

2020

Elaia 2020

Stephen Case

Olivet Nazarene University, scase@olivet.edu

Follow this and additional works at: <https://digitalcommons.olivet.edu/elaia>



Part of the [Agriculture Commons](#), [Behavioral Disciplines and Activities Commons](#), [Digestive System Diseases Commons](#), [Economics Commons](#), [Maternal, Child Health and Neonatal Nursing Commons](#), [Oil, Gas, and Energy Commons](#), [Other Environmental Sciences Commons](#), [Pediatric Nursing Commons](#), and the [Plant Sciences Commons](#)

Recommended Citation

Case, Stephen (2020) "Elaia 2020," *ELAIA*: Vol. 3 , Article 1.

Available at: <https://digitalcommons.olivet.edu/elaia/vol3/iss1/1>

This Article is brought to you for free and open access by the Honors Program at Digital Commons @ Olivet. It has been accepted for inclusion in ELAIA by an authorized editor of Digital Commons @ Olivet. For more information, please contact digitalcommons@olivet.edu.

E LA IA

Volume 3 2020



The Honors Journal of Olivet Nazarene University

Personality Traits as Covariates of Rock-Climbing Performance in Novice Rock Climbers

Parent Perspectives of Perceived Racial Bias in their Adolescent's Healthcare Experience in Emergency Rooms

Barriers to Pregnancy Healthcare as Perceived by Hispanic Women in the Northern Midwest

Protective Effects of the Novel Phytonutrient S7 Against Intestinal Tight Junction Disruption: Composition Matters

Monetary Policy and Income Inequality in the United States and Spain

Nutrient Recycling from Aqueous for Nitrogen Supplementation in Algae Growth



The name Olivet comes from Mount Olivet, or the Mount of Olives, a hill outside Jerusalem known in ancient times for its olive groves and which featured prominently in Christ's life and ministry. Olives have been cultivated for thousands of years and hold rich theological symbolism (the olive branch as a symbol of peace, for instance, or anointing with olive oil). In selecting a name for this journal, we wanted a title that drew upon the symbolism and history in Olivet's name itself.

ELAIA (el'AYE'ah) is the phonetic spelling of the Greek word for olive. The symbolism is apt in more ways than one: olive trees take years to mature and bear fruit, and the research contained in this journal is likewise the fruit of these students' years of labor. Like the olive tree, we pray these students continue to grow, cultivate deep roots, and bear the fruits of peace and holiness in all their scholarly endeavors.



ELAIA

The Honors Journal of Olivet Nazarene University

VOLUME 3 2020

Honors Program Administration

Stephen Lowe, *Vice President for Academic Affairs; Director*
Stephen Case, *Editor and Associate Director*
Cheryl Paarlberg, *Administrative Assistant*

Honors Faculty Council

Stephen Lowe, *Vice President for Academic Affairs; Chair and Dean of the College of Arts and Sciences*
Aram Agajanian, *Engineering*
Justin Brown, *Mathematics*
Stephen Case, *Geosciences*
Mark Frisius, *Church History*
Pam Greenlee, *Benner Library*
Rob Knisley, *Business*

Elizabeth Schurman, *English*
Daniel Sharda, *Biology*
Brian Stipp, *Education*
Neal Woodruff, *Music*

Honors Program Teaching Faculty

Justin Brown, *Mathematics*
Stephen Case, *Geosciences*
Ryan Himes, *Biology*
Kristy Ingram, *Center for Academic Excellence*
Heather McLaughlin, *Communications*
Charles Perabeau, *Sociology*
Elizabeth Schurman, *English*
Daniel Sharda, *Biology*
Brian Stipp, *Education*



DIRECTOR'S NOTE

Each fall, the Honors Program at Olivet Nazarene University admits a small number of academically gifted students into its freshman class. From the moment they set foot on our campus, these women and men join a community of scholars, and together they read, reflect upon, and discuss the most important ideas of the past and present—all within a Christian fellowship. The first two years of the program involve a series of Honors courses, taught by a team of faculty and modeled on the historic “old-time college,” where small class relationships, interdisciplinary discussion, and debate prevailed.

In the junior and senior years, the Honors Program shifts its focus away from the classroom to the laboratory or library. There, students work on a capstone scholarship project within their major that involves original research and writing. Honors students gain experience comparable to what happens at large research institutions as they work one-on-one with a faculty mentor and alongside their classmates in research seminars to conceive and complete their individual projects. For our graduates—many of whom go on to advanced study in medicine, law, or other fields—scholarship becomes a deeply personal, transformative, and spiritually meaningful act. Throughout their four years, Honors students ultimately learn how to love God with their minds, as well as their hearts.

Since its establishment in 2007, the program has continued to grow and flourish, and the depth of its research continues to increase. This third volume of *ELAIA* represents the fruits of that development, containing capstone research projects from the 2020 Honors Program senior class and their faculty mentors. The Table of Contents is diverse, and in that way it is a crystalline reflection of our program's community of scholars.

I, along with the members of the Honors Council, am gratified by the work of each student and faculty mentor printed within these pages.

- Stephen Lowe, *Honors Program Director*

CONTENTS

Personality Traits as Covariates of Rock-Climbing Performance in Novice Rock Climbers <i>Courtney N. Gearhart; Prof. Kristian Veit - Mentor</i>	5
Parent Perspectives of Perceived Racial Bias in their Adolescent's Healthcare Experience in Emergency Rooms <i>Ashleigh E. Godby; Dr. Yvette Rose - Mentor</i>	21
Barriers to Pregnancy Healthcare as Perceived by Hispanic Women in the Northern Midwest <i>Anna O. King; Prof. Cathy Dillinger - Mentor</i>	43
Protective Effects of the Novel Phytonutrient S7 Against Intestinal Tight Junction Disruption: Composition Matters Abstract Only <i>Erin E. Olson; Dr. Daniel Sharda - Mentor</i>	67
Monetary Policy and Income Inequality in the United States and Spain <i>Brooke L. Whetstone; Dr. Paul Koch - Mentor</i>	71
Nutrient Recycling from Aqueous for Nitrogen Supplementation in Algae Growth <i>Alyssa L. Young; Dr. Willa Harper - Mentor</i>	89



Personality Traits as Covariates of Rock-Climbing Performance in Novice Rock Climbers

Courtney N. Gearhart

ACKNOWLEDGEMENTS

I would like to thank Dr. Veit, my research mentor, for his investment, guidance, and support in research methodology, the process of statistical analysis, preparation for presentation at the conference of the Associated Colleges of the Chicago Area, and all of the frustration and excitement along the way. I would also like to thank the Graven Family, Dr. Schurman, Dr. Case, Dr. Stipp, Dr. Sharda, Cheryl Paarlberg, and Professor Young, along with the rest of the Honors Program, for their investment in me and this project.

ABSTRACT

Background

Existing literature has connected heightened levels of conscientiousness and grit and lowered levels of neuroticism to greater general athletic performance (Courneya & Hellsten, 1998; McEwan, Boudreau, Curran, & Rhodes, 2019; Steca et al., 2018). Rock-climbing is a growing field of interest and the question of whether conscientiousness, neuroticism, and grit are correlated with rock-climbing performance and improvement remains unexplored.

Methods

To assess relationships among conscientiousness, neuroticism, grit, and rock-climbing performance, twenty-three undergraduate students with no significant climbing experience participated in a two-part study at a small religious university in the Midwest. Participants were recruited through professors known by the researcher, who passed sign-up sheets to their classes. Upon participation, students were given informed consent forms and scales measuring grit and Big-Five traits, including conscientiousness and neuroticism, then were measured climbing three routes at varying difficulty levels on two occasions, six weeks apart.

Results

Data were analyzed using repeated-measures ANOVA tests, and no statistically significant interactions were found between conscientiousness, neuroticism, or grit and rock-climbing performance.

Conclusion

The lack of statistical significance suggests that the anticipated relationships did not exist in the sample surveyed. However, the sample size was small, and a floor effect existed for one of the operationalizations of rock-climbing performance. Therefore, our conclusions regarding the relationships between conscientiousness, neuroticism, grit, and rock-climbing performance are regarded as tentative.

Keywords: grit, conscientiousness, neuroticism, Big-Five, personality, rock-climbing, athletic performance.

LITERATURE REVIEW

Empirical correlates of rock-climbing performance

Rock-climbing is a growing area of interest, and in August 2016 it was approved to be added to the program of the Tokyo 2020 games (International Olympic Committee, 2017). The growth of the sport for competitive purposes has been accompanied by a dramatic growth in indoor recreational climbing gyms in America (IBIS World, 2018).

Physiological correlates of rock-climbing

As interest in climbing has grown, there has been increased interest in possible contributing factors to and correlates of rock-climbing performance. Pijpers, Oudejans, Holscheimer, and Bakker (2003) found that muscles were more rigid and participants

more anxious at a higher-altitude and that increased anxiety lead to higher entropy and displacement along with longer climb-times. Zarattini et al. (2018) conducted a study with nine participants measuring heart rate and climb time of intermediate climbers climbing a lead route versus a top route. The results showed that there are higher physiological demands involved in lead climbing, as demonstrated by higher average and maximum heart rates, as well as longer climb-times.

Psychological profile of rock climbers

The first major psychological profile of rock climbers was based on a group of climbers who were able to lead climb routes five-eight grade and above on the U.S. grading system (Robinson, 1985). The study found that participants were not drawn specifically to climbing as a means of affiliation, but that affiliation played a role in climbers sticking to the sport. There was no difference between elite climbers and the population of undergraduate males in Need for Achievement, but elite climbers were significantly lower on the Trait Anxiety Inventory and higher in sensation seeking.

Sarrazin, Roberty, Cury, Biddle, and Famose (2002) continued this line of research by conducting a course-based research design to show that participants who were high in task-orientation (motivation based on intrinsic completion) versus ego-orientation (motivation based on extrinsic evaluation) exerted the most effort on the most difficult courses. This study used only boys age twelve to sixteen who had at least one year of climbing experience. Egan and Stelmack (2003) conducted a personality profile of Mount Everest climbers, looking for correlations between climbing performance and personality traits as assessed by the Eysenck Personality Questionnaire-Revised (Roger & Morris, 1991). The study found no significant predictors of climbing performance in personality traits. There were trends in the mean scores indicating that in a male sample, climbers were higher in extraversion, psychoticism, and lie, which tests for social desirability in responses. There was also a nonsignificant trend towards male climbers having lower levels of neuroticism. This study is relevant to the body of research, but it is important to note that this sample of mountaineering rock climbers is not representative of all rock climbers. This study is one of the few studies that looks at personality specifically with respect to rock climbers and does so only at the elite level with mountaineers using a less inclusive personality inventory.

Four years later in 2007, Aşçi, Demirhan, and Dinc demonstrated that intrinsic motivation, which is correlated with grit, is significantly positively related to rock-climbing expertise. In 2010, Sanchez, Boschker, and Llewellyn took mental state and performance information from nineteen male climbers competing in the Belgian Climbing Championship to look at psychological states as they relate to climbing performance. The states of interest were cognitive anxiety, somatic anxiety, and self-efficacy or self-confidence. Performance was measured by tracking a magnesium bag attached to the climber. Performance was measured by entropy and flow while climbing, as well as how many and how quickly holds were reached. The results showed that cognitive anxiety was negatively correlated with performance both in success and in speed climbed, and that somatic anxiety and self-efficacy were positively correlated. Looking at the previous research, it is clear that the need remains for more recent personality profiles of those who engage in and excel in rock-climbing.

In addition, researchers have called for an increased attention to detail with respect to rock-climbing research. For example, Draper et al. (2011) reviewed the research literature and studies on rock-climbing and proposed climbing measurement and research report methods to facilitate consistency in data reporting. They outlined important information to be included in sample size and characteristics, defined key terms in climbing such as *lead*, *sport*, *top*, *bouldering*, *trad*, *redpoint*, *flash*, and *ascent*. They also developed two different ability classification tables for male versus female climbers, explaining the necessity of clear denotation between skill levels beyond abstract qualitative terms such as “elite, expert, intermediate,” and “recreational.” Similarly, Zarattini et al. (2018) showed that time taken to climb a route could be validated as a measurement of climbing performance.

The Big-Five model of personality

The Five-Factor Model (FFM) of personality was the result of years of factor-analytic work from the trait perspective (Allport & Odbert, 1936; Cattell, Eber, & Tatsuoka, 1970). The FFM was given the label “Big-Five” to describe the broad nature of the dimensions (Goldberg, 1981) and has been supported from both lexical (Goldberg, 1990) and questionnaire-based approaches (Costa and McCrae, 1992). The traits that make up the Big-Five model are conscientiousness, neuroticism, extraversion, agreeableness, and openness or intellect. Those high in conscientiousness are generally “cautious, dependable, persevering, organized, and responsible” (Friedman & Schustack, 2016, p. 187). Neuroticism, also called emotional instability, refers to those who tend to be “nervous, high-strung, tense, volatile, moody, and worrying” (p. 187). Extraversion describes those who are “energetic, enthusiastic, dominant, sociable, and talkative” (p. 187). Agreeable people are “friendly, cooperative, trusting, and warm” (p. 187), whereas those high in openness or intellect generally appear “imaginative, witty, original, and artistic” (p. 187). The fifth factor of openness to experience or intellect has been defined differently across cultures and questionnaires and is the most controversial of the five factors (John & Srivastava, 1999).

The Big-Five grew to become the dominant model of trait psychology (Donnellan, Oswald, Baird, & Lucas, 2006) and several questionnaires were developed to measure Big-Five traits. To increase efficiency, the 50-item International Personality Item Pool-Five Factor Model (IPIP-FFM) was condensed to a shorter twenty-item scale (Mini-IPIP) (Donnellan, Oswald, Baird, & Lucas, 2006). Since then, psychometric properties of the mini-IPIP have been validated with different samples (Baldasaro, Shanahan, Bauer, 2013) and continue to be used in current scholarly research (McEwan, Boudreau, Curran, & Rhodes, 2019). Comprehensive meta-analyses looking at Big-Five correlates have found relationships that include, but are not limited to: burnout, relationship satisfaction, job satisfaction, job performance, academic performance, and team performance (Allen, Greenlees, & Jones, 2013).

Big-Five traits and athletic behavior

A study of 264 undergraduate students found that extraversion and conscientiousness were positively correlated with exercise behavior whereas neuroticism was negatively correlated, with neuroticism negatively and conscientiousness positively most

consistently related to exercise barriers (Courneya & Hellsten, 1998). A meta-analysis of personality in sport performance found higher levels of extraversion and lower levels of neuroticism in high-risk sport participants (McEwan, Boudreau, Curran, & Rhodes, 2019). Another study of 881 male athletes and non-athletes found that beyond athletic participation, athletes who had experienced the most success in their sport were higher in conscientiousness and agreeableness but lower in neuroticism (Steca et al., 2018). The less-successful athletes were only higher than non-athletes in agreeableness and extraversion. The only study correlating Big-Five traits and a type of rock-climbing looked at Mount Everest climbers and was measured by Eysenck Personality Questionnaire-Revised (Roger & Morris, 1991). Results were not statistically significant but found a trend towards lower neuroticism. These findings lead us to Hypothesis One through Hypothesis Four, which expect more successful climbers to be higher in conscientiousness and lower in neuroticism.

Hypothesis One: Conscientiousness levels will be positively correlated with climbing improvement (as measured by time to completion) with a sample of novice climbers.

Hypothesis Two: Conscientiousness levels will be positively correlated with amount of increase in holds reached over a six-week period with a sample of novice climbers.

Hypothesis Three: Neuroticism levels will be negatively correlated with climbing improvement (as measured by time to completion) with a sample of novice climbers.

Hypothesis Four: Neuroticism levels will be negatively correlated with amount of increase in holds reached over a six-week period with a sample of novice climbers.

Grit as a measure of personality

Grit is defined as the passion and perseverance for longterm goals (Duckworth, Peterson, Matthews, & Kelly, 2007). Whereas the FFM comes from an inductive and data-driven origin, grit is a deductive and theory-driven measure of personality. In a study seeking to find a predictor of success and retention with United States Military Academy (USMA) West Point cadets, grit was first defined and found to be a significant predictor over academic scores, physical ability, intelligence quotient (IQ), and Big Five personality traits. Beyond USMA cadet retention, grit was found to be a significant predictor of success in the following areas: educational attainment, grade point average among Ivy League undergraduate students, and ranking in a national spelling bee. Grit itself was not found to be significantly correlated with IQ but was found to be significantly correlated with the Big-Five trait conscientiousness. The original Twelve-Item Grit Scale (GRIT-O) was revised to a newer Short Grit Scale (GRIT-S) (Duckworth & Quinn, 2009), and since then the original studies have been replicated with respect to Big-Five personality traits, USMA retention (Kelly, Matthews, & Bartone, 2014), and academic performance (Rimfeld, Kovas, Dale, & Plomin, 2016).

Grit and athletic behavior

Further research has expounded on grit literature in finding grit as a predictor in the athletic arena. One such study outlined the correlations between grit, conscientiousness,

industriousness, and exercise score, finding grit the strongest predictor of exercise score (Reed, 2014). Two years later, Larkin, O'Connor, and Williams (2016) used GRIT-S in addition to soccer-specific perceptual-cognitive expertise assessments to collect data. They surveyed 385 soccer players, finding significant positive correlations between grit, engagement, and perceptual-cognitive expertise. A study conducted using National Collegiate Athletic Association division II basketball players found through quantitative and qualitative measures that grit scores and basketball performance were positively correlated (Morgan, 2017).

However, grit has not been studied specifically with respect to climbing performance or retention in the sport. Personality traits somewhat related to grit including sociability, toughmindedness, and anxiety have been studied in climbers, but the correlations between these and climbing ability have not been significant (Egan & Stelmack 2003). A study of rock-climbing performance and improvement that looks at grit as a personality trait may yield more significant results. Studying grit in the area of climbing performance and improvement would have interesting implications for climbing gyms and individual climbers, as well as add to the growing body of research on both topics. These findings lead to Hypotheses Five and Six, which expect climbers to have higher grit levels.

Hypothesis Five: Grit levels will be positively correlated with climbing improvement (as measured by time to completion) with a sample of novice climbers.

Hypothesis Six: Grit levels will be positively correlated with amount of increase in holds reached over a six-week period with a sample.

METHODS

Participants

Participants included 31 undergraduate students recruited through introduction to psychology courses at a small religious university in the Midwestern United States. All participants were novice climbers, defined as having climbed three times or fewer. Eight participants did not return for the second round of data collection and were not included in the data. The average age of participants was 19.5 years ($SD = 1.5$ years), and females accounted for 19 of the 23 completed responses. Of the participants, the majority of participants (17) identified as white, with four identifying as Hispanic, Latino, or Spanish origin, and two as Black or African American. Twenty-six percent of participants (6) were fourth-year students, 17.4% (4) were third-years, 17.4% (4) were second-years, and 39.1% (9) were first-years.

Six and a half percent of students (2) reported that they had climbed once at an off-campus gym. Four participants reported climbing at least once in the past and had an average time spent in one climbing visit of 11.3 minutes. Average enrolled credit hours at the time of the study was 15.6 ($SD = 1.63$).

Materials

Big-Five traits were assessed using the Mini-IPIP (Donnellan, Oswald, Baird, & Lucas, 2006). The scale included twenty total statements (four statements for each of the Big-Five traits) assessed on Likert scales with five points ranging from very accurate to very inaccurate. After reverse-scoring, higher scores mean higher levels of the trait being measured. Internal consistency for each of the Big-Five traits was high (*Table 1*).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Conscientiousness	—														
2. Neuroticism	0.13	—													
3. Grit	0.11	-0.28	—												
4. Intellect	-0.10	0.19	-0.33	—											
5. Extraversion	-0.27	-0.25	0.09	-0.05	—										
6. Agreeableness	-0.25	0.16	0.13	0.03	0.22	—									
7. Time Route A	0.03	0.26	-0.02	0.13	-0.47 *	-0.22	—								
8. Holds Route A	-0.04	0.18	0.07	0.15	-0.47 *	-0.24	.71 **	—							
9. Falls Route A	0.14	-0.03	-0.09	-0.10	0.20	-0.13	-0.54 **	-0.74 **	—						
10. Time Route B	-0.32	-0.13	-0.19	0.06	<0.01	-0.10	0.18	0.28	-0.49 *	—					
11. Holds Route B	-0.12	-0.19	-0.18	0.21	0.15	-0.32	0.02	0.37	-0.45 *	0.51 *	—				
12. Falls Route B	0.02	0.12	-0.36	-0.05	-0.04	-0.18	0.32	0.06	-0.11	0.56 **	0.26	—			
13. Time Route C	0.05	-0.14	0.18	0.15	0.07	-0.04	0.44 *	0.26	-0.23	0.04	-0.07	0.24	—		
14. Holds Route C	0.13	0.06	-0.51 *	0.09	-0.12	0.09	-0.04	0.17	-0.13	0.01	0.27	0.19	-0.25	—	
15. Falls Route C	0.25	-0.10	0.06	0.13	0.03	-0.08	0.40	0.07	-0.11	-0.06	-0.20	0.28	0.88 **	-0.16	—
Mean	14.6	11.3	3.54	16.1	13.2	16.9	16.2	1.52	0.00	31.1	-0.13	1.00	56.3	0.09	2.17
Standard Deviation	3.92	3.67	0.49	2.09	2.70	2.39	28.7	6.93	0.41	57.7	2.83	2.02	104	7.35	4.74
Reliability	.81	.89	.83	.78	.91	.80									

Items 7-8 are discrepancy scores created from subtracting scores time two from time one. ** $p < .01$, * $p < .05$.

Grit was assessed using Grit-O (Duckworth, Peterson, Matthews, & Kelly, 2007). Participants responded to twelve statements on four-point scales with endpoints ranging from “very much like me” to “not like me at all.” All items were reverse scored so that higher scores reflected higher levels of grit. This scale had high internal consistency (*Table 1*).

Climbing performance was measured by time taken to climb each route and highest hold reached. A record was kept of number of falls taken. The three routes were climbed top-rope in growing difficulty: Route A (35 holds, 25 ft), Route B (25 holds, 37 ft), and Route C (52 holds, 56 ft). Finally, participants were asked to indicate their gender, year in school, age, ethnicity, credit hours, climbing experience, and whether or not they had a job outside of schooling (Hughes, Camden, & Yangchen, 2016).

Procedures

Participants received a sign-up sheet from their introductory psychology professor briefly describing the study and requesting their participation. Participants wrote their name and email then followed a link sent to them where they selected a 30-minute time slot to participate. Some participants entered their names to receive extra credit in a course, and all participants were awarded a five-dollar gift card upon completion of participation.

Once students arrived for the study for the first time, they were met by a researcher (or a research assistant). Each participant was given an informed consent document that gave students a brief overview of the procedures and objectives of the research and explained the completely voluntary nature of their participation. Participants were reminded that they could withdraw from the study at any time without penalty, privacy expectations were discussed, and contact information was given.

Participants were then given both personality inventories. Upon completion, they were asked to climb all three routes interspersed with 90-second breaks. Each climb was timed, and a record was kept of the number of holds reached and number of falls taken. After climbing, students filled out the demographic questionnaire.

Upon second participation, six weeks after the first set of climbs, participants were again met by a researcher or research assistant. There, they climbed Routes A through C again with 90-second breaks between each route. After climbing, students were debriefed on the intent of the study. Once collected, data was entered into and analyzed using the Jamovi computer program. Hypotheses were tested using repeated-measure ANOVAs with personality traits as covariates.

RESULTS

Table 1 contains the means, standard deviations, and intercorrelations between each of the main continuous variables in this study. In addition, internal consistency for each of the scales used to assess personality can be found in **Table 1**.

An initial repeated-measures ANOVA found significant differences between all three climbing measures on each route, so three separate calculations corresponding to each of the three routes were conducted for all six hypotheses. No significant differences or strong effect sizes were found for either improvement in number of holds reached on Routes A through C or improvement in number of falls on Route A. Of the five remaining areas of significant improvement, no significant interactions were present. **Tables 2** through **4** contain the means and standard deviations for time, holds, and falls for each of the routes climbed, both at time one and at time two.

TABLE 2: REPEATED-MEASURES ANOVA RESULTS FOR ROUTE A

	Time 1		Time 2		F	p	η^2_p
	M	SD	M	SD			
Route A							
Time	78.7	31.8	62.5	31.9	7.33	0.01 *	0.25
Conscientiousness					0.02	0.90	<0.01
Neuroticism					1.47	0.24	0.07
Grit					0.01	0.92	<0.01
Extraversion					5.88	0.02 *	0.22
Hold	31.1	5.84	29.6	7.57	1.11	0.30	0.05
Conscientiousness					0.03	0.86	<0.01
Neuroticism					0.70	0.41	0.03
Grit					0.09	0.77	<0.01
Falls	0.44	0.51	0.44	0.51	0.00	1.00	0.00

Personality traits under measurements of climbing performance refer to covariates in repeated-measures ANOVA analyses. * $p < .05$.

TABLE 3: REPEATED-MEASURES ANOVA RESULTS FOR ROUTE B

	Time 1		Time 2		F	p	η^2_p
	M	SD	M	SD			
Route B							
Time	135	80.2	104	66.8	6.67	0.02 *	0.23
Conscientiousness					2.43	0.13	0.10
Neuroticism					0.35	0.56	0.02
Grit					0.78	0.39	0.04
Hold	11.7	8.16	11.8	7.70	0.05	0.83	<0.01
Conscientiousness					0.33	0.57	0.02
Neuroticism					0.78	0.39	0.04
Grit					0.68	0.42	0.03
Fall	2.52	2.15	1.52	1.27	5.62	0.03 *	0.20
Conscientiousness					0.01	0.92	<0.01
Neuroticism					0.29	0.60	0.01
Grit					3.21	0.09	0.13

Personality traits under measurements of climbing performance refer to covariates in repeated-measures ANOVA analyses. * $p < .05$.

TABLE 4: REPEATED-MEASURES ANOVA RESULTS FOR ROUTE C

	Time 1		Time 2		F	p	η^2_p
	M	SD	M	SD			
Route C							
Time	149	108	92.9	59.3	6.68	0.02 *	0.23
Conscientiousness					0.06	0.82	0.00
Neuroticism					0.41	0.53	0.02
Grit					0.73	0.40	0.03
Hold	16.7	15.4	16.6	17.0	<0.01	0.96	<0.01
Conscientiousness					0.37	0.55	0.02
Neuroticism					0.08	0.79	<0.01
Grit					7.23	0.01 *	0.26
Fall	4.87	5.09	2.70	2.14	4.83	0.04 *	0.18
Conscientiousness					2.60	0.12	0.11
Neuroticism					0.22	0.64	0.01
Grit					0.07	0.80	<0.01

Personality traits under measurements of climbing performance refer to covariates in repeated-measures ANOVA analyses. * $p < .05$.

Hypothesis One predicted a positive correlation between conscientiousness and climbing performance as measured by time to completion. Inconsistent with our predictions, no relationship was found between conscientiousness and improvement in time to completion on routes A, B, or C (*Tables 1 through 4*).

Hypothesis Two predicted a positive correlation between conscientiousness and climbing performance as measured by number of holds reached. Inconsistent with our predictions, no relationship was found between conscientiousness and improvement in number of holds reached on routes A, B, or C (*Tables 1 through 4*).

Hypothesis Three predicted a negative correlation between neuroticism and climbing performance as measured by time to completion. Inconsistent with our predictions, no

relationship was found between neuroticism and improvement in time to completion on routes A, B, or C at time one or at time two (*Tables 1 through 4*).

Hypothesis Four predicted a negative correlation between neuroticism and climbing performance as measured by number of holds reached. Inconsistent with our predictions, no relationship was found between neuroticism and improvement in number of holds reached on routes A, B, or C (*Tables 1 through 4*). This is because no actual differences were found between time one and time two for number of holds reached.

Hypothesis Five predicted a positive correlation between grit and climbing performance as measured by time to completion. Inconsistent with our predictions, no relationship was found between grit and improvement in time to completion on routes A, B, or C (*Tables 1 through 4*).

Hypothesis Six predicted a positive correlation between grit and climbing performance. Inconsistent with our predictions, no relationship was found between grit and improvement in number of holds reached on routes A, B, or C (*Tables 1 through 4*). This is because no actual differences were found between time one and time two for number of holds reached.

With respect to exploratory analyses, there was a significant interaction between extraversion and time taken to climb Route A with a medium-strong effect size, meaning that participants with higher extraversion took less time to complete the easiest route (*Table 2*). No notable relationships or trends were found with respect to agreeableness or openness. There was a significant decrease in falls taken on Routes B and C, but no interactions with personality traits were present (*Tables 3 and 4*). Grit as a covariate had a medium effect size on number of falls taken on Route B from time one to time two (*Table 3*).

As further exploratory analyses, independent samples t-tests were conducted comparing those who finished Routes A and B with those who did not on conscientiousness, neuroticism, and grit for both time one and time two. Similar analyses were only conducted with Route C for time two because no participants completed Route C at time one. At time two, there were significant differences between finishers and non-finishers for Routes A and B on conscientiousness. At times one and two, a significant difference was found with respect to neuroticism on Route B with a strong effect size. There was also a nonsignificant difference of grit between finishers and non-finishers on Route A (*Table 5*).

DISCUSSION

This study assessed the interactions between conscientiousness, neuroticism, and grit with rock-climbing improvement among university students over a six-week period. The study found no relationships between conscientiousness, neuroticism, grit, and two different indices of climbing performance. Some of this deviation from the research may be due to the relative expertise of the novice samples in this study as compared

TABLE 5: INDEPENDENT SAMPLES T-TEST

	Time 1			Time 2		
	t	p	Cohen's d	t	p	Cohen's d
Route A						
Conscientiousness	1.09	0.28	0.39	0.46	0.65	0.19
Neuroticism	0.40	0.69	0.14	0.72	0.48	0.31
Grit	1.74	0.09	0.62	1.66	0.11	0.70
Route B						
Conscientiousness	1.95	0.06	0.89	2.35	0.03 *	1.30
Neuroticism	2.62	0.01 *	1.19	2.30	0.03 *	1.27
Grit	1.58	0.13	0.72	0.27	0.79	0.15
Route C						
Conscientiousness				3.40	<0.01 **	2.11
Neuroticism				1.72	0.10	1.07
Grit				-0.69	0.50	-0.42

An independent samples t-test was not conducted for Route C at time one because only one student finished the route at that time. * $p < .05$, ** $p < .01$.

the expert samples of the research. Nonetheless, this result contradicts the research hypotheses and appears to contradict the implications of existing literature on the topics, at least suggesting that relationships between the variables are less meaningful than other research would point to. The exceptions to this are in the interaction between extraversion and time taken to climb and the differences between finishers and non-finishers on conscientiousness and neuroticism. However, these were exploratory analyses and replication would be necessary to draw further conclusions.

This study is hindered by several limitations. Small sample sizes, though realistic for the study, contributed to less statistical power. For half of the hypotheses, analyses were not possible because there was no significant change over time with respect to number of holds reached. This outcome may be due to the fact that the study involved such time- and energy-intensive participation and was encouraged with extrinsic reward. This may have led students to participate based on a desire for specific reward rather than a desire or interest in rock-climbing, which may be more representative of the population of beginning rock climbers. For this and other reasons, the sample may not be representative of the beginning-climber or undergraduate population. This could be remedied through random selection of those who have expressed a previous interest in rock-climbing. There may be a sampling bias due to the recruiting methods used to obtain participants, through professors known by the researcher.

Future research in this area would benefit from different methods of assessing personality traits and rock-climbing performance. Many of the participants were not able to complete the routes, leading to time as an inconsistent measure of performance. More precise and accurate measurements of climbing performance such as entropy-

tracking could provide more reliable and valid data (Pijpers, Oudejans, Holscheimer, & Bakker, 2003; Sanchez, Boschker, & Llewellyn, 2010).

The hypothesized relationships, therefore, may truly not exist in this population, or they may have been identified using a different, valid scale to measure climbing performance. Presenting participants with more attainable goals would reduce a floor effect and including a restriction on number of falls and time spent hanging may have led to a more valid measure of time taken to climb and number of holds reached.

Given the growing interest in the sport of rock-climbing, research identifying non-physiological causes and correlates climbing improvement could lead to a valuable increase in body of knowledge and predictive opportunity. Although this study did not provide conclusive results, the implications for sport-psychology and rock-climbing should be considered.

REFERENCES

- Allen, M. S., Greenlees, I., & Jones, M. (2013). Personality in sport: A comprehensive review. *International Review of Sport and Exercise Psychology*, 6(1), 184–208. doi: 10.1080/1750984X.2013.769614
- Allport, G. W., & Odbert, H. S. (1936). Trait-names: A psycho-lexical study. *Psychological Monographs*, 47(1), i–171. doi: 10.1037/h0093360
- Aşçi, F. H., Demirhan, G., & Dinç, S. C. (2007). Psychological profile of Turkish rock climbers: An examination of climbing experience and route difficulty. *Perceptual and Motor Skills*, 104(3, Pt 1), 892-900. doi:10.2466/PMS.104.3.892-900.d
- Baldasaro, R. E., Shanahan, M. J., Bauer, D. J. (2013). Psychometric properties of the Mini-IPIP in a large, nationally representative sample of young adults. *Journal of Personality Assessment*. 95(1), 74-84. doi:10.1080/00223891.2012.700466.
- Cattell, R. B., Eber, H. W., & Tatsuoka, M. M. (1970). *The handbook for the Sixteen Personality Factor Questionnaire*. Champaign, IL: Institute for Personality and Ability Testing, Inc.
- Costa, P. T., & McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual Differences*, 13(6), 653–665. doi: 10.1016/0191-8869(92)90236-I
- Courneya, K. S., & Hellsten, L.-A. M. (1998). Personality correlates of exercise behavior, motives, barriers and preferences: An application of the five-factor model. *Personality and Individual Differences*, 24(5), 625–633. doi: 10.1016/S0191-8869(97)00231-6
- Donnellan, M. B., Oswald, F. L., Baird, B. M., & Lucas, R. E. (2006). The Mini-IPIP scales: Tiny-yet-effective measures of the Big Five factors of personality. *Psychological Assessment*, 18(2), 192–203. doi: 10.1037/1040-3590.18.2.192
- Draper, N., Canalejo, J. C., Fryer, S., Dickson, T., Winter, D., Ellis, G., & ... North, C. (2011). Reporting climbing grades and grouping categories for rock climbing. *Isokinetics & Exercise Science*, 19(4), 273-280. doi: 10.3233/ies-2011-0424
- Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, 92(6), 1087–1101. doi: 10.1037/0022-3514.92.6.1087
- Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (GRIT–S). *Journal of Personality Assessment*, 91(2), 166-174. doi: 10.1080/00223890802634290

Egan, S., & Stelmack, R. M. (2003). *A personality profile of Mount Everest climbers. Personality and Individual Differences, 34*(8), 1491-1494. doi: 10.1016/s0191-8869(02)00130-7

Friedman, H. S., Schustack, M. W. (2016). *Personality: Classic theories and modern research*. Pearson.

Goldberg, L. (1981). Language and individual differences: The search for universals in personality lexicons. In L. Wheeler (Ed.), *Review of Personality and Social Psychology* (pp. 141-165). Beverly Hills, CA: Sage Publication.

Goldberg, L. R. (1990). An alternative “description of personality”: The Big-Five factor structure. *Journal of Personality and Social Psychology, 59*(6), 1216–1229. doi: 10.1037/0022-3514.59.6.1216

Hughes, J.L., Camden, A.A., & Yangchen, T. (2016). Rethinking and updating demographic questions: Guidance to improve descriptions of research samples. *Psi Chi Journal of Psychological Research, 21*(3), 138-151. doi: 10.1037/a0039906

IBIS World (2018, November). *Indoor climbing walls industry in the US - Market research report. International Olympic Committee. (2017, August 23). Welcome to the instinctive, white-knuckle world of sport-climbing. Olympic. <https://www.olympic.org/news/welcome-to-the-instinctive-white-knuckle-world-of-sport-climbing>*

John, O. P., & Srivastava, S. (1999). *The Big Five Trait taxonomy: History, measurement, and theoretical perspectives*. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research.*, 2nd ed. (pp. 102–138). New York, NY: Guilford Press.

Kelly, D. R., Matthews, M. D., & Bartone, P. T. (2014). Grit and hardiness as predictors of performance among West Point cadets. *Military Psychology, 26*(4), 327–342. doi: 10.1037/mil0000050

Larkin, P., O’Connor, D., & Williams, A. M. (2016). Does grit influence sport-specific engagement and perceptual-cognitive expertise in elite youth soccer? *Journal of Applied Sport Psychology, 28*(2), 129–138. doi: 10.1080/10413200.2015.1085922

McEwan, D., Boudreau, P., Curran, T., & Rhodes, R. E. (2019). Personality traits of high-risk sport participants: A meta-analysis. *Journal of Research in Personality, 79*, 83-93. doi: 10.1016/j.jrp.2019.02.006

Morgan, T. P. (2017). *Grit and student-athlete performance: A case study*. ProQuest Information & Learning. Retrieved from ProQuest Dissertations & Theses Global. (Accession no. 10126070)

Pijpers, J., Oudejans, R., Holscheimer, F., & Bakker, F. (2003). Anxiety-performance relationships in climbing: a process-oriented approach. *Psychology of Sport & Exercise*, 4(3), 283-304. Retrieved from <https://www.journals.elsevier.com/psychology-of-sport-and-exercise/>

Reed, J. (2014). A survey of grit and exercise behavior. *Journal of Sport Behavior*, 37(4), 390-405. Retrieved from <https://www.ncbi.nlm.nih.gov/labs/journals/j-sport-behav/>

Rimfeld, K., Kovas, Y., Dale, P. S., & Plomin, R. (2016). True grit and genetics: Predicting academic achievement from personality. *Journal of Personality and Social Psychology*, 111(5), 780-789. doi: 10.1037/pspp0000089

Robinson, D. (1985). Stress Seeking: Selected Behavioral Characteristics of Elite Rock Climbers. *Journal of Sport Psychology*, 7(4), 400-404. doi: 10.1123/jsp.7.4.400

Roger, D., & Morris, J. (1991). The internal structure of the EPQ scales. *Personality and Individual Differences*, 12(7), 759-764. doi: 10.1016/0191-8869(91)90232-Z

Sanchez, X., Boschker, M. S. J., & Llewellyn, D. J. (2010). Pre-performance psychological states and performance in an elite climbing competition. *Scandinavian Journal of Medicine & Science in Sports*, 20(2), 356-363. doi: 10.1111/j.1600-0838.2009.00904.x.

Sarrazin, P., Roberts, G., Cury, F., Biddle, S., & Famose, J. (2002). Exerted effort and performance in climbing among boys: the influence of achievement goals, perceived ability, and task difficulty. *Research Quarterly for Exercise & Sport*, 73(4), 425-436. doi: 10.1080/02701367.2002.10609042

Steca, P., Baretta, D., Greco, A., D'Addario, M., & Monzani, D. (2018). Associations between personality, sports participation and athletic success: A comparison of Big Five in sporting and non-sporting adults. *Personality and Individual Differences*, 121, 176-183. doi: 10.1016/j.paid.2017.09.040

Zarattini, J. A., Santos, D. M., Abreu, E. A. C., Costa, H. A., Carvalho, G. L., Mendes, T. T., & Rabelo, A. S. (2018). Lead climb induces higher heart rate responses compared to the top rope in intermediate and advanced climbers. *Journal of Exercise Physiology Online*, 21(1), 102-111.



Parent Perspectives of Perceived Racial Bias in their Adolescent's Healthcare Experience in Emergency Rooms

Ashleigh E. Godby

ACKNOWLEDGEMENTS

Thank you to the Olivet Honors Program for providing the tools and the environment to pursue my passions. I will always be thankful for the things I have learned throughout my experience in the program: the will to persevere, the passion to remain curious, and the humility to ask for help. Thank you to my mentor, Dr. Yvette Rose. Your wisdom and knowledge of the medical field was invaluable to my research, and I could not have finished this project without your assistance and encouragement. Thanks also to Dr. Beth Schurman and Dr. Dan Sharda who both walked me through the research process and who lent such important advice. To my friends and family, you believed in me when I didn't believe in myself, and I am forever indebted to you for your constant encouragement and love. Your texts and hugs encouraged me to keep pressing on towards my goals, and I truly couldn't have done any of this without you. Thank you.

ABSTRACT

Background

Research reports that health outcomes are not equal among individuals in the United States. For instance, maternal death rates are higher for Black women than for White (Rabin, 2019). Such healthcare disparities are not limited to adult healthcare. Some research indicates evidence of disparity in pediatric prescriptions and diagnoses of certain illnesses in Black children versus non-Black children (Gerber et al., 2013). Additionally, research has been published discussing the prevalence of implicit bias in health care and how such bias impacts implementation of medical care (Gerber et al., 2013; Wisniewski & Walker, 2020; Sabin & Greenwald, 2012). A review of literature found no qualitative studies discussing the parent perspectives of perceived racial bias in their child's healthcare in emergency departments. This study seeks to fill this gap in the research by using a qualitative method of interviewing mothers of minority children and mothers of White children to investigate the levels of perceived racial bias in their adolescents' previous emergency room visits.

Methods

Perceived bias was assessed by interviewing 10 mothers of minority children and 9 mothers of White children. Participants included mothers from Illinois, South Carolina, Tennessee, and Texas. An 11-item semi-structured interview guide was used in order to discover participants' perceptions of their child's emergency room care. Two questions from the Commonwealth Fund's 2001 Health Quality survey were used to assess participants' views on discrimination in healthcare and life in the United States. Interviews were transcribed and analyzed utilizing in-vivo and general inductive coding methods.

Results

Mothers of minority children did not perceive negative medical treatment of their children; however, 40% of mothers of minority children felt misunderstood because of race or something cultural about them. Further codes or themes of participant interviews included: Familiarity with Emergency Room Staff, Insurance, and Privilege. Mothers of minority children perceived higher levels of discrimination in healthcare and general minority discrimination than mothers of White children.

Conclusions

Some surveyed mothers of minority children perceived racial bias and cultural misunderstanding in their adolescents' care in emergency rooms. Though mothers of minority children did not necessarily feel as though their children received lower levels of care due to race, it is important to note how perceptions of bias and cultural misunderstandings affect minorities' perceptions of their child's healthcare.

Keywords: parent perspectives, racial bias, perceived bias, minority healthcare

REVIEW OF LITERATURE

Racial Disparities in Healthcare

Racial bias and disparities have been studied extensively over the years, and perceptions of bias have been reported by Black patients as recently as 2018 (Gonzalez et al.). These disparities are not fully explained by differences in access, clinical appropriateness, or patient preferences (Johnson et al., 2004). This means that differences in the implementation of healthcare among ethnic minorities is tied to a broader systematic bias, economic inequality, and prejudice (Johnson et al., 2004). The findings of the 2018 National Healthcare Quality and Disparities Report noted the persistence of healthcare disparities, especially in poor and uninsured populations. This national survey, mandated by Congress, provided an overview of the quality of healthcare received by the U.S. population. Reported disparities in quality measures included: person-centered care, patient safety, healthy living, effective treatment, care coordination, and affordable care. Specifically, in 40% of healthcare quality measures, the report found that Blacks, American Indians and Alaska Natives, and Native Hawaiians/ Pacific Islanders received worse healthcare quality than Whites. Additionally, Hispanics had poorer healthcare than Whites in 35% of healthcare quality measures and Asians received poorer healthcare quality in 27% of measures. However, Asian populations reportedly had better care than Whites in 28% of healthcare quality measures (National Healthcare Quality and Disparities Report, 2018). The pervasiveness of this issue has caused divides in quality of health care, and it is important to continue discovering how to address and mend the issue.

In May of 2019, the *New York Times* published findings about racial disparities in pregnancy-related deaths in Black women versus white (Rabin, 2019). Results showed Black women are 3.3 times more likely to die of a pregnancy related death than White women. A factor in this statistic is the major cause of deaths: cardiovascular disease. Black women suffer disproportionately from cardiovascular disease. In order to prevent avoidable deaths, gaps, like differences in factors such as heart health, should be identified and assessed while any patient is under care (Rabin, 2019).

There have also been documented disparities in pain management among minority patients (Todd et al., 2000). Black patients, when compared to White, are given lower dosages of pain medication. It is thought that such disparities may be attributed to false beliefs physicians have about biological differences between White and Black patients (Hoffman et al., 2016). To analyze this further, Hoffman, Trawalter, Axt, and Oliver assessed physicians' beliefs about biological differences and the effects on treatment recommendations (2016). Participants in this study read medical scenarios of both White and Black patients and rated the patient's prospective pain level and made treatment recommendations. Additionally, participants took a survey assessing false beliefs about biological differences between Black and White individuals. For instance, one false belief statement was, "Blacks' nerve endings are less sensitive than Whites". About 50% of medical students and physicians rated at least one of these false statements as true or probably true. Individuals who had false beliefs rated a Black person's pain as lower and made less accurate treatment recommendations than

those who did not hold false beliefs about biological differences. This study determined that some individuals with medical knowledge may hold false beliefs about biological differences between races, and this could have an impact on healthcare treatment of minority patients (Hoffman et al., 2016).

Perceived Bias in Healthcare

Additional studies, like that of Johnson et al. (2004), show disparities in the perception of healthcare of Black patients in comparison to White patients. Researchers surveyed 6,000 adults and asked questions like, “Do you believe your medical care would have been better if you were a different race?” The results showed that a statistically significant percentage of African Americans believed that they would receive better health care if they were a different race and that medical staff judged them based on their race. African Americans reported having lower levels of respect for their provider and less time spent with the provider than White patients (Johnson et al., 2004). Additionally, in a study conducted by Campesino, Saenz, Choi, and Krouse, 56% of African Americans disagreed with the statement, “Most people in the United States receive the same quality of healthcare regardless of their racial background or language spoken” (2012). In qualitative interviews, 36% of those interviewed perceived discrimination in quality of health care due to race or ethnicity, Spanish language, skin color, citizenship status, or having low income.

A 2018 study interviewed 74 participants with an interview guide that focused on racial and ethnic bias (Gonzalez, Deno, Kintzer, Marantz, Lypson, & Mckee). In their findings, some participants who perceived bias had lower levels of trust in their provider and delayed seeking future medical care. However, the researchers concluded that some instances of perceived bias could still lead to positive outcomes. This depended on whether or not the physician acknowledged the bias and made subsequent behavioral changes. Differences in healthcare implementation might be remedied by an increase in cultural competence. This is accomplished when a healthcare provider adjusts and recognizes the differences in order to better understand the culture of the patient (Johnson et al., 2004).

Racial and Ethnic Disparities in Pediatric Health and Healthcare

Flores reviewed literature over a 57-year period and noted the persistence of disparities in the healthcare of children (Flores, 2010). The review noted disparities in the healthcare of children related to mortality rates, access to care and use of services, prevention and population health, chronic diseases, special healthcare needs, and quality of care. Racial and ethnic minorities had a greater risk of death from drowning, acute lymphoblastic leukemia, and after congenital heart defect surgery than White children. This review of literature reveals the historic pervasiveness and persistence of racial and ethnic disparities in the health and healthcare of minority children (Flores, 2010). Gerber and others, in their study of the prescription of antibiotics, added to the evidence of the racial differences in the medical treatment of children (Gerber et al., 2013). The study provided strong statistical evidence for the disparity in pediatric prescriptions and diagnoses of certain illnesses in Black children versus non-Black children. Specifically, their results concluded that Black children were less likely to

receive a prescription for antibiotics, namely broad-spectrum, than non-Black children even when a prescription of antibiotics was justified (Gerber et al., 2013).

In addition to disparities in the prescription of antibiotics, there has been documented evidence for racial disparities in pain management (Todd et al., 2000). A 2015 study conducted by Goyal et al. reported evidence of racial disparity in pain management in children as well. This study analyzed a national sample of visits to the emergency department for associations between race and prescription of nonopioid and opioid analgesic medication among pediatric patients. Black patients with moderate pain were less likely to receive any analgesia when compared to White patients (15.7% versus 58.5%), and Black patients with severe pain were 34% less likely to receive opioids than White patients. Additionally, Black children with appendicitis had one fifth the odds of receiving a prescription for opioids than White children. The researchers made note that the rate of opioid prescription among children with appendicitis is typically low, but the results of this study showed evidence of racial disparity among children who received opioid analgesia. Over the seven-year period of data analysis, racial disparities in opioid prescription persisted (Goyal et al., 2015).

A current study of pediatric healthcare revealed the persistence of disparities in the care of children in the emergency department (Zhang et al., 2019). Researchers analyzed data from the National Hospital Ambulatory Medical Survey (NHAMCS) in order to investigate racial and ethnic disparities in the health outcomes of children. The study estimated the association of the Emergency Severity Index (ESI) and race. The ESI scale categorizes patients on a scale of 1 to 5 with 1 being the most urgent and 5 being the least urgent. The data showed disparities among the treatment of minorities regarding factors such as wait times, ESI score, and medical resource utilization. Hispanic and Black children had significantly longer wait times in the ED compared to White children as well as longer visit times. Black and Hispanic children were less likely than Whites to be classified as needing immediate or urgent care, and this was not fully explained by demographic, socioeconomic, or clinical variables. Additionally, Black, Hispanic, and Asian children were significantly less likely than Whites to receive blood tests, X-rays, and CT scans. Disparities in pediatric ED care persisted over the study period for Black and Hispanic patients and not for White and Asian children (Zhang et al., 2019).

A study conducted by Stockwell et al. (2019) assessed the association of the race and insurance status of pediatric patients and the severity of adverse events (AEs). Adverse events include any incident that results in harm to a patient and range in severity from mild to severe. The researchers concluded that Latino children showed a significant difference in adverse events, including preventable and high severity, when compared to White patients. Additionally, children with public insurance had significantly higher AEs than privately insured children. These findings are evidence of how socioeconomic status and race might affect healthcare outcomes in children (Stockwell et al., 2019).

Flores surveyed parents by telephone in order to assess the health and healthcare quality of children (2005). Minority parents were less likely to report their child as having

“excellent” or “very good” health. For instance, 90% of White parents gave ratings of “good” or “excellent” when asked about their child’s health. Black and Hispanic parents gave high health ratings only 79% and 72% of the time, respectively. White children were more likely to have “well” visits in private or group practices, whereas minority children were more likely to receive care in health centers or public clinics with an assigned provider. Additionally, minority parents, more so than White parents, reported their child’s healthcare provider “never” or “only sometimes” respected them as the expert on the child. This study’s results also identified concerns with healthcare providers contributing to the stereotyping of minorities. This concern was evidenced in that minority parents were three times more likely than White parents to report instances where their provider discussed things such as, community violence, household smoking, household use of alcohol or illicit drugs, and paying for the child’s basic needs. This “over-discussion” and conscious or unconscious stereotyping raises concerns about minorities interpreting these interactions with their child’s provider as discriminatory. This may lead to lower satisfaction in care and negatively affect communication between the patient and provider (Flores, 2005). Though this study noted no disparities in some areas such as overall ratings of the well- care provider, there were disparities in the overall health of minority children. Specifically, Black children were two times as likely to not be in “excellent” or “very good” health compared to White children (Flores, 2005).

Implicit Bias in Healthcare

In other studies, there have been recorded instances of bias from the physician’s perspective. Green et al. used the established Implicit-Association Test (IAT) to measure implicit bias of 220 internal medicine and emergency medicine residents in Boston, Massachusetts, and Atlanta, Georgia (2007). Though there were no significant findings of explicit or self-reported bias among physicians, there were significant findings of implicit, or unconscious, biases. In such cases of high levels of implicit bias, there were differences in the likelihood of the physician to offer thrombolysis. This study acknowledges that implicit bias might not lead to explicit racism but could lead to a portion of health care disparities (Gerber et al., 2007).

Wisniewski and Walker assessed implicit bias of race and ethnicity and its association in the scheduling practices of primary care appointments (2020). Seven females of different racial or ethnic backgrounds called primary care offices in order to schedule the next available appointment after introducing themselves with their name. White patients were asked about their insurance status 38.5% of the time whereas Black patients were asked 80.9% of the time. To eliminate variability, all of the patient callers were uninsured. Questions about status of insurance were asked by the offices most often and had the highest rates of racial and ethnic disparity. Disparity was associated with race and ethnicity and was not affected by location of the primary care office or type of healthcare provided. There was no disparity in amount of offered appointments. However, Black and Hispanic patients received later appointments than White callers. The researchers concluded that discrimination

against minorities may result in disparities with minorities' access to healthcare (Wisniewski & Walker, 2020). It is important, then, to further research how implicit biases and discrimination against minorities affects the implementation and equality of healthcare among minority populations.

In addition to recorded disparities in the healthcare of children, there has also been evidence of the association of implicit bias among physicians and the prescription of pain medication to children (Sabin & Greenwald, 2012). Implicit biases are biases against an individual that occur outside the conscious awareness and may subtly affect behavior. Sabin and Greenwald studied the association of physicians' implicit biases and treatment recommendations for children with conditions of asthma, attention deficit hyperactivity disorder (ADHD), urinary tract infections (UTI), and pain (2012). Doctors who scored highly on the IAT and had more pro-White implicit bias were more likely to prescribe pain medication to White pediatric patients than to Black patients (Sabin & Greenwald, 2012). This study provides evidence of how implicit bias and unconscious attitudes of healthcare providers affects the healthcare quality of Black children.

The US Census Bureau projects that by the year 2030 there will be more minority children than non-Hispanic White children (US Census Bureau, 1996). Therefore, it is important to further analyze and study the healthcare disparities that currently exist in the healthcare of minority children today. Many studies of racial differences in healthcare focus on technical implementation of care including diagnostic tests, procedures, and prescriptions. However, healthcare is a complex combination of interpersonal processes that can lead to perceptions of bias and discrimination (Johnson et al., 2004). Qualitative studies have been published discussing implicit bias in health care including incorporating patient perspectives. Though racial disparities in pediatric healthcare have been evidenced and reported, the review of literature found no qualitative studies discussing the parent perspectives and perceptions of racial bias in their child's healthcare in emergency departments. It is important to continue the pursuit of researching biases and racial disparities in healthcare until the issue is remedied.

METHODS

Participants

Participants involved in this study were selected through convenience sampling and were contacted through university mentors and professors. Of the 19 total participants, 16 visited emergency rooms in Kankakee, Illinois, but two participants were located in Greenville, South Carolina and one in Franklin, Tennessee. One participant currently located in Greenville, South Carolina also discussed an emergency room visit while living in Arlington, Texas. Participants included ten mothers of minority children of Black, Asian, and Hispanic race. However, three of these mothers were White with minority children. The comparative population of participants included nine White mothers of White children. Each mother was interviewed about her child's most recent emergency room visit. The age of children at the time of the emergency room

visit ranged from eight months to fifteen years. The reasons for the emergency room visits varied by participant and included instances of high fever, sutures, asthma complications, and burns. Before the analysis and coding of participant transcripts, each participant was assigned a pseudonym to protect their identity.

Materials

Materials included a semi-structured interview guide (see Appendix 1) that was modified from Gonzalez, Deno, Kintzer, Marantz, Lypson, & McKee's focus group interview guide (2018) and Campesino, Saenz, Choi, and Krouse's seventeen-item interview guide (2012). Views on perceived discrimination in healthcare and life in the United States were assessed using two questions from the Commonwealth Fund's Health Quality Survey (2001).

Procedure

Four face-to-face interviews were conducted at Second Baptist Church in Kankakee, Illinois, and Olivet Nazarene University in Bourbonnais, Illinois. Before starting the interview, participants gave written and verbal informed consent, and each participant agreed voluntarily. The audio from the interviews were recorded electronically and transcribed using the professional service, Scribie. Fifteen interviews were conducted over the phone, and consent was obtained verbally. Calls were recorded using the app "Rev Call Recorder," and participants were made aware that the call was recorded for the purpose of data analysis. Interviews ranged in length from ten to fifteen minutes.

Analysis

Saldaña's qualitative in-vivo analysis method was employed in primary readings of transcripts (2016). Specific phrases spoken by respondents were used as tentative codes or themes. The first categories created were kept tentative throughout the first and second cycle of data analysis because some categories were not the most accurate representation of themes present in all of the data. As described by Thomas, further analyses of transcripts followed the general inductive method which was characterized by a second detailed reading of interview transcripts in order to further categorize concepts and themes present in the data (2006). In the second cycle of coding, excerpts were assigned to predominant, existing codes. The themes that were most significant or most frequently present in transcripts were finalized as codes. Numerical data included ratings of level of care and two survey questions about treatment of minorities in healthcare and general minority discrimination. The mean of participants' ratings was calculated and compared between minority and White participants.

Misunderstood Because of Race or Culture

Forty percent of mothers with minority children reported feeling that she or her child was misunderstood because of race or some aspect of culture. Similar reports were found in a study conducted by Campesino et al. (2012). Thirty-six percent of their minority participants clearly perceived discrimination in their healthcare due to race or ethnicity. Participants in the present study did not use the word 'discrimination' when describing their experiences. Additionally, all mothers of minority children who perceived misunderstanding by healthcare staff rated the level of care given to their

TABLE 1

Four themes and one sub-theme determined from the in-vivo coding method with example quotations.

Theme	Sub-theme	Example Quotation
Misunderstood Because of Race or Culture		“So, it was like, they (ER staff) just didn’t have the time, they just kind of shifted us to the side. I don’t know if it was because he was black or because he was just a big black guy, it’s a difference.”
	Assumption	“Assuming by someone’s, let me guess color, ‘cause I don’t know what else he could’ve went off of, what type of insurance they have is just not acceptable in this day and age. I just think it’s unprofessional to just assume, and I think everyone deserves good healthcare no matter what insurance you have.”
Familiarity with Emergency Room Staff		“I’m satisfied but I still always say because I worked there. I don’t want to call it ‘special treatment’ or ‘preferential treatment’, but it’s like when you go there, they would call you by your first name.”
Insurance		“He had state insurance and so working in the healthcare field myself, I know that kids of all ages, adults of all ages, don’t get the care that someone would necessarily get that has private insurance through work. So, I feel like they hold back on tests and they hold back on... It’s just kind of a quick fix because they know it’s the state paying for it, and I see them kind of more rushed than a child that would have good insurance.”
Privilege		“My kids are of different ethnicity, but I think that they received care as if they were privileged white, because they live in a privileged white home, and in a privileged white community.”

child highly. According to participants within this study, any assumption or cultural misunderstanding did not necessarily hinder the medical care given to their child. In contrast to minority participants, all nine mothers of White children stated that they had never felt misunderstood because of race during an ER visit.

Lisa, a Black mother of a Black child, took her 14-year-old son to the emergency room because he mistakenly took more than the prescribed dose of sleep-aid medication. In explaining the context of her son’s treatment by ER staff, Lisa explained that her child has a behavior disorder, is “intimidatingly” tall for his age, and was particularly verbal upon arrival to the ER. When asked if she or her child had ever been misunderstood by

hospital staff due to race or culture, she responded, “Yes, because of race and culture.” When asked to expand on this experience, Lisa added, “So, it was like, they (ER staff) just didn’t have the time, they just kind of shifted us to the side. I don’t know if it was because he was black or because he was just a big black guy, it’s a difference.”

Tracy, a White mother of an Asian son, also perceived misunderstanding by ER staff due to cultural differences. However, she felt as though her child’s care was excellent. The only misunderstanding she perceived was due to the way the ER nurses medically assessed her child. Tracy’s son visited the emergency room to receive sutures after sustaining a head injury. She explained that some healthcare visits are different for him because of his race. For instance, because he has slanted, almond shaped eyes, medical assessments can differ for him versus White patients. She explained:

So, as they were doing his neuro exam and assessing his eyes that day in the ER, they’re like, ‘Open your eyes,’ and he’s like, ‘They are, can’t you see that I’m Asian?’ So eighth grade freshman year, he’s like, ‘Do they not see that my eyes don’t open like everyone else’s?’

In this case she perceived a misunderstanding but did not indicate that this interaction between her son and the ER staff was negative. Later on, however, when asked if she felt like there could have been any improvement in her child’s ER assessment, she said, “I just think that overall, we need to do a better job in treating our culturally diverse patients as a whole. We need to do a better job at that.” In her opinion, it is important for healthcare providers to understand cultural differences in order to provide the same level of care to all patients.

Assumption

Two minority participants, when asked if they or their child had ever been misunderstood because of race, noted feeling like staff had made negative assumptions about them. Both mothers included references to the color of their skin when explaining their experience with perceived assumptions. In both cases, however, assumptions were directed towards the mother more so than the child. Karen, a Black mother of a Black child, took her child to the emergency room, and the doctor prescribed medication for nausea. However, the doctor mentioned that state insurance would not provide coverage for this medication. Karen became upset because she had private insurance and not a “medical card.” Karen commented further:

If a medication works better, then that’s the medication I want her on. Assuming by someone’s, let me guess color, ‘cause I don’t know what else he could’ve went off of, what type of insurance they have is just not acceptable in this day and age. I just think it’s unprofessional to just assume, and I think everyone deserves good healthcare no matter what insurance you have.

Another Black mother of a Black child, Cherie, is a registered nurse, and in one ER visit with her child, she felt as though the nursing staff assumed she was uneducated because of the way they talked to her. She remarked:

Oh, I know one time, think it was my daughter, my 13-year-old, had a muscle spasm in her neck and she couldn't move her neck and so she (the nurse) was talking to me and my husband as we... as if we was like uneducated black people, and so we sat, I sat there, he sat there, we just listened. And I said, 'Okay, now since you're saying that I do have education,' I said, 'As a matter fact I got more education than you. So, I think you need to talk to me like you would talk to a Caucasian woman.' And so, she never did come back in there. She sent somebody else in there.

Familiarity with Emergency Room Staff

Three participants with minority children (30%) were either staff members or known by staff at the emergency room where their child was seen. Each participant who reported familiarity with hospital staff expressed their hypothesis that this relationship could have changed their child's ER experience in some way. Each participant who reported a level of familiarity with hospital staff gave high ratings for the level of care their child received (ratings of 4 or 5). Tracy, a White mother of an Asian child remarked:

... and then going to a hospital system that I worked at for years and knew the staff. I think it probably would've been different if we didn't know any of the folks. I think that we probably would've had a different experience.

Upon clarification, however, Tracy did not think that her child's experience would have necessarily been negative if she had not known the staff.

When asked, "Do you think if something were different about your child that they would receive better care?", Linda, a Black mother of Black children responded:

I'm satisfied but I still always say because I worked there. I don't want to call it 'special treatment' or 'preferential treatment,' but it's like when you go there, they would call you by your first name.

Though some participants noted how relationships with staff effect level of care, such conclusions about preferential treatment cannot be made within the parameters of this study. It is important, though, to note that familiarity with ER staff factored into how these three minority participants perceived the level of care their child received.

Insurance

When asked about their specific child's healthcare or minority healthcare discrimination, 40% of minority participants noted insurance as a factor in healthcare treatment. A similar response was given by mothers of White children. Kelly, a White mother of Black children, spoke of her child's experience on Medicaid:

I had to take my son to the emergency room. It was on Christmas Eve. And we were on Medicaid and we were poor and all that stuff. So, with Medicaid in Texas, you can only go to a specific doctor and it was like on that or you had to go to the emergency room. But the doctor's was closed over Christmas Eve and Christmas and then it was a weekend, so it was closed for four or five days in a row, but my

son came down with pinkeye and I had to get treatment for him. And I remember walking out, and I heard one of the nurses saying, 'Are you kidding me? That baby's just here for a cold?' So, I mean that instance kind of was like... really? Come on.

In this case, the participant did note that her son received the care and treatment needed, and the staff member who voiced the negative comments about her son's visit was not providing direct care. After explaining this incident, she answered "no" when asked whether or not she or her child had been negatively judged in a visit to the emergency room. In most of her past emergency room visits with her children, Kelly reported high levels of care, and the comment made about her son was a sole incident. However, experiences like Kelly's shed light on negative assumptions that occur in emergency rooms today, even if such incidences might not occur the majority of the time.

Three (33%) of mothers of White children also noted insurance as a barrier to healthcare, either in their child's or in the United States as a whole. Angela, a White mother, reported having difficulty in seeking care for herself and her children while on Medicaid. Her experience working in doctors' offices and hospitals has exposed her to instances when types insurance can affect the level of care provided to patients. When asked, "Do you think that if something were different about your child, that they would have received better care during that visit?" she replied:

Possibly. He had state insurance and so working in the healthcare field myself, I know that kids of all ages, adults of all ages, don't get the care that someone would necessarily get that has private insurance through work. So, I feel like they hold back on tests and they hold back on... It's just kind of a quick fix because they know it's the state paying for it, and I see them kind of more rushed than a child that would have good insurance.

Though types of insurance were not the original question of the present study, both minority and White participants perceived it as a factor in the level of care received. For some mothers, like Angela, there was a perceived difference in the quality of healthcare their child received based on having state insurance versus private insurance.

Privilege

One mother of a minority child (10%) perceived privilege due to race as a factor in the level of care her child received. In her case, she is a White mother of two Asian children. In explaining her perceptions of care in emergency rooms she said, "My kids are of different ethnicity, but I think that they received care as if they were privileged white, because they live in a privileged white home, and in a privileged white community." Four mothers of White children (44%) addressed their perceptions of privilege in the healthcare of themselves and their children. Each of which perceived benefit to her own healthcare as well as her child's due to their race. For instance, Emily, a White mother remarked:

My primary care provider is a Caucasian female, and all my midwives were Caucasian females, so there's a shared commonality there, and I do think it makes a difference. But having said that, I've also been seen by an Indian doctor and had a great relationship with her. But I do think the system probably favors, yeah, Caucasian people. And I have the education and information to know like... I have a medical bill right now from my son's birth that I'm gonna call and dispute, because we were charged for an out-of-network doctor when he was born, and we didn't have the option to say whether we wanted an in-network or an out-of-network doctor, and because I'm a white woman, I feel like that, I don't know, I'm listened to more probably.

Mothers who reported racial privilege noted that their race might have been a factor in the level of care their child received.

Level of Care

Mothers rated the level of care of their child's emergency room visit from 1 to 5, with 5 being the greatest level of care possible. Results are tabulated in Table 2. Mothers of minority children, on average, rated level of care 4.5 with a mean variance of 0.24. Mothers of white children rated a lower level of care with a mean of 4.17; however, this mean varied by 1, whereas mothers of minority children were more consistent with level of care ratings. The lower score given by mothers of white children may be attributed by a mother who gave a rating of 2, which was an outlier. This mother gave a lower rating because she felt as though the emergency room was not equipped to handle pediatric emergencies. The mother and child waited a "really, really long time to get in" and after three and a half hours, they left the hospital because her child's fever was reduced with Tylenol. The participant described her experience by saying:

"They're just not set up for children... it felt like they were just understaffed and there was no urgency to the matter." Forty percent of mothers with minority children did not give a rating of five, however, those who did not give a score of 4. Mothers of minority children who did not give a care rating of 5, described various reasons for doing so.

One participant attributed the lower score to long ER wait times. Another participant gave a rating of 4 because the ER visit was the best for "what they're able to provide" for pediatric emergencies. Difference in level of care cannot necessarily be attributed to race because none of the minority participants mentioned race or ethnicity as the reason for rating their child's level of care lower than a 5.

TABLE 2

Comparison of mean values and mean variance for level of care, perceptions of healthcare equality, and perceptions of minority discrimination.

	Mean Value Mothers of Minority Children (n = 10) (± Mean Variance)	Mean Value Mothers of White Children (n = 9) (± Mean Variance)
Level of Care (out of 5, 5 being the highest)	4.5 ± 0.24	4.17 ± 1
“Most people in the United States receive the same quality of healthcare regardless of their racial background or language spoken.” (1 = strongly agree to 4 =strongly disagree)	3 ± 1	2.56 ± 0.91
“How much discrimination against minorities do you feel there is in the United States today?” (1 = none to 4 = a lot)	3.3 ± 0.21	2.78 ± 0.78

Perceived Healthcare Discrimination

Though 60% of the participants with minority children have never felt their child was treated differently because of race, 70% either disagreed or strongly disagreed (ratings of 3 or 4) with the statement, “Most people in the United States receive the same quality of health care regardless of their racial background or language spoken.” These data are also tabulated in Table 2.

Within this study, participants recognized racial or ethnic disparities within healthcare, even if their own experience did not reflect any negative treatment. In Campesino’s study of Latina and Black women who had been treated for breast cancer, 46% of women felt healthcare quality differed due to an individual’s spoken language or racial background (Campesino et al., 2012). Similar to the present study, participants in Campesino’s study referenced general healthcare discrimination even if they had not perceived racial discrimination in their own healthcare experience. Within Campesino’s study, Spanish-speaking Latinas gave a mean score of 2, Black women gave a mean score of 2.56, and English-speaking Latinas gave a mean score of 2.6. Within this present study, mothers of minority children gave a mean score of 3 with a variance of 1. Participants with White children gave similar scores to Campesino’s minority participants. When asked about healthcare discrimination, White participants of the present study gave a mean score of 2.56 with the mean varying by 0.91.

Three participants with minority children (30%) gave ratings of 2 when asked about equality of healthcare among minority participants. In their explanations, participants clarified the score as a ‘middle’ rating and did not agree with the statement that all individuals receive the same level of health care.

Seven (78%) mothers of White children reported that not all healthcare treatment is equal for individuals of minority racial background or non-English speakers. When asked to expand on ratings given, participants responded in a variety of ways. Lisa, a mother of Black children remarked, “They might treat you different if you’re Hispanic, they might treat you different if you’re African-American, they might treat you different if you’re a Jew; just different things.” When Emily, a White mother of a White child, rated the survey statement a 4, she gave this reason:

I’ve had no issues with my providers. I always felt that they listened to me. I had confidence in them, but I know for African American women and Latin American women in the United States, I think they have... Their mortality rate in childbirth is like three or four times higher than that of Caucasian women. And it’s interesting, like they’re... When they express pain or symptoms that they’re having, like doctors tend to downplay their level of pain and the kind of toxic racism that they experience impacts their maternal well-being. So that’s kind of a personal... On a personal note, just because I am privileged to have had the experience I have because of my ethnic background.

Five mothers of White children (56%) mentioned language as a barrier and one mother of a minority child (10%) specifically addressed language as a factor in healthcare discrimination. When asked to rate the statement, Marissa, a White mother of a Hispanic child, noted language as a barrier more so than race. She gave a rating of 2 for the assessment of healthcare discrimination and commented on the lack of Spanish-speaking medical providers in Kankakee, Illinois. She said, “I think I would probably say that’s due more to maybe not ethnicity but just language.”

Marissa, though she does speak Spanish and has Hispanic children, has never perceived discrimination due to language or racial factors. Perceived bias due to language goes beyond the scope of this study. This study’s sample does not reflect perceived racial bias due to language barriers, and thus, no conclusions about such discrimination can be made.

Perceived General Discrimination

Perceived general discrimination was measured by asking each participant, “How much discrimination against minorities do you feel there is in the United States today?” All mothers of minority children (100%) gave a rating of 3 or 4, when a rating of 4 meant “a lot.” The mean ratings given by mothers are recorded in Table 2. One mother of a Black child reported, “a lot of how we treat people in this country is still based upon how they look.” One participant, a White woman with Black children, referenced minority representation when asked this survey question. Her daughter, when watching the Macy’s Thanksgiving Day parade, said, “Why are there no brown people

like me dancing?” Her mother did not know how to answer why there was not more diversity represented.

In Campesino et al.’s study of 39 minority women, 77% reported perceiving bias against minorities in the United States today (2012). The present study’s minority participants perceived general discrimination at a higher rate. However, this difference cannot be necessarily attributed to higher levels of perceived bias due to the difference in sample size (n=10 versus n=39).

Of the other White participants with White children, four (46%) gave lower ratings of perceived minority discrimination (1 or 2). Such ratings were accompanied with statements like, “I feel like it has blown highly out of portion. I would honestly say that I believe it would be more along the lines of a two.”

One mother of a White child reported “some” discrimination in the United States today but remarked:

I think a lot of people like to stir up the race card and use that to their advantage, if they feel like they don't get what they want. But in general, I think that everyone in an employee standpoint, is taught to treat people respectfully and if they're not, then that's their own ... personal choice.

However, five mothers of White children (56%) perceived higher levels (ratings of 3 or 4) of minority discrimination in the United States today. When asked to expand on answers, two mothers of White children noted that levels of discrimination vary based on location. Both of these participants compared their experiences in larger cities in the United States to their current location, Kankakee, Illinois. In larger cities, they perceived lower levels of minority discrimination, but higher rates in Kankakee. One mother described Kankakee County as more rural and less diverse. She remarked:

Yeah, when I first moved out here, 'cause I grew up multi-cultural. I was the minority where I grew up in, very Asian-populated, Indian-populated. I was probably in the 17th percentile of Whites in my school I went to. So, when I first moved out here, went to a library, one of the librarians said, “Oh, those illegals” and I was like, “Whoa!” Or they used the terms “Oriental.” Those are not professionally appropriate words to use, ever. Those would just be very derogatory comments.

Overall, within this study’s sample, general minority discrimination was reported at different rates between minority participants and White participants. White mothers of White children perceived, on average, lower levels of general discrimination than mothers of minority children.

CONCLUSION

Some surveyed mothers of minority children perceived racial bias and cultural misunderstanding in their adolescents' care in emergency rooms, and this study highlights the importance of qualitative research that gives voices to participants and their experiences. Though the majority of minority patients did not perceive low levels of care in their child's visit to the emergency room, it is important to consider those who have experienced racial bias, cultural misunderstandings, and racial differences in treatment. Their voices and experiences shed light on the negative assumptions that occur in healthcare, including pediatric care, today. Still, mothers of minority children rated levels of healthcare equality lower and general discrimination higher than White mothers despite them not having personally experienced mistreatment within their child's healthcare.

Though participants included mothers located in different geographical locations, this study is not representative of the United States in its entirety. As a result, these findings cannot be generalized to all minority and White populations. Additional limitations include possible differences in face-to-face interviews and phone interviews. The manner in which different interviews were conducted could have had an effect on responses, so future studies could be conducted solely face-to-face to control for variability.

This study focused on perceptions of racial bias in pediatric care, but both minority and White participants mentioned insurance as an influence in level of care provided in emergency room settings. Thus, future studies could explore perceived bias in healthcare as it pertains to types of insurance and whether perceptions differ between individuals of different races or ethnicities. Future studies could also include perceptions of children with special health care needs (CSHCN). Two minority participants had children with special healthcare needs, and both mothers noted feelings of nervousness when considering visiting emergency rooms due to their incapability to meet their child's healthcare needs. Language as a factor in healthcare discrimination could also be further investigated. Five mothers of White children identified language as a barrier, and one mothers of a minority child did so. However, language as a barrier in healthcare goes beyond the scope of this study, and thus, further conclusion cannot be made.

Though minority parents in this sample did not feel as though their child got lesser medical care due to race, it is important to note the instances of misunderstanding and assumption due to race. Their experiences and views on healthcare are important tools to guide necessary change among healthcare staff. For some of these mothers, their experience furthers the call for cultural and sensitivity training. Linda, a Black mother of Black children expressed:

I still think there are flaws in the healthcare system, and there is room for much improvement. But also, society does play a part in that, you know. When the kids present to the ER, along with their parents, of course parents are gonna be upset,

it's their child, but I think the ER staff, they all need to be educated in mental health, as well as cultural competency, because all cultures are going to be different. And then I think with them having some type of education it kind of takes away some of the biases and the stereotypes.

Further studies could be conducted on methods in which to reduce racial bias in health-care and how cultural misunderstandings can be effectively reduced. Though level of care was rated highly by all minority mothers, their views on healthcare were still impacted by perceptions of racial and cultural misunderstanding. Though this sample is not representative of the entire United States, the participant's experiences are crucial for recognizing racial bias and cultural misunderstanding in pediatric healthcare.

APPENDIX A Semi- Structured Interview Guide

Follow-up questions included, "tell me more about that," "what was that experience like," etc.

1. Can you describe for me your children, age, why the child was in the ER (if you are comfortable with letting me know what they were treated for)?
2. Which emergency room where you in?
3. In thinking about your child's most recent visit to the emergency room, how would you rate the level of care your child received? (On a scale of 1 to 5 with 5 being the highest)
4. In thinking about the experiences your child had in the emergency rooms, have there been times when you felt your child was treated differently by doctors (and the other staff including nurses and receptionists)?
 - a. Can you describe what occurred for me?
5. Do you think if something were different about your child that they would get better care?
6. Have you ever felt that your child was negatively judged during a visit to the emergency room?
 - a. If so, what made you feel like your child was judged? Can you describe for the situation in which you felt that way?
 - b. How do you react when you feel like your child is negatively judged?

7. Do you think the emergency room doctors or nurses have ever misunderstood you and your child because of your race or ethnicity or something cultural about you?
8. How does your child's treatment by the emergency room staff impact your view of the healthcare system?
9. Do you have any suggestions on how we can address the differences of how children are negatively treated by emergency room staff?
10. How would you rate the following statement,
 - a. "Most people in the United States receive the same quality of health care regardless of their racial background or language spoken."
(1= strongly agree to 4= strongly disagree)
11. How would you rate the following question,
 - a. "How much discrimination against minorities do you feel there is in the United States today?" (1= none to 4= a lot)

REFERENCES

2018 National Healthcare Quality and Disparities Report. Rockville, MD: Agency for Healthcare Research and Quality; September 2019. AHRQ Pub. No. 19-0070-EF.

Camposino, M., Saenz, D. S., Choi, M., & Krouse, R. S. (2012). Perceived discrimination and ethnic identity among breast cancer survivors. *Oncology Nursing Forum*, 39(2), E91–E100. <https://doi.org/10.1188/12.ONF.E91-E100>

Commonwealth Fund. 2001 Health Quality Survey. 2001. Retrieved from <http://www.commonwealthfund.org/Content/Surveys/2001/2001-Health-Care-Quality-Survey.aspx>

Flores, G. (2005). Racial and ethnic disparities in early childhood health and health care. *Pediatrics*, 115(2), e183–e193. <https://doi.org/10.1542/peds.2004-1474>

Flores, G. (2010). Racial and ethnic disparities in the health and health care of children. *Pediatrics*, 125(4), e979–e1020. <https://doi.org/10.1542/peds.2010-0188>

Gerber, J. S., Prasad, P. A., Localio, A. R., Fiks, A. G., Grundmeier, R. W., Bell, ... & Zaoutis, T. E. (2013). Racial differences in antibiotic prescribing by primary care pediatricians. *Pediatrics*, 131(4), 677–684. doi:10.1542/peds.2012-2500

Gonzalez, C. M., Deno, M. L., Kintzer, E., Marantz, P. R., Lypson, M. L., & Mckee, D. (2018). Patient perspectives on racial and ethnic implicit bias in clinical encounters: Implications for curriculum development. *Patient Education and Counseling*, 101(9), 1669–1675. doi:10.1016/j.pec.2018.05.016

Goyal, M. K., Kuppermann, N., Cleary, S. D., Teach, S. J., & Chamberlain, J. M. (2015). Racial disparities in pain management of children with appendicitis in emergency departments. *JAMA Pediatrics*, 169(11), 996. <https://doi.org/10.1001/jamapediatrics.2015.1915>

Green, A. R., Carney, D. R., Pallin, D. J., Ngo, L. H., Raymond, K. L., Iezzoni, L. I., & Banaji, M. R. (2007). Implicit bias among physicians and its prediction of thrombolysis decisions for Black and White patients. *Journal of General Internal Medicine*, 22(9), 1231–1238. Doi:10.1007/s11606-007-0258-5

Hoffman, K. M., Trawalter, S., Axt, J. R., & Oliver, M. N. (2016). Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proceedings of the National Academy of Sciences*, 113(16), 4296–4301. <https://doi.org/10.1073/pnas.1516047113>

Johnson, R. L., Saha, S., Arbelaez, J. J., Beach, M. C., & Cooper, L. A. (2004). Racial and ethnic differences in patient perceptions of bias and cultural competence in health care. *Journal of General Internal Medicine*, 19(2), 101-110. doi:10.1111/j.1525-1497.2004.30262.x

Rabin, R. C. (2019, May 7). Huge racial disparities found in deaths linked to pregnancy. *The New York Times*.

Sabin, J. A., & Greenwald, A. G. (2012). The influence of implicit bias on treatment recommendations for 4 common pediatric conditions: pain, urinary tract infection, attention deficit hyperactivity disorder, and asthma. *American Journal of Public Health*, 102(5), 988–995. <https://doi.org/10.2105/AJPH.2011.300621>

Saldaña, Johnny. (2016). *The coding manual for qualitative researchers*. Los Angeles: SAGE.

Stockwell, D. C., Landrigan, C. P., Toomey, S. L., Westfall, M. Y., Liu, S., Parry, G., Coopersmith, A. S., & Schuster, M. A. (2019). Racial, ethnic, and socioeconomic disparities in patient safety events for hospitalized children. *Hospital Pediatrics*, 9(1), 1–5. <https://doi.org/10.1542/hpeds.2018-0131>

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, 27(2), 237–246. <https://doi.org/10.1177/1098214005283748>

Todd, K.H., Deaton, C., D’Adamo, A.P., Goe, L. (2000) Ethnicity and analgesic practice. *Annual Emergency Medicine* 35(1): 11–16.

US Census Bureau. Population projections of the United States by age, sex, race, and Hispanic origin: 1995 to 2050. Retrieved from www.census.gov/prod/1/pop/p25-1130/p251130.pdf

Wisniewski, J. M., & Walker, B. (2020). Association of simulated patient race/ethnicity with scheduling of primary care appointments. *JAMA Network Open*, 3(1), e1920010. <https://doi.org/10.1001/jamanetworkopen.2019.20010>

Zhang, X., Carabello, M., Hill, T., He, K., Friese, C. R., & Mahajan, P. (2019). Racial and ethnic disparities in emergency department care and health outcomes among children in the United States. *Frontiers in Pediatrics*, 7. <https://doi.org/10.3389/fped.2019.00525>



Barriers to Pregnancy Healthcare as Perceived by Hispanic Women in the Northern Midwest

Anna O. King

ACKNOWLEDGEMENTS

I would like to thank my mentor, Professor Cathy Dillinger for supporting and encouraging me throughout this process. Thank you Dr. Schurman for encouraging me, helping me create a project about which I am passionate and interested, and working with me through the process. Thank you to Dr. Sharda, Dr. Stipp, and Dr. Case along with the Honors faculty and Program for helping us find a place in our communities and world. Thank you to the Program for providing the funds and tools to conduct research. Thank you to the other honors students for their insight, support, and friendship. A big thank you to my translator and friend, Sam Lopez, and all the work she did with me on this project.

ABSTRACT

Background

This study explored the barriers to pregnancy health care experienced by Hispanic women. Research has shown that Hispanic patients are less likely to have adequate health insurance coverage compared to the white population in the United States and frequently face communication barriers in health care, as interpretive services are underutilized. These barriers may cause the Hispanic population to delay seeking health care and can lead to poor health outcomes. This is especially a problem in pregnancy health care, where prompt prenatal care is essential in ensuring a healthy pregnancy and positive health outcomes in both mother and baby.

Method

This was a qualitative study consisting of twelve Hispanic mothers from Illinois and Iowa with children ages eight months to 37 years old. Semi-structured focus group interviews were conducted using questions based off the Pregnancy Risk Assessment Monitoring System (PRAMS). Data was transcribed and coded manually using Microsoft Word and a descriptive coding process.

Results

Communication barriers emerged as the most significant among participants during pregnancy health care, as the majority utilized family or friend translators or their own understanding of English. Participants referenced not being provided sufficient patient education during health care, leading to inaccurate or inadequate information. Half of the participants mentioned that insurance impacted where they sought pregnancy health care, which occasionally delayed care.

Conclusion

Only one woman utilized interpretive services, and the others reported that they would have felt more comfortable if they were provided professional translation. The misinformation found in the data could be the result of miscommunication or lack of patient education during health care. Regardless of barriers reported, participants expressed satisfaction with health care.

Keywords: Hispanic, pregnancy health care, barriers, language, insurance, patient education.

LITERATURE REVIEW

Introduction

Health care providers are tasked with consistently providing attentive, empathetic, and quality care. Individualized patient care has the ability to directly influence health outcomes. Health care professionals have the responsibility of individualizing care and advocating for minority patients by providing translation services, ensuring the patient has access to appointments and pharmacies, and minimizing bias in health care. Blair et al. (2013) found that often in providing care for minority patients, nurses and physicians

overlook the barriers they face in accessing and utilizing health care. Providing individual, culturally competent care can increase patient satisfaction, which is often used as a measure of quality of care (Johansson, Oléni, & Fridlund, 2002).

The Hispanic population is a growing and often under-served minority population in the United States. First- and second-generation Hispanic patients tend to speak primarily Spanish and have limited access to insurance (Hawks et al., 2018). Studies show that Hispanic patients are less likely to have adequate insurance coverage, which often prevents them from receiving preventative and adequate health care (Cristancho, Garces, & Peters, 2008; Gresenz, Rogowski, & Escarce, 2009; Law & VanDerslice, 2011). Additionally, Hispanic patients frequently face communication barriers when interpretive services are unavailable or under-utilized, leading to confusion, poor health outcomes, and dissatisfaction in health care (Jacobs, Shepard, & Suaya, 2004; Nápoles et al., 2009). These disparities are especially pronounced in areas with low Hispanic populations and when patients are primarily Spanish-speaking or undocumented (Gresenz et al., 2009). Bias is one way in which patient-centered care and therapeutic interpersonal communication between healthcare providers and patients can be interrupted.

Implicit bias

Although bias should not affect how health care professionals interact with patients, research has found that both explicit and implicit bias does impact health care perception in minority populations. Studies show that health care providers are not likely to explicitly express bias towards minority patients (Blair et al., 2013). However, implicit bias typically presents in subtle and unrecognized ways, and for this reason can be hard to measure in a quantitative study. Even though health care providers strive for equal treatment for patients of all racial and ethnic backgrounds, bias is subconsciously endorsed (Chapman, Kaatz, & Carnes, 2013). Blair et al. (2013) conducted one of the first studies to evaluate implicit bias and communication in clinical relationships, using Implicit Association Tests (IAT) to measure physician bias against black and Hispanic minorities. The IAT tests implicit bias by measuring the time it takes for an individual to respond in a positive or negative way to a group. After obtaining data from 134 physicians in the Denver area, they found that although no physician reported explicit bias, the IAT found about two thirds of them to have implicit bias towards black and Hispanic patients (Blair et al., 2013). Blair et al. also administered a patient survey to 2,908 adults to compare to the IAT, finding that overall Hispanic and Latino patients report being less satisfied with health care providers, but these results did not correlate with implicit bias in physicians. More research needs to be conducted on how Hispanic patients perceive their health care.

Chapman et al. (2013) conducted a literature review to explore implicit bias in health care and the ways in which it affects health outcomes. This study found that the interaction between patient and physician is affected by implicit bias, and this often leads to patient nonadherence and decreases in follow-up care. Not only does implicit bias in health care affect the relationship with the patient, but it also affects health outcomes. Hispanic patients are significantly less likely to receive adequate pain management compared to white patients; even though the physicians reported being able to judge severity of pain regardless of ethnicity, they provided less analgesia to Hispanic patients than to white

patients with the same severity of injury (Chapman et al., 2013). This study also found that these racial disparities may lead to increases in morbidity. Bias is subconsciously endorsed in ways that negatively impact the patient's health outcomes.

Insurance

Although physician bias may play a role in the Hispanic patients' satisfaction with care received, it does not seem to be a primary barrier to accessing quality health care. Avila and Bramlett (2013) found that the most profound disparity to accessing adequate health care for the Hispanic population is lack of insurance. Cristancho et al. (2008) conducted a series of semi-structured focus groups with a total of 80 Hispanic adult participants in Illinois, finding that main barriers to accessing and utilizing health care include lack of health insurance, communication and transportation issues, and lack of documentation. Hispanic people are much less likely to be insured, especially if they are undocumented (Cristancho, et al., 2008). Avila and Bramlett (2013) utilized the National Survey of Children's Health (NSCH) to survey 91,642 adults through random-digit-dial and found that even Hispanic children who live in English-speaking households have lower health outcomes than white children. This could be partly because Hispanic people are less likely to be insured than their white counterparts.

Especially with Hispanics along the border and those without documentation, there is a complex relationship between socio-demographic factors and access to health care. A study conducted in El Paso County, Texas by Law and VanDerslice (2011) used the Behavioral Risk Factor Surveillance System (BRFSS) to survey 653 adults through random-digit dialing. The results of this study showed that 32% of Hispanics reported not being able to see a doctor because of cost, a percentage that is almost double that reported from non-Hispanics in the same region. Without insurance, a lot of the Hispanic population is unable to afford health care, which likely contributes to differences in health status between the racial groups. Employment status is the biggest determinant of insurance, with those who receive government-aided insurance policies such as Medicaid and retirement funds more likely to be adequately insured (Law & VanDerslice, 2011).

Communication and language

In order to provide high quality health care for their patients, health care providers must be able to adequately communicate. With patients in the United States for whom English is not their primary language, this entails providing professional medical interpreters or translation services, rather than relying on broken translations or family translators who lack training in medical translation. Hospitals are required to provide translations for consent forms and legal documentation, but often times these resources are underutilized in routine care and interaction with health care providers (Guo et al., 2018).

Hispanic patients may speak basic English or none at all, making it difficult to communicate with health care providers untrained in medical translation. Many Hispanic patients resort to bringing along a family member or friend as a translator to medical appointments, but this often leads to misinterpretations and omissions that could have serious clinical consequences (Cristancho, et al., 2008). Interpretation services are often unavailable or underutilized in health care. In all focus groups conducted, Cristancho et al. (2008) found communication issues listed as a main barrier encountered by Hispanic

patients when accessing and utilizing health care. Improper communication can often be interpreted as disinterest or disrespect to the patient, which is associated with a decrease in satisfaction (Cristancho et al., 2008; Nápoles et al., 2009). In these studies, participants reported physicians rushing through interactions, not taking the time to explain results or interventions, saying they are more satisfied when health care providers involve them in the process of deciding a course of action.

Studies have showed that interpretive services of any capacity improve patient satisfaction, and in turn, patient health outcomes. However, for Hispanic patients, especially those with subpar or no insurance, it can be costly. There is a significant increase in cost for health care for patients who utilize translation services, and typical insurances do not cover this cost (Jacobs et al., 2004). This could pay off, as patients who choose to pay for interpretive services on the front end typically spend less on health care in the long run. This study conducted by Jacobs et al. (2004) sampled a total of 4,499 adult patients separated into two groups enrolled in a health maintenance organization before and after interpreter services were implemented. They found that though interpretive services increased the immediate cost of health care, the patients who utilize translators receive more preventative services, physician visits, and prescription drugs, all of which could reduce cost of health care in the long term (Jacobs et al., 2004).

These studies all suggest that language and communication are primary barriers to adequate health care, and poor health outcomes can result from misinterpretations or inadequate translation services. These disparities are especially pronounced in rural communities, whereas living in areas with more Spanish speakers increases access to care (Cristancho et al., 2008; Gresenz et al., 2009). Hispanic people living in communities with a higher Hispanic population are less likely to experience barriers to receiving needed care. This could be the result of a greater availability of Spanish-speaking physicians or simply the social networks within the community that facilitate the transmission of information for which doctors and hospitals provide the most culturally competent care or who has bilingual staff (Gresenz et al., 2009).

Pregnancy health care in Hispanic women

Though several studies suggest that barriers such as bias, insurance, and language exist to providing health care in the Hispanic community, these studies have not focused specifically on how these barriers to healthcare manifest in the female Hispanic population. A study conducted by Butler, Kim-Godwin, and Fox (2008) began to explore the female demographic by conducting semi-structured interviews with eight Hispanic adult women in Bladen County, North Carolina. The participants of this qualitative study indicated that they often learned medical practices through traditions passed down through generations, asking the older generations for advice when needed. This is part of Hispanic culture but may also be due to the fact that many exclusively Spanish-speaking women have less access to healthcare and may be unable to afford primary care. Additionally, these women reported difficulty arranging and keeping appointments due to transportation issues (Butler et al., 2008). Interpreters were not always utilized, in which case one woman and her husband had difficulty explaining symptoms and understanding treatments described to them by the physician.

Women's health is important when exploring health care during and after pregnancy. A study conducted by Bromley, Nunes, and Phipps (2012) began to look at pregnancy care for Hispanic women through a retrospective cohort study with 9,906 participants using the Rhode Island Pregnancy Risk Assessment Monitoring System (PRAMS). They found that although Medicaid provides insurance to pregnant and postpartum women with low incomes, income still plays a significant role in the disparities to receiving prenatal care. Already Hispanic women are typically younger, less educated, and have lower insurance rates prior to pregnancy and are at risk of delayed or inadequate prenatal care (Bromley et al., 2012). Recently, there has been more research conducted regarding the barriers to pregnancy health care, but there is still much to learn.

Lack of education

Many Hispanic women, especially the undereducated, have not received adequate preconception education, which can lead to postponed prenatal care and poor health outcomes for mother and baby. Hawks, McGinn, Bernstein, and Tobin (2018) utilized data from the Pregnancy Risk Assessment Monitoring System (PRAMS), finding that Hispanic and black women have a higher rate of unintended pregnancies but not a lower rate of contraception use. They assume that Hispanic and black women either have less access to higher quality contraceptives because of cost or are less educated than their white counterparts on how to accurately use contraceptive devices (Hawks, et al., 2018). Hispanic women with insurance were more likely to receive preconception and prenatal care; however, frequently the insurance these women utilize is Medicaid, under which the rates of preterm and low birthweight rates are higher (Parekh, Jarlenski, & Kelley, 2018).

Pregnancy health care is imperative to proper prenatal nutrition and positive pregnancy outcomes. Unfortunately, Hispanic patients typically have below-basic health literacy compared to white patients and are less likely to receive adequate care throughout the pregnancy period (Guo et al., 2018). Guo's (2018) study conducted surveys and focus groups on 26 women in Orange County, California, finding that the participants were generally dissatisfied with the care they received postpartum. The women reported barriers to communication, including complicated medical jargon that went unexplained and doctors who were too rushed to answer questions and spend time with the patients. They reported bringing their children to help translate, as they were unable to understand the doctors and would have appreciated access to their health records to help them understand what was going on.

Recently more studies have been conducted to analyze the barriers Hispanic women face to obtaining pregnancy health care, but a research deficit still exists as to how Hispanic women perceive their own health care. Researchers can measure patient outcomes that correlate to barriers in health care, but if patients perceive a problem or disparity in their health care, then a problem exists somewhere in the system. Statistical data is important in measuring patient outcomes, but ultimately the best way to see the extent to which race impacts access to adequate health care is to ask the patients about their perceptions and experiences through qualitative research (Johansson et al., 2002).

Previous research shows that factors such as implicit bias, lack of transportation and insurance, and language barriers lead to disparities in health care in the Hispanic population. This research picks up where other studies left off to answer the question: how do Hispanic women in the northern Midwest perceive their pregnancy health care? This study seeks to answer this question through a qualitative approach by conducting focus group interviews with 12 Hispanic women throughout the northern Midwest.

METHODS

Participants

Participants included eight women from two towns in Illinois and four from Iowa. Participants were identified through the pastor of a local church, a compassion center, and a peer. The participants were mothers of children aged eight months to 37 years. Four of the mothers had their children outside of the United States the rest had their children between Iowa, Illinois, Georgia, and Wisconsin. One participant was native to the United States, whereas the rest were native to Mexico (five), Puerto Rico (three), Guatemala (one), Peru (one), and Honduras (one). See Table One for participants and the location of where they had their children.

Table 1
Participant Pseudonyms and The Location of Childbirth

Name	County
Adriana	Mexico
Anita	U.S.
Carla	U.S.
Carmen	Costa Rica & Peru
Eva	U.S.
Cynthia	U.S.
Andrea	U.S.
Brenda	Honduras
Sofia	U.S.
Rosa	Puerto Rico
Daniela	U.S.
Dariana	U.S.

Interviews

Data collection began upon approval from the Institutional Review Board. Participants signed a letter of informed consent before initiating the interviews, and participants were assigned pseudonyms. Focus groups were conducted in the participants’ primary language through translation and lasted from thirty minutes to one hour. Interviews were recorded and transcribed by the interviewer. Both the interviewer and translator were present in all interviews. Two focus groups were conducted in Illinois and two in

Iowa. Interviews were semi-structured and based off questions from the Pregnancy Risk Assessment Monitoring System (PRAMS). See Appendix A for the list of interview questions. All participants were rewarded a 10-dollar gift card for their participation.

Coding

The interviews were transcribed manually in English. Transcriptions were coded manually using Microsoft Word through the process of descriptive coding, with second-cycle coding as needed. There were a total of thirteen codes between the four focus groups. For example, the code “misinformation” included instances in which the participant expressed either inaccurate information or lack of information, such as “I just heard it was abnormal” and “I thought it was normal.”

RESULTS AND DISCUSSION

Below is a table detailing the codes encountered in the data, the number of times they appeared, and the number of participants by which they were cited.

Table 2
Codes and Code Frequency

Code	Number of Citations	Number of Participants
Misinformation	5	4
Education*	5	3
Educational Resources*	8	4
Satisfaction: Provider Relationship	24	9
Satisfaction: Bad Experience	7	6
Insurance	18	11
Transportation	15	8
Translation Services and Translators	26	10
Family and Friend Translators	9	4
Frustrated/Intimidated	6	5
Pre-conception Care	6	2
Breastfeeding	4	2
Domestic Abuse	3	1

**Secondary Codes*

Misinformation

The code “misinformation” was mentioned five times between four participants who reported instances of lack of patient education or inaccurate information that occurred during the prenatal and postpartum periods. Anita was experiencing complications during her prenatal period, including hyperemesis, saying, “For three months I was just throwing up and throwing up. Everything made me sick.” When asked if she received medical attention for this condition she responded, “I didn’t tell my doctor because I thought it was normal. My doctor just told me I was decreasing in weight rather than

increasing and I needed to do something about that.” Similarly, Carla was discussing her prenatal care and mentioned a risk for miscarriage. She said she was not educated as to why she was at risk for miscarriage or on bed rest, stating, “I rested a lot, but they didn’t tell me why.” Another participant, Adriana, was told of an abnormal pap smear during her pregnancy but nobody followed up or explained what that meant she just “heard it was abnormal.” These women all experienced a complication to their pregnancy but were not informed of the extent of their condition.

One postpartum story of misinformation came from Adriana. She had a large birth weight child and gave birth vaginally, after which she recalled, “I had some bleeding, so they had to like every half an hour try to push my stomach all the way through to make it stronger or something, I don’t know.” Health care providers in the postpartum unit provide fundal massage and examinations to decrease the risk of hemorrhage, which is what Adriana is describing here. Adriana was unaware of the rationale behind this procedure and even listed it as a reason to avoid postpartum check-ups, saying “So I think I just didn’t want to go... I didn’t want to deal with that for a while.” Hispanic women typically have below-basic health literacy and report being dissatisfied with postpartum care, which can be related to medical jargon or just inadequate education from health care providers. Guo et al. (2018) found similar results, that Hispanic women could not understand medical terminology, even when translated to Spanish, often saying that the doctor did not take the time to explain things to them.

In another instance, Carla and Carmen were discussing misinformation regarding prenatal nutritional needs and their pregnancy eating habits. Carmen stated “At that time they say, ‘You have to eat double for you and the baby,’” whereas Carla responded that her doctor said, “You’re not eating for two, just add enough calories to make sure the baby has enough to sustain itself.” This discrepancy between misinformation and accurate information could be due to the country of pregnancy care, Carmen having her children in Costa Rica and Peru, and Carla in the United States, or the fact that Carmen had her children about thirty years before Carla did. Another difference between the participants who had their children in the United States and those who gave birth in Latin America was noted in Rosa from Puerto Rico. Rosa had a unique case during pregnancy, as she had been fighting breast cancer when she got pregnant. She emphasized a close relationship with the health care providers during her pregnancy wherein they provided a lot of patient education, saying, “They always explained everything really well.”

Education

Misinformation can come from lack of appropriate guidance from health care providers, inaccurate information from secondary sources, or lack of education. A large part of health care is patient education, which should be present throughout the duration of care. A secondary code from the code misinformation is “education,” referring to the education received specifically from health care providers, or the lack of education provided in the health care setting for these women.

When specifically asked about patient education, the code “education” was referenced five times by three participants. When asked about preparedness for the first birth and

taking care of a newborn, Adriana stated that she was not ready and the conception of their first child was much earlier than they had planned, as she and her husband did not use contraceptives. She said they were aware of contraceptives but “didn’t really pay attention to it.” Hispanic women tend to receive less education on contraceptive use, with statistically higher rates of unintended pregnancies compared to other races with the same rates of contraceptive use (Hawks, et al., 2018). The rate of contraceptive use is lower in under developed countries, in part because of lack of education and resources, which could explain why Adrianna, who had her children in Mexico, did not utilize contraceptive devices (de Vargas Nunes Coll, Ewerling, Hellwig, & de Barros 2019).

Comparing the code “education” referenced in participants who had their children in the United States to those who had their children in Latin America, it seems that those in Latin America received less prenatal education than those in the United States. Various studies indicate that women in Latin America are not receiving adequate education regarding women’s health, but little research exists to examine the quality of patient education these women receive prenatally or in the hospital (Dongarwar & Salihu, 2019; Liebermann et al., 2018). Carmen referenced lack of education regarding prenatal care during a conversation about prenatal education, saying, “I didn’t have much education,” and later saying she only got basic information about how to take care of a baby. Differing slightly, Adriana said the nurses after her first child “gave me information about vaccines, milk, attention for mothers” but did not follow up with education after the second child. Carla recounted her experience with the doctor in Georgia: “Dr. Johnson was very thorough with everything and I was very well educated on what needed to be done,” and Cynthia said in reference to prenatal vitamins and education “usually when you go to normal check-ups, the nurses and people in charge explain to you what the vitamins are for.” These examples could indicate a difference between the education received in the hospital from women having their children in Latin America and Hispanic women having children in the United States.

Educational resources

There is more than one way for patients to learn about pregnancy, the birth process, and postpartum care. Various educational resources exist for patients to learn about their health outside of the health care settings, which can be especially beneficial for patients to receive education in their primary language. Another secondary code to misinformation was “educational resources,” which references the additional resources the participants utilized during their pregnancy health care experience.

Some health care providers may not be providing adequate information or education for Hispanic patients before, during, and after pregnancy, but there are more resources to educate women during the pregnancy and birth process than just health care providers. Carmen described this, saying, “I did have my doctors and it was all just general information. It’s not just what my doctor said but also what my mom and other family members said that helped me throughout my pregnancy because all the doctor’s information was very general.” People in Hispanic cultures tend to support each other and rely on familial and community help, sharing helpful information with each other (Gresenz et al., 2009). This was evident in the data, as the code “educational

resources” appeared eight times among four participants. Carmen mentioned multiple times relying on the information her mother provided when navigating pregnancy through statements like, “my main nutrition education came from my mom,” “the only care I received was from my mom,” and “my mom was the book” in reference to a conversation about books, classes, and videos provided to Carla throughout her pregnancy. Cynthia echoed this in another interview: “A lot of times too when you are around people, your friends, they start talking, so part of [education] is society.” However, this could lead to inaccurate information, such as it did in Anita’s case with hyperemesis. She was told by her mother that throwing up during pregnancy was normal, and nobody told her otherwise, so she delayed care when she was going through that experience.

Other participants mentioned utilizing books and video resources, which Carmen referenced as a newer form of education. Carla and Cynthia have children who are under 15, whereas Carmen has children over 30, so it is possible that these discrepancies are due generational differences and the evolution of media. Carla mentioned feeling alone with her husband after moving and switching doctors and turning to other resources for prenatal education, stating, “We didn’t have a lot of outside help, and I think that’s why we looked for those resources and that’s why we did all the books and videos and all that stuff.” Cynthia also spoke about receiving books during her pregnancy about prenatal care and what to expect during pregnancy and after and reported that she “usually got more information from the book than anything else.”

Satisfaction: Provider relationship

“Satisfaction” as a code was mentioned 24 times between nine women and included instances where the women were satisfied with their health care providers and when they were not. Carla started her pregnancy health care in Georgia at a clinic and had a good OB/GYN there. She mentioned in her interview five times that she was very satisfied with her doctor in Georgia. Examples of this include, “The prenatal care I had when I was in Georgia was phenomenal,” and “I had a lot of support from her and it made me feel a lot more confident.” When she moved to Illinois, she stayed in contact with her doctor in Georgia for the duration of her pregnancy, since she was “not confident with the OB here.” She recounted a story from one of her friend’s that was parallel to how she felt with an OB in Illinois. Her friend said to her, “My doctor does nothing. She just goes, checks, makes sure the baby’s fine, and on your way.” When women feel that their doctor is rushed, they may feel more intimidated to ask for education or clarification. In contrast, Carla felt as though she could discuss anything with her doctor, which increased her confidence in caring for herself during pregnancy and her child.

Other participants echoed Carla’s experience in Georgia. Cynthia said, “Everything was good. I had good experiences with the doctors and nurses,” and Sofia said, “I thought it was good because they always ask if you’re in pain and help you get into a more comfortable position if you needed it.” Rosa stated that she “thought it was good, obviously I had a unique case because I was always in the hospital,” meaning she already had a relationship with health care providers in the area because she spent a lot

of time in the health care system while battling breast cancer. Anita had children at two separate hospitals and discussed the satisfaction she felt after having children in both, saying she felt better at one hospital than the other.

Daniela noted a difference between experiences at different hospitals, but overall said, “they were very good, yes, I had a good experience.” The participants generally responded with a better relationship with their nurses than their primary providers and physicians, saying the care the nurses provided was more personal than the doctor’s. Anita said, “The nurses are a bit more involved. The doctor just comes, checks in, and leaves,” which was a sentiment echoed in several other participants. Adriana said she “felt like I received more personal attention from the nurses” and “The doctor was worried with other things... I felt more of a relationship with the nurse.” Additionally, Brenda stated that “the nurse is the one who does the hard job.” Dariana even mentioned that the nurse working during her second birth helped name her daughter. Participants in a study conducted Cristancho et al. (2008) expressed similar dissatisfaction with doctors in the United States, saying that the doctors did not care about the patient relationship or take time to educate the patient during care. As medicine advances, the physician-patient relationship loses emphasis, and patients are left with shallow interactions and less focus on their individual needs (Aoun, Al Hayek, & El Jabbour, 2018). In turn, nurses and other health care staff often provide this relationship for the patient.

Participants generally reported satisfaction with those involved in their pregnancy health care. A few of the women who had their children in other countries and have received care in the United States talked about feeling better cared for in the United States than in their home country. Dariana said, “I felt like I got better attention and care than in Puerto Rico.” Sofia said, “I got better care in the United States than in Guatemala,” and Brenda from Honduras said, “It’s totally different in every aspect. There, people die in the hall waiting a long time.” Even if the primary language is different and communication is impaired in the United States with these Hispanic women, they felt like the care they received was higher quality.

Satisfaction: Bad experience

Though most participants expressed satisfaction with health care providers, there were five participants who shared a bad experience with health care providers during their prenatal and delivery periods. Carmen shared a story from Peru with a night shift nurse, saying, “after my c-section, the nurse was sleeping during the night shift.” Anita said that during her delivery, “my doctor told me that I needed to give birth before seven because she needed to go see the Chicago Bears game.” There were a couple similar accounts of situations in which these women felt as though they were not being listened to or heard. One of these was Andrea, who recalled a bad experience where she went to the doctor for bad contractions but was told to return home and wait even though it was already past her due date, at which point her baby was too big and she had to have a c-section. She said after her procedure, “They put staples instead of stitches and when it was time to let me go two days later, they made me walk the baby in the car seat by myself.”

Another bad experience regarding under-medication was when Eva had her child in Wisconsin. She was in a lot of pain, but whenever she would go to the doctor, they would send her back home with “sleeping pills.” At one point, they kept her in the hospital due to pain and after giving her these sleeping pills, and she recalled, “I was hallucinating, and the nurses were laughing to death because... I didn’t know where I was, and I thought I was a bug crawling on the floor.” After a few days of this pain, her husband took her to the hospital and insisted they admit her. She had a similar experience in Iowa too, where the nurse told her she could not come to the hospital because it was not her due date. She said, “I got my husband at like four in the morning and said, you know we’re leaving. And when I was there... I was almost 9 cm dilated.” Eva felt disappointed in her health care providers for not listening to her and helping her when she was in pain. Aoun et al. (2018) found that minority patients, including Hispanics, are less likely than whites to receive adequate pain management in a hospital setting. In this study conducted by Chapman et al. (2013), the physician detected the same amount of pain in a white and Hispanic patient yet prescribed less pain medication to the Hispanic patient. This finding is echoed in a study conducted by Janakiram et al. (2018) who found that Hispanic patients were half as likely to receive opioid pain medication following dental procedures as white patients.

Insurance

Out of all twelve participants, two of them had no insurance during their pregnancies, both of whom had their children in Latin America. Some women had insurance through their place of work, three used Medicaid, and the rest had various insurances. Six women mentioned eight times that insurance or lack of insurance impacted where they sought pregnancy care. Those without insurance mentioned not being able to receive adequate care compared to those with health insurance. Carla said her insurance was accepted and approved everywhere she went, and Daniela said the same was true of those who had Medicaid. Some had to seek care where their insurance permitted. Sofia said, “With my insurance, they almost recommend a place for you to go and get the best place that’s closest to you, but with [my insurance] they’ll send you to like... a hospital that’s not as convenient.” Rosa echoed this experience, saying that her insurance told her where to go, and Dariana was unable to find a doctor or gynecologist when she was pregnant because they did not take her insurance. When these women are told where to seek health care, they may not be able to get to their appointments, which could cause a negative impact to their health and the health of their developing child.

Transportation

Two out of the twelve participants reported their first prenatal appointment as being not as early as they would have liked it to be. Adriana did not state a reason for this, and Carmen had problems with insurance, but for many women this could be a result of limited transportation (Cristancho, et al., 2008). The code transportation was mentioned fifteen times among eight participants. Sofia, Rosa, and Adriana reported no problems with transportation; they had cars and getting to appointments and the pharmacy was not a problem for them. Carla said her insurance would offer rides to the gynecologist and the pharmacy when she needed transportation; however, she had her

husband take her where she needed to go, so they did not utilize this service. Brenda said in Honduras she had to walk everywhere.

Anita shared in detail about relying on her sister-in-law to transport her to the doctor as needed. She said it was not very reliable, and since she was so dependent on her sister-in-law, if her sister-in-law needed to cancel for any reason, Anita would not be able to get to the appointment that day. She said she did not know how to use public transportation and her hospital did not arrange transportation. She also shared a story of a friend, saying, “I know somebody that was driving people; she would charge like 20 dollars to drive people. She would schedule all the appointments in the same day within the same hour, so she would drive like four or five people up at the same time.”

Transportation services through hospitals or insurance companies are available for patients to utilize, as is public transportation, but often patients are unaware of the availability of these or how to use them. Underutilization of transportation services or limited access to transportation can lead to delayed treatment, missed appointments, and inability to access prescriptions (Cristancho, et al., 2008). In a study conducted by Butler et al. (2008), all participants reported difficulty keeping appointments due to lack of transportation. With pregnancy, limited access to transportation could lead to detrimental delays in prenatal and delivery care.

Translation services and translators

One resource available to hospitals is a language line, and though this terminology may differ from hospital to hospital the concept is the same. With a language line, the health care provider can speak into a telephone in English, where it is translated to whatever language is needed and the patient listening on the other end can understand in their language. This resource is becoming increasingly available and is important to utilize, even in routine care. When asked about language lines, four participants reported being offered translation services during delivery, whereas four said they were not offered at all. Of those who were offered translation services; only one reported utilizing these services, many of the others said they had friends or family with them to translate.

One aspect of providing translation services is ensuring resources for patient education are available in their primary language. Six participants were offered prenatal classes in Spanish in the United States. Some of these women chose to participate in the English classes, like Carla, and others did not attend prenatal courses, like Anita. After delivery, neither Carla nor Anita was offered resources in Spanish for how to care for a baby. Anita said she had a hard time understanding postpartum education, and her husband “told me whatever he understood.” She said it would have been nice throughout this process to be provided with written copies of patient education in Spanish so she could follow along.

During health care, especially in the hospital during delivery it is beneficial to have translation services so the patient can understand what’s going on. Anita was not offered a language line or interpreter during delivery, but her husband was with her and knows English. When asked whether or not her husband would have been qualified to

translate medical jargon and terminology, she said he has a high school education and was not able to translate the “medical stuff” very well. Sometimes health care providers assume a patient understands English or is able to translate. Carmen told of this also, saying, “I go by myself and I try so hard to understand them,” and when asked if she is ever offered a language line, “no, because they think I speak English. Generally, I understand the doctors. But if I don’t understand, I ask questions or ask them to write it down so I can ask other people.” Other participants spoke of relying on friends and family rather than the provided translators, like Cynthia, who said, “sometimes they offered, but since I had my friends, I just asked them.”

There were several women who reported being offered translation services consistently, including Andrea who said, “Everyone was talking Spanish to me [at the hospital].” Sofia said, “If you ask, there is always someone who will go,” and Dariana said, “I was always offered translations, I didn’t always need it... but I was always offered translation with any medication. I was... offered an explanation for it and they would break it down and tell me everything.” Additionally, Rosa said, “Thankfully they always had translators or someone to help.” The women who reported being offered translation services, or being treated by Spanish-speakers in Andrea’s case, had their children within the past five years, whereas all the other women had their children over twenty-five years ago. This could explain the discrepancy, as states began requiring facilities to provide translation services in the early 2000s (Foden-Vencil, 2014). Eva even said that when she would go with her friends, sometimes the hospitals will not allow nonprofessional translators and provide their own professional translation services. Professional translators are trained in medical terminology and are to remain in accordance of privacy laws. With untrained or non-professional translators, this privacy and competence cannot be ensured

Family and friend translators

Though health care providers are encouraged to utilize the translation services and professional translators during care to avoid miscommunication errors and ensure privacy, they often still rely on family and friend translators out of convenience and availability. Participants were asked whether they have relied on friends or family for translation, provided a friend or family member with translation, and how those experiences went. Four participants mentioned family and friend translators nine times. Carla shared that she translated for her mother at thirteen years old when her mother was pregnant. She would accompany her at doctor appointments, but was in school when her brother was born, so her aunt helped translate during delivery. This was almost fifteen years ago, and Carla’s mother was not provided translation services through the hospital and had to rely on her daughter to translate. When asked whether or not she felt she could adequately translate for her mother, she responded:

I was probably not adequately conveying, I was translating what I knew how to translate, and what I didn’t know how to translate, I kind of filled in the blanks. I feel like if someone was there to translate appropriately, she could have asked more questions... I feel like I did the best I could at the time.

Carla continued to say later that she felt like her mother had more questions for the doctor but “she was just like, okay, it’s fine then” and moved on.

This is a similar experience to what Anita went through when she was pregnant with her children. She brought her sister-in-law or her husband with her to doctor appointments and the hospital. She said she felt more comfortable with her husband than her sister-in-law, but she usually had to go with her sister-in-law, who would control the situation by saying what she wanted to say or not asking what Anita wanted her to ask the doctor. Anita’s sister-in-law would answer the questions for Anita without asking the doctor, which Anita elaborated on by saying, “Before the doctor had even answered the question, my sister-in-law had already answered it for the doctor.” For several reasons, she said that she would have preferred to have a medical translator with her, one of which being, “I would have had answers for all my questions the way I wanted them to be answered.” Additionally, she said:

I think that I would have felt more comfortable and trusting of somebody that was there professionally to translate because with my sister-in-law and my husband, I just had to trust whatever they were saying, and they could’ve translated it in whatever way they wanted... and sometimes with a family member or someone you know, you feel less comfortable sharing some things because you feel like they’re listening in on what you have to say.

Anita did say she was glad to have her sister-in-law and husband with her, because it was better than having no translator present, but she would have felt more comfortable and satisfied with a professional translator.

For these women, a personal translator was the only option if they wanted to be able to communicate with their health care providers. However, to provide comprehensive care to people who speak a different language, it is important for the health care providers to provide professional translators or interpretive services. A study conducted by Foden-Vencil (2014) found that the rate of error in interpretation was 12% with professional translators, as opposed to 22% for non-professionals, a margin of error that dropped to 2% when utilizing experienced medical translators. These translation errors can cause clinical consequences. According to Ku and Flores (2005), if the patient can understand their care and ask the questions they need to, there are less likely to be negative health outcomes and the patients are more likely to be satisfied with care.

Frustrated/ Intimidated

The code “frustrated/ intimidated” was found six times with five participants regarding communication and language. Some women like Carmen said they have no problem asking for clarification with the doctor and asking questions when they do not understand. Other people, like Carla’s mother and Anita stopped asking questions when relying on a family or friend translator and could not adequately express their concerns. When asked whether they felt intimidated or discouraged to ask for clarification, Brenda originally said no, but after Eva expressed her embarrassment on occasion, agreed with Eva. Eva answered by saying, “I was embarrassed that I didn’t

understand” so she would just nod her head and answer yes to whatever the doctor was saying, even though she had no idea what they were saying or asking her. A health care provider might see this response and assume the patient is understanding the education when actually the patient is too intimidated to ask for clarification. In response to Eva, Cynthia said, “Sometimes if they ask or talk too fast, I don’t understand what they’re saying.” In this instance, the focus group setting opened a dialogue about the frustrations of not being able to understand a doctor and gave these women an outlet to express that sometimes they feel embarrassed.

Anita was talking about how she emphasizes to her children the importance of learning both Spanish and English so they can help people like herself. She said, “I knew how frustrating it was for me sometimes when I had to go by myself, and I just felt incompetent because I couldn’t understand or just couldn’t do anything to understand or help when I was by myself.” Adriana said something similar about telling her kids to learn both languages, especially since the Hispanic community is growing. She said more people are going to need help with translation and “more people that feel intimidated by not being able to speak English and wanting translation.” Anita said recently she has been seeing more help in terms of translation since she had her children and more people know Spanish, which is encouraging.

Pre-conception care

Only two participants discussed pre-conception care and complications. Adriana got pregnant a month after she got married because she and her husband did not receive or use any contraceptives. When asked whether or not they had contraceptive education, she responded, “I just didn’t really pay attention to it. We kind of regret it and to this day we always talk about it.” Hispanic women have similar rates of use of contraceptives, but a significantly higher rate of unintended pregnancies, and thus it may be due to lack of education about use of contraceptives, which was seen with Adriana’s story (Hawks et al., 2018). On the other side, Anita experienced fertility issues. She did not receive much education as to why this was occurring, but she said, “I had some sort of infection that was killing the sperm so that’s why I wasn’t getting pregnant.” The doctor gave her vaginal suppositories and she got pregnant a few months later. When asked whether her husband accompanied her to the fertility doctor or got tested at all, she simply said she went by herself.

Breastfeeding

In one interview, the participants discussed breastfeeding trends and their own experiences. The code “breastfeeding” appeared four times between two participants. Adriana said she felt that people were less likely to breastfeed in the United States than in Mexico and she speculated that it was “just because of lack of encouragement and the lack of push for moms to breastfeed and teach moms that breastfeeding is a better option.” She spoke about Mexico and how there are “less resources to buy formula and they encouraged you to breastfeed more” than they do in the United States. Anita said she and her other friends had trouble producing milk, so they had to switch to formula after her first child. Adriana had her children in Mexico, whereas Anita had her children in the United States. Garrett et al. (2018) found that 81% of non-Hispanic mothers

compared to 57% of Hispanic mothers report exclusively breastfeeding, which is not what the women from this study seemed to think. In Latin America, women often use both formula and breastfeeding in a practice called “las dos cosas.”

Domestic abuse

One unexpected finding was a story from Eva about her experience with domestic abuse from her first husband. She said, “he was very violent, we were fighting every single day of my pregnancy... I tried to leave him several times, but every time I tried, he would try to kill me.” When asked whether she confided in anyone about her situation or talked to her doctors or nurses about it, she said:

I never told them... I tried to call the cops. I ran out of the house trying to find a pay phone because I didn't have a phone at all. And I never could find a pay phone and I was hoping to see people in the street because it was late at night, but nobody was there to help me, so I had to go back again, walking home alone in the dark because I had nobody to ask for help.

She said she wishes the health care providers had asked if everything was okay or would have at least been able to recognize the signs that somebody was going through a situation like she was. She said, “I was more afraid because I wanted my son to have a father, and I felt that I had no help... because I had no communication or sources to get information.” She was never informed of a domestic abuse hotline or any resources that could have helped her get out of that situation. Since then, she has escaped that situation and remarried, but at the time had nobody to turn to who understood her or could adequately communicate with her.

CONCLUSION

Hispanic patients in pregnancy health care perceived barriers to health care in terms of language and communication, insurance, and education. Participants reported satisfaction in spite of such barriers, especially with their nurses during pregnancy care and delivery. Only one participant used professional translation services during her stay in the hospital, the others relying on family or friends or their own understanding of English. When utilizing family and friends, participants admitted that they were not qualified to translate medical terminology or knowledgeable of healthcare in a capacity sufficient for medical interpretation. These women said they would have felt more comfortable asking questions with a professional translator present than somebody they knew personally, but ultimately this did not impact their reported satisfaction with health care.

Half of the participants mentioned that insurance or lack of insurance impacted where they sought care and occasionally had to postpone seeking health care due to insurance-related issues. Insurance companies in some instances provided transportation services, but other women who could not drive or could not access public transportation had to rely on friends or family to get to appointments and the hospital as needed.

Participants reported several instances of misinformation, or times where they were not provided sufficient patient education or educational resources during their pregnancy period. Phrases such as “nobody told me” and “I thought it was normal” occurred five times in the data, lending to the question of whether or not Hispanic women are getting health education during care. This lack of health literacy could be due to a communication barrier and women who are intimidated to ask for clarification, or a misunderstanding between health care provider and patient, or simply a lack of explanation and patient education.

This study was limited by sample size due to the nature of qualitative research. Future studies could sample a larger population across the northern Midwest and compare community demographics to qualitative data. Data collection could have been influenced by focus group environment where some participants were required to bring their children and other distractions were present. Future studies could use statistical data about patient health outcomes to compare to perceptions for more depth. There is still a deficiency in information regarding patient education, especially during pregnancy health care in Latin American countries. Future research could study pregnancy health care in Latin America compared to the United States, and health outcomes in patients who utilize professional translators in comparison to those who use family or friends as translators.

APPENDIX A

Interview Questions

- Regarding prenatal care
 - o Describe your level of satisfaction with your prenatal care
 - o How would you describe your prenatal nutrition? Did you regularly consume prenatal vitamins and folic acid? Did you get education on this?
 - o How many weeks or months pregnant were you when you had your first visit for prenatal care? Was that as early as you wanted? Where did you go for prenatal visits?
 - o How well did you feel prepared in understanding prenatal care?
 - o How well did you feel prepared and informed for your first birth and caring for a newborn? Were you offered prenatal classes in your primary language?
- Regarding birth
 - o Describe your level of satisfaction with the care provided during your stay at the hospital during delivery.
 - o Was an interpreter or language line needed and utilized?
 - o Describe your level of satisfaction with your relationship with the physician during delivery.
 - o Describe your level of satisfaction with your relationship with the nurses and other health care staff during delivery

- Regarding postpartum
 - o Tell me about your postpartum care and education.
 - o Since your baby was born, did you have a postpartum checkup for yourself? If not, why not? If so, where did you go? How long after birth?
 - o After your delivery, did the hospital send a survey about your hospital stay, and was it in your primary language?
 - Did you fill out and return the survey? If not, why not?
- Did you face any complications to your pregnancy prior, during, or after birth?
- What kind of health insurance did you have prior to your pregnancy, or each of your pregnancies? Did health insurance or lack thereof impact how or where you sought prenatal and pregnancy care, and how so?
 - o If you did not have health insurance, why not? How did you pay for prenatal care and delivery?
- If you have had multiple children, were there significant differences between the care you received with each one?
- Did you receive care from different providers or hospitals?
- Were you able to get to appointments, pharmacies, and the hospital as needed for pregnancy care? (transportation, location)
- Were you able to adequately communicate with health care providers during any prenatal, delivery, and postnatal care?
 - o Were you provided with translation services if needed? If so, did that impact your perception of care or ability to communicate with health care staff?
 - o Did you ever bring a friend or relative as a translator to a prenatal or postnatal appointment? Have you been a translator for a friend? Can you describe these experiences?
 - o Have you ever felt intimidated or discouraged to ask for translator or clarification?

Demographic questions:

- Where did you have your children?
- Are you native to the United States?
- What is your primary language?
 - o Do you speak English as a secondary language

REFERENCES

- Aoun, A., Al Hayek, S., & El Jabbour, F. (2018). The need for a new model of the physician–patient relationship: A challenge for modern medical practice. *Family Medicine & Primary Care Review*, 20(4), 379–384. <https://doi.org/10.5114/fmpr.2018.79351>
- Avila, R. M., & Bramlett, M. D. (2013). Language and immigrant status effects on disparities in Hispanic children’s health status and access to health care. *Maternal and Child Health Journal*, 17(3), 415–423. <https://doi.org/10.1007/s10995-012-0988-9>
- Blair, I. V., Steiner, J. F., Fairclough, D. L., Hanratty, R., Price, D. W., Hirsh, H. K., ... Havranek, E. P. (2013). Clinicians’ implicit ethnic/racial bias and perceptions of care among black and Latino patients. *The Annals of Family Medicine*, 11(1), 43–52. <https://doi.org/10.1370/afm.1442>
- Bromley, E., Nunes, A., & Phipps, M. G. (2012). Disparities in pregnancy healthcare utilization between Hispanic and non-Hispanic white women in Rhode Island. *Maternal and Child Health Journal*, 16(8), 1576–1582. <https://doi.org/10.1007/s10995-011-0850-5>
- Butler, C., Kim-Godwin, Y., & Fox, J. A. (2008). Exploration of health care concerns of Hispanic women in a rural southeastern North Carolina community. *Online Journal of Rural Nursing and Health Care*, 8(2), 12.
- Chapman, E. N., Kaatz, A., & Carnes, M. (2013). Physicians and implicit bias: How doctors may unwittingly perpetuate health care disparities. *Journal of General Internal Medicine*, 28(11), 1504–1510. <https://doi.org/10.1007/s11606-013-2441-1>
- Cristancho, S., Garces, D. M., Peters, K. E., & Mueller, B. C. (2008). Listening to rural Hispanic immigrants in the Midwest: A community-based participatory assessment of major barriers to health care access and use. *Qualitative Health Research*, 18(5), 633–646. <https://doi.org/10.1177/1049732308316669>
- de Vargas Nunes Coll, C., Ewerling, F., Hellwig, F., & de Barros, A. J. D. (2019). Contraception in adolescence: The influence of parity and marital status on contraceptive use in 73 low-and middle-income countries. *Reproductive Health*, 16(1), 21. <https://doi.org/10.1186/s12978-019-0686-9>
- Dongarwar, D., & Salihu, H. M. (2019). Influence of sexual and reproductive health literacy on single and recurrent adolescent pregnancy in Latin America. *Journal of Pediatric and Adolescent Gynecology*, 32(5), 506–513. <https://doi.org/10.1016/j.jpag.2019.06.003>

- Garrett, C. C., Azimov, M., Campwala, K., Sarmiento, M., & Linton, K. F. (2018). Breastfeeding practices among Hispanic and non-Hispanic Women at the postpartum visit. *Journal of Human Lactation*, 34(3), 485–493. <https://doi.org/10.1177/0890334418774765>
- Gresenz, C. R., Rogowski, J., & Escarce, J. J. (2009). Community demographics and access to health care among U.S. Hispanics. *Health Services Research*, 44(5p1), 1542–1562. <https://doi.org/10.1111/j.1475-6773.2009.00997.x>
- Guo, Y., Hildebrand, J., Rousseau, J., Brown, B., Pimentel, P., & Olshansky, E. (2018). Undeserved pregnant and postpartum women's access and use of their health records. *Wolters Kluwer Health, Inc*, 43(3), 164–170. doi:10.1097/NMC.0000000000000432.
- Hawks, R. M., McGinn, A. P., Bernstein, P. S., & Tobin, J. N. (2018). Exploring pre-conception care: Insurance status, race/ethnicity, and health in the pre-pregnancy period. *Maternal and Child Health Journal*, 22(8), 1103–1110. <https://doi.org/10.1007/s10995-018-2494-1>
- HIPAA Compliance | What it Means for Language Service Providers. (2016, July 29). *Interpreters Unlimited*. <https://interpretersunlimited.com/uncategorized/hipaa-compliance-language-service-providers/>
- Jacobs, E. A., Shepard, D. S., Suaya, J. A., & Stone, E.-L. (2004). Overcoming language barriers in health care: Costs and benefits of interpreter services. *American Journal of Public Health*, 94(5), 866–869. <https://doi.org/10.2105/AJPH.94.5.866>
- Janakiram, C., Chalmers, N. I., Fontelo, P., Huser, V., Lopez, M. G., Iafolla, T. J., ... Dye, B. A. (2018). Sex and race or ethnicity disparities in opioid prescriptions for dental diagnoses among patients receiving Medicaid. *The Journal of the American Dental Association*, 149(4), 246–255. <https://doi.org/10.1016/j.adaj.2018.02.010>
- Johansson, P., Oléni, M., & Fridlund, B. (2002). Patient satisfaction with nursing care in the context of health care: A literature study. *Scandinavian Journal of Caring Sciences*, 16(4), 337–344. <https://doi.org/10.1046/j.1471-6712.2002.00094.x>
- Ku, L., & Flores, G. (2005). Pay now or pay later: Providing interpreter services in health care. *Health Affairs*, 24(2), 435–444. <https://doi.org/10.1377/hlthaff.24.2.435>
- Law, J., & VanDerslice, J. (2011). Proximal and distal determinants of access to health care among Hispanics in El Paso County, Texas. *Journal of Immigrant and Minority Health*, 13(2), 379–384. <https://doi.org/10.1007/s10903-010-9327-7>

Liebermann, E. J., VanDevanter, N., Hammer, M. J., & Fu, M. R. (2018). Social and cultural barriers to women's participation in pap smear screening programs in low- and middle-income Latin American and Caribbean countries: An Integrative Review. *Journal of Transcultural Nursing*, 29(6), 591–602. <https://doi.org/10.1177/1043659618755424>

Nápoles, A. M., Gregorich, S. E., Santoyo-Olsson, J., O'Brien, H., & Stewart, A. L. (2009). Interpersonal processes of care and patient satisfaction: Do associations differ by race, ethnicity, and language? *Health Services Research*, 44(4), 1326–1344. <https://doi.org/10.1111/j.1475-6773.2009.00965.x>

Parekh, N., Jarlenski, M., & Kelley, D. (2018). Prenatal and postpartum care disparities in a large Medicaid program. *Maternal and Child Health Journal*, 22(3), 429–437. <https://doi.org/10.1007/s10995-017-2410-0>



Protective Effects of the Novel Phytonutrient S7 Against Intestinal Tight Junction Disruption: Composition Matters

Erin E. Olson

ACKNOWLEDGEMENTS

I would like to express my most sincere gratitude to my research mentor, Dr. Daniel Sharda. His expertise, guidance, and support throughout the process of project design and execution were truly invaluable. I am thankful for his constant encouragement as we navigated hurdles and interpreted endlessly interesting data, as well as for his constructive feedback on the art of scientific writing. I would also like to thank Alexi Zastrow, who worked with Dr. Sharda and me during summer 2019 to conduct a parallel study, investigating the impact of S7 on M1-macrophage activation. Her positivity and constant encouragement as well as assistance with reagent preparation and cell passaging were greatly appreciated. Thanks also to my Honors Cohort professors, Dr. Stephen Case, Dr. Beth Schurman, Dr. Brian Stipp, and Professor Eric Young, who fostered a love of scholarship and critical analysis and provided support and feedback during early stages of project development. Special thanks also to Carrie Yuan at Hunter Laboratory, who instructed Dr. Sharda and me in the use of the TEER apparatus and provided valuable troubleshooting advice.

Financial support for this research was provided by the ONU Honors Department, the Elbert Pence and Fanny Boyce Undergraduate Summer Research Experience, and the Hippenhammer Faculty Research Grant. Caco-2 cells were a gift from Hunter Laboratory at Northwestern University. S7 reagents and Restore were gifts from Futureceuticals and Biomic Sciences respectively.

ABSTRACT

The prevalence of intestinal inflammatory diseases is increasing, and pharmacologic agents for intervention are currently limited. Preserving epithelial tight junction (TJ) integrity and preventing underlying immune cell activation by intestinal bacteria are key targets for abrogating the perpetual inflammatory cycle that plagues these diseases. Phytonutrients have shown promise for their ability to reduce cellular inflammation, but the extent of their efficacy in an intestinal model of inflammation is not well understood. Here, we hypothesized that S7, a novel phytonutrient derived from extracts rich in curcuminoids and catechins, would reduce immune cell inflammation and preserve TJ integrity in an *in vitro* co-culture model of intestinal inflammation. We further investigated whether a curcumin-containing formulation (S7-C) or its metabolite, tetrahydrocurcumin (S7-THC) would similarly preserve TJ integrity.

An *in vitro* intestinal co-culture model was established by seeding Caco-2 epithelial cells on semipermeable transwell inserts 21 days prior to the addition of RAW264.7 macrophages in the basolateral chamber. Macrophages were next stimulated with 10 ng/ml lipopolysaccharide (LPS) to induce inflammation, and subsequent TJ disruption in the co-cultured Caco-2 cells was assessed by transepithelial electrical resistance (TEER) using epithelial ohmmeter chopstick electrodes. We found that administration of S7-THC containing 1-5 μM THC produced dose dependent mitigation of LPS-induced decreases in TEER and approached the efficacy of the pharmacologic agent, budesonide. However, S7-C at 5 μM curcumin was unable to preserve TEER, suggesting that the specific combination of phytonutrients is important for preventing inflammation-induced TJ disruption. We also found that, though apical application (Caco-2 only) of budesonide was sufficient for preserving TEER in our model, S7-THC required both apical (Caco-2) and basolateral (RAW264.7) treatment, suggesting that reducing macrophage inflammation is important for limiting epithelial TJ disruption in this context. Interestingly, S7-C was more effective than S7-THC or budesonide at reducing inflammatory basolateral nitric oxide (NO) production as determined by the Griess assay. This suggests that, though S7-C more effectively reduces this aspect of inflammation, another inflammatory mediator is responsible for conveying TJ disruption and is governed differentially by S7-THC. Further support of this comes from our finding that S7-THC, but not S7-C, ameliorated the LPS-induced increase in myosin light chain kinase (MLCK) expression in Caco-2 cells as determined by Western blot. Together, these findings suggest that phytonutrients such as S7-THC have prophylactic potential in the preservation of TJ integrity, and the specific composition of these phytonutrients matters.

Keywords: Intestinal tight junctions, intestinal inflammation, intestinal barrier, lipopolysaccharide, Caco-2 cells, transepithelial electrical resistance, phytonutrients, S7



Monetary Policy and Income Inequality in the United States and Spain

Brooke L. Whetstone

ACKNOWLEDGEMENTS

I would like to thank the Olivet Honors Program for enabling me to complete a research project during my undergraduate experience. I would also like to thank my fiancé for his support. I would also like to thank my project mentor, Dr. Koch, for sharing his expertise during this process. Finally, I would like to thank the other five remaining members of Cohort 10 of the Honors Program. These women have been an incredible support system as we walked through the process together.

ABSTRACT

Background

Contractionary monetary policy has long-term effects on inequality (Feldkircher & Kakamu, 2018). However, other forms of monetary policy do not have a clear effect on income inequality. Central banks defend the position that other factors are the driving forces behind income inequality (Powell, 2018).

Methodology

This investigation utilized ANOVA regression analysis to determine if income inequality, as measured by wage growth by sector, is related to interest rates in the United States and Spain. If applicable, slopes of the regression lines for each sector were compared to see if they were significantly different in a statistical sense.

Results

At interest rates above 0.4 percent in the United States, the Federal Funds Rate has asymmetric effects on the sectors studied. In Spain, there is no clear relationship between the European Central Bank (ECB) rate of discount and wage growth, so tests of the slope were not relevant.

Conclusion

In the United States, higher, or contractionary, rates of interest appear to have an impact on income inequality. This is in line with the results of previous studies.

Keywords: income inequality, monetary policy, United States, Spain

REVIEW OF LITERATURE

One of the major sources of economic policy is a nation's central bank. Central banks intervene in an economy through monetary policy. Monetary policy refers to the actions of central banks to steer the direction of the economy by adjusting the money supply and interest rates. Contractionary monetary policy occurs when central banks increase interest rates or decrease the money supply to slow economic growth. Expansionary monetary policy refers to a decrease in interest rates or increase of the money supply in order to spur economic growth. Some of economists' major historic indicators of a recession are now considered unreliable, due to the intervention of central banks. For example, the Phillips Curve, a model that shows the tradeoff between unemployment and inflation, has flattened, meaning low unemployment no longer seems to put upward pressure on the average price level. As of 2019, the United States economy was operating with low unemployment and low inflation. According to the traditional Phillips Curve, this should not be possible. The flattening of the Phillips Curve, according to current and previous chairs of the Federal Reserve, may be the result of the Federal Reserve's ability to anchor inflation expectations (Sheiner, 2018). As economists try to navigate an economic state that is theoretically impossible, concerns surrounding the effects of adjusting the economy through monetary policy have arisen following the 2007 global financial crisis.

Central banks defend monetary policy

One such concern is the impact central banks have on income inequality. Income inequality is defined as a relative disparity in income or consumption (Bourguignon et al., 2010). Income inequality is generally addressed by means of fiscal policy, government intervention in the economy through taxes, and government spending. The impact of monetary policy on income inequality was first investigated by Romer and Romer (1999) through the process of multicollinearity. Romer and Romer saw rising income inequality as a cause of higher poverty rates. Their investigation sought to determine if monetary policy could have positive distributive effects to help the poor, individuals earning incomes below the poverty line (Romer & Romer, 1999). However, their model was based upon the dual mandate. The dual mandate refers to the Congress mandated focus of the Federal Reserve on unemployment and inflation. Thus, using unemployment and inflation indicators as determinants of poverty, they investigated the distributional effects of the actions of the Federal Reserve (Romer & Romer, 1999). Given the current state of the Phillips Curve, their model may yield different results today. Since their investigation, further research has been done to investigate the distributive effects of monetary policy. Ben Bernanke, chair of the Federal Reserve Board of Governors from 2006 to 2014, discussed his view on the causes of income inequality on his Brookings Institution blog. Bernanke asserted that income inequality is largely the result of globalization, technological change, demographics, and institutions. He does not attribute the rise in income inequality to changes in monetary policy (Bernanke, 2001). In contrast, Bernanke's successor, Janet Yellen who served as chair from 2014 to 2018, emphasized the importance of monitoring rising income inequality in her 2014 speech. While the heads of the Federal Reserve have had differing opinions on the importance of income inequality, studies within central banks around the world have been conducted to determine if there is a statistical relationship between the two.

Several researchers at the European Central Bank conducted a study on the distributive impacts of monetary policy with specific focus on quantitative easing. Quantitative Easing (QE) refers to large scale liquid asset purchases in order to increase the amount of money in circulation. This became a popular form of monetary policy during the Great Recession despite being controversial due to fears that QE would cause depreciation and rapid inflation. In order to determine the distributional effects of monetary policy, this study analyzed the direct and indirect channels through which interest rate adjustments and asset purchases impact income and wealth inequality. Here, direct impacts were defined as changes in the incentives of households to save and changes in net household financial income. Indirect impacts result from equilibrium changes in the employment level, including wages and prices. The researchers concluded that asset purchases and expansionary interest rate adjustments lead to decreases in distributional inequality. However, on an overall basis, monetary policy has a minimal effect on income inequality (Ampudia et al., 2018). As the indicators defined as indirect channels in this study are easier to measure than the Gini or Theil Indexes, these channels will form the basis for this study.

Research conducted outside of central banks

Despite the assertions of central banks that their policies do not increase income inequality, researchers outside of the institutions have found otherwise. Several studies have been conducted to look at this relationship by investigating the channels through which monetary policy indirectly affects income inequality. For example, Coiboin, Gorodnichenko, Kueng, & Silvia conducted a study in 2016 which suggested that contractionary monetary policy shocks within the United States have significant impacts on long-run inequality, due to their influence on personal consumption and income.

A similar study conducted in Japan used income statistics from the Japanese Family Income and Expenditures Survey. This survey collected income data from a group of 9,000 individuals on a monthly basis. Using this data, Feldkircher and Kakamu (2018) approximated the Gini Index, a measure of income inequality, using a log normal distribution. The researchers in this study were able to estimate Japan's Gini Index through their sample. The Gini Index calculates the area between the current distribution of income held by each percentage of the population and the line of perfect equality. The greater the value of the Gini Index, the higher the level of income inequality is. This estimate was utilized to see if changes in income inequality, as measured by the Gini index, were attributable to monetary policy. This study concluded that monetary tightening does lead to an increase in income inequality in Japan. This study is unique because the researchers had access to a large sample of monthly income statistics. As the Gini Index is only calculated annually, it is difficult to compare it to the monthly measure of interest rates. Feldkircher and Kakama illustrate that new methods of research are showing greater evidence of a statistical relationship between monetary policy and income inequality, suggesting there is a need for a further investigation into this topic. There has yet to be a notable study that investigates the impact of monetary policy on income inequality in two countries with different central banks.

Even though there are not specific studies that focus on the comparison of monetary policy and income inequality in different countries, there are cross-country comparisons of income inequality. For example, Wang, Caminada, and Goudswaard (2012) compared the Gini Indices of nations that are part of the Organization for Economic Cooperation and Development using data from the Luxemburg Project, which had been adjusted for redistributive tax policies. Alternatively, another study investigates how educational attainment impacts the gap in income inequality between nations using a metric known as the Theil Index (Ahmed, Bussolo, Cruz, Go, & Osorio-Rodarte, 2017). Thus, there is precedence for income inequality comparisons between nations.

Implications of income inequality

The current study was conducted at a time that dignity is becoming a greater concern of ongoing public policy. The American Enterprise Institute, a public policy research organization, or "think tank" in the United States, has launched the Human Dignity Project in an effort to ensure that policy takes the dignity of individuals into account. Similarly, The Brookings Institute is working on the Hamilton Project which seeks to create an economy that benefits more Americans ("The Hamilton Project," n.d.).

The British White Paper issued in November of 1997 mentions that “true progress in poverty reduction cannot be achieved unless all individuals are treated with dignity” (Agola & Awange, 2014). Thus, this investigation will also discuss the impact of the data on human dignity and the future of policy.

Though dignity is making its way to the forefront of public policy, income inequality is not. In general, income inequality has not been a prominent issue in public policy. Cornia and Stewart (2014) discuss the neglect of income inequality in public policy. They largely attribute this trend to the attitude of economists. In this book, attitudes of economists are consistent with that of Willem Butier who said, “Poverty bothers me. Inequality does not. I just don’t care” (Cornia & Stewart, 2014, p.99). Cornia and Stewart (2014) consider the attitude to be the result of several economic principles. First, free-market economists argue that competition produces “the optimal functional income distribution” because the market operates efficiently without intervention (p. 111). Second, it is argued that by allowing individuals to keep a larger portion of their income, incentives to work are created and the resultant hard work will benefit the rest of society (Cornia & Stewart, 2014). This sentiment continues to be present, In an interview with Michael Strain, the director of American policy studies at the American Enterprise Institute, he describes concerns about inequality as the manifestation of populist frustration on the political left (Pethokoukis, 2019).

As policy has focused on poverty rather than income inequality, so have the recent dignity projects. However, according the most recent survey by the Bureau of Labor Statistics, income inequality is the highest it has been since they began measuring it five decades ago despite poverty reaching historic lows (Telford, n.d.). Thus, this investigation looks at dignity in the context of income inequality and raises a question regarding the morality of economic policy. If in fact there is a relationship between income inequality and economic policy, what impact does it have on those asymmetrically affected? According to Gronbacher (1998), “the central aim of economic policy” is to increase “the quality of life for individuals and the community in a manner consistent with the dignity of persons.” He asserts, it “is impossible [to do this] without regard for economic liberty and private property” (Gronbacher, 1998,p.15). Because human dignity should be something policy makers are concerned about and is, as defined by Gronbacher, a central aim of economic policy, it should be addressed. Thus, dignity must be taken into account even when policy is pursued for the sake of progress.

Ultimately, economic and political systems are evaluated by different criteria from the criteria by which the actions of individuals are evaluated. One such criteria for evaluating economic systems is economic justice. However, how one defines economic justice impacts his or her evaluation of income inequality. The two most common definitions include defining justice as fairness in the process and defining it as equality in opportunity and/or income. For the sake of this investigation, economic justice will be defined as equality in the opportunity and income. Economic opportunity is generally defined in terms of the poverty line.

This investigation seeks to answer the question: *Is there a statistical relationship between monetary policy and income inequality in the United States and Spain when measuring income inequality by employment fluctuations by industry?*

METHODS

The investigation sought to answer the specific question: Is there a statistical relationship between monetary policy and income inequality in the United States and Spain when measuring income inequality with wage growth by sector? In this case, monetary policy will be represented as the level of interest rates.

United States

For the United States, monetary policy is represented as the monthly average of the Federal Funds Rate found on the website of the Federal Reserve Bank of St. Louis (FRED). Wage growth data comes from a monthly survey of Current Employment Statistics (CES) conducted by the Bureau of Labor Statistics. CES provides access to average hourly earnings reports from a variety of specific jobs as well as industries. In order to obtain diverse pay bands, the sectors of retail, manufacturing, financial activities, and professional services were selected. These occupations vary with education attainment and skills required.

Spain

Spain was used in this investigation to see if there is a parallel trend between a nation in a monetary union when compared to a country like the United States in control of its own monetary policy. Out of all of the countries in the Euro Area, Spain was chosen as a case study due to its high rate of youth unemployment. High rates of youth unemployment indicate a possible disparity in the distribution of income by age brackets. For Spain, the analysis uses quarterly ECB discount rates as monetary policy. The quarterly ECB discount rate is also available on FRED. Quarterly wages for the sectors of industry, construction, and services are available on Eurostat, a statistical database organized by the European Commission in the European Union. Unlike in the United States, less published data on wages are published in Spain. Thus, the only sectors available to compare were industry, construction, and services. While these sectors are more narrow than those chosen for the United States, they still vary in skills and education attainment required.

Statistical process

Using SPSS, linear regression models were created using interest rates as the independent variable and the average weekly earnings of the various sectors as the dependent variables. ANOVA regression analysis assumes that the mean of the errors terms is zero, errors are approximately normally distributed, the error terms have equal variances, and the error terms are independent. The slope of each regression lines measures the impact on the average hourly earnings for that sector of a one-unit change in the interest or discount rate. If applicable, the slope of each line was then tested against the industry average to see if it was statistically different. If the slopes for individual industries are significantly different from the industry average, this may

indicate that monetary policy has a greater impact on income for certain sectors of the economy over others.

RESULTS

United States

In order to assess the best type of regression possible, the wages by sector were graphed against interest rates to determine if a linear model was applicable. **Figure 1** shows that there may be linear trends between interest rates and wages of each sector. Despite all occurring at different wage levels, each line appears to follow a similar trend. However, regression analysis was needed to determine what this trend is.

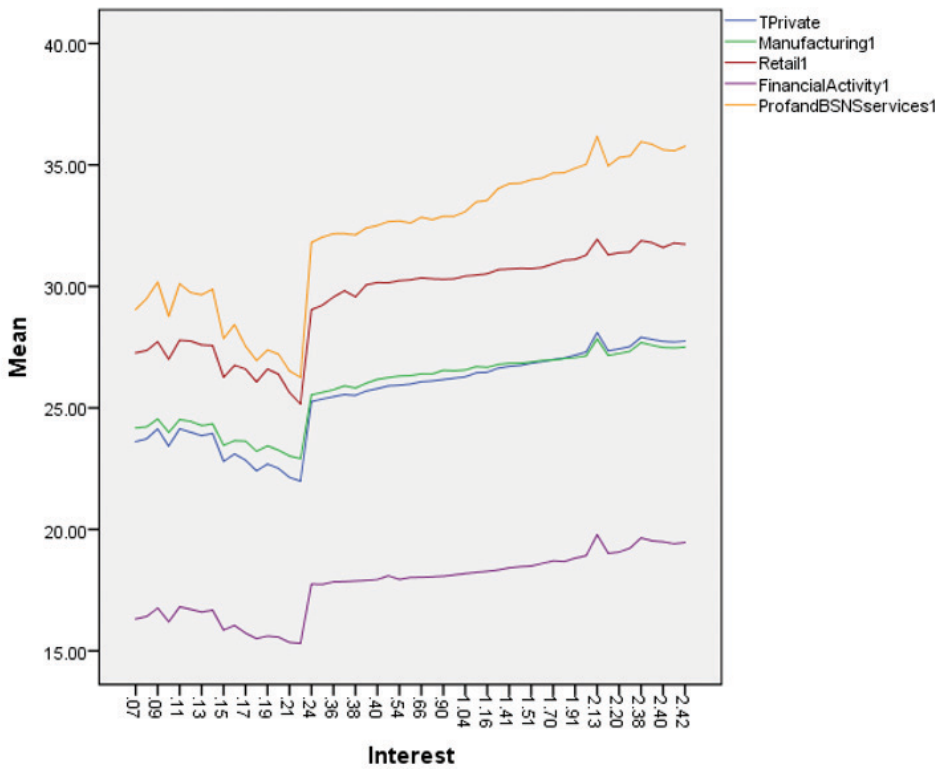


Figure 1: Mean Average Hourly Earnings by Sector and the Fed Funds Rate. Figure 1 shows the values of average hourly earnings for each sector graphed by interest rate. The vertical axis, labeled mean, uses the mean value of average hourly earnings for that sector at the specified interest rate. Because interest rates have repeated between 2000 and 2019, the function is not one-to-one. Using the mean enables SPSS to connect the data in a single line.

TABLE 1: UNITED STATES LEAST SQUARES REGRESSION SLOPES

Slope of each regression line as well as the correlation coefficient. The slope represents the change in average hourly earnings per a one unit increase in the interest rate. The correlation coefficient demonstrates how well the regression line represents the data. An R^2 value of one would indicate that the line fits the data perfectly.

United States Least Squares Regression Slopes		
Sector	Slope	R^2
Total Private	1.992	0.681
Retail	1.417	0.664
Manufacturing	1.66	0.672
Financial Activity	1.417	0.664
Professional Services	3.134	0.64

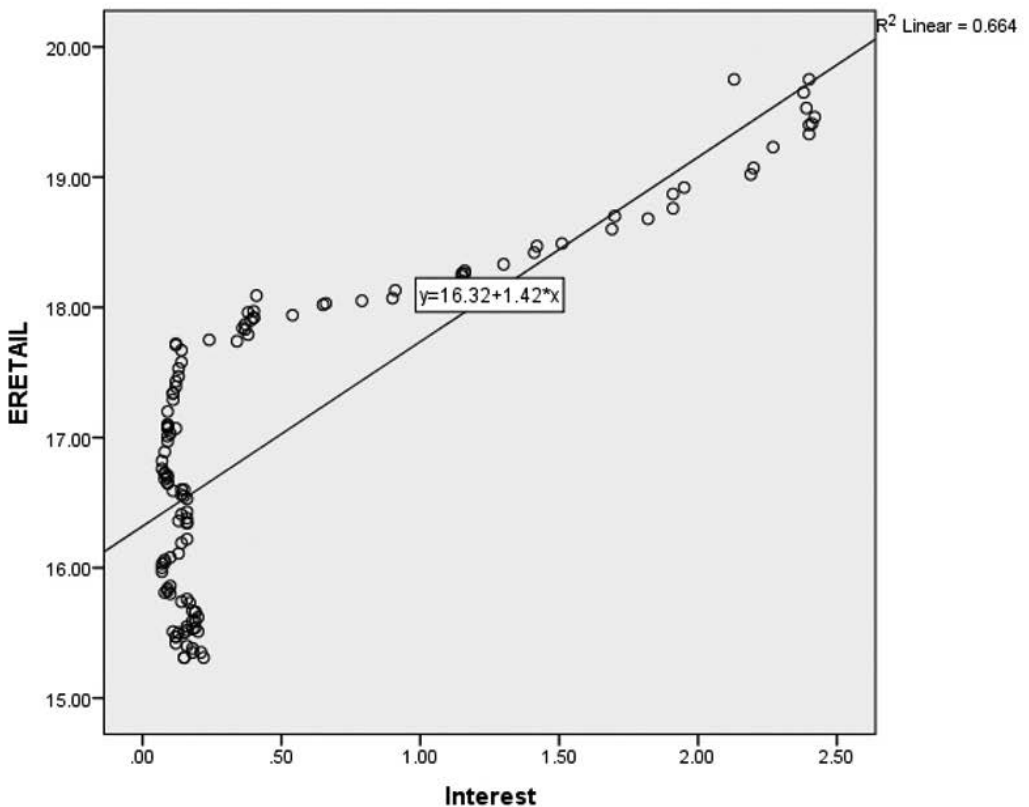


Figure 2: Average Hourly Earnings for Retail Scatter Plot. Figure 2 shows the scatter plot of the data for the average hourly earnings of retail employees by interest rate in the United States. The line on the graph is the least squared regression line calculated. As indicated by an R^2 value on 0.664, the line does not appear to fit the data very well. This trend is consistent for each of the sectors analyzed as evident by the R^2 values in table one.

As demonstrated by **Figure 2**, despite relatively low r^2 values, there appears to be a definite linear trend after an interest rate of 0.4. The graph below illustrates that all the sectors in the United States follow a similar linear trend. Using the same methodology, the experiment was re-conducted using only interest rate values above 0.4.

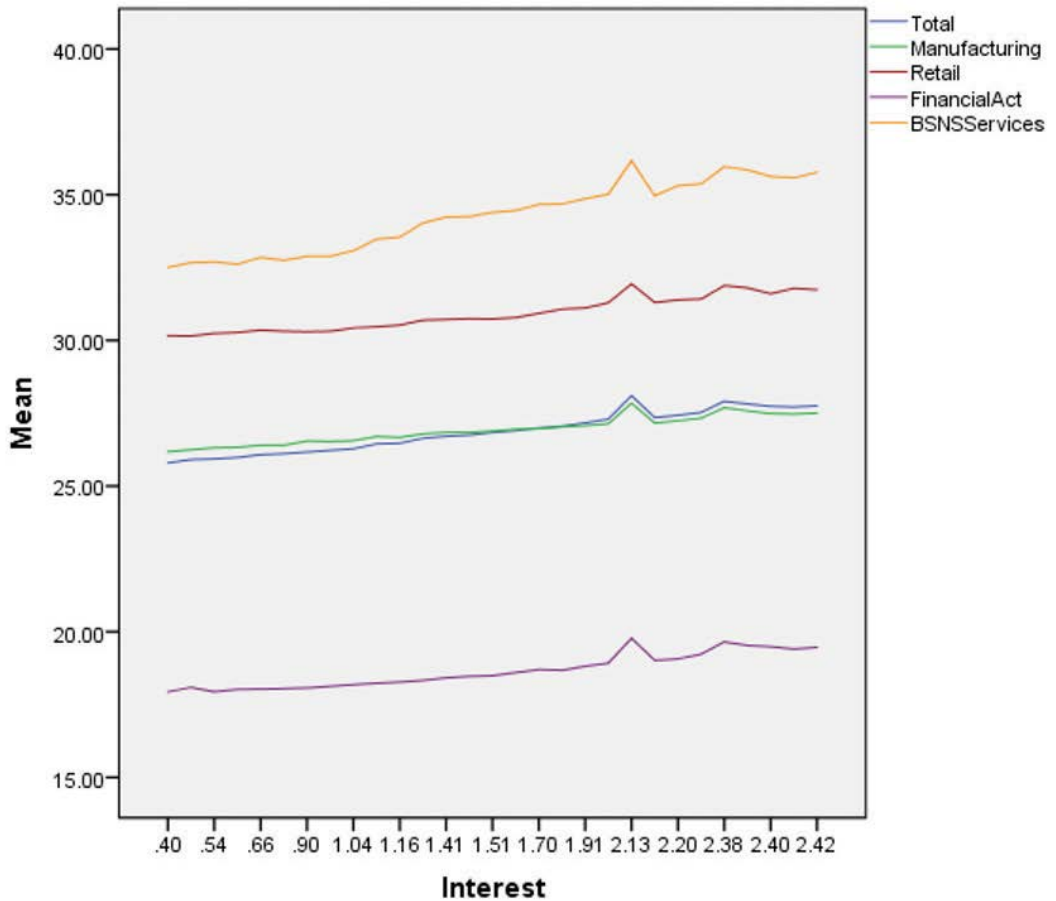


Figure 3: Mean Average Hourly Earnings by Interest Rates above 0.4. Figure 3 shows the linear trends evident between average hourly earnings by sector and the Federal Funds Rate when values at volatile interest rates are removed.

Just as in **Figure 1**, the vertical axis uses the mean value of the average hourly earnings from each sector at the given interest rate. In **Figure 2**, it is more obvious that there appears to be a definite linear trend. Using only this segment of the data, the regression analysis was re-conducted to determine a new line of best fit.

TABLE 2: REGRESSION LINES ABOVE INTEREST RATES OF 0.4

The slope represents the change in average hourly earnings for each industry per one unit change in the Federal Funds Rate. The R² value gives the correlation coefficient indicating how well the regression line fits the data.

Regression Lines above Interest Rates of 0.4		
Sector:	Slope	R²
Total	0.996	0.959
Manufacturing	0.655	0.926
Retail	0.808	0.922
Financial Activity	0.803	0.900
Professional Services	1.691	0.956

After removing the volatile trend among lower interest rate values, the correlation coefficients are much higher. Thus, the regression lines are better models of the data. Additionally, with the exception of professional and business services, all the slopes are below one.

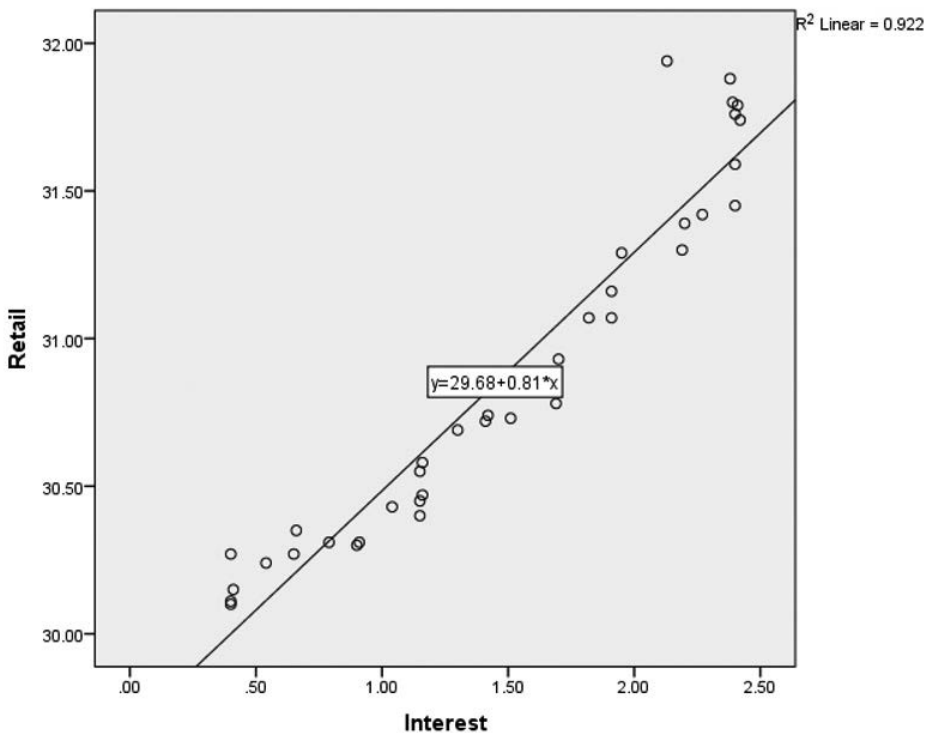


Figure 4: Federal Funds Rate and Average Hourly Earnings. Figure 4 represents the least squares regression line graphed against the scatter plot of average hourly earnings for retail and the Federal Funds Rate. The least squares regression line is represented by the equation $y = 29.68 + 0.81x$, where y is the average hourly earnings and x is the Federal Funds Rate.

Figure 4 shows the relationship between average hourly earnings in retail graphed by interest rates above 0.4. Here, the least squares regression line represents the data more accurately. Thus, there appears to be a linear relationship between interest rate and average hourly earnings above a federal funds rate of 0.4.

Test of slope

After determining that a linear trend exists above an interest rate of 0.4, a test of slopes was performed to determine if the various sectors have slopes that are significantly different from one another. To determine this, the total average hourly earnings slope was compared to each sector's slope using a t-test. The corresponding p-value for each t-test is deemed significant if it is below 0.05.

TABLE 3: TEST OF SIGNIFICANCE OF THE SLOPE

Results from the test of significance when interest rates above 0.4 are included. The slopes of each sector are listed along with the standard error associated with the calculation of each slope. The t value in the fourth column shows the t statistic calculated by taking the difference between the slopes and dividing by the square root of the sum of the squared standard errors. The degrees of freedom are $n_1 + n_2 - 4$. The p value is the significance value found from the respective t values. Using an alpha value of 0.05, all are significantly different from the total average hourly earnings slope.

Test of Significance of the Slope					
Factor	Slope	s_b	t	df	p
Total	0.996	0.035			
Manufacturing	0.655	0.031	-7.29339	68	0.00000***
Retail	0.808	0.040	-3.53711	68	0.00040***
Financial Activity	0.803	0.045	-3.38544	68	0.00060***
Professional Services	1.691	0.062	9.76166	68	0.00000***

***Significant at an alpha of 0.001

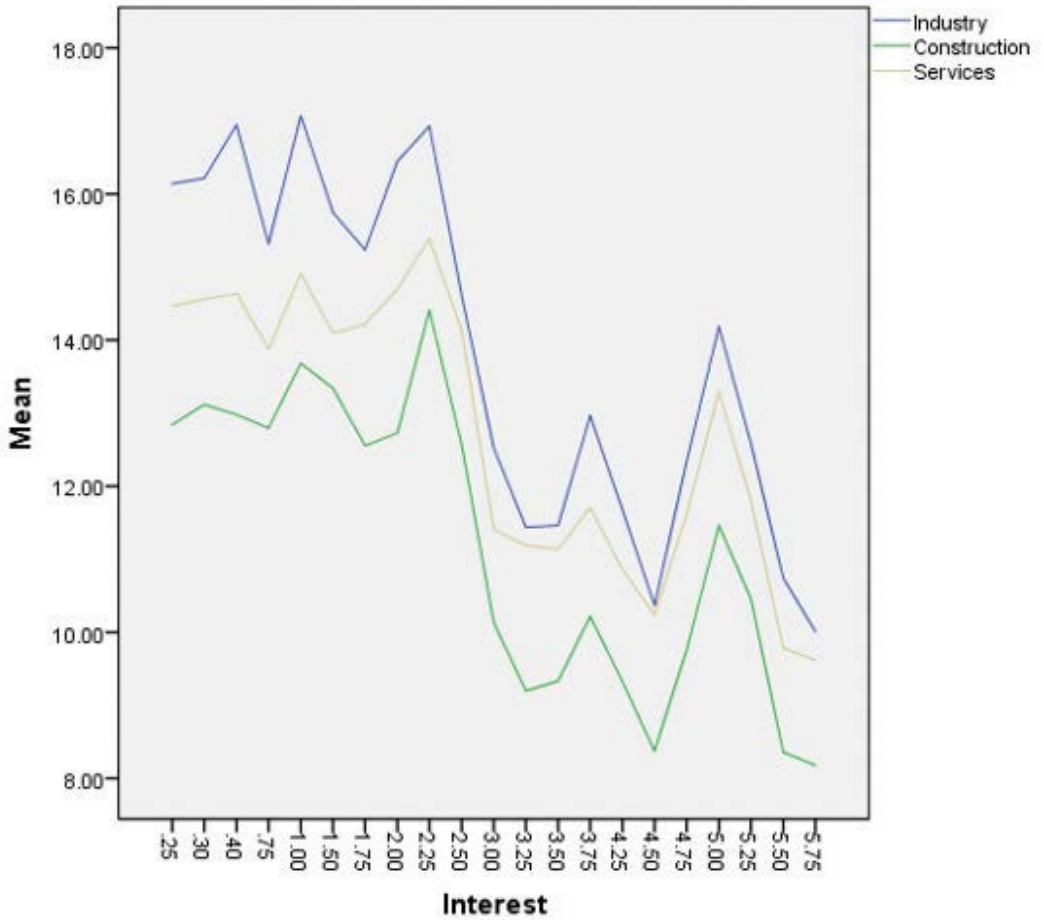


Figure 5: Mean Average Hourly Earnings by Discount Rate. Figure 5 models the trend between wages and interest Rates in Spain. The horizontal axis represents the quarterly discount rate. The vertical axis uses the average of the average hourly earnings for each sector at the given discount rate.

Figure 5 demonstrates that while each industry follows a similar trend, there does not appear to be strong linear relationship like the one seen in the United States data for any discount rate interval.

TABLE 4: SPAIN LEAST SQUARES REGRESSION LINES

Slopes of the lines for each sector as well as the respective correlation coefficients. Low R^2 values highlight that this relationship is not very linear.

Spain Least Square Regression Lines		
Sector:	Slope	R²
Industry	-0.987	0.546
Construction	-0.817	0.517
Services	-0.78	0.506

In this case, the regression analysis does not appear to show a clear relationship between interest rates and wages in Spain. However, it is notable that all the slopes in this case are negative in comparison to positive slopes for the United States. Because low R^2 values indicate the linear relationships do not fit the data well, further analysis of these slopes would not yield any significant results.

DISCUSSION

The primary finding from this investigation is that the Federal Funds rate appears to asymmetrically affect wages by sector. Analysis conducted for Spain does not yield any significant regression lines; however, it does demonstrate that there is a negative relationship between wages and the ECB's rate of discount. Though other studies on this topic have used regression techniques, this study is unique because it measures income inequality by wages of various sectors.

The goal of comparing the United States and Spain was to determine if a consistent underlying trend exists. These two countries make for an interesting case study because the monetary policy of the United States is based on the data for the United States, whereas monetary policy in Spain is dependent on the state of the entire Euro Zone. Although the Federal Reserve's monetary policy specifically targets aspects of the U.S. economy, ECB rates are less able to do this. Ultimately, the study showed that there was no similar underlying trend between the income inequality and monetary policy in the United States and Spain. This lack of trend in Spain was unexpected. A future study, investigating whether or not this trend is consistent for other Euro Zone countries, would be informative.

Analysis of the data from the United States seems to be in line with previous studies. Research conducted within the United States and Japan suggested that monetary policy has distributional effects when it is contractionary in nature (Feldkircher & Kakamu,

2018; Coibion et al., 2016). The current investigation yielded similar results. Though there appeared to be no trend at interest rates near the zero-lower bound, as the interest rate increase, or became more contractionary, a trend developed.

In an essay about economic dignity, Sperling (2019) defines *economic dignity* in terms of three pillars: ability to provide opportunity for one's family, chances to pursue one's potential, and the capacity to contribute economically with respect ("Economic Dignity," 2019). Income inequality has the greatest impact on the ability to provide for one's family. While the data showed that the wages of various industries are affected by monetary policy at significantly different rates, there was a positive correlation for each. Due to positive slopes for each category, there is no indication that monetary policy harms one group with benefiting another. However, despite these positive relationships, there is evidence that monetary policy adjustments provide greater benefits to certain sectors.

From the test of slopes, manufacturing and retail were the most negatively affected in comparison to total average hourly earnings. According to the Bureau of Labor Statistics (2018), incidence of falling into the working poor category varies by occupation. Individuals with high educational attainment such as business professions were calculated to have a 1.6% chance of being classified as the working poor as of 2016. In comparison, workers in service occupations, such as retail, characterized by low levels of education attainment and low earnings had a 10.7% of becoming working poor. Finally, manufacturing occupations have a 5.7% chance of being classified as working poor. Given these probabilities and the definition of economic justice, it is apparent that in addition to the wages of workers in the manufacturing and retail sectors in the United States being asymmetrically affected, workers in these sections already face a higher chance of being pushed below the poverty line. Given these two criteria, workers in these two sectors appear to have been treated unjustly.

One weakness of this study is that it does not take into account time lags of monetary policy. Finding a way to mathematically incorporate the time lags of monetary policy may indicate a more significant trend. However, because results seem to be in line with previous studies, policy lags may not have a significant impact on wages. Similar results without adjusting time lags may suggest that employers adjust wages with policy expectations in mind. However, due to the frequent changes in interest rates but relatively stagnant wages, this is unlikely.

Overall, significantly different slopes for different sectors indicate that United States monetary policy asymmetrically affects income in those sectors. However, while the sectors were growing at significantly different rates, the wages in each sector were still increasing as the interest rate increased. Further investigations could consider other indicators besides monetary policy that could impact rising rates of income inequality.

REFERENCES

Agola, N. O., & Awange, J. L. (2014). Poverty and income inequality: Global perspective. In N. O. Agola & J. L. Awange, *Globalized Poverty and Environment* (pp. 125–142). https://doi.org/10.1007/978-3-642-39733-2_10

Ahmed, S. A., Bussolo, M., Cruz, M., Go, D. S., & Osorio-Rodarte, I. (2017). *Global inequality in a more educated world*. <https://doi.org/10.1596/1813-9450-8135>

A profile of the working poor, 2016 : *BLS Reports*. (2018, July 1). Retrieved from <https://www.bls.gov/opub/reports/working-poor/2016/home.htm>

Bernanke, B. S. (2001, November 30). Monetary policy and inequality. Retrieved February 24, 2018, from Brookings website: <https://www.brookings.edu/blog/ben-bernanke/2015/06/01/monetary-policy-and-inequality/>

Bourguignon, F., Ferreira, F., Milavonic, B., & Ravallion, M. (2010). Global income inequality. In K. A. Reinert, & R. S. Rajan (Eds.), *The Princeton encyclopedia of the world economy*. Princeton University Press. Credo Reference.

Cornia, G. A., & Stewart, F. (Eds.). (2014). *Towards human development: New approaches to macroeconomics and inequality*. Retrieved from <https://books.google.com/books?hl=en&lr=&id=0JsyAwAAQBAJ&oi=fnd&pg=PA99&dq=why+economists+don't+care+about+income+inequality&ots=f10LZd5gUI&sig=gqWK-wwSDjCsqyA9CbGTSGwd7W-g#v=onepage&q=why%20economists%20don't%20care%20about%20income%20inequality&f=false>

Database—Eurostat. (n.d.). Retrieved March 4, 2020, from https://ec.europa.eu/eurostat/data/database?p_p_id=NavTreeportletprod_WAR_NavTreeportletprod_INSTANCE_nPqeVbPXRmWQ&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_pos=1&p_p_col_count=2

Federal Reserve Bank of New York. (2000, July 3). Effective Federal Funds Rate. FRED, Federal Reserve Bank of St. Louis; FRED, Federal Reserve Bank of St. Louis. <https://fred.stlouisfed.org/series/EFFR>

Featured CES Searchable Databases: U.S. Bureau of Labor Statistics. (n.d.). Retrieved March 4, 2020, from <https://www.bls.gov/ces/data/home.htm>

Feldkircher, M., & Kakamu, K. (2018). How does monetary policy affect income inequality in Japan? Evidence from grouped data. *ArXiv:1803.08868* [Econ]. Retrieved from <http://arxiv.org/abs/1803.08868>

Gronbacher, G. M. A. (2012). The need for economic personalism. *Journal of Markets & Morality*, 1(1). Retrieved from <http://www.marketsandmorality.com/index.php/mandm/article/view/660>

Pethokoukis, J. (2019, October 17). 5 questions for Michael Strain on inequality and public policy. Retrieved October 17, 2019, from American Enterprise Institute—AEI website: <https://www.aei.org/economics/5-questions-for-michael-strain-on-inequality-and-public-policy/>

Romer, C. D., & Romer, D. H. (1999). Monetary policy and the well-being of the poor. *Economic Review* (01612387), 84(1), 21.

Sheiner, M. N., David Wessel, and Louise. (2018, August 21). The Hutchins Center explains: The Phillips Curve. Retrieved October 17, 2019, from Brookings website: <https://www.brookings.edu/blog/up-front/2018/08/21/the-hutchins-center-explains-the-phillips-curve/>

Sperling, G.. (2019, March 11). Retrieved November 12, 2019, from Democracy Journal website: <https://democracyjournal.org/magazine/52/economic-dignity/>

Telford, T. (n.d.). Income inequality in America is the highest it's been since Census Bureau started tracking it, data shows. Retrieved October 17, 2019, from Washington Post website: <https://www.washingtonpost.com/business/2019/09/26/income-inequality-america-highest-its-been-since-census-started-tracking-it-data-show/>

The Hamilton Project. (n.d.). Retrieved October 17, 2019, from <https://www.brookings.edu/project/the-hamilton-project/>

Yellen: Federal Reserve likely to raise rates. (2014). Retrieved February 13, 2018, from <http://ebscovideos.ebscohost.com/v/118607894/yellen-federal-reserve-likely-to-raise-rates.htm>



Nutrient Recycling from Aqueous for Nitrogen Supplementation in Algae Growth

Alyssa L. Young

ACKNOWLEDGEMENTS

There are many individuals and organizations that made this project possible. I would first like to thank the Olivet Honors Program for the opportunity and funding to complete this project. I would also like than the Chemistry and Biology departments for allowing me to use laboratory space to perform my experiments.

I would like to thank my mentor Dr. Willa Harper for her guidance and encouragement throughout this project. I would also like to thank Dr. Dan Sharda for his invaluable advice and instruction throughout this project.

I would also like to thank my mentors at the National Renewable Energy Laboratory, Dr. Lieve Laurens and Dr. Steven Rowland. Without their expertise and knowledge this project would not have been possible. The following people were also instrumental in the completion of this project: Nick Sweeny, Damien Douchi, Tao Dong, Brittiany Thornton, and Bonnies Panczak.

This work was financially supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internship (SULI) program at the National Renewable Energy Laboratory during the summer 2019.

ABSTRACT

Algae-derived biofuels have the potential to become a source of renewable liquid fuel via hydrothermal liquefaction. However, for algal biofuels to be economically and environmentally feasible, sustainable nutrient recycling must be achieved. *Desmodesmus armatus* is a microalga to be used in hydrothermal liquefaction, but it is not yet known if the aqueous product waste from the biofuel production process can be recycled as a nitrogen source to support the growth of subsequent cultures of *D. armatus*. Here, aqueous product was treated with a Dowex 50WX8 resin for twenty-four hours. Growth media was prepared with treated and untreated aqueous product at 25% nitrogen supplementation for culturing *D. armatus*, and growth was tracked using optical density measurements. We found that growth rates between the untreated, treated, and control conditions were similar, and not significantly different. This indicates that the recycling of aqueous product from hydrothermal liquefaction for the growth of *D. armatus* is a sustainable way to achieve nutrient recycling for algae biofuels. If it is possible to recycle aqueous product directly from hydrothermal liquefaction to growth media, then the overall process of algae biofuels will become more economically feasible than using the treated aqueous product. This study demonstrates, for the first time, the possibility of using untreated aqueous product for use in growing *D. armatus*.

Keywords: Aqueous product, nutrient recycling, algae biofuels, biofuels, hydrothermal liquefaction

INTRODUCTION

As the world's energy demand continues to increase, the production of renewable forms of energy will become even more important to the global energy portfolio. In the last five decades, there have been many advancements in renewable energy, including the creation of fuel from microalgae via hydrothermal liquefaction (HTL) (Jiang et al., 2019; Laurens, 2017; Leng et al., 2018). Microalgae biofuels have the potential to replace traditional nonrenewable sources of liquid fuels. Algae are uniquely suited to become a feedstock, or source, for biofuel production because of their ability to be cultivated at mass scale, as they are fast-growing and can be grown on non-arable lands (Elliott et al., 2015). The microalgae species *Desmodesmus armatus* (*D. armatus*) is a particularly promising microalgae species. *D. armatus* is known for its ability to grow in non-ideal conditions and its high lipid content (P. H. Chen et al., 2020).

HTL of microalgal biomass yields a liquid fuel that is comparable to current liquid gasoline, allowing for the possibility of direct supplementation of liquid fossil fuels with little to no modification of current technologies. HTL is the application of high temperature and pressure to a biomass slurry to create mainly a bio-crude oil (Elliott et al., 2015; Juneja et al., 2013; Laurens, 2017; Shakya et al., 2017). There are three products produced from HTL: biocrude oil, aqueous product (AP), and char (Leng et al., 2018; Shakya et al., 2017; Vo et al., 2017). A general process flow diagram can be seen below (**Figure 1**).

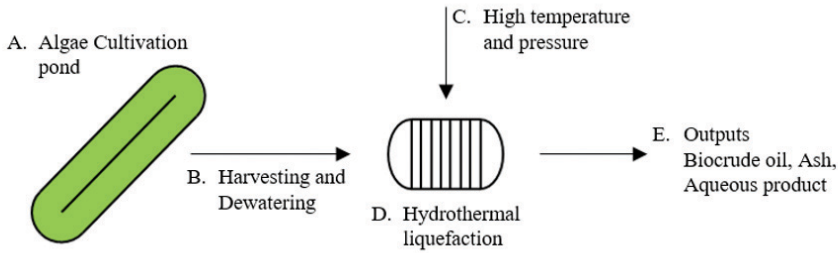


Figure 1: General process flow diagram for a hydrothermal liquefaction process. General process flow diagram for a hydrothermal liquefaction process showing A) the cultivation of microalgae B) the harvesting a dewatering of the microalgae C) the application of high temperature and pressure via D) hydrothermal liquefaction E) biocrude oil, ash, and aqueous product.

HTL is a promising fuel conversion method because it does not require a feedstock that has gone through a costly drying processes (Quinn & Davis, 2015). However, bio-crude oil from the HTL of microalgae tends to contain high levels of nitrogen and oxygen, meaning further upgrading is required to meet national fuel standards, which require low levels of NO_x emissions (Wang & Tao, 2016). This increases the cost of HTL derived biofuels. Another aspect leading the increased costs of HTL-derived biofuels is the inconsistency in the output from HTL. HTL products are highly dependent upon input feed, changing based upon biomass composition, wt.% biomass, and media used to grow the biomass. Due to the multiple input variables, it is difficult to predict and classify the outputs of HTL leading to increased costs.

Currently, microalgae biofuels from HTL are predicted to cost \$4.35–\$4.49 per gasoline gallon equivalent (GGE) (Davis et al., 2016). The United States Department of Energy Bioenergy Technologies Office has set a goal of \$3/GGE for liquid biofuels. Therefore, the cost of HTL-derived biofuels from microalgae must decrease significantly to reach this goal (Davis et al., 2016).

One way to potentially decrease the costs of microalgae biofuels is through nutrient recycling. Growing microalgae requires substantial amounts of the nutrients phosphorus and nitrogen (Juneau et al., 2013). The demand for nutrients makes microalgae biofuels currently unfeasible, as the creation and acquisition of fresh nutrients can be detrimental to the environment and cost prohibitive (Davis et al., 2016; Laurens, 2017). Estimates done by Davis et al. suggest that 22% of the minimum biomass selling point is accounted for by CO₂ and nutrient inputs for an average 10-acre pond (Davis et al., 2016). If nutrients can be recycled back into the growth media used for growing microalgae, then fewer fresh nutrients will need to be used, and the cost of producing microalgae biofuels can be decreased. Nitrogen is one of the main nutrients needed for microalgae growth, and previous work has shown that the nitrogen content in microalgae growth media may be supplemented with nitrogen from a waste product of HTL (P. H. Chen et al., 2020).

HTL yields two main waste products: aqueous product (AP) and char (Leng et al., 2018; Shakya et al., 2017; Vo et al., 2017). AP has been shown to retain a high percentage of the nitrogen found in the feedstock used for conversion (Shakya et al., 2017). Moreover, microalgae will grow in AP that has been diluted into other growth mediums (Biller et al., 2012; Garcia Alba et al., 2013). A study done by Biller et al. tested five different microalgae species and found that all had inhibited growth at 50x dilution of AP, but growth was improved once 200x dilution of AP was achieved. A similar study by Alba et al. showed that the microalgae species *Desmodesmus* sp. can grow in solutions containing demineralized water, standardized growth media and AP at approximately 50, 49.75, and .25 wt.% respectively. There was no significant difference between growth rates for *Desmodesmus* sp. grown in the given solution and those that grew in standard growth media. The researchers also found that there are compounds in AP that can inhibit microalgae growth such as toxic organic compounds or ammoniacal nitrogen (Garcia Alba et al., 2013).

Because of the hypothesis that there are toxic components in AP, multiple studies treating AP with different adsorbents have been attempted. These studies have cited improved growth of microalgae in media containing AP treated with various adsorbents when compared to growth in media containing untreated AP. These studies used adsorbents such as cation exchange resins and granulated active carbon (K. Chen et al., 2015; P. H. Chen et al., 2020; Fushimi et al., 2016). However, these studies have not definitively shown that the compounds removed by the adsorbents inhibit growth of microalgae, and there has been little work done to classify which compounds these adsorbents removed from the AP. As a result, the inhibited growth could be caused by something other than compounds in the AP.

One adsorbing agent that shows promise is a cation exchange resin called Dowex. This resin has been shown to improve the growth of *Chlorella* sp. when growth in treated AP is compared to growth in untreated AP (P. H. Chen et al., 2020). In 2020, P.H. Chen reported that there was a linear growth rate of approximately 0.3 grams per day for *Chlorella* sp. grown in both traditional growth media and media containing AP treated by Dowex and diluted to 100x. This is an improvement over a linear growth rate of approximately 0.1 grams per day for *Chlorella* sp. grown in traditional growth media containing untreated AP diluted to 100x (P. H. Chen et al., 2020).

D. armatus is a microalgae species that has some promising properties for HTL due to its robust growth in outdoor conditions and attractive biomass composition for conversion (P. H. Chen et al., 2020). These properties are due to *D. armatus*' ability to grow in adverse conditions such as non-optimized media and in the presence of toxins. There is a large interest in testing *D. armatus*' response to growth in AP. However, there is little known about the AP derived from *D. armatus* and how Dowex treatment would affect subsequent growth.

In this study, we investigated how AP derived from the HTL of *D. armatus* would affect the growth of *D. armatus*, and the ability for treatment with Dowex 50WX8 to improve growth. Growth trials were performed using *D. armatus* to determine the

feasibility of nitrogen recycling from AP for microalgae growth. We hypothesized that media containing treated AP from the HTL of *D. armatus* would lead to improved growth rates when compared to growth media containing untreated AP.

MATERIALS AND METHODS

HTL aqueous phase

D. armatus was harvested from two 75 L raceway ponds. Once harvested the algae was dewatered via centrifugation until the dry weight was between 20-30%. This created an algal slurry that was used for HTL. Four 75 mL Parr reactors were loaded with approximately 25g of algae slurry each. The reaction vessels were purged prior to heating, and HTL was performed at 300°C for 30 min. After the reaction was complete, the AP was separated from the biocrude through gravity filtration. The AP was then passed through a 0.22-micron filter to remove the remaining ash.

Aqueous product treatment

The isolated AP (40 mL) was placed in a beaker with 8g of Dowex 50WX8 resin, and the mixture was covered and placed on a stir plate for 24 hrs. The treated AP was separated from the spent Dowex resin using a Buchner funnel with .22-micron filter paper. The AP was filtered three times to ensure full removal of Dowex resin.

Adsorbate removal

The Dowex resin used to treat the AP was washed with various solutions to remove some of the adsorbates. The washes used were dichloromethane: methanol (50:50 v/v) with acetic acid (10%); methanol: acetic acid (95:5); water: acetic acid (95:5). All washes were performed three times, with separation of the Dowex resin from the wash via vacuum filtration performed after each rinse. The washes were then combined and dried under nitrogen. The removed adsorbates were re-dissolved using water: 95% ethyl alcohol (90:10). This method was also applied to *Chlorella vulgaris* (*C. vulgaris*) for comparison with previous work. The removed adsorbates from *D. armatus* that were re-dissolved were used to create growth media.

Mass balance

Mass balance calculations were performed to determine the mass of material removed from the Dowex resin. Three 1mL samples from the untreated AP and the treated AP were taken and dried under nitrogen. Three 1mL samples from the three Dowex washes were also dried under nitrogen. After evaporation under nitrogen, the samples were weighed to determine the mass yield of each wash in comparison to the treated and untreated AP samples.

Nitrogen determination

The amounts of carbon, hydrogen, and nitrogen present in untreated AP, treated AP, and the adsorbates removed from *D. armatus* were analyzed by carbon, hydrogen, nitrogen combustion analysis (Table 1). The information gathered was used to calculate the amount of each solution needed to reach 2.5 mM nitrogen (**Table 1**). All growth trails contained 10 mM nitrogen per liter of growth media, hence 2.5 mM of nitrogen represents 25% nitrogen replacement for one liter of growth media.

TABLE 1: NITROGEN PRESENT IN VARIOUS SOLUTIONS

Amount of solution needed for 2.5 mM nitrogen in 1 L of growth media determined by CHN combustion analysis.

Solution	Nitrogen % in solution	Amount of solution needed for 2.5 mM of nitrogen in 1 L of media
Untreated AP	0.67	5.05 mL
Treated AP	0.23	15.78 mL
Adsorbate solution	0.12	30.75 mL

Algae cultivation and analysis

Different conditions were created and tested to demonstrate how *D. armatus* grows in AP. All media contained modified artificial seawater media (MASM) without any nitrogen sources added (Table 2). Once created, all media were adjusted to a total nitrogen concentration of 10 mM using NH₄Cl and recycled HTL aqueous phase. The following media were created, and growth trials for each media were performed in triplicate (Figure 2).

TABLE 2: RECIPE FOR MASM USED AS BASE MEDIA IN GROWTH TRIALS

Component	Amount per Liter
NaCl ¹	8.0 g
MgSO ₄ • 7H ₂ O	2.49 g
KCl	0.6 g
CaCl ₂ • 2H ₂ O	0.3 g
Tris base	1.0 g
NaHCO ₃	0.84 g
KH ₂ PO ₄	2 ml of a 25 g/l mixture
CM T.E.	6.0 ml
Thiamine and B ₁₂ mixture	0.5 ml

¹ The repeated growth trial did not contain any NaCl

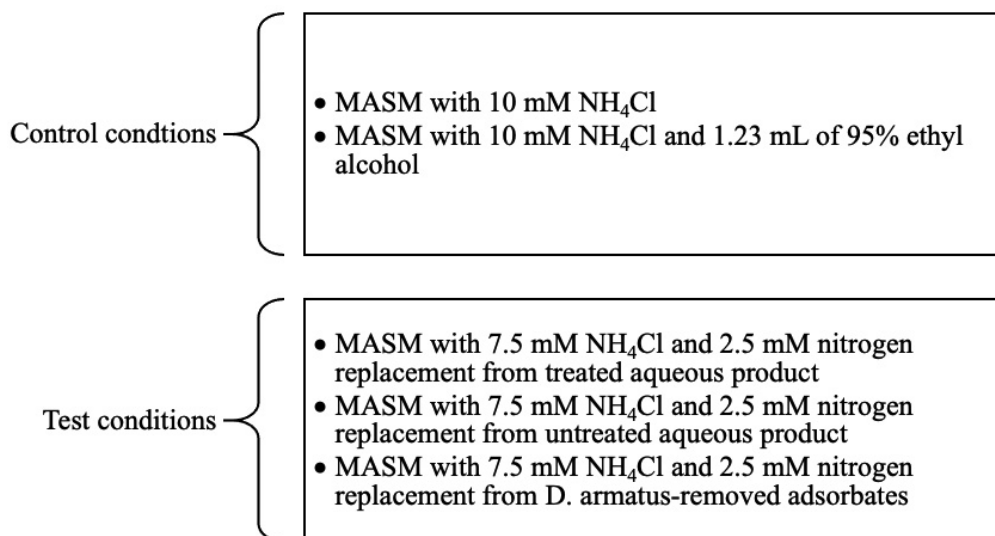


Figure 2: Summary of growth conditions. Summary of growth conditions used to test the effects that untreated and treated AP has on the growth of microalgae species *D. armatus*. Growth conditions all contained 10 mM total nitrogen.

Since the solution containing the adsorbates removed from *D. armatus* contains 95% ethyl alcohol, there was a possibility that the ethyl alcohol would inhibit growth. To control for this, a media was created with 10 mM NH₄Cl and 1.23 mL of 95% ethyl alcohol. This control media contains the same amount of ethyl alcohol that is in the experimental condition for the removed adsorbates.

Growth media were inoculated with wild type *D. armatus* to an optical density (OD) at 750 nm (OD₇₅₀) of approximately 0.1. All conditions were repeated in triplicate with a working volume of 125 mL in 500mL flasks with foam tops. All flasks were placed on shaker plates with consistent light of 50-60 μ m with temperatures ranging from 24-26°C. Optical density measurements, at 750 nm, were taken every weekday to develop growth curves for each experimental condition. All trials were compared with a blank of a sample of the growth media for that experimental condition.

A repetition of the experiment was performed to increase confidence in the results. The setup for the second replicate was slightly altered due to space and material resource availability. All conditions for the second replicate were performed in triplicate with a working volume of 50 mL in 250 mL flasks with foam tops. MASM without NaCl or nitrogen was used as the base media. Light was supplied consistently at 30 μ m, and the temperature was constant (24°C). Because different light conditions and timing were used, the two trials were examined separately.

Contamination

To monitor for the interference of bacterial growth on reported data, appropriate measures were taken to determine when or if a growth trial was dominated by bacterial growth rather than algae growth. These measures included OD taken at 680 nm, visual inspection, and microscopy.

Growth curves at 680 nm

Growth curves for both the initial and repeated growth trials were developed for a wavelength of 680 nm in addition to the growth curves developed at 750 nm. If the growth curves between the 750 nm and 680 nm wavelengths showed similar trends, then it was determined that the condition was not overly contaminated. Growth curves at 680 nm can be found in Appendix B.

Visual inspection

Each day, flasks were visibly inspected to determine the degree of contamination. If the growth conditions were good (*i.e.*, small amounts of bacteria growth), the samples appeared a dark green color when mixed and had longer settling times. After settling, a clear media appeared on top. Experimental conditions that became more contaminated appeared a pale green when mixed and settled more quickly than the other conditions. After settling, a cloudy media appeared on top. Images showing the characterization of the different trials can be found in Appendix C

Microscopy

Aliquots from each sample were observed under a microscope at 40x magnification to determine the condition of each flask. If a culture had a high density of algae with little to no background bacteria, it was considered usable. Experimental conditions with a high density of bacteria and lots of debris were considered overly contaminated and not used. Only cultures that had both a high density of bacteria and high mobility were categorized as contaminated. Example images from microscopy with descriptions can be found in Appendix D.

RESULTS

Mass balance

Mass balance calculations were performed to quantify the effects of treating AP with a Dowex 50WX8 resin. Untreated and treated AP were dried down under nitrogen to determine the mass present in 1 mL of respective AP samples. Percent recovery was then determined by comparing the mass found in 1 mL of untreated AP to the mass found in 1 mL of treated AP. To determine the percent recovery of material from washing the spent Dowex resin, the same procedure was performed on the three different solutions that were used to for washing the Dowex. A summary of these results can be found in **Figure 3**.

The development of the solutions used to wash the Dowex resin used to treat the *D. armatus* AP was developed using AP from the microalgae species *C. vulgaris*. Dowex 50WX8 resin was used to treat AP from the HTL of *C. vulgaris*. The spent Dowex resin was washed with various solutions until the optimum method for removing

material was found. The following three solutions were found to be the most effective: a) dichloromethane: methanol: acetic acid, b) methanol: acetic acid, c) water: acetic acid. Mass balance calculations were performed as described to determine the percent recovery of mass in the treated AP and removed adsorbates for *C. vulgaris* and *D. armatus*. The results are shown in **Figure 3**.

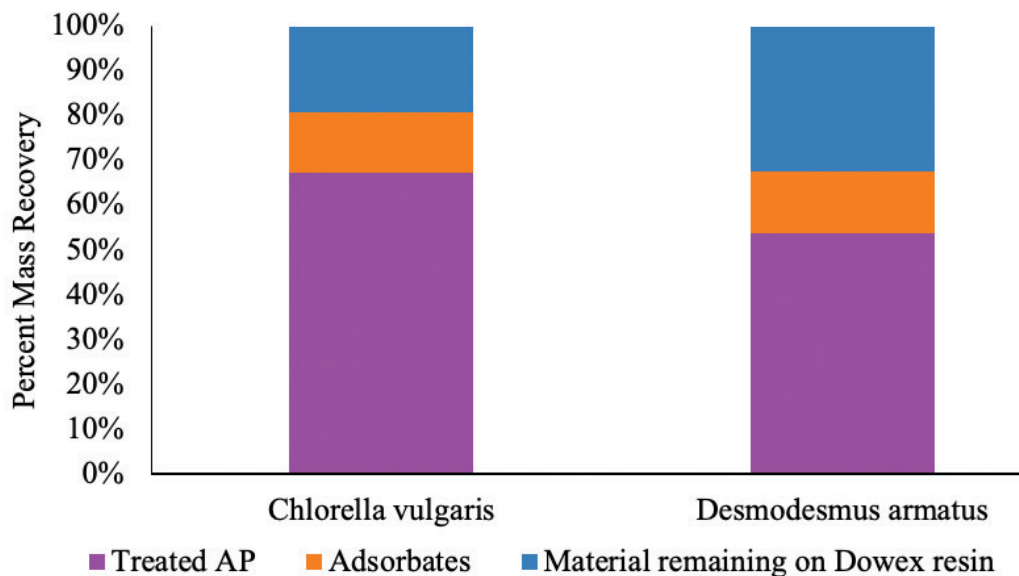


Figure 3: Comparison of percent mass recovery from *C. Vulgaris* and *D. armatus*. When looking at 1 mL samples of the following solutions dried under nitrogen in comparison to untreated aqueous product from the two microalgae species. Solution one: aqueous product from *C. vulgaris* and *D. armatus* treated with a Dowex 50WX8 resin. Solution two: adsorbates removed from spent Dowex resin used the following washes: a) dichloromethane: methanol: acetic acid, b) methanol: acetic acid, c) water: acetic acid.

C. vulgaris had a 67% recovery of the treated AP fraction compared to 53% for *D. armatus*. The adsorbates exhibited a percent recovery of approximately 13% in both cases. The remaining fraction is the material that was left of the Dowex 50WX8 resin. Comparison of these samples also reveals that *D. armatus* resulted in a greater quantity of irreversibly adsorbed compounds when compared to *C. vulgaris* (34% vs. 20%). This is likely due to greater molecular polarity in the HTL aqueous phase for *D. armatus*, which makes recovery from the resin more difficult. Further work is necessary to determine if these highly polar compounds may be removed and what chemical properties lead to their strong interaction with Dowex.

Algae cultivation and analysis

Figure 4 shows the growth curves for the first trial of the experiment. The growth curve was developed by taking ODs at 750 nm. The treated AP, untreated AP, and control conditions all exhibited comparable growth rates throughout the experiment. We had hypothesized that the untreated AP would yield the lowest growth rate and that the treated AP would yield the highest growth rate. This is not supported by the data, since the growth rates between the untreated AP and treated AP were comparable.

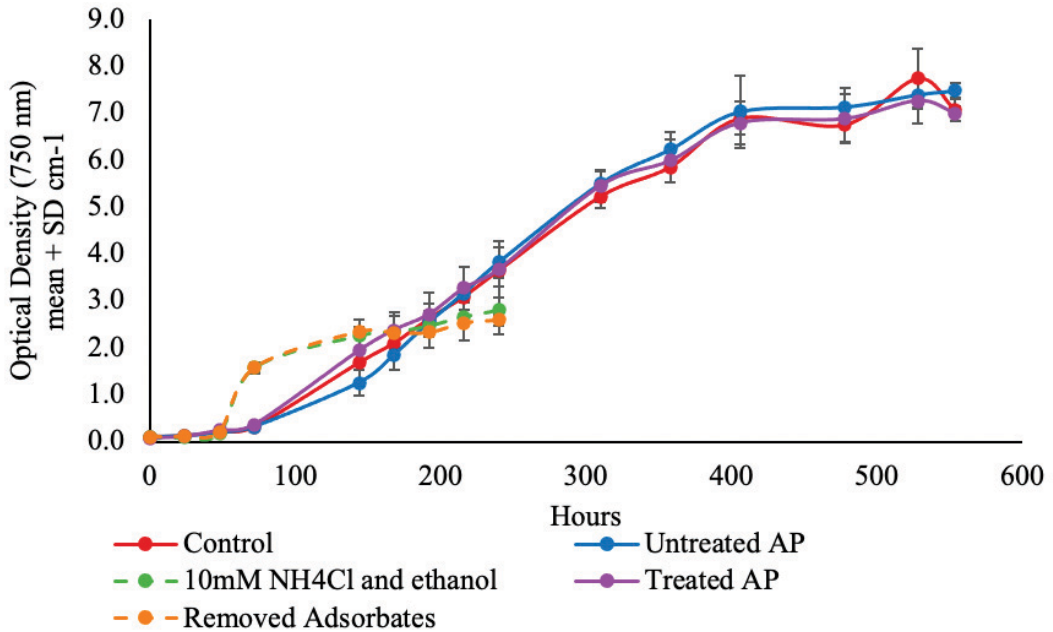


Figure 4: Growth curves for second growth trial with OD taken at 750 nm. Growth conditions were as follows: control conditions: MASM with 10 mM NH₄Cl, MASM with 10 mM NH₄Cl and 1.23 mL of 95% ethyl alcohol. Experimental conditions: MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from treated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from untreated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from adsorbates removed from *D. armatus*. Growth trials were grown in triplicate.

The first trial showed similar results, and growth curves for the first growth trial can be found in appendix A. The treated AP conditions, untreated AP conditions, and control conditions all exhibited comparable growth rates. For both experiments, the 10 mM NH₄Cl-ethanol and removed adsorbate trials became overly contaminated with bacteria early in the growth period, yielding inconclusive data.

DISCUSSION

This study sought to characterize the effects of nitrogen supplementation with treated or untreated AP on microalgae growth. We found that both treated and untreated AP lead to comparable growth rates. In addition, these growth rates were equivalent with the growth rates from the control trials using ammonium chloride, indicating that both treated and untreated AP can be used in nitrogen supplementation for the growth of *D. armatus*. This is significant because other species of algae have not shown the ability to grow in untreated AP. If untreated AP can be used for nitrogen supplementation in growth media, the overall process of algae biofuel production will become more economically feasible and environmentally friendly.

The data gathered from this experiment indicate that the growth of *D. armatus* is not affected by either untreated or treated AP when 25% nitrogen replacement is used as a

basis. The optical density for the control, untreated, and treated AP samples were within the range of 7-7.5 absorbance units (once corrected for dilution) during the repeated growth trials. In addition, none of these trials showed high levels of contamination, indicating that the *D. armatus* microalgae cells were not excreting extracellular polymeric substances. Therefore, they were not stressed. As the *D. armatus* cultures were not stressed by the introduction of treated or untreated AP, it would be beneficial to determine the extent to which nitrogen supplementation via AP can be achieved. A study done by P.H. Chen et al. examined the relationship between microalgae growth and varied percent nitrogen supplementation from Dowex 50WX8-treated AP. This study examined the growth of *C. vulgaris*. The researcher found that *C. vulgaris* growth rate, with nitrogen supplementation from Dowex-treated AP (to a level of 35% nitrogen replacement), were comparable to control condition growth rates. A similar methodology could be used to determine the extent to which nitrogen supplementation from untreated AP can be performed for *D. armatus*.

The conclusion that *D. armatus* yields comparable growth rates for treated AP and control condition is in line with the current literature. P.H. Chen et al. determined that *C. vulgaris* has comparable growth rates for treated AP and control conditions when a Dowex resin is used to treat the AP (P. H. Chen et al., 2020). Multiple studies cite improved growth rates of microalgae in treated AP over untreated AP, indicating that untreated AP contains compounds that inhibit the growth of microalgae (Biller et al., 2012; P. H. Chen et al., 2020; Garcia Alba et al., 2013). *D. armatus* did not show inhibited growth rates in media containing untreated AP at 25% nitrogen replacement (approximately 5 wt.%), showing that either AP from the HTL of *D. armatus* does not contain growth-inhibiting compounds or that *D. armatus* is robust enough not to be affected by any growth-inhibiting compounds, that may be present in the untreated AP. To determine whether the AP from the HTL of *D. armatus* contains growth-inhibiting compounds, it may be beneficial to test the growth of other algae species in untreated AP from the HTL of *D. armatus*. It may also be beneficial to test algae growth by increasing the percent nitrogen replacement in the growth media.

The uninhibited growth of *D. armatus* when in the untreated AP media was unexpected. All other studies indicate that microalgae do not grow as well in untreated AP (K. Chen et al., 2015; P. H. Chen et al., 2020; Fushimi et al., 2016). For example, a study done by P.H. Chen showed that *Chlorella sp.* had comparable growth rates when grown in traditional growth media and when grown in traditional growth media with Dowex-treated AP. The rates were approximately 0.3 grams per day when the treated AP was diluted 1:100. *Chlorella sp.* grown in traditional growth media with untreated AP had a linear growth rate of approximately 0.1 grams per day (P. H. Chen et al., 2020). However, this is the first study performed on *D. armatus* growth in media containing AP. This is a novel finding that will have to be investigated farther.

It is important to note that in both iterations of the growth trials, the conditions containing ethanol (10 mM NH₄Cl and ethanol, removed adsorbates) experienced unexpected bacterial growth, indicating that additional experimental controls should be used in any repetitions of this experiment. Since both trials included the addition

of ethanol, it is possible that the presence of ethanol is responsible for the increased bacterial growth. This finding is not supported by the literature, but no studies have been conducted exploring the relationship between algae growth and ethanol. The exact reason why the two trials containing ethanol showed high levels of bacterial growth is unknown. One reason is that ethanol could have caused bacterial growth by stressing the *D. armatus* cultures, leading to the excretion of exopolysaccharides. Bacteria can feed off exopolysaccharides, which may have led to the high level of bacterial growth for these two trials. Future work investigating a possible link between ethanol and bacterial growth or ethanol and inhibited algal growth of *D. armatus* may prove insightful.

If untreated AP can be used in nitrogen supplementation for the growth of *D. armatus*, the overall process of algae biofuel production will become more economically feasible and environmentally friendly. It is difficult to quantify the effects of nitrogen supplementation because there is not enough information available about *D. armatus* as a feedstock for algae biofuels. It can be assumed, however, that if nitrogen can be recycled without treatment, fewer fresh nutrients would be required; and the cost of algae biofuels would decrease. However, the extent to which this may affect the cost of biofuels from *D. armatus* is not known. It can also be assumed that if nitrogen no longer needs to be produced at mass scale to grow algae biofuels, then it becomes a more environmentally friendly operation.

This study showed that *D. armatus* can grow in media containing 25% nitrogen replacement from untreated AP. More work should be done to determine the extent to which nitrogen can be replaced by either treated or untreated AP. In addition, work should be done to determine the chemical composition of AP derived from HTL of *D. armatus* for comparison with AP derived from other microalgae species. This may give a better understanding of why *D. armatus* was able to grow in untreated AP when other algae species have not. The development of commercial scale algae biofuels operations appears to be on the horizon.

REFERENCES

- Biller, P., Ross, A. B., Skill, S. C., Lea-Langton, A., Balasundaram, B., Hall, C. Riley, R., & Llewellyn, C. A. (2012). Nutrient recycling of aqueous phase for microalgae cultivation from the hydrothermal liquefaction process. *Algal Research*, 1(1), 70–76. <https://doi.org/10.1016/j.algal.2012.02.002>
- Chen, K., Lyu, H., Hao, S., Luo, G., Zhang, S., & Chen, J. (2015). Separation of phenolic compounds with modified adsorption resin from aqueous phase products of hydrothermal liquefaction of rice straw. *Bioresource Technology*, 182, 160–168. <https://doi.org/10.1016/j.biortech.2015.01.124>
- Chen, P. H., Venegas Jimenez, J. L., Rowland, S. M., Quinn, J. C., & Laurens, L. M. L. (2020). Nutrient recycle from algae hydrothermal liquefaction aqueous phase through a novel selective remediation approach. *Algal Research*, 46, 101776. <https://doi.org/10.1016/j.algal.2019.101776>
- Davis, R., Markham, J., Kinchin, C., Grundl, N., Tan, E. C. D., & Humbird, D. (2016). *Process Design and Economics for the Production of Algal Biomass: Algal Biomass Production in Open Pond Systems and Processing Through Dewatering for Downstream Conversion* (NREL/TP--5100-64772, 1239893). <https://doi.org/10.2172/1239893>
- Elliott, D. C., Biller, P., Ross, A. B., Schmidt, A. J., & Jones, S. B. (2015). Hydrothermal liquefaction of biomass: Developments from batch to continuous process. *Bioresource Technology*, 178, 147–156. <https://doi.org/10.1016/j.biortech.2014.09.132>
- Fushimi, C., Kakimura, M., Tomita, R., Umeda, A., & Tanaka, T. (2016). Enhancement of nutrient recovery from microalgae in hydrothermal liquefaction using activated carbon. *Fuel Processing Technology*, 148, 282–288. <https://doi.org/10.1016/j.fuproc.2016.03.006>
- Garcia Alba, L., Torri, C., Fabbri, D., Kersten, S. R. A., & (Wim) Brilman, D. W. F. (2013). Microalgae growth on the aqueous phase from Hydrothermal Liquefaction of the same microalgae. *Chemical Engineering Journal*, 228, 214–223. <https://doi.org/10.1016/j.cej.2013.04.097>
- Jiang, Y., Jones, S. B., Zhu, Y., Snowden-Swan, L., Schmidt, A. J., Billings, J. M., & Anderson, D. (2019). Techno-economic uncertainty quantification of algal-derived biocrude via hydrothermal liquefaction. *Algal Research*, 39, 101450. <https://doi.org/10.1016/j.algal.2019.101450>

Juneja, A., Ceballos, R. M., & Murthy, G. S. (2013). Effects of Environmental Factors and Nutrient Availability on the Biochemical Composition of Algae for Biofuels Production: A Review. *Energies*, 6(9), 4607–4638. <https://doi.org/10.3390/en6094607>

Laurens, L. (2017). *State of Technology Review—Algae Bioenergy*. <https://doi.org/10.13140/RG.2.2.11770.90560>

Leng, L., Li, J., Wen, Z., & Zhou, W. (2018). Use of microalgae to recycle nutrients in aqueous phase derived from hydrothermal liquefaction process. *Bioresource Technology*, 256, 529–542. <https://doi.org/10.1016/j.biortech.2018.01.121>

Quinn, J. C., & Davis, R. (2015). The potentials and challenges of algae based biofuels: A review of the techno-economic, life cycle, and resource assessment modeling. *Bioresource Technology*, 184, 444–452. <https://doi.org/10.1016/j.biortech.2014.10.075>

Shakya, R., Adhikari, S., Mahadevan, R., Shanmugam, S. R., Nam, H., Hassan, E. B., & Dempster, T. A. (2017). Influence of biochemical composition during hydrothermal liquefaction of algae on product yields and fuel properties. *Bioresource Technology*, 243, 1112–1120. <https://doi.org/10.1016/j.biortech.2017.07.046>

Vo, T. K., Kim, S.-S., Ly, H. V., Lee, E. Y., Lee, C.-G., & Kim, J. (2017). A general reaction network and kinetic model of the hydrothermal liquefaction of microalgae *Tetraselmis* sp. *Bioresource Technology*, 241, 610–619. <https://doi.org/10.1016/j.biortech.2017.05.186>

Wang, W.-C., & Tao, L. (2016). Bio-jet fuel conversion technologies. *Renewable and Sustainable Energy Reviews*, 53, 801–822. <https://doi.org/10.1016/j.rser.2015.09.016>

APPENDIX A

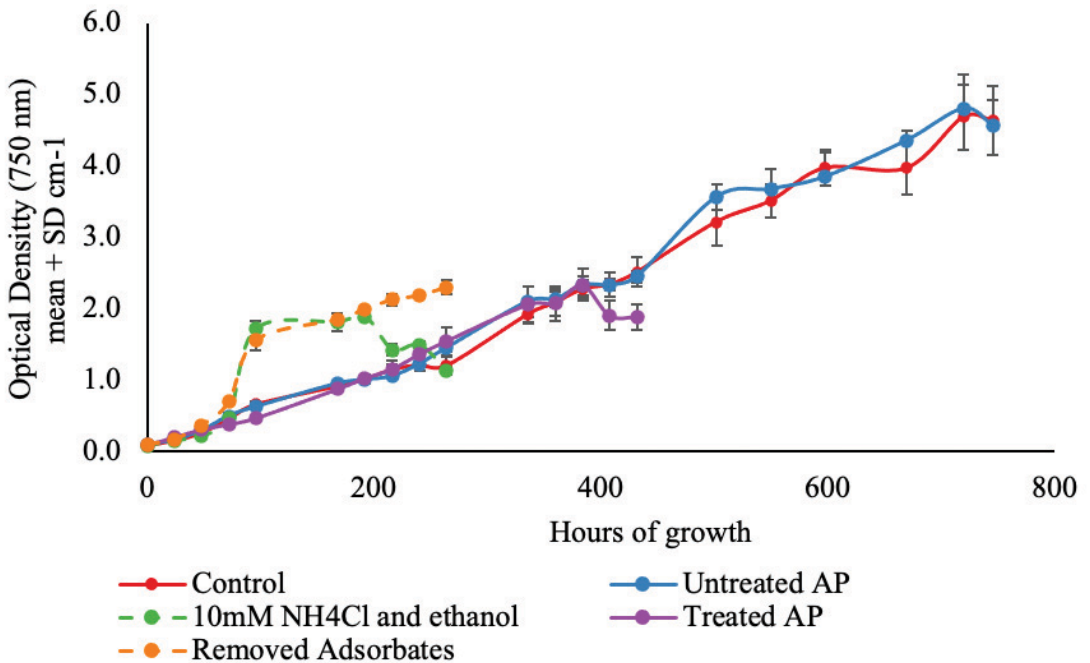


Figure A1: Growth curves for initial growth trial with OD taken at 750 nm. Growth conditions were as follows. Control conditions: MASM with 10 mM NH₄Cl, MASM with 10 mM NH₄Cl and 1.23 mL of 95% ethyl alcohol. Experimental conditions: MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from treated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from untreated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from adsorbates removed from *D. armatus*. Growth trials were grown in triplicate. Dashed lines indicate contaminated cultures.

APPENDIX B

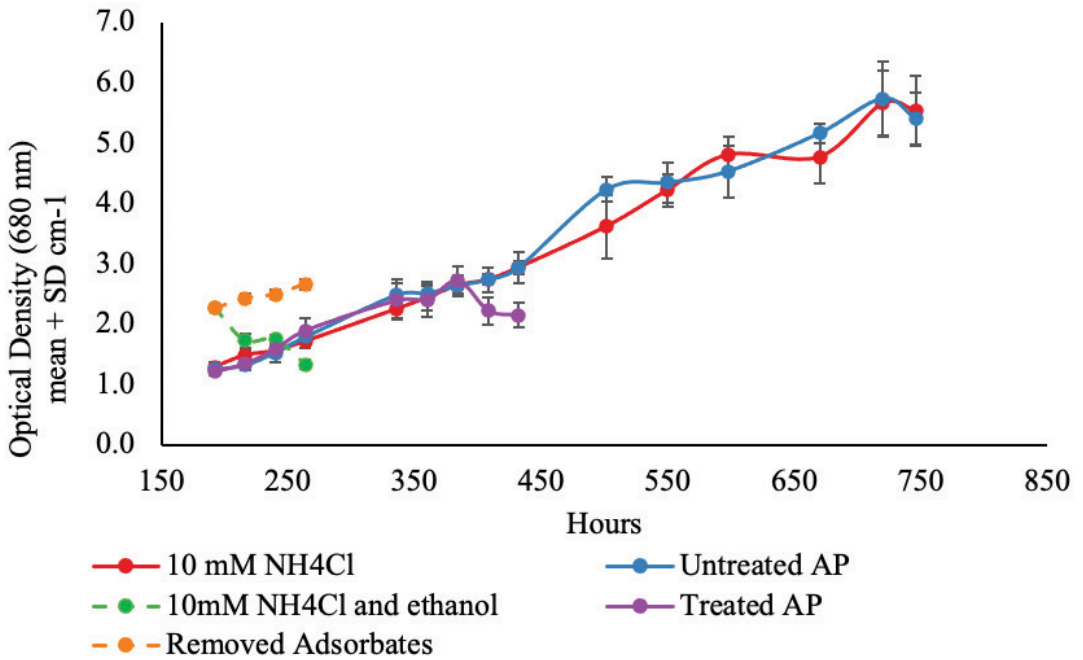


Figure B1: Initial growth curve of *D. armatus* at 680 nm. Growth conditions were carried out as follows. Control conditions: MASM with 10 mM NH₄Cl, MASM with 10 mM NH₄Cl and 1.23 mL of 95% ethyl alcohol. Experimental conditions: MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from treated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement adsorbates removed from *D. armatus*. Growth trials were grown in triplicate. Dashed lines indicate contaminated cultures.

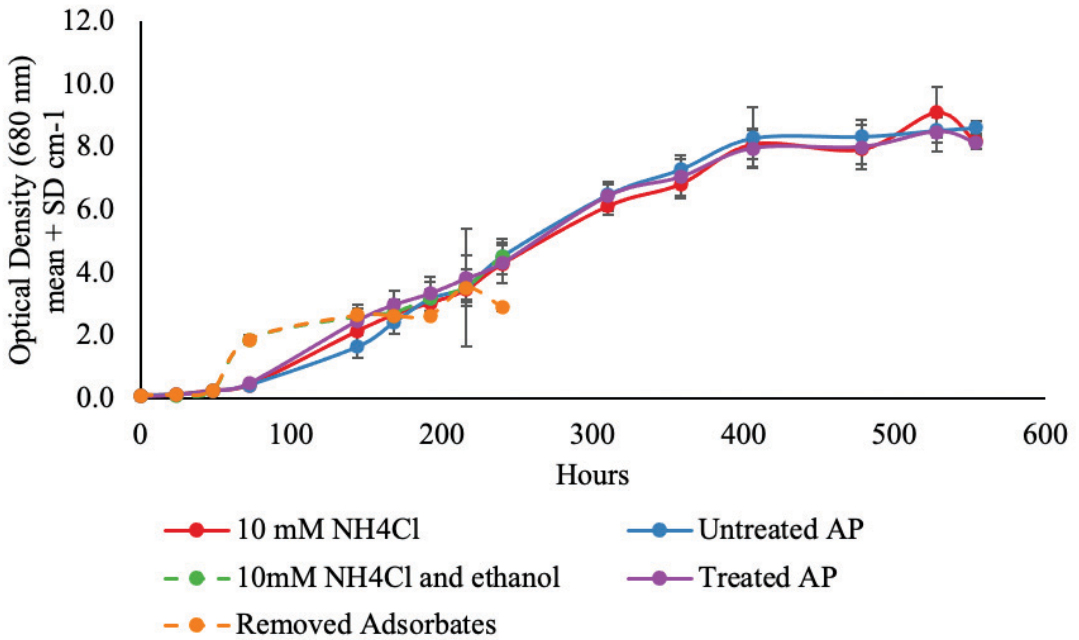


Figure B2: Repeated growth curve of *D. armatus* at 680 nm. Growth conditions were as follows. Control conditions: MASM with 10 mM NH₄Cl, MASM with 10 mM NH₄Cl and 1.23 mL of 95% ethyl alcohol. Experimental conditions: MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement from treated aqueous product, MASM with 7.5 mM NH₄Cl and 2.5 mM nitrogen replacement adsorbates removed from *D. armatus*. Growth trials were grown in triplicate. Dashed lines indicate contaminated cultures.

APPENDIX C

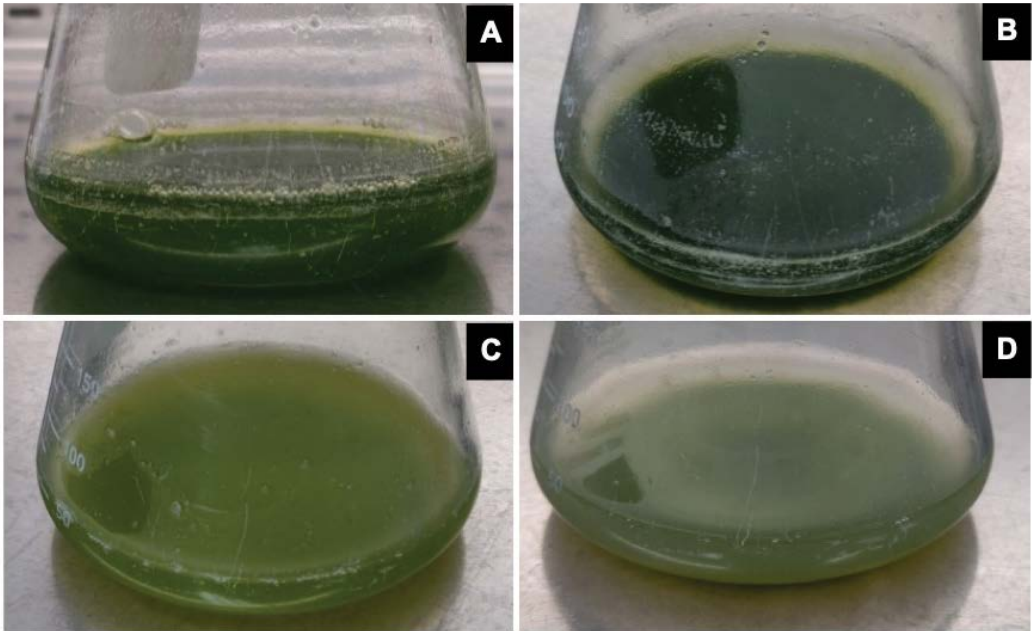


Figure C1: Images for visual inspection of various conditions. Examples of cultures: (a) control condition agitated culture exhibiting a dark green uniform color indicating minimal contamination (b) control condition settled culture with clear media on top layer indicating minimal contamination. (c) 10 mM NH_4Cl and ethanol agitated culture exhibiting light green inconsistent coloring indicating contamination. (d) 10 mM NH_4Cl and ethanol settled culture with opaque media on top layer indicating contamination.

APPENDIX D

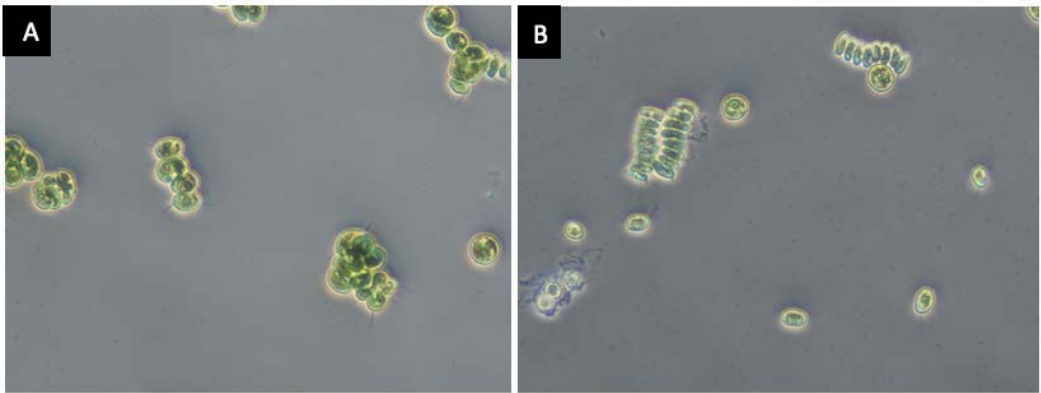


Figure D1: Microscopy images of a cultures that were not contaminated. A) Image A shows a control condition culture expressing a high density of *D. armatus* cells with little background bacteria. B) Image B shows a treated AP culture expressing a higher density of bacteria with no mobility, culture still possessed a high density of *D. armatus* cells.

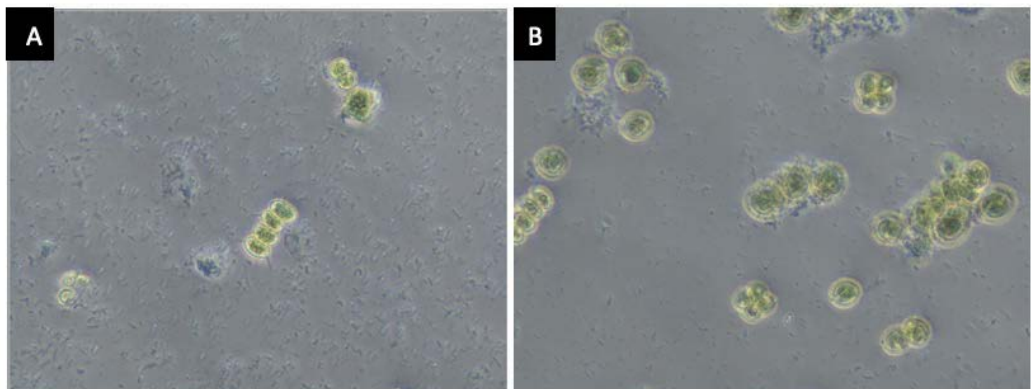


Figure D2: Microscopy images of cultures that were contaminated. A) Image A shows a removed adsorbate culture expressing a high density of bacteria and debris, bacteria had high motility, density of *D. armatus* cells was low. B) Image B shows a 10 mM NH₄Cl and ethanol culture expressing a moderate density of bacteria with high mobility, culture still possessed a moderate density of *D. armatus* cells.

PHOTOS BY IMAGE GROUP



Olivet Nazarene University Honors Program Graduates for 2020 - This page: Top (L to R): Courtney Gearhart; Dr. Stephen Case - Associate Program Director. Bottom (L to R): Anna King; Dr. Elizabeth Schurman - Chair of the English Department and Honors Council Member (introducing the graduates). **Opposite Page:** Top (L to R): Brooke Whetstone; Erin Olson. Bottom (L to R): Ashleigh Godby; Alyssa Young.



Photos taken at Honors Day 2019. The annual Honors Day event offers graduating seniors a chance to present their research findings in a formal seminar setting. A panel discussion gives freshman, sophomore, and junior students a glimpse into the research process.



OFFICE OF ADMISSIONS
ONE UNIVERSITY AVENUE
BOURBONNAIS, IL 60914

800-468-6400

OLIVET.EDU