



Sacred Heart University
SCHOLAR

Sacred Heart University Scholar

Volume 1 | Number 1

Article 6

Fall 2017

Sacred Heart University Scholar, Volume 1, Number 1

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Citation

"Full Issue." *Sacred Heart University Scholar* 1, no. 1 (Fall 2017): 1-47.

Available at: <http://digitalcommons.sacredheart.edu/neje/vol20/iss1/5>

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Sacred Heart University Scholar

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Air Pollution and Life Expectancy

Zoë Kelly, Economics¹

Abstract: This article explores the effect of air pollution on life expectancy. While prior studies heavily supported the link between long-term exposure to air pollution and harmful effects on health, most are based on single-country data. The objective of this article is to fill the gap in the literature by conducting a cross-country analysis. It evaluates the effect of average air pollution on life expectancy across 111 countries between 2010 and 2015. The additional country-specific control variables that are used include GDP (Gross Domestic Product) per capita, percentage of people with access to water, population density, health care expenditure (in terms of GDP), and the GINI index (a measure of inequality). This study finds a negative association between average exposure to air pollution and life expectancy. Specifically, it is estimated that for every additional mean microgram per cubic meter of PM (Particulate Matter) 2.5 air pollution exposure, life expectancy declines by 0.04 years on average.

Introduction

In recent years, environmental consciousness and sustainability have become a greater focus, as global warming threatens the stability of the planet. In September of 2016, the United States joined the Paris Agreement, one of the most comprehensive climate change agreements in history. More than 190 countries pledged to this agreement, with the intention of reducing global emissions and maintaining temperature increases with targets through 2030 (Peters, et al. 2016).² During a historic period in the climate change movement, it is imperative now more than ever to understand the consequences of environmental neglect. Existing studies have presented a heavily supported link between long-term exposure to air pollution and harmful effects on health (Correia 2013). The majority of these studies, however, are based on single country data.

It is estimated that up to 40 percent of premature mortality is related to the adverse effects of pollution (Goenka 2012). Additionally, a recent World Health Organization (WHO) study suggests that approximately 656,000 premature deaths occur due to air pollution and 96,000 as a result of water pollution in China. By comparison, the number of premature deaths in India due to air pollution is estimated to be 537,000 while the corresponding estimate is 46,000 in the United States (Goenka 2012). Since the 1970s, Congress has passed several laws to protect the environment in the United States. In order to reduce air pollution across the country, the first Clean Air Act was introduced in 1970 under the supervision of the Environmental Protection

¹ I would like to thank Professors Khawaja Mamun and Jennifer Trudeau for their helpful comments and insight.

² Following the 2016 U.S. presidential election, however, President Donald Trump maintained his campaign vow by announcing the US withdrawal from the Paris Agreement on June 1, 2017 (Böhringer and Rutherford 2017).

Agency (EPA). This act set limits on the amount of pollution released into the air by large industries such as steel mills and chemical plants. The increasingly strict air quality controls required by the EPA over the years have led to improvements in ambient air quality in the United States at costs that have been estimated as high as \$25 billion per year (Correia 2013). Unfortunately, many developing countries are not able to afford this standard of environmental care. As a result, air pollution levels may be higher in those countries. While the results from this study are not causal, they confirm the single-nation study results--that air pollution has a negative association with life expectancy.

Literature Review

The available research on this topic is somewhat limited in that past population-based studies were based on the associations between air pollution and mortality. The analysis of mortality data, however, requires a time-series model in order to account for daily variations in pollution and mortality counts. The downfall of using a time-series model for this kind of data is that the results can be biased from factors such as temperature and influenza epidemics, which are prone to variation within a short time frame (Goenka 2012). Consequently, more recent studies have analyzed the relationship between air pollution and life expectancy as a measure of overall public health, as life expectancy is gathered at a yearly rate of comparison.

The most recent study published in 2013 gathered data from the years 2000-2007 and found that ambient levels of fine particulate matter (PM_{2.5}) in the United States have been declining as a result of EPA interventions. Yet this decline occurred at a slower rate than previous years of data collection and analysis (1980-2000). Researchers included several variables that measure socioeconomic status, smoking prevalence, and demographic characteristics for the purpose of control variables. This study also concluded that a decrease of 10_{mg}/m³ in the concentration of PM_{2.5} was associated with an increase in average life expectancy of 0.35 years. It indicated that this association was stronger with more urban and densely populated areas. These results have important implications for public health because reductions in particulate matter air pollution are associated with reductions in both cardiopulmonary mortality and overall mortality (Correia 2013).

Another study by Pautrel (2007) investigated the effect of environmental policy on economic growth, emphasizing the relationship between pollution and life expectancy as the foremost channel of transmission. The researcher concludes that, "when pollution affects health and health influences life expectancy, environmental policy is ambiguous for growth" (Pautrel 2007). Overall, he found that environmental policy is a positive tool for stimulating growth. Based on this study, the evidence suggests that active environmental policies may be implemented to improve health and therefore promote growth.

Mariani, Pérez-Barahona, and Raffin (2009) conducted a cross-section analysis of 132 countries and found strong evidence in support of the relationship between longevity and

environmental quality. The authors argued that, in order to increase longevity, people should be willing to invest in all aspects of the environment. This study focused on the environment as a whole, including air and water pollution, depletion of natural resources, biodiversity, and sustainable energy as critical factors affecting environmental health. One interesting aspect of this study was that as a result of the findings, some countries end up caught in a “low-life-expectancy/low-environmental-quality trap.” More specifically, “out of 66 countries with an EPI index lower than the median value (56.04), 54 also belong to the group characterized by a life expectancy below the median (69.5),” and that, “out of the 66 countries with lower-than median life expectancy, 55 also exhibit a below-the-median value of the EPI.”

These researchers suggest that the way people value their future is critically affected by their life expectancy. When longevity increases, people become more sympathetic to future generations as well as their future selves. Therefore, if someone expects to live longer, he or she should be more invested in the quality of their environment and surroundings. There is a consensus among scientists and economists alike that pollution has a negative impact on life expectancy. With both the global environment and longevity of everyone in consideration, this topic of research is abundantly relevant and critical.

Empirical Model and Data Description

Due to the structure and availability of data, the model used in this research is cross sectional. Of the 195 countries in the world, 111 samples were gathered. The model takes the following form:

$$\text{Lifeexp} = f(\text{Pollu}, \text{GDPPC}, \text{Accesstowater}, \text{Popdens}, \text{Healthcareexp}, \text{Gini})$$

where *Lifeexp* is the life expectancy at birth in years, *Pollu* is mean exposure to PM2.5 air pollution (micrograms per cubic meter), *GDPPC* is GDP per capita, *Accesstowater* is percentage of population with access to an improved water source, *Popdens* is population density (people per square km. of land area), *Healthcareexp* is health expenditure as a percentage of total GDP, and *Gini* is the GINI index (a measure of inequality). A priori, it was expected that *GDPPC*, *Accesstowater*, and *Healthcareexp* would have positive coefficients and that *Pollu*, *Popdens*, and *Gini* would have negative coefficients. The countries that were examined in the study are depicted in Figures 1 and 2, where average pollution level and average life expectancy are shown.³

³ These figures were produced by the author using Stata.

Figure 1

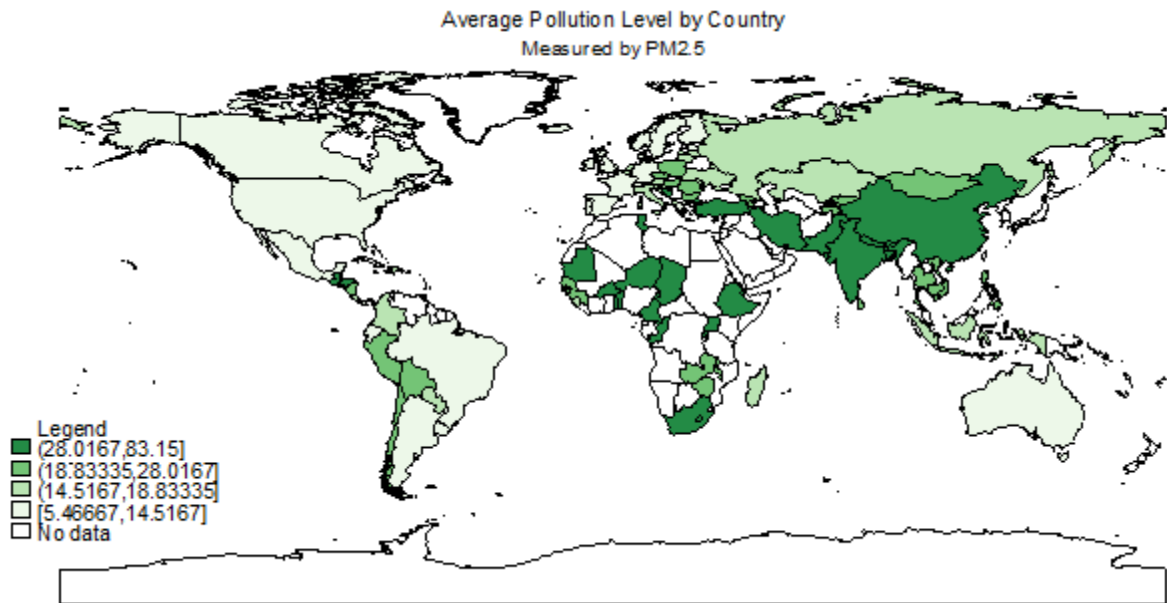
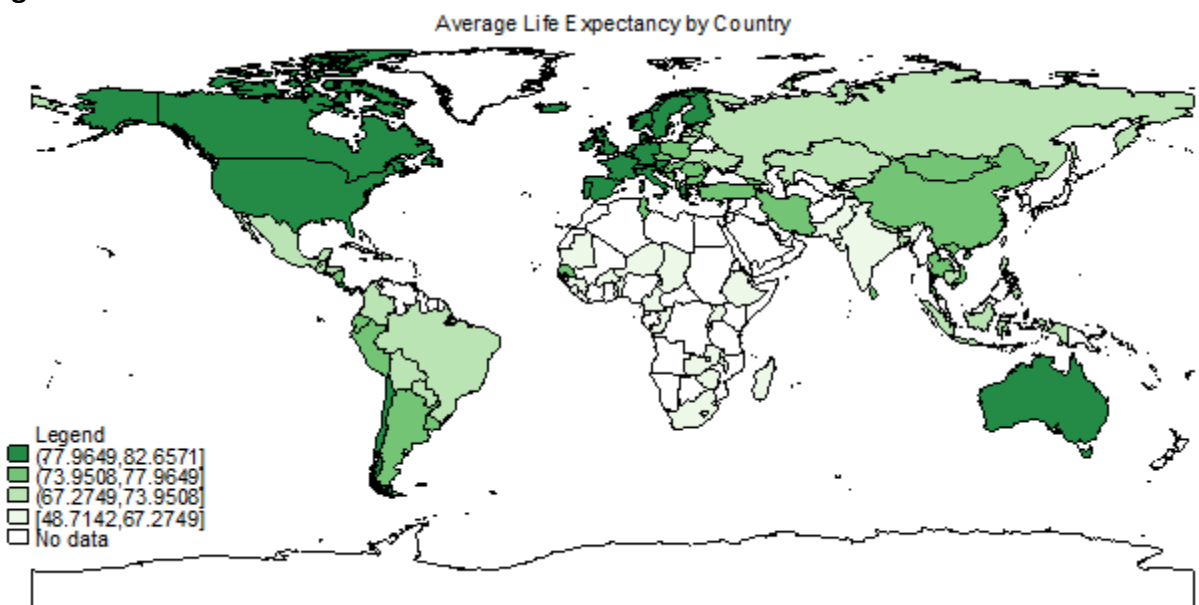


Figure 2



This study uses 111 observations total from 111 countries with data averaged between the years 2010 and 2015, using data from the World Bank's DataBank. The summary statistics are provided at the end of the section in Table 1.

The dependent variable in this study is life expectancy at birth, measured in years. It is the number of years a newborn would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life (World Bank). The mean life expectancy from the data is approximately 71 years, with a maximum measure of 83 years (in Switzerland) and a

minimum of 49 years (in Lesotho). The key independent variable is population-weighted exposure to ambient PM_{2.5} pollution, which is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter. These particles are capable of penetrating deep into the respiratory tract and severely affecting health. This exposure is calculated by weighting mean annual concentrations of PM_{2.5} by population in both rural and urban areas (World Bank). The mean level of PM_{2.5} exposure is 25.5 mg/m³, with a maximum measure of 120 mg/m³ (in Saudi Arabia) and a minimum of 3 mg/m³ (in Kiribati). It was hypothesized that a higher level of pollution would decrease life expectancy.

The other control variables included in the model are also drawn from WorldBank. GDP per capita is measured as gross domestic product divided by mid-year population, in constant U.S. dollars. I predicted that an increase in GDP per capita is associated with an increase in life expectancy. The GINI index measures the extent to which the distribution of incomes among individuals and households within an economy deviates from a perfectly equal distribution. This is generally a good measure of economic inequality within a nation (World Bank). It was predicted that a higher score on the GINI index decreases life expectancy.

Population density is defined as the mid-year population divided by land area in square kilometers. Population includes all residents regardless of legal status or citizenship and land area is a country's total area, excluding area under inland water bodies (World Bank). It was predicted that an increase in population density decreases life expectancy, based on the idea that places with higher population density are generally exposed to more environmental factors, including air pollution.

Additionally, the model controls for two key determinants of life expectancy, access to water sources and health care expenditures. Access to an improved water source refers to the percentage of population using an improved drinking water source. This includes piped water on premises such as well water and other improved drinking water sources such as public supply, protected springs, and rainwater collection (World Bank). It was hypothesized that an increase in access to water increases life expectancy. The total for public and private health care costs is counted as health care expenditure. This includes health services, family planning, diet and nutrition, and emergency funds. It does not include provisions for water and sanitation (World Bank). It was predicted that a higher health care expenditure increases life expectancy.

Table 1. Summary Statistics

Variable Name	Observations	Mean	Std. Dev.	Max.	Min.
<i>Lifeexpect</i>	202	70.95	8.66	83.54	48.71
<i>Pollu</i>	194	25.5	19.33	120.15	3.27
<i>GDP per capita</i>	197	\$15,243.14	\$23,110.25	\$145,221	\$216.40
<i>Accesstowater</i>	197	88.14	15.35	100	31.5
<i>Popdens</i>	216	420.13	1920.96	18693.3	0.137
<i>Healthcareexp</i>	190	6.72	2.74	17.11	1.09
<i>GINI</i>	113	38.11	8.42	63.38	24.55

Results

Table 2 reports the effect of each variable, including pollution, on life expectancy. The White Test revealed there was significant heteroskedasticity in the model that needed to be corrected for (reported in Table 2, Panel B). The issue of heteroskedasticity may be present due to the multicollinearity between GDP per capita and health care expenditure as a percentage of total GDP. Across the adjusted and unadjusted models, the estimate of the effect of the GINI coefficient remained insignificant.

The results confirmed the hypothesis regarding the effect of air pollution on life expectancy—that increased air pollution has a negative association with life expectancy. From Table 2, we can conclude that for every mean microgram per cubic meter of PM_{2.5} exposure, life expectancy decreases by 0.04 years, or 15 days, on average. This variable is also significant at 5% with an adjusted t-score of -2.14. The average life expectancy for the entire sample was equal to 70.95 years. Comparing this with the 70 countries with the highest measures of air pollution (above the mean of 25.5 mg/m³) encountered an average of 44.7 mg/m³ of exposure and a life expectancy of 66.54 years demonstrates that it is important to consider the effects of pollution on these vulnerable populations. These findings are consistent with earlier findings, which presented a “low-life-expectancy/low-environmental-quality trap” (Mariani, Pérez-Barahona, and Raffin, 2009). They are also very similar results to the Correia (2013) study which observed that in the United States, for a decrease of in the concentration of PM_{2.5} by 10 mg/m³ there was an increase in average life expectancy of 0.35 years.

According to the model, both GDP per capita and access to water are significant determinants of life expectancy. The results indicate that an increase in GDP per capita increases life expectancy by approximately 1.5 years while an increase in the percentage of people with access to water also increases life expectancy by 0.34 years. Both variables are significant at 1 percent. Population density, health care expenditure and the GINI index, once controlling for heteroskedasticity, are not significant determinants of life expectancy according to the model.

Conclusion

The purpose of this study was to understand the associations between air pollution and life expectancy on a global scale. This study confirms the hypothesis that an increase in average air pollution exposure decreases life expectancy, on average, when utilizing cross-country data. The model including observations from 111 countries yields results that each additional microgram per cubic meter of PM_{2.5} decreases life expectancy by 0.04 years. This is in line with the expectation that air pollution would have a negative effect on average life expectancy with the inclusion of GDP per capita, access to water, population density, health care expenditure, and the GINI index as variables within the model.

There are, however, several limitations to consider. First, there may be other control variables that are important in explaining the variation in life expectancy across these countries, but data was limited. A second consideration is multicollinearity in the included measures. Although the adjusted models account for heteroskedasticity in the data by running the regression a second time to get accurate t-scores, there may be some remaining. For example, it may have been better to obtain a measure of healthcare expenditure data independent of the country's GDP per capita since it is another control in the model.

One shortcoming of this study is that we only observe the association, and not the causality, between air pollution and life expectancy. Future research should consider the causal link between the two variables in order to make accurate policy decisions. Based on this study, as well as prior research, it would prove beneficial for a nation to increase environmental protection laws in order to increase life expectancy. While many countries prosper with high environmental quality and high life expectancy, those that fall within the lower ends of those categories, the low-life-expectancy/low-environmental-quality trap, will need to consider serious changes in order to improve the conditions of their nation. Global agreements enforcing positive environmental policy, such as the Paris Agreement, are a step in the right direction. A reduction in air pollution benefits not only the planet, but the life of its inhabitants as well.

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Table 2. Main Results (Panel A: Life Expectancy)

<i>Life Expec</i>	Model I	Model II	Model III	Model IV	Model V	Model VI
<i>Pollu</i>	-0.12*** (-3.68)	-0.07*** (-2.71)	-0.04** (-2.03)	-0.04** (-2.08)	-0.04** (-2.2)	-0.08 (-2.47)**
<i>GDPPC</i>		2.69x10 ⁻⁴ *** (9.85)	1.54x10 ⁻⁴ *** (6.54)	1.52x10 ⁻⁴ *** (6.37)	1.61x10 ⁻⁴ *** (6.53)	1.26x10 ⁻⁴ *** (4.29)
<i>Accestowater</i>			0.34*** (12.1)	0.34*** (11.79)	0.35*** (12.17)	0.34*** (9.03)
<i>Popdens</i>				6.72x10 ⁻⁴ (1.05)	4.55x10 ⁻⁴ (0.71)	3.37x10 ⁻³ (1.11)
<i>Healthcare exp</i>					-0.13 (-0.72)	-0.28 (-1.37)
<i>GINI</i>						-0.11** (-2.01)
<i>Obs.</i>	189	183	178	177	175	111
<i>Adj. R²</i>	0.06	0.39	0.67	0.66	0.68	0.72
<i>F-Stat</i>	13.57 (0.00)	58.48 (0.00)	118.27 (0.00)	86.54 (0.00)	73.11 (0.00)	46.21 (0.00)
<i>Heteroskedasticity</i>	4.13 (0.04)	1.18 (0.31)	5.01 (0.002)	3.81 (0.005)	3.97 (0.002)	4.31 (0.001)
<i>DW Stat</i>	1.64	1.83	1.78	1.73	1.76	1.31

Table 2. Main Results (Panel B: Consideration for Heteroskedasticity)

<i>Life Expec</i>	Model I	Model II	Model III	Model IV	Model V	Model VI
-	-	-0.07***	-0.04**	-0.04**	-0.04**	-0.08**
<i>Pollu</i>	0.12*** (-2.90)	(-2.85)	(-2.44)	(-2.53)	(-2.5)	(-2.14)
<i>GDPPC</i>		2.69x10 ⁻⁴ *** (8.99)	1.54x10 ⁻⁴ *** (7.82)	1.52x10 ⁻⁴ *** (7.82)	1.61x10 ⁻⁴ *** (6.79)	1.26x10 ⁻⁴ *** (4.00)
<i>Accestowater</i>			0.34*** (11.68)	0.34*** (11.21)	0.35*** (11.74)	0.34*** (7.73)
<i>Popdens</i>				6.72x10 ⁻⁴ (1.43)	4.55x10 ⁻⁴ (1.11)	3.37x10 ⁻³ (1.26)
<i>Healthcare exp</i>					-0.13 (-0.63)	-0.28 (-1.18)
<i>GINI</i>						-0.11 (-1.46)
<i>Obs.</i>	189	183	178	177	175	111
<i>Adj. R²</i>	0.06	0.39	0.67	0.66	0.68	0.72
<i>F-Stat</i>	13.57 (0.00)	58.48 (0.00)	118.27 (0.00)	86.54 (0.00)	73.11 (0.00)	46.21 (0.00)
<i>Heteroskedasticity</i>	4.13 (0.04)	1.18 (0.31)	5.01 (0.002)	3.81 (0.005)	3.97 (0.002)	4.31 (0.001)
<i>DW Stat</i>	1.64	1.83	1.78	1.73	1.76	1.31

Use of Academic Resources Among Different Socioeconomic Classes

Kristin Zimmerman, Sociology¹

Abstract. Access to academic resources is influenced by socioeconomic status. Based on Bourdieu's concept of economic and cultural capital and Lareau's theory of social inequality, it is hypothesized that students from high socioeconomic status would access academic resources at a significantly higher rate. This hypothesis was evaluated in a survey of 120 college students. Basic hypothesis testing showed no significant differences. Advanced hypothesis testing, however, found a significant difference for males and undergraduate seniors. The results suggest a trend that students from lower socioeconomic families access academic resources at a higher rate than students from higher socioeconomic families. A more diverse and sufficient sample would be needed to further test the hypothesis. Further studies should focus on students with the same GPA in different socioeconomic classes and take into consideration other factors contributing to the rate at which students access academic resources.

Socioeconomic status affects individuals in many ways. Countless studies have shown a positive relationship between socioeconomic status and academic achievement. However, other factors can contribute to this correlation. Socioeconomic status can influence the rate at which a student accesses academic resources. The frequency at which students use the academic resources available to them is an important aspect that can influence academic achievement. The following study examines the connection between socioeconomic status and the rate at which students access resources. These resources include library databases, professor's office hours, and career development centers.

Background

The first publication to look at school resources and student achievement was by Coleman in 1966. The study found that higher levels of availability of school resources have no effect on student performance. However, in the last decade, new studies have proven otherwise. Card and Krueger (1998) examined the performance of students in an institutional setting, based on the academic resources available. They examined the connection between the schooling, quality of school, and the earnings of students after they graduate from school. Much of their findings showed that there was a positive and significant relationship between school resources and student earnings.

¹ I would like to give thanks to the people who have helped with this study. To the Sacred Heart University Sociology department, especially Dr. Gerald Reid for guiding and helping me complete the study in good academic achievement, and to all the respondents for their cooperation in the study. The survey instrument and complete data set and analysis are available upon request. Direct all communications to zimmermank17@gmail.com.

Study after study shows the positive correlation socioeconomic status and academic success. Ethnically diverse students are placed in the low-resourced, under-staffed schools, adding to the already inferior education. Right from the start, students of color and disadvantage ethnicities have a higher probability of receiving a lower quality education. Tracking based on race and ethnicity appears as early as first grade, placing kids into “advanced” or “special” classes, increasing the inequalities of education and resource allotment. As early as kindergarten, students of a different race or ethnicity have significantly lower test scores than white children. Ethnically diverse students demonstrate an average math score 21 percent lower than white students (Fisher, 2012).

Many studies have shown that school success and quality of education is associated with social backgrounds, influencing the resources available to students. Researchers have examined the different aspirations for higher education of students from different socioeconomic backgrounds (Wilks and Wilson, 2012). They looked especially at the pathways and barriers that low income student’s face and the effects these barriers have on a student’s educational aspirations. The results showed students from low socioeconomic families are more likely to be alienated from the cultures and resources universities offer to help students achieve academic success. Due to this isolation of resources and lack of instruction on how to properly use them, lower socioeconomic students never fully learn how to access these educational resources and use them to gain academic achievement. But what happens when these students continue on to colleges or universities? Will their past experiences with the education system effect how they access academic resources in college?

Moreover, a student’s zip code plays a huge role in determining the quality of education he or she will receive. Schools located in poor or less-populated areas are faced with less funding and less qualified teachers. Lower funding leads to fewer academic resources available to students. Educational levels across the United States are becoming increasingly dissimilar. Cities such as Boston, San Francisco, and Washington have a growing population of educated individuals. These school systems have more resources and more qualified teachers than other cities, such as Las Vegas, Memphis, and Dayton, all of which are falling behind in education levels (Fisher, 2012). After funds are distributed among school districts, these funds are used to support the offering of honors and advanced placement courses, college credit courses, and other curricular enhancements.

Studies have focused on the determinants of school funding, including the demand for education, the ability to pay for education, and models of funding that emphasize property taxes. The local initiatives to increase resource allotment were related to local schools. It has been found that local districts hold much of the power to decide how the flow of state resources will be used. Most schools try to maximize their budgets in ways that will increase the number of teachers on staff, the number of aids, and the level of experience of the teachers. Yet schools in lower socioeconomic areas almost always begin with a lower budget per pupil (Monk, 1981).

Surprisingly, existing research has also suggested that schools perform just as well with lower spending. Steele, Vignoles, and Jenkins (2007) suggest that the decrease in student academic attainment is due to a lack of competitive pressures requiring schools to use their resources efficiently. These findings demonstrate that how schools use the resources given to them and how accessible they make the resources to students can affect the academic outcomes of the students. This study looks at the rate at which students access the resources available to them in relation to their socioeconomic status.

Theoretical Framework

In her work, *Unequal Childhoods*, Annette Lareau explains the differences in parenting styles as related to class distinctions and inequalities. She observed how socioeconomic status influences a child's academic performance and interactions with adults in positions of authority. "Highly valued resources such as the possession of wealth; having an interesting, well-paying, and complex job; having a good education; and owning a home are not evenly distributed throughout society," she writes. "Moreover, their resources are transferred across generations" (2003, pp. 7-8). While urban schools face serious limitations, such as limited supplies and teacher shortages, suburban schools have ample teachers and classroom supplies. "Across the country, communities where the average social class position of parents is higher have vastly more favorable public school systems," Lareau notes (2003, p. 24). Additionally, the differences in educational resources at home significantly impacts a child's academic development. From increased intellectual conversations to educated facilitated concerted cultivation, middle-class children take these advantages and use them in institutional settings.

Economic constraints make it difficult for lower-class families to provide a safe place to live, let alone the academic resources required to stimulate a child's learning. There are different ways in which parents can help enrich the cognitive development of their children. Parents can follow the guidelines of doctors and teachers on normative behavior, which forms a "dominant set of cultural repertoires" for children, or what is called "concerted cultivation." This set of standards includes "the importance of talking with children, developing their educational interests, and playing an active role in their schooling" (Lareau, 2003, pp. 2-4). These middle-class parents take the time to stimulate their children's cognitive development and build their social skills. During this process of concerted cultivation, the children grow a sense of entitlement that follows them into institutional settings. Children from middle-class families grow up questioning adults and addressing them as equals instead of figures of authority. These children are comfortable in academic situations, open to sharing information and asking for attention. On the other hand, working-class children have a sense of constraint in institutional settings, accepting the teachings of authority figures and do not seek additional attention (Lareau, 2003, p. 6). Based upon the socioeconomic status of the family, a child can be raised either to have a sense of entitlement or a sense of constraint.

Lareau defines cultural capital as, “skills individuals inherit that can then be translated into different forms of value as they move through various institutions” (2003, p. 7). Middle-class children gain favorable “cultural capital” and learn how to make the institutional system work in their favor, while lower-class children fail to achieve these advantages. The openness to access academic resources can be seen as a form of cultural capital because student’s use the resources to benefit their academic success. Bourdieu and Lareau’s work would suggest that students from higher socioeconomic families will access academic resources at a higher rate than students from lower socioeconomic families.

As a social theorist, Pierre Bourdieu also focused on the intersection of social inequality, class and capital. He conceptualized inequality stemming from the differential amounts of economic capital, social capital, and cultural capital of individuals among the different economic classes (Dillion, 2014, p. 428). Bourdieu argued social inequality was defined by a three-dimensional hierarchy composed of these three capitals. Economic capital is not only measured by money, but also by property ownership or investments. Cultural capital is formulated based off the cultural competence, education, and ease of everyday life (the ability to fit in with peers). Cultural competence is the set of norms that are formed by a particular social group. Bourdieu examined how both formal and informal education and cultural habits influence individuals’ actions in society. Social capital refers to an individual’s social networks and social connections. Economic, social, and cultural capitals are expressed differently in different social classes. While each capital is distinct, each influences the others and are interrelated. Bourdieu was especially interested in looking at how economic and cultural capital produce and reproduce social inequality (Dillion, 2014, p. 432). Students from higher socioeconomic families are better prepared entering higher level education and may not need to access additional academic resources, which can be seen as an interconnection between both economic and cultural capital. Although economic and social capital are interrelated, they are also analytically independent. An individual may have an influential amount of economic capital but little social capital, or vice versa. However, a wealthy individual can use his or her economic capital to gain social capital and enhance their social reputation or symbolic capital (Dillion 2014, p. 433). The significance of an individual’s family helps determine the ease of an individuals’ access to capital.

While education can independently enhance economic capital, there is also a strong positive relationship between ascribed socioeconomic status and future educational attainment. Children raised in high socioeconomic families are more likely to succeed in college, ultimately achieving occupational-economic success (Dillion, 2014, p. 433). Similar to Lareau’s theory of concerted cultivation, children who grow up in more affluent households are more likely to have knowledge of resources available at schools because they are immersed in them early in life. These resources can be in the form of educational toys, books, or private tutors, all of which high socioeconomic families can afford. Parents with strong academic backgrounds generally come from higher socioeconomic families. Therefore, these parents proceed to teach their children

how to properly use the academic resources available to them most efficiently. The higher income families can afford the best schools, learning materials, and extra academic programs, all of which are resources lower socioeconomic families probably cannot afford. Bourdieu states, “The educational capital held at a given moment expresses, among other things, the economic capital and social level of the family of origin” (1984, p. 105). Children grow and learn through family-social experiences. Different family learning environments are determined by social-class differences, such as the resources available for intellectual experiences. Culture, educational, and social capital all work together to allow children from high socioeconomic families to be immersed in resources and give them the knowledge of how to use them.

This study explored how a student’s economic background affects how he or she accesses academic resources, such as library databases, professor’s office hours, and career development centers. Based upon the social theories of Bourdieu and Lareau, one would expect students from different socioeconomic backgrounds would access academic resources at varying rates. I hypothesize that students from higher socioeconomic status would access academic resources at a significantly higher rate.

Existing Studies

A multitude of studies have examined the relationship between socioeconomic status and academic behavior and attitudes. For example, Ming-Hsueh and Fu-Yu (2013) looked to understand the relationship between family socioeconomic status and academic attainment through Structure Equation Models (SEM). They examined the impact of socioeconomic status on academic performance. The authors used a study by Coleman (1966) that was originally designed to weigh a student’s academic performance based on the educational resources available at a school. Coleman found that resources, such as equipment, books, teacher’s educational level, and parent’s educational level, were more significant (Coleman 1966). Ming-Hsueh and Fu-Yu (2013) proposed that socioeconomic status is positively correlated with academic achievement and parent child interaction. Maximum likelihood estimation was used to confirm the reliability and convergent validity, confirming both hypotheses. This study looks at how the socioeconomic status of a family will affect the rate at which a student accesses academic resources.

Wilks and Wilson (2012) look specifically at the educational aspirations, pathways, and barriers that low-income students face. The study found that low-income students are more likely to be alienated from the cultures of universities and, subsequently, the resources that will help them to achieve academic success. These results follow Lareau’s theory of sense of constraint, in which students from lower-classes do not question the social norms of an institutional setting. The primary and secondary students were interviewed, with questions focusing on socioeconomic status, cultural and social capitals, and barriers and enablers they face accessing higher education and academic resources. By using both qualitative and quantitative

methods, the study was able to gather more opinions from the students about the availability of resources and access to higher education. The results showed that as students grow older they lose aspirations for high academic success, such as bachelor or master degrees. Students with family who have higher education also have stronger ambitions to continue their education and access academic resources. These findings demonstrate how important a family's display of academic resources and educational attainment affect students' aspirations. My study looked to for a connection between family income and the initiative to use available academic resources.

Taffs and Holt (2013) examined the expanding use of online information and communication technologies (ICTs) in educational settings. ICT is an innovative way to enhance learning and provide effective methods to give students multiple curriculums. However, ICTs rely on the student's ability to access them and the appropriate use of them. Past studies have found that even though the resources are available, the use of online resources has been limited. Researchers conducted a survey and found that both on campus and online students had high percentages of using online resources; however, online students accessed the resources at an increased rate. The results also showed that online resources were deemed useful. My study looked at overall use at academic resources, and if the use of these resources is impacted by the socioeconomic status of students.

Purpose of Research

The gap between educational outcomes among students of different socioeconomic status is widening. We know there is a strong relationship between socioeconomic status and academic achievement. Now, we must examine the factors that influence this relationship. This study focuses on the rate at which students use the academic resources available to them at a college level. It is hypothesized that students from higher socioeconomic backgrounds will access academic resources at a significantly higher rate than students from lower socioeconomic backgrounds. If the hypothesized difference exists in the access of academic resources, efforts can then be made to increase the accessibility of resources for students of lower socioeconomic status.

Methods

Participants. The participants in this study were 120 undergraduate college students. Diversity with gender and class was not achieved. Eighty percent of the participants were female, 92.5 percent were white, 63.3 percent had GPAs ranging from 3.6-4, and approximately 50 percent of participants had parental incomes ranging from \$75,000-\$124,999.

Research Design. The research design used for this study was quantitative, using a cross-sectional survey. The survey was designed to examine the relationship between socioeconomic status and the use of academic resources among college students. The following academic

resources were observed: accessing library databases, consulting with professors, using teacher assistant hours or learning center hours, and use of the wellness center.

Measures. In this study, the independent variable was self-identified socioeconomic status and approximate average household income for 2016. Self-identified socioeconomic status was measured by the economic class the student most identified with: lower, lower-middle, middle, upper-middle, or upper-class. The income variable was measured by the average income of the student's household per year. Given that there were many categorical values, the incomes groups were divided into four broader income ranges: \$0-\$74,999, \$75,000-\$124,999, \$125,000-\$174,999, \$175,000-300,000+.

The dependent variable measured the use of academic resources. A survey of twenty-three questions was constructed to measure the extent to which students access the academic resources available to them at their universities. The resources included the library databases, CLA hours, professor office hours, wellness centers, academic learning centers, etc. Two indexes were created to measure the dependent variable, help index and access index. For each metric, the scoring range was 1-5, with 1 being never and 5 being always accessing resources or looking for help.

The control variables included basic demographics, such as gender and race, past exposure to educational resources, and parental involvement in education. Past exposure to educational resources could be in the form of educational toys or intellectual activities students used throughout their childhood. Past exposure to these resources, either through parents or lower level institutions, can influence the rate at which student's access academic resources in higher education. Parental involvement in student's education growing up included help with class work and engagement in educational activities. Other demographics included were undergraduate class, race and ethnic identity, and GPA.

Procedures. A nonprobability, purposive sampling was conducted. The selection criteria for the sample pool maintained that respondents had to be undergraduate college students. Survey Monkey was used to construct the survey. The link was sent out to as many participants as possible through e-mail and Facebook, aiming for the diversity in student backgrounds and gender. Follow-up reminders were also sent out for those slow to respond.

Results

Two independent variables were used in this study: students' approximate average household income for 2016 and the socioeconomic group they most identified with. Based upon a frequency analysis of reported household incomes, an index was created for students' approximate household income: \$0-\$74,999, \$75,000-\$124,999, \$125,000-\$174,999, and \$175,000-300,000. For each index, the scoring range was 1-5, with 1 being never and 5 being always accessing resources or looking for help.

A One-Way ANOVA statistical test was used for the basic hypothesis testing. Both independent variables, average household income and self-identified socioeconomic group, were analyzed against the dependent variable, help index. No significant results were found. Students from higher socioeconomic status families do not necessarily access academic resources at a higher rate (Figure 1).

One-Way ANOVA Against Help Index

		Sum of Squares	df	Mean Square	F	Sig.
IncomeRecode	Between Groups	8.879	10	.888	.925	.514
	Within Groups	92.168	96	.960		
	Total	101.047	106			
Which socioeconomic group do you most identify with:	Between Groups	3.404	10	.340	.784	.644
	Within Groups	42.969	99	.434		
	Total	46.373	109			

Figure 1. One Way ANOVA test of independent variables against Help index.

A one-way analysis of variance (ANOVA) was run on the independent variables, income recode and self-identified socioeconomic group, against the dependent variable, access index. No significant results were found. Students from higher socioeconomic status families do not necessarily access academic resources at a higher rate than students from lower socioeconomic status families (Figure 2.) An opposite trend was seen.

One-Way ANOVA Against Access Index

		Sum of Squares	df	Mean Square	F	Sig.
IncomeRecode	Between Groups	14.207	22	.646	.620	.898
	Within Groups	86.444	83	1.041		
	Total	100.651	105			
Which socioeconomic group do you most identify with:	Between Groups	10.672	22	.485	1.171	.295
	Within Groups	35.640	86	.414		
	Total	46.312	108			

Figure 2. One way ANOVA test with independent variables against the Access Index.

A One-Way ANOVA test was also used for the advanced hypothesis testing in differences between gender and academic year. Both independent variables, income recode and self-identified socioeconomic group, were analyzed against the dependent variable, help index and access index. There was a significant difference between gender when the independent variable, income recode, against the dependent variable, help index, with a significant value of .082 (Figure 3).

One-Way ANOVA Against Help Index Selecting for Males

		Sum of Squares	df	Mean Square	F	Sig.
IncomeRecode	Between Groups	11.578	8	1.447	2.676	.082
	Within Groups	4.867	9	.541		
	Total	16.444	17			
Which socioeconomic group do you most identify with:	Between Groups	4.244	8	.531	1.418	.306
	Within Groups	3.367	9	.374		
	Total	7.611	17			

Figure 3. Advanced hypothesis one-way ANOVA with independent variables against the Help Index, selecting for males only.

One-Way ANOVA Against Access Index Selecting for Seniors

		Sum of Squares	df	Mean Square	F	Sig.
IncomeRecode	Between Groups	17.425	15	1.162	1.493	.218
	Within Groups	12.450	16	.778		
	Total	29.875	31			
Which socioeconomic group do you most identify with:	Between Groups	11.269	15	.751	2.635	.024
	Within Groups	5.417	19	.285		
	Total	16.686	34			

Figure 4. Advanced hypothesis one-way ANOVA with independent variables against Access Index, selecting for seniors only.

The academic years (freshman, sophomores, juniors, and seniors) were analyzed using one-way ANOVA. Seniors were seen to have a significant difference when the independent variable, self-identified socioeconomic status, was analyzed against the dependent variable, access index, with a significant value of .024 (Figure 4).

Discussion

A one-way ANOVA was used for basic hypothesis testing and advanced hypothesis testing for differences between gender and academic year, both with a p-value significance of $< .1$. Academic year was used because it had the most diversity among participants.

This study suggests that students from lower socioeconomic families access academic resources at a higher rate than students from higher socioeconomic families. According to Annette Lareau's theory of "concerted cultivation," students from higher socioeconomic families develop a sense of entitlement in institutional settings (Lareau, 2003, p. 2-4). On this basis, I hypothesized that students from higher socioeconomic families would access academic resources at a higher rate than students from lower socioeconomic families. However, the results do not support this hypothesis. Perhaps students from higher socioeconomic families are better prepared and do not need additional help or academic resources to achieve academic success. Alternatively, students from higher socioeconomic families might feel as though they are entitled to academic success and do not seek out additional resources. It could also be that middle-class children learn to question adults, addressing them as equals instead of figure of authority, therefore do not follow the advice to use and access academic resources, whereas students from

lower socioeconomic families are less likely to question authority and more likely to use academic resources as recommended.

Pierre Bourdieu focused on the connection between social inequality, economic and cultural capital (the ability to fit in with peers with ease and competence). Students from different socioeconomic families learn how to use resources differently. Both cultural capital and economic class are likely to affect how a student will use academic resources. As this study suggests, lower socioeconomic students seem to use resources more, which does not follow Bourdieu's predictions on class and social inequality. Students from higher socioeconomic status families are likely better prepared entering a higher level of education and do not need to access additional resources, which could be seen as an increased "cultural capital."

This study also proposes further investigation on the differences among academic years. Seniors were seen to have a significant difference when the independent variable, self-identified socioeconomic status, was analyzed against the dependent variable, access index, with a significant value of .024 (Figure 4). As students progress through their undergraduate career, accessing resources could be seen as a developed habit. The use and access of academic resources could be a learned process as students' progress through higher level and more difficult coursework. Higher socioeconomic status students may learn at a faster rate, thereby using the resources more frequently to achieve higher academic success. Additionally, there was a significant difference between genders when the independent variable, income recode, was correlated against the dependent variable, help index. With a significance of .082, male students from higher socioeconomic status families accessed academic resources (help index) at higher rate than females (Figure 3). However, these results were not representative of the general population because the sample was 80 percent female. The academic level of a student could influence the rate at which they access academic resources. Students with the same GPA in different socioeconomic classes should also be examined to further test the predictions based on Bourdieu's theories of class and social inequality. A school's efforts to educate students on resources available could also influence these results.

Study Limitations

Another survey with a larger, more diverse sample size would be needed to further test the hypothesis. An important limitation to note is internal validity; therefore, causation is not supported. Because the sample was not random, findings cannot be generalized to the overall population. Another limitation is the breadth and diversity of the sample. Class, academic level, and gender were all skewed. For example, respondent's socioeconomic backgrounds may not differ that much due to the majority of respondents were from a private institution. Additional methodologies, such as focus groups and interviews, could be used instead of a survey, to further test the hypothesis. Surveys have limitations such as close-ended questions, which can have lower validity rates—in that participants may not feel comfortable providing accurate, honest

answers; data errors may occur due to participants not answering questions; and participants recall about childhood academic activities may be imperfect. Further studies should focus on students with same GPA in different socioeconomic classes, and take into consideration other factors contributing to the rate at which students access academic resources.

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Gender, Race, and Violence: A Critical Examination of Trauma in *The Color Purple*

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Abstract. The purpose of this article is to analyze the roles gender and race play in relation to trauma in Alice Walker's novel, The Color Purple. Specifically, the article argues that gender and race are the underlying causes of the violence and trauma experienced by Walker's female characters, Celie, Sophia, and Squeak. While violence does not always lead to internal conflict, this critical examination looks chiefly at trauma that is derived from violence. As a catalyst for targeted violence, identity categories, in particular female and African American are explored and their roles in oppression are investigated. In doing so, the notion of identity-based marginalization and double discrimination is unpacked. The article denotes the implications of intersectional identities, for example, female and African American, and reveals a startling connection between one's gender and race and the susceptibility to trauma. The latter acts as a springboard for an analysis of the psychological effects of trauma. This study is rooted in a psychoanalytic framework that constructs the foundation for the argument. More specifically, in support of its argument, the literary criticism delves into the psychology of trauma to help navigate through the characters' identity experiences and traumatic experiences. Ultimately, in both exposing the connection of gender and race to oppression and trauma as well as unpacking the psychology of trauma, this article illuminates Walker's literary techniques, narrative structures, use of language, and calculated character dynamics—all of which support and demonstrate the ways in which the female characters' gender and race are the underlying causes of their traumatization.

Keywords: Gender; Race; Trauma; Violence; Discrimination

Throughout her novel *The Color Purple*, Alice Walker investigates the notion of double discrimination. She points out that a woman's gender largely contributes to her discrimination. Walker outlines race as an equally influential component of discrimination and, with that, highlights both gender and race as a driving force behind an individual's identity. Through her carefully constructed female characters, Walker successfully exposes how both gender and race act as a catalyst for oppression against African American women. The novel focuses on rigid gender and race-based stereotypes imposed by society on African American women in the early 20th century.

¹ I would like to thank Drs. Magee, Loris, and Zdanys for their encouragement and support throughout my academic career at Sacred Heart. They have instilled in me a love for literature and writing and have given me the confidence needed to grow as both a student and a future educator. Direct all correspondence to lewisj0315@gmail.com.

Harsh categories constructed around differences act as a springboard for violence upon those perceived as inferior. African American women, who are viewed as subordinate because of both their gender and race, are more susceptible to experiencing trauma. While violence does not always lead to trauma, this critical examination of Walker's novel looks chiefly at trauma that *is* derived from violence. Walker shows how the oppression and discrimination of gender and race are exhibited against African American women in various forms of physically and sexually traumatic events.

Identity Categories and their Role in Oppression

The construction of gender and race in contemporary America pushes labels and statuses on individuals, which promotes oppression. Categories like "race, sex, class, and sexual orientation may be described as 'master statuses'" (Rosenblum and Travis 1). These "statuses" influence an individual's daily life and are the building blocks for one's identity. Double discrimination is catalyzed through the many different categories that have existed in society for centuries. As Rosenblum and Travis observe, individuals are not pigeonholed to only one socially constructed status, but can instead occupy multiple (1). An individual cannot separate the make-up of his or her societal status; when combined, the categories of gender and race create a recipe for a specific type of stereotype, discrimination, and oppression. Using the theory of intersectionality, Kimberle Crenshaw narrows the categorical lens, analyzing double discrimination in terms of "women of color." She explains that gender, race, and other identity categories are treated as "intrinsically negative frameworks in which social power works to exclude or marginalize those who are different" (1242). In other words, identity categories *do* have a profound impact on the individuals occupying them: "the concept of political intersectionality highlights the fact that women of color are situated within at least two subordinated groups that frequently pursue conflicting political agendas" (1251-1252).

In accordance with Crenshaw's claim, Rosenblum and Travis unpack the essentialist and constructionist perspectives. Both offer different viewpoints on "categories of difference." As they write, "an essentialist asks what causes people to be different; a constructionist asks about the origin and consequence of the categorization system itself" (5). While both perspectives talk about discrimination, the constructionist approach acknowledges the profound impact categories like gender and race have on an individual. Walker's novel does not necessarily focus on what makes people different, as much as she demonstrates the consequences of the categorization system. The name of a category like *woman* or *African American* forces a person to become a member of that category. Membership in a specific population wrongly stereotypes certain characteristics as being the group's "most important qualities," which disregards individual characteristics and potential (Rosenblum and Travis).

The attribution of certain qualities to a specific group is common in today's society. One of the most popular examples is that all women gravitate toward homemaking. Placing particular

qualities on to all members of a group and dubbing those characteristics most essential puts individuals at a disadvantage when breaking out of the mold society thinks they belong in. Preconceived expectations of a certain group promote discrimination and oppression for those members who challenge the constructed societal norms.

Estelle Disch explains that Western society has an “A and Not-A” system. “A” represents the “normal, dominant” gender, while “Not-A” represents the subordinate and different gender (99). Society deems men as “A” and women as “Not-A.” Division by gender furthers social stratification, where men also rank above women. In referencing the Marxist feminist theory, Disch exposes an “explanation” for gender inequality, where “demeaning women’s abilities and keeping them from learning valuable technological skills” allows men to maintain control over their abilities and success (99). Race, like gender, can be broken up into “A” and “Not-A” groups. In America, White is “A” and African American is “Not-A.” The dichotomization of racial categories goes as far as falling under the concept of “American/non-American” (Rosenblum and Travis 16). Rosenblum and Travis explain that these are “racial categories, because they effectively mean white/non-white” (16). Ruglass and Kendall-Tackett add to this critical conversation by claiming that “it has been generally recognized that groupings based on race, ethnicity, or culture have their limitations” (82). African American women face a severe disadvantage in society; not only are they part of the subordinate group for gender, they are the subordinate group in regards to race, too (Disch 99).

Crenshaw draws on the concept of intersectionality to demonstrate that African American women are not confined to traditional boundaries of gender and race-based discrimination or oppression. Instead, they lie within boundaries that intersect sexism and racism. She asserts, “women of color occupy positions both physically and culturally marginalized within dominant society” (1250). The overlapping generates a very specific type of marginalization and ultimately a very specific type of traumatization (1244). She explains that for both African American men and white women, there is no need to spilt their “political energies” between two often opposing categories because the two groups do not belong to multiple categories. On the other hand, this “dimension of intersectional disempowerment” forces women of color to confront (1252). Crenshaw calls for “a focus on the intersections of race and gender [to highlight] the need to account for multiple grounds of identity when considering how the social world is constructed” (1245). Through her carefully constructed female characters and literary techniques, Walker’s novel also calls for a focus on intersections of race and gender in an effort to advocate for both understanding and change.

When combined, identification with two subordinate categories generates different life experiences than those associated with membership in either one or no subordinate statuses. Category-derived experiences for those in inferior groups include oppression and discrimination in forms of violence and traumatic events. Furthermore, trauma is very closely related to gender and race. In regards to gender, while both men and women are exposed to traumatic events,

women are “more likely to be exposed to chronic high-impact traumas such as childhood sexual abuse and rape” (Ruglass and Kendall-Tackett 76). Ruglass and Kendall-Tackett expose the severity of sexual violence explaining that it is one of the most “high risk factors” contributed to the development of posttraumatic stress disorder (77). Pertinent to the trauma experienced by Walker’s female characters is the likelihood of women to be victims of rape: twenty percent of women have experienced rape in their lifetime, while only one percent of men have (Ruglass and Kendall-Tackett).

Additionally, traumatic experiences rooted in race are more common for racial and ethnic minorities. Low socioeconomic status plays a large role in the probability of exposure to severe stressors amongst racial minorities. Ruglass and Kendall-Tackett reference a review conducted by Alim, Charney, and Mellman which found that “African Americans were more likely to be exposed to violent traumas such as homicide, physical assaults, and rape than Whites” (84). Race-related trauma is linked to vulnerability based on differences. African American individuals, like women, are more likely to face traumatic events because of stigmas and prejudices that cloud the marginalized group.

Trauma in Relation to Violence

Although violence does not always lead to trauma, this critical examination investigates trauma that *is* derived from violence. Celie, Sofia, and Squeak are subject to oppression and violence that results from their gender and race, a traumatizing realization in itself. The identity-specific suffering speaks to the connection between violence and trauma throughout Walker’s novel. Given the emotional, physical, and sexual abuse Celie, Sofia, and Squeak collectively endure, it is not far-fetched that their violent experiences have led to their traumatization. Judith Herman notes that violence committed by someone the victim knows is particularly traumatizing; she states, “in most instances of rape, for example, the offender is known to the victim...the rapist often enjoys higher status than his victim within their shared community” (62). Not only do Celie, Sofia, and Squeak know their abusers, but they also exist at a lower status than them. Herman backs the plausible relationship between violence and trauma by unpacking one form of violence the women fall victim to: “The malignant effects of rape are not surprising given the particular nature of the trauma. The essential element of rape is physical, psychological, and moral violation of the person” (57).

It is extremely unlikely that the women are *not* traumatized from their experiences with violence, given the nature of the abuse is not only identity-based, but both physical and sexual as well. Celie, for example, actively demonstrates the link between violence and trauma in her experiences stating, “I look at women, tho, cause I’m not scared of them” (Walker 5). The violence Celie endures does not fit into her “‘inner schemata’ of self in relation to the world” (Herman 51). Celie, in a rightfully traumatized state, no longer trusts men. The identity-based

violence she experiences destroys her assumptions of safety in men and in the world, resulting in her traumatized state (Herman 51).

Twofold Nature of Gender and Racial Trauma

The psychological impact of an individual's gender or race being the source of suffering can be traumatizing in itself, but adversity resulting from one's gender and race can be doubly painful. Oftentimes the psychological effect of gender and race result from the responses members of the minority receives from majority groups about their abilities, skin color, or other physical features (Ruglass and Kendal-Tackett 83). The groups are marginalized for a genetic makeup over which they have no control; it is specifically that genetic makeup that supports the continuation of oppression, discrimination, and ultimately the infliction of trauma. African American women are subject to rejection for no other reason than their identity in itself. Oppression and discrimination that stems from one's identity acts as a form of self-betrayal. Ruglass and Kendall Tackett state, "certain discriminatory practices (*e.g.* hate crimes) may be traumatic events in and of themselves, which increases exposure to trauma among racial and ethnic minorities" (86-87). While recognizing that adversity develops because of one's identity is both disheartening and traumatizing, at the same time the suffering that derives from an individual's "master status" is also traumatic. The recursive cycle demonstrates the way in which gender and race create trauma; it speaks of the twofold nature of the situation.

The Psychology of Trauma

Walker's novel is a model of how gender- and race-related trauma is expressed in literature. Aside from showcasing trauma in a literal way, through various violent physical and sexual events, the novel is written to mimic the feelings associated with trauma. To understand how Walker captures the essence of trauma, one must understand general symptoms of trauma from a psychological standpoint. An event is considered traumatic if it "resulted in death or threatened death, actual or threatened physical injury, or actual or threatened sexual violence" (Ruglass and Kendall-Tackett 5). Physical and sexual violence elicit serious psychological symptoms that include feelings of intense fear, helplessness, and horror (Ruglass and Kendall-Tackett). There are three cardinal symptoms associated with traumatic events and posttraumatic stress disorder (PTSD): "hyperarousal," "intrusion," and "constriction" (Herman 35). Hyperarousal involves the expectation of danger, intrusion involves the lasting memory traumatic events leave on individuals, and constriction involves the paralyzing feelings connected to surrendering (Herman 35). Both during and following traumatic experiences, victims frequently report feelings of confusion and helplessness.

Processing a traumatic event is incredibly difficult; confusion surfaces as the human mind tries to understand what has happened in a logical way, but realistically there is no logical or rational explanation for why such awful violence and suffering occurs. Herman explains that

traumatic symptoms often become disconnected from the event itself. She describes the sense of fragmentation that arises with a traumatic experience. As Herman writes, “this kind of fragmentation, whereby trauma tears apart a complex system of self-protection that normally functions in an integrated fashion, is central to the historic observations of post-traumatic stress disorder” (34). A sense of disconnection from both the present and other individuals acts as a barrier for traumatized people. Trauma often severs a sense of connection and attachment between the victim and his or her community. Such events damage a victim’s perception of safety in the world around them as well as their concept of self-worth and meaning. If a victim is already part of multiple “Not-A” categories, when combined with trauma, the internalization of disconnection, low self-worth, and loss of meaning is much greater. It mixes with the already negative preconceived notions of self-worth and meaning associated with the marginalized group, while adding to the rejection and disconnection the minority faced prior to the trauma.

Trauma Narratives and the Role of an Epistolary Structure

Trauma is a theme that can be traced throughout literature because it speaks of the human condition, a condition in which no person is immune to. Recognizing common thoughts and feelings associated with traumatic events sets the foundation for understanding how Walker uses literary techniques to recreate those symptoms. The novel’s fragmented structure illustrates feelings of posttraumatic stress disorder; it is written as individual letters, which captures the essence of fragmentation and disarray the female characters experience as victims of physical and sexual violence. From a psychoanalytical standpoint, Charles Proudfit writes, “It is a style that mirrors Celie’s traumatized cognitive processes and depressed emotional state” (17). The letters themselves are short, prompting the reader to jump from idea to idea, as Celie, Sofia, and Squeak do while confronting the confusion based around the trauma, oppression, and discrimination they endure. Separating the novel in letters rather than chapters is fragmented in itself; the isolation of the writing is representative of the isolation African American women encounter. While the letters specifically represent the isolation Celie experiences, on a broader scale, the letters written to God and Celie’s sister, Nettie, reveal the women’s only outlet from the trauma to be a spiritual figure or other members of their master status. The letters speak of the silence and oppression African American women experience as a result of their gender and race.

Celie’s status as an African American woman determines her willingness to come forward about her abuse. Early 20th century society has deemed her less than human because of her combined gender and race. Societal constructs create Celie’s low self-confidence and tendency to direct her blame inward, which is shown through her decision to confess her abuse only through letters to God. In her book, *Trauma and Survival in Contemporary Fiction*, Laurie Vickroy refers to psychiatrist Alice Miller, who notes that trauma victims who are most damaged, “are those who are unable or prevented from voicing their anger or pain” (6). Celie, like many victims, is unable to voice her trauma because of her subordinate statuses. In a letter to Celie, Nettie

reveals, “I remember one time you said your life made you feel so ashamed you couldn’t even talk about it to God, you had to write it, bad as you thought your writing was” (Walker 130). Vickroy attests to the power of Celie’s letters, which act as her trauma narratives, explaining that these narratives, “enact the directing outward of an inward, silent process to other witnesses, both within and outside the texts” (3). In other words, these narratives allow for the traumatic memory to begin to lose its power as a fragment or symptom and instead be reconstructed and integrated as a memory. While Celie’s letters act as an outlet and may somewhat aid in her healing process, overall the letters elicit the feelings of confusion, isolation, and despair the characters encounter as African American women in a white patriarchal society.

Replicating trauma through the novel’s structure allows Walker to highlight the severity of the suffering while calling attention as to *why* the women are the victims of violence. Identifying the signs of trauma throughout the novel acts as a bridge to understanding the source behind the symptoms and provides a narrower lens for analyzing how gender and race relate suffering. While structuring the novel in epistolary form illustrates the trauma the women are subjected to, it also portrays the marginalization that African American women struggle with. It does so through its lack of traditional narration, which is instead conveyed through Celie’s personal letters. Her letters demonstrate her ignorance, and generally speaking, allude to African Americans’ lack of opportunity, which propels oppression specifically amongst women. Linda Selzer draws upon Elliot Butler-Evans’s viewpoint of the epistolary structure to heighten her argument. Butler-Evans points out that, while other criticisms argue that the letters and personal narration take away from the race issue because “it is constricted to the viewpoint of an uneducated country woman,” the letters actually allow for racial implications to be analyzed (Selzer 67). Selzer quotes Butler-Evans, who asserts that the letters serve as a “textual strategy by which the larger African-American history, focused on racial conflict and struggle, can be marginalized by its absence from the narration” (67). Lauren Berlant, on the other hand, considers the letters to take away from the novel’s ability to transcend from the personal to the public lives of African Americans. In accordance with Selzer and Butler-Evans, the letters actually appear to amplify the issues of gender and race on a larger scale. In that sense, Walker uses the narrative strategy to draw attention to families and kinships (Selzer 68). Selzer claims that this “enables Walker to foreground the personal histories firmly within a wider context of race and class” (Selzer 68). Essentially, the letters demonstrate the personal lives of the narrators, which speak on behalf of the wider issues of gender and race in the African American community. Celie and Nettie’s letters show the larger issue of oppression, and it is that oppression that evidently launches the trauma the women face.

The structuring of the novel in epistolary form emphasizes how race leads to trauma. As Selzer writes: “Indeed, the personal point of view of *The Color Purple* is central to its political message: it is precisely the African American woman’s *subjectivity* that gives the lie to cultural attempts to reduce her [Celie]—like Sofia—to the role of the contended worker in a privileged

White society" (75). The epistolary format reveals that gender and race are in fact the underlying cause of the trauma the women experience in the novel. Celie and Nettie's personal accounts show how imposed societal stereotypes centered on gender and race influence oppression and, in turn, promote abuse and suffering.

Language and Educational Oppression

The novel's epistolary format calls attention to the educational oppression the female characters are subject to in *The Color Purple*. Walker's use of dialect, most obviously her incorporation of broken English, illustrates the inferior status of the female characters. Celie's letters are not written in Standard English; the women's broken dialect sounds choppy and is challenging to read, forming a sense of fragmentation. From a young age Celie faces horrific physical and sexual abuse; her stepfather began beating and raping her at fourteen years old, ultimately forcing her to carry his two children just to have them taken away from her at birth. When Celie recounts her difficult experiences, her language mimics the sense of fragmentation and isolation trauma victims often feel. Celie remembers the first time the abuse occurred: "When that hurt, I cry. He start to choke me, saying You better shut up and git used to it. But I don't ever git used to it. And now I feels sick every time I be the one to cook. My mama she fuss at me an look at me. She happy, cause he good to her now" (Walker 1). The spelling and grammar Celie uses plays against a smooth read, recreating the sense of confusion, turmoil, and fragmentation she experiences following the start of the abuse as well as while dealing with the aftermath of the trauma. The language also simultaneously recreates the feelings of isolation, confusion, and helplessness that many trauma victims experience. The sense of confusion positions the reader to ask *why* the characters are victims of such violent abuse. The language speaks of the educational oppression Celie, Sofia, and Squeak suffer because of their gender and race, which directly contributes to their trauma.

Educational oppression is a way in which men can maintain control over women's abilities and remove opportunities for success, forcing complete dependence. Lauren Berlant points out, "*The Color Purple* opens with Celie falling through the cracks of a language she can barely use" (837). Based on Walker's use of language, the audience might assume that the narrator has not been given optimal educational opportunities, which once again segues into the question of *why*? The broken dialect speaks of a larger issue at hand—the complacency and inferiority African American women internalize because they are in a perpetual state of control by members of superior categories. Selzer argues that the women's broken English, specifically Celie's limited knowledge of the larger world, points to the "domestic site she [Celie] occupies as the novel's main character" (67). The language reveals how the women's ignorance allows them to fall victim to abuse, oppression, and discrimination. In trying to learn where her sister Nettie is, she explains, "One time I ast him could I look at the stamps but he said he'd take it out later. But he never did" (Walker 118). Mr. _____ intentionally oppresses Celie because of her position in

society as an African American woman; a lack of education allows for the men in her life to maintain control and continue using her as an object that will not question authority. While discovering Nettie's hidden letters, Celie exposes her limited scope of knowledge: "I don't know where England at. Don't know where Africa at either" (Walker 119). Celie has been purposely kept in the dark regarding education. Celie remarks on the stamps on Nettie's letters and exclaims, "Little fat queen of England stamps on it, plus stamps that got peanuts, coconuts, rubber trees and say Africa" (Walker 119).

The novel's political innuendos call attention to the issues of race. Selzer explains that the latter demonstrates the notion of imperialism. The stamps act as juxtaposition—England representing royalty, while Africa represents the opposite. The stamps show how the novel is riddled with the implications of racial inequality, with Celie representing the intentional oppression of African American women into positions of subordination. Celie's language, which points to her lack of education, illustrates how her race is a catalyst for abuse. The female characters in the novel are at a clear intellectual disadvantage because as African American women, earning an education does not fit in to their master status, supporting the fact that gender and race are the causes of trauma. The women's lack of opportunity transcends into a lifetime of discrimination, oppression, and abuse.

Gender and Race-Based Trauma

For Walker, trauma is cumulative. She examines the impact gender and race have on African American women through a wide range of interpersonal violence. The violence results from the greater systemic issue at hand, which includes contributing factors such as African American women's rigid societal roles in contrast to men's superiority complex. Categorical roles determine what African American women can and cannot do. Celie, Sofia, and Squeak are part of two "Not-A" categories, which produces group-specific adversity. Juliet Mitchell argues that patriarchy is a "universal feature of human societies," through which "women are oppressed in their very psychologies of femininity" (Jackson 9, 11). This idea becomes evident through Celie's relationship with her father, who has robbed her of the opportunity to receive an education once he got her pregnant. As Celie tells it: "The first time I got big Pa took me out of school. He never care that I love it...You too dumb to keep going to school, Pa say" (Walker 9). Celie's life is constructed around patriarchal ideals, supporting how women's inferior status influences the trauma they experience.

Pa, as the patriarch, is a catalyst for gender- and race-based trauma. His view on African American women's rights propels Celie's oppression. When referring to Celie's schoolteacher, Pa asserts, "She run off that mouth so much no man would have her" (Walker 10). Celie's father spells out men's expectations of women, believing that they should be obedient, complacent, and uneducated so they are easier to control. Celie's father blatantly calls attention to how gender and race influence the trauma the women in the novel experience. He also plays into the

recursive cycle of trauma. Pa yells at Celie because she never dresses nicely but beats and rapes her when she dresses up because she “looks like a tramp.” As Celie explains, “He beat me for looking trappy but he do it to me anyways” (7). Her identity causes the abuse, which is doubly traumatic. Pa continues to represent society’s view on African American women by treating Celie as an object, offering her up to any man that comes asking for a wife. He describes Celie to “Mr. _____” as “ugly” (8). When Mr. _____ returns to talk to Pa about taking one of his daughters he says, “Mr. _____ want another look at you” (10). Celie is nothing more than an object who will belong to a man for all of her life. She adds: “Mr. _____ marry me to take care of his children. I marry him cause my daddy made me. I don’t love Mr. _____ and he don’t love me” (63). Celie has no say over her body or her life; she is given to one abusive man from another because society deems that, “A girl is nothing to herself; only to her husband can she become something” (155). Ultimately, a woman’s looks and ability to care for a house and children determines her worth, demonstrating how social constructs are at the core of oppression and suffering.

The body is fundamental to a person and abuse on the body removes personhood in the same way categorization systems do. The trauma the women experience is directly linked to the type of oppression and violence they suffer. Celie’s suffering does not end once she is given to Mr. _____. Celie, like Sofia and Squeak, is victim to brutal physical and sexual abuse throughout her life because of the categories she belongs to. Mitchell offers an explanation to the women’s cyclically oppressed existence stating, “gendered subjectivity can be seen as constituted ideologically, ensuring the continual reproduction of dominant masculinity and dominated femininity” (Jackson 9). The women in Walker’s novel have found themselves in a lifetime of abuse. “A girl child ain’t safe in a family of men,” Sofia reflects (Walker 40). Sofia, who acts as one of the novel’s stronger characters, offers an explanation as to why she learned how to fight; using her personal childhood experiences, she expresses the dangers that come for women living in a world run by oppressive men. Walker’s glimpse into Sofia’s childhood highlights the cycle of abuse women face, while providing explicit evidence to support how a woman’s inferior status promotes trauma.

Celie’s continued abuse and discrimination throughout her childhood and adult life also illuminate the universality and commonality of gender and race associated oppression. Her abusive father gives Celie away to an abusive husband, “Mr. _____,” which extends the trauma from her childhood to adulthood. Celie explains, “Most times mens look pretty much alike to me” (Walker 15). She is in an endless cycle of abuse at the hands of men, a result of her subordinate identity. Celie calls her husband, Albert, “Mr. _____.” Neglecting to write Albert’s name points to the reality that this could be any abusive man; the gender and racial abuse is not confined to Celie’s specific situation, but is instead a constructed categorical issue at large (Brogan). By omitting Albert’s name, Celie also indicates her fear of men. Her fear of men is warranted given the abuse she was exposed to as a child. As a child, she was conditioned not to speak out against her abuse, behavior that transitioned into adulthood. Celie recounts Mr. _____ raping her and

discloses: “But I don’t cry. I lay there thinking bout Nettie while he lay on top of me, wondering if she safe” (Walker 12). She continues to explain: “I don’t know how to fight. All I know how to do is stay alive” (17). For years the abuse is so severe that Celie cannot fight back without risking her life; her identity has forced her into life or death situations and Walker uses graphic abuse scenes to better depict the implications of her gender and race.

Walker’s abuse scenes emphasize both men’s control over women and White’s control over African Americans. Overtime, Celie is repeatedly raped by Mr. _____, confessing, “Once he git on top of me I think bout how that’s where he always want to be” (Walker 65). Walker focuses on detail, while describing the abuse to call attention to the reason behind the trauma; she calls attention to a man’s desire to “be on top” in regards to their relationships and dynamic with women—a classic power struggle. As African American women, Celie, Sofia, and Squeak will never be “on top”; society places individuals occupying multiple “Not-A” categories on the bottom of the totem pole. Crenshaw remarks, “many women of color for example, are burdened by poverty, childcare responsibilities, and the lack of job skills”—factors that maintain their subordination (1245). Burdens of poverty, childcare responsibility, and lack of job skills are characteristic of Walker’s female characters, which speaks to their confinement in roles that are inferior to their male and/or White counterparts. Crenshaw’s assertion points to Celie, Sofia, and Squeak’s vulnerability to identity-based oppression, violence, and trauma. Walker’s abuse scenes depict how a woman’s gender and race put her at a greater risk of suffering traumatic events.

Walker’s male characters, who pride themselves on keeping women “below them,” blatantly promote oppression and discrimination, highlighting how gender and race cause the infliction of abuse and trauma. Harpo is symbolic of how gender and racial stereotypes are maintained over multiple generations. He demonstrates how patriarchal society passes down gender and race derived expectations to their sons, sustaining the cycle of discrimination, oppression, and abuse. Harpo very clearly defines how gender and race are the underlying causes of the trauma the women experience in *The Color Purple*. Harpo often references his father, Mr. _____, and his “women handling skills” when commenting on the “proper” way to treat women. Harpo asserts: “Women work. I’m a man” (Walker 21). Harpo’s statement demonstrates the larger issue at hand: he is a representation of society’s view on women’s worth and potential. He illustrates the way in which oppression is distilled in the generations of men to come. Harpo learns a woman’s worth and potential from the standards society and his father set for young boys to uphold. Harpo argues: “I want her to do what I say, like you do for Pa...When Pa tell you to do something, you do it, he say. When he say not to, you don’t. You don’t do what he say, he beat you” (62-63). Harpo continues, “The wife spose to mind” (63). He claims: “Wives is like children. You have to let ‘em know who got the upper hand. Nothing can do that better than a good sound beating” (35). Harpo explicitly says that men feel they have the upper hand over women, proving differences in gender to be a clear incentive for physical and sexual abuse. In Harpo’s eyes, men “have” a wife so they “mind” and blindly listen to instruction; they are placed

in a position of subordination on purpose. Women are not viewed as human, but instead as an object willing to jump at a man's beck and call. Harpo continues to offer "justification" for the oppression and abuse of women when his wife, Sofia, tries to hold her mother's casket at her funeral, declaring: "But peoples use to men doing this sort of thing. Women weaker, he say. People think they weaker, say they weaker, anyhow. Women spose to take it easy. Cry if you want. Not try to take over" (217). Walker uses Harpo's clouded view of women to prove gender, along with race, as one of the contributing factors of the trauma the women experience in the novel.

In illustrating how a woman's race plays a hand in her oppression and suffering, Walker introduces the mayor and his wife, Miss Millie, who through their interactions with Sofia, spell out the crux of the trauma. Sofia at first acts as a foil to Celie. Never allowing Harpo to beat her, Sofia does not "mind" until she is arrested for talking back to Miss Millie and pushing the mayor down. Miss Millie saw Sofia in town and exclaimed, "All your children so clean, she say, would you like to work for me, be my maid" (Walker 85). She responds "hell no" and follows by pushing the mayor down for slapping her (85). The mayor and his wife symbolize racial limitations for African American women in early 20th century America. Despite Sofia's "clean" appearance, fine looking children, and nice wristwatch, her identity as an African American woman dictates her potential; she is seen as capable of only being a White family's maid. Miss Eleanor Jane, who is the White child Sofia raises as a maid, further proves the rigid gender and racial roles African American women are expected to uphold: "All the other colored women I know love children. The way you feel is something unnatural" (265). Society deems African American women "unnatural" if they do not conform to their gender and race specific roles. Sofia's master status does not provide her with equal opportunities to White women, African American men, or White men. Her gender and race trap her in a small bubble that contains minimal opportunity yet a great deal of oppression and abuse.

Despite her tough attitude, Sofia is knocked down each time she tries to function outside of her master status, showing how society's categories of difference promote oppression and trauma. Sofia is thrown in jail and Harpo finds a new girl, Squeak, who fits the "obedient woman" stereotype he praises. Squeak's real name is Mary Agnes; she received her nickname because of her passivity. She is described as a "little yellowish girlfriend" who will "do anything Harpo say" (Walker 82). Sofia adopts a similar complacency while in jail. Sofia explains, "Every time they ask me to do something, Miss Celie, I act like you" (Walker 88). Like Celie, Sofia's spirit has been broken; she does as she is told, and as a result, internalizes how society views her. Sofia's life in prison is symbolic of African American women's lives; they are prisoners in their own body and a prisoner to society's gender and race constraints.

Sofia faces extreme adversity while in jail and in an effort to break her out of prison, Celie and her family dress Squeak up "like she a white woman" because she is "the warden's black kinfolks" (Walker 92-93). Squeak's efforts to convince the White male warden to release Sofia

fails as she reveals, “He took my hat off...Told me to undo my dress” (Walker 96). The White warden rapes Squeak because of her inferior status. The warden defends his behavior by claiming that Squeak could not have been kin to him. She admits: “He say if he was my uncle he wouldn’t do it to me. That be a sin. But this was just a little fornication. Everybody guilty of that” (Walker 96). The warden sees Squeak as an African American woman who, despite her mixed race, is placed in both “Not-A” categories, catalyzing the sexual assault. As a woman of mixed-race, Squeak might demonstrate the severity gender alone has on one’s susceptibility to trauma. Jacqueline Brogan argues the “race-less” aspect of oppression, stating the commonality of “the continued abuse of white women, black women, all women, no matter what ethnicity or race” (196). Brogan indicates that Squeak’s trauma is not as much a race issue as it is a gender issue. On the contrary, Squeak’s traumatic event in fact speaks of marginalization deeply rooted in both gender and race. As a “yellowish girlfriend,” Squeak could identify with her White background over her African American background, but society’s strong emphasis on oppression and discrimination based on appearances will not allow her to do so. Walker’s novel as a whole, but specifically her female characters’ experiences, illustrates how race, alongside gender, is a huge factor in extending the abuse and traumatization of women. While the broad terms of gender and race can be unpacked to reveal discrimination fixed in each category alone, Walker’s novel illuminates the specific trauma that emerges when the two minority categories are combined.

While working for the mayor’s wife, Sofia portrays the group specific adversity African American women endure opposed to members occupying other categories. Sofia is barred from seeing all but one of her children, going five years without even a single visit. While cleaning their house Sofia exclaims, “I’m slaving away cleaning that big post they got down at the bottom of the stair” (Walker 102). Sofia’s son says, “Don’t say slaving, Mama” (103). Sofia angrily exposes the harsh oppression, discrimination, and trauma forced upon her because of her position in society, a source of her gender *and* race. She declares:

Why not? They got me in a little storeroom up under the house, hardly bigger than Odessa’s porch, and just about as warm in the winter time. I’m at the beck and call all night and all day. They won’t let me see my children. They won’t let me see no mens. Well, after five years they let me see you once a year. I’m a slave, she say. What would you call it? A captive, he say. (103)

Sofia’s experiences epitomize trauma stemming from gender and race. As an African American woman, she is confined to “slaving” for a White family in a female specific role. Walker uses Sofia’s encounter with the mayor and Miss Millie to shake the reader into understanding the driving force behind her suffering. Like Celie and Squeak, Sofia’s gender and race corner her into a life of oppression and discrimination, which ultimately induces her trauma.

Resilience and Transformation

Despite the trauma the women have endured, they are able to undergo important transformations in their healing processes. Herman affirms the difficulty of such a task. She explains that traumatic events strain social relationships and challenge our sense of selves. They also challenge belief systems and threaten severe personal crises (51). Celie, Sofia, and Squeak all experience the sense of disconnect and shattered beliefs that Herman claims is typical of trauma survivors; yet the women still demonstrate a transformation. Although gender- and race-based oppression, violence, and trauma can shatter the victim's world, healing and growth is not impossible. Herman explains that a supportive response from others can mitigate the impact of the event (61). Although the victim's sense of self has been damaged, "that sense can be rebuilt only as it was built initially, in connection with others" (61). Celie, in particular, validates the power of support; her transformation is contingent upon her strong, healing connections. She finds her voice in her relationships with women experiencing intersectionality and suffering as she does. Crenshaw, in her exploration of violence rooted in intersectional identities, raises a noteworthy point regarding the transformative nature of particular types of violence and trauma. As she writes, "battering and rape, once seen as private (family matters) and aberrational (errant sexual aggression), are now largely recognized as a broad-scale domination that affects women as a class" (1241). Wide-scale recognition of an issue affecting a group at large offers validation for its victims; it is representative of the transformative potential of the women's specific experience with trauma. While the women are indeed traumatized in the novel, they are not permanently arrested by the violence. Unfortunately, their trauma is indicative of a largely "social and systemic" issue at hand (1241). In understanding the commonality of their trauma, Celie, Sofia, and Squeak turn towards their shared experiences as a "source of strength, community, and intellectual development" (1242). Such recognition, discussion, and support leaves room for healing, growth, and transformation in the traumatized individual's life.

Conclusion

The Color Purple speaks of issues that are not only confined to Celie, Sofia, and Squeak, but in fact transcend from the specific individuals, setting, and time period of the novel to present day. Walker calls attention to the marginalization of groups at large through her depiction of gender and racial issues. Celie, Sofia, and Squeak's life experiences demonstrate how gender and race have a hand in the infliction of trauma. Though violence does not always lead to trauma, Celie, Sofia, and Squeak's specific experiences with violence are linked to their traumatization; the women are susceptible to such trauma because of the *type* of violence inflicted upon them—intersectional identity-based oppression, physical assault, and sexual assault, all of which results in a certain "group-specific trauma." The women not only find their voice as individuals, separate from their master statuses, but also find solidarity in each other, a community of African American women.

It is only members of both groups, female and African American, that can understand the group specific oppression, abuse, and trauma driven by gender and race. The novel's epistolary format directly engages the reader, calling on the audience to recognize the African American woman's plea for change. Celie's letters represent the marginalized group as a whole, who are asking for a solution to the trauma they experience. The abuse and suffering Celie, Sofia, and Squeak endure is a result of their identities and while the women cannot change their master statuses, the novel acts as a platform to change the stigmas that cloud them. The issues raised in Walker's, *The Color Purple* are timeless. Given recent categorical divisions in a so-called "progressive" America, gender and race appear to remain steady as central issues demanding a great deal of focus from our nation.

The lack of tolerance that surrounds gender and racial categories in today's society raises the following question: God may have been listening to Celie, but have we?

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Will Vestibulo-Ocular Reflex and balance rehabilitation reduce visual deficits & improve stability of a patient with Multiple Sclerosis?

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ABSTRACT

Context. Identification of rehabilitation exercises to decrease symptomology in a patient with Multiple Sclerosis (MS) is necessary for enhancing quality of life. Various vestibulo-ocular reflex (VOR) rehabilitation exercises can help patients adapt to balance problems. Currently, no researcher has utilized the VSR™ Sport and *inVision*™ systems by NeuroCom® for rehabilitation among patients with MS.

Objective. The purpose of the study was to create a rehabilitation protocol incorporating VOR and balance exercises to decrease visual deficits and improve stability in a patient with MS. This study will examine the effects of rehabilitation and determine if scores improve from baseline testing.

Design: Original Quantitative Research

Setting: Sacred Heart University Doctor's office

Patient: 40-year-old male with relapsing remitting Multiple Sclerosis (Height: 175.25cm; Weight: 72.5kg)

Interventions: One-hour VOR and balance rehabilitation sessions three days per week, for six weeks. The subject was baseline and post-tested using the VSR™ Sport and *inVision*™ systems by NeuroCom®.

Main Outcome Measures: Data were collected using VSR™ Sport and *inVision*™ systems by NeuroCom®. Baseline and post-test scores were compared and percent changes were calculated via Microsoft Excel.

Results: There was an overall improvement in scores for VOR and balance from pre- to post-tests. GST L increased by 60 percent from 98 to 157 deg/s, DVA L improved by 80 percent from 0.3 to 0.06 logMAR. LOS Mvmt Velocity L increased by 96% from 2.4 to 4.7 deg/s. SET sway velocity improved by 55 percent from 6.9 to 3.1 deg/s.

Conclusions: The six-week rehabilitation protocol using the NeuroCom® systems was effective in improving the subject's balance and VOR scores. A decrease in symptoms can improve the quality of life for a patient with MS.

Key words: Multiple sclerosis, VOR, Balance, VSR™ Sport, *inVision*™, NeuroCom®, rehabilitation

¹ We would like to Thank Dr. Theresa Miyashita for giving us the opportunity to work with the VSR™ Sport and *inVision*™ systems, also to Sacred Heart University Athletic Training Program, which has provided us with the supplies, support, mentorship, and the ability to complete this project.

Introduction

Multiple sclerosis (MS) is a chronic autoimmune neurological disease of the central nervous system (CNS) that affects approximately 2.3 million individuals worldwide. Many patients experience episodes of potentially reversible neurological deficits, which are often followed by progressive neurological deterioration. Relapsing-remitting MS is the most common diagnosis affecting approximately 85 percent of MS patients, and is characterized by short terms of various symptoms followed by periods of remission.² The potential symptoms one may experience include but are not limited to: dizziness, vestibular dysfunction, fatigue, instability, decreased strength, and impaired cognition. There is currently no cure for an MS diagnosis, but visual, cognitive, and somatosensory rehabilitation and various medications are being used in an attempt to decrease symptomology and slow progression.³

Research has proved rehabilitation programs are effective, specifically in improving balance and VOR test scores in patients with MS.⁴ Because all patients with MS present differently, each rehabilitation program is individualized for the needs of the patient based on their specific symptoms.⁵ Various research has been done to show the effectiveness of vestibular rehabilitation in reducing dizziness, improving gait, and balance function in post-concussion patients.⁶ These patients are comparable to those with MS due to similar CNS and vestibular disruption. Research results also suggest VOR rehabilitation is beneficial for a patient experiencing vestibular dysfunction and instability.⁷ Improving instability and gait in this patient may also serve to decrease other deficits such as muscle strength, tremors, and fatigue.⁸

The patient participating in this study was diagnosed with relapsing-remitting MS and experiences visual and balance deficits on his left side. There is limited research on a rehabilitation program specifically combining the effects of both VOR and balance training on a single patient with MS. The purpose of the study was to create a rehabilitation protocol incorporating VOR and balance exercises to decrease visual deficits and improve stability in a patient with MS. This study will examine the effects of rehabilitation and determine if scores improve from baseline testing.

² Parsa MS, et al. Cervical and Ocular Vestibular Evoked Myogenic Potentials in Multiple Sclerosis Participants. *Med J Islam*. 2015; (29).

³ Goldenburg M. Multiple sclerosis review. *P&T*. 2012;37(3): 175–184.

⁴ Burks JS, Bigley GK, Hill HH. Rehabilitation challenges in multiple sclerosis. *Ann Indian Acad Neurol*. 2009;(12):296-306.

⁵ Srulijes K, et al. Association between vestibulo-ocular reflex suppression, balance, gait and fall risk in ageing and neurodegenerative disease: protocol of a one-year prospective follow-up study. *BMC Neurology*. 2015;(15):192.

⁶ Alsalaheen BA, Mucha A, Morris LO, et al. Vestibular rehabilitation for dizziness and balance disorders after concussion. *J. Neurol. Phys. Ther.* 2010;34(2):87-93.

⁷ Alsalaheen BA, Mucha A, Morris LO, et al.

⁸ Burks JS, Bigley GK, Hill HH.

Methods

Participants. One 40-year-old male with relapsing remitting MS (height: 175.25 cm weight: 72.5 kg) participated in this study. The subject had not participated in any rehabilitation related to MS since his diagnosis but is extremely active and maintains a healthy lifestyle. The subject administers three 40mg injections of Copaxone per week prescribed by his doctor.

Instrumentation. Pre- and post-test data were collected using the VSR™ Sport and *inVision*™ systems by NeuroCom® (Clackamas, OR). The testing screen was 1.1m off the ground and the participant's eyes were 2.13m from the screen specifically for VOR rehabilitation, and the force plate was 1.1m from the screen for balance exercises. VOR was assessed using *inVision*™ system to measure: perception time (PTT), static visual acuity, gaze stabilization (GST), and Dynamic Visual Acuity (DVA). These tests require the patient to move his head to a fixed velocity while keeping his eyes on a fixed optotype on the screen. The ability to maintain the determined velocity and amount of errors recalling the direction of the optotype on the screen were measured by the researchers. The subject wore a calibrated head accelerometer provided by the *inVision*™ system to measure head velocity and degree of head movement.

The subject's instability was assessed using VSR™ Sport System tests: limits of Stability (LOS), which required the subject to control his center of gravity by shifting his weight to specified points on the force plate and Stability Evaluation Test (SET), which is similar to the Balance Error Scoring System completed in the Sport Concussion Assessment Tool. The subject completed these tests standing on a force plate and high-density foam, provided by the VSR™ Sport system, to measure his center of gravity and sway velocity.

Procedures and Data Collection

Prior to the start of the study, the subject signed an informed consent form approved by the University's Institutional Review Board. Prior to the six-week rehabilitation program, the patient completed a VOR and balance baseline test. Both examiners were present for the baseline test. The participant completed the baseline tests in the following order: PTT, GST, DVA, SET, and LOS. The rehabilitation program was divided into three sessions per week and performed in the same order each week (VOR, balance, and VOR and balance). The sessions took place at 7am on Monday, Wednesday, and Friday for six consecutive weeks. The exercises remained the same each session unless difficulty was increased or additional exercises were added (Figure 1, Table 2). The subject was not participating in any other rehabilitation training but had been running at least 3x per week prior to the start of the six-week program.

The *inVision*™ system is pre-programmed with levels of difficulty for each background type including: color, stripes, checkers, and falling objects. The examiner manipulated the target head velocity, size of optotype, and metronome pace. The patient calibrated the accelerometer before each trial and was given a practice trial before each assessment. Before and after each trial, the patient was asked to rate any occurring symptoms on a scale from zero-ten including:

dizziness, nausea, eye pain, headache, or foggiess. During each trial, the optotype “E” appeared on the testing screen in different directions (left, right, up, down). The patient recited what he saw on the screen and the same examiner recorded it on the provided remote for each session. The variables changed in difficulty based on the progress of the patient (Figure1). The subject’s progression included background change, decreased optotype size, and increased metronome to pace his head velocity. The system measured average head velocity, optotype size, compliance, and the percent of average head symmetry for each trial.

The VSR™ Sport System provided the option to choose a sequence training program or a custom training program for the examiner to manipulate. The pre-programmed baseline test measured the patient’s stationary double leg and single leg stability, and double leg stability while shifting center of gravity, on various surfaces (*i.e.* firm, foam). The sequence-training program allowed the examiner to choose which joint to focus each rehabilitation exercise on, including ankle, knee, hip, and lumbar spine. Each joint category had levels based on weight bearing status, level of stability, and exercise difficulty. The patient started each category on level three and progressed by weight bearing status, pace time, and surface type (Figure 2). Prior to each trial, the patient was able to practice the exercise. Left- and right-side weight shifts and single leg exercises lasted for one minute and double leg center of gravity exercises lasted for two minutes. Center of gravity control and the core were exercised with the lumbar stability test using a weighted medicine ball that increased in weight each week. The protocol consisted of different exercises requiring the subject to shift his weight to specific targets, or maintain balance for a period of time. Toward the end of the protocol, the examiner manipulated the pace time and position targets using the custom training sequence. As the patient’s performance improved, the rehabilitation protocol progressed. The system measured compliance and pace time for each trial.

All exercises during the VOR and balance rehabilitation protocol differed from assessments in the baseline test and post-test. After the six weeks of VOR and balance rehabilitation, the subject was then post-tested utilizing the same baseline test.

Statistical Analysis

SPSS was not used to run stats because there was only one subject and no other data points to compare the results to. The results from the pre- and post-rehabilitation tests were entered into a Microsoft Excel spreadsheet. Percent changes between the pre- and post-test scores for both VOR and balance were calculated.

Results

The patient had an overall improvement in VOR scores between pre- and post-test scores (Table 1). From pre- to post-test the patient achieved the best possible score of 20ms for PTT. GST had a bilateral increase in achieved average head velocity from pre- to post-test with a 44.6 percent

increase on the right from 121 to 175 deg/s and a 60 percent increase on the left from 98 to 157 deg/s. The patient improved from favoring his right side by 11 percent to favoring the impaired left side by 5 percent. PTT, GST, DVA percent changes are highlighted in Table 1.

Balance pre- and post-test score improvements are highlighted in Table 2. LOS forward reaction time improved from 1.13 seconds to 0.49 seconds. Forward movement velocity improved from 1.9 deg/sec to 4.7 deg/sec and to the right from 2 deg/sec to 6.8 deg/sec. Sway velocity decreased on tandem foam from 10.9 to 4.1 deg/sec. A majority of the scores improved on the stability evaluation test (Figure 3).

Discussion

Our subject was diagnosed with relapsing-remitting MS in 2003, and continues to have relapsing symptoms, specifically vision (blinders) and balance deficits, on his left side. The subject is aware of deficits in his fine motor skills and balance when performing activities of daily living (ADLs) and work-related tasks. An effective rehabilitation program for MS requires acknowledgement of patient's potential impairments.⁹ The patient was compliant throughout the protocol and honest about his symptoms. Patients with MS depend strongly on vision for balance control mostly because of proprioceptive and vestibular deficits.¹⁰ This rehabilitation protocol combines VOR and proprioceptive exercises to potentially provide increased stability, coordination within motor functions, and higher quality of life among a patient with MS.

VOR is a reflex used to stabilize gaze, which provides a stable environment for retinal focus.¹¹ As an individual ages, his or her VOR is increasingly impaired and negatively effects their perception of balance.¹² VOR has been rehabilitated to achieve normal function in many neurodegenerative diseases such as Parkinson's and progressive Supranuclear Palsy.¹³ There is no research using the *inVision™* system for VOR rehabilitation on patients with MS, but similar symptoms from head-induced trauma have decreased from these VOR interactive exercises.¹⁴ According to Cohen, it is necessary to incorporate VOR therapy and rehabilitation programs for patients who are experiencing balance deficits.¹⁵ Balance is the second-most-common symptom

⁹ Burks JS, Bigley GK, Hill HH; and Shah P. Symptomatic Management in Multiple Sclerosis. *Ann Indian Acad Neurol.* 2015;(18):35-42.

¹⁰ Cattaneo D, et al. Effects of balance exercises on people with multiple sclerosis: a pilot study. *Clin Rehabil.* 2007;21:771-781

¹¹ Srulijes K, et al.

¹² Cattaneo D, et al.

¹³ Srulijes K, et al.

¹⁴ Gottshall KR, Hoffer ME. Tracking recovery of vestibular function in individuals with blast-induced head trauma using vestibular-visual-cognitive interaction tests. *J Neurol Phys Ther.* 2010;34(2):94-7.

¹⁵ Cohen A. Vision Rehabilitation for visual-vestibular dysfunction: The role of the neuro-optometrist. *Neurorehabilitation.* 2013;(32):483-492.

associated with MS, and one of the most disruptive symptom in patients' lives.¹⁶ Davide Cattaneo found patients with MS have difficulty maintaining balance with a reduced base of support, specifically when dynamically transferring their center of mass and when sensory input is disturbed.¹⁷ As seen in the results the subject had a bilateral improvement in head velocity during GST and in movement velocity from right to left during LOS. The somatosensory system allows for proprioceptive function to work with vision and balance. It is necessary to also train balance in conjunction with VOR, as both of these systems work together with one another during ADLs.¹⁸ In our study, the scores of both VOR and balance improved throughout the protocol. Post-test VOR scores have a greater increase from baseline than balance scores.

Exergaming is a term used for videogames that are also used as a form of exercise. Researchers believe playing exergames on an unstable surface, such as foam, appears to be an effective way to improve balance and gait in patients with MS.¹⁹ The integration of exergames has a positive effect on adherence and is thus potentially beneficial for the long-term effectiveness of rehabilitation programs. The VSR™ Sport System is comparable to exergaming because of the computer-based exercises and the subject's ability to follow their movements on a given surface and on the screen provided.

The patient has not partaken in any previous rehabilitation programs for his symptoms. Our results indicate the combination of VOR and balance rehabilitation has a positive effect on a patient with MS experiencing these specific symptoms. Using the systems provided by NeuroCom® is an effective way to maintain the patient's adherence and utilize practical balance and VOR exercises. The results show that this protocol is able to increase his stability and VOR during these assessments. The patient did not report a noticeable difference after the rehabilitation protocol but did not experience symptoms before, during, or after the six weeks.

Further research should compare the effects of a similar rehabilitation protocol on multiple patients suffering from various symptoms. The progression in this protocol was based on the patient's ability to perform and therefore can vary among other patients. SET tandem firm was the only assessment that did not have a positive improvement. This could be possible because of the patient's frustration during the assessment causing him to fall off of the firm surface. Patients' behaviors throughout the protocols should be considered when progressing the exercises. Uplifting music was added to the balance rehabilitation sessions to help with the patient's frustration and adherence but was not used during pre- or post-tests.

¹⁶ Zackowski K, Cameron M, Wagner J. 2nd International Symposium on Gait and Balance in Multiple Sclerosis: interventions for gait and balance in MS. *Disabil. Rehabil.* 2014; 36(13): 1128-1132. Kliem A, Wiemeyer J. Comparison of a Traditional and a Video Game Based Balance Training Program. *IJCSS.* 2014;9:80-91.

¹⁷ Cattaneo D, et al.

¹⁸ Cohen A.

¹⁹ Kliem A, et al. Exergaming with Additional Postural Demands Improves Balance and Gait in Patients with Multiple Sclerosis as Much as Conventional Balance Training and Leads to High Adherence to Home-Based Balance Training. *Arch Phys Med Rehabil.* 2014;(95)10:1803-1809.

Rehabilitation is designed to prevent complications and minimize functional deterioration. Vestibular rehabilitation attempts to help patients adapt to balance problems.²⁰ Many researchers have analyzed the correlation between VOR rehabilitation for MS patients and balance rehabilitation for MS patients. No researchers have used the NeuroCom® systems to rehabilitate patients with MS. This six-week rehabilitation program was successful at improving scores from pre- to post-test; however, we are unable to determine if these findings have a statistical significance.

²⁰ Burks JS, Bigley GK, Hill HH.



FIGURE 1. VOR Rehabilitation Protocol via NeuroCom® InVision System

FIGURE 3. Stability Evaluation Test pre- and post-test results

