as a Medical Assistant in Pediatrics has pushed him to provide high quality health care to individuals and families in need. Daniel is thrilled to provide his insight in the writing and research he has conducted, and gain insight from peers through their hard work and dedication through the research submitted to the CROW.

Grace Boulanger is a junior undergraduate student pursuing a Bachelor's of Arts in Culture, Literature, and the Arts. She currently works at the UWB Writing and Communication Center as a peer consultant for student writing, as well as managing WaCC projects. She hopes to use her education to study history, folklore, and classical literature. Upon her graduation in 2019, she hopes to further expand her education into linguistics by using her BA as a reference point. Her interests include reading historical fiction, gardening, and hiking. She is excited to learn about the publication process and hopes to lend a critical eye to the CROW editorial team.

Kimberley Cross will be graduating in 2019 with a Bachelor of Arts in Health Studies and a Bachelor of Arts in Community Psychology. She currently works in the Writing and Communication Center as a peer consultant and has research experience with trauma informed practice. Upon graduation she plans to attend graduate school and pursue a dual master's degree in Social Work and Public Health. Kimberley's career goal is to become a clinical social worker. She is enthusiastic about research and loves writing, which is why she chose to be on The CROW editorial board.

Heidi Stedman will graduate in June 2018 with a Bachelor of Arts in Health Studies and Minor in Business Administration. After graduation, Heidi hopes to use her education in health and business to pursue a career in healthcare administration. Outside of class, Heidi works at a chiropractic clinic in Mill Creek as a receptionist and medical biller. Heidi is excited to help fellow students in the publication process and learn about student research being done on campus while improving her own writing and editing skills.

Kathleen Sundet will graduate in June 2018 with a Bachelor of Arts in Law Economics & Public Policy. After graduation, Kathleen hopes to use her degree to pursue a career in public service, law, or administration. Her interests include history, outdoor activities and reading fantasy novels. She currently works as a Lead Peer Consultant in the Writing and Communication Center and hopes to use her training to provide thoughtful and constructive feedback while learning more about the publishing process.

Neele Thom will graduate in Spring of 2019 with a B.S. in Biology. Outside of classes she works as a peer consultant at UWB's Writing and Communication Center, and is an undergraduate researcher in the Hematology Department at the University of Washington Medical Center. Upon graduation, she plans on continuing her research and pursuing her PhD in molecular and cellular biology. Her interests in both research and in writing have led her to publish in the CROW in 2017, and now to joining its editorial board. She hopes to contribute her perspective at the intersection of academic research and writing to the journal.

