RECIPIENTS OF MAJOR SCIENTIFIC AWARDS

A DESCRIPTIVE AND PREDICTIVE ANALYSIS

by

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DISSERTATION

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ABSTRACT

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Recent trends demonstrate an increase of women in leadership roles, STEM fields, and participating in higher education including graduate and doctoral programs, which is a result of Title IX. This quantitative study considered major scientific awards awarded to females and examines demographic characteristics of awardees from the Nobel, National Academy of Sciences (NAS), and National Science Foundation (NSF). More specifically, the following awards were examined the Nobel Prize in Chemistry, the NAS Public Welfare Medal, and the NSF National Medal of Science within the discipline of Physical Science. Also, this study focused on equality to determine if a fair playing field and equal opportunity for women in academics has improved since Title IX. A limited amount of research has explored female award recipients. Specifically, existing research, has not examined the pinnacle of academic performance in the form of national and international awards. In the present study, I posed research questions relating to demographic characteristics of award recipients from the Nobel, NAS, and NSF between 1975 and 2015. Additionally, I examined if sex and age of the awardees could predict early career award obtainment. Through the frame of Social cognitive theory (Bandura, 1986, 1997, and 2005) I considered how perceptions of gender roles are a product of influence by society and the possible connection to performance. Results indicated a limited number of females have received these scientific awards and the awardees age could predict receiving an award early in their career. Additionally, the study provided insight into the progression of Title IX within the context of athletics and academics. It addressed the incremental and systematic increase in academics for women at high school, college, career, and scientific awards. Perhaps most importantly, it identified an observed pattern for female science award recipients reaching a critical mass and a tipping point.

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CHAPTER I

INTRODUCTION

The 14th Amendment to the Constitution of the United States consists of four major clauses relating to citizenship, privileges or immunities, due process, and equal protection. Regarding education, the equal protection clause was defined in the Brown v. Board of Education Supreme Court case in 1954. In essence, this case involved challenges with segregation. In addition, the Court determined,

> The Court reasoned that denial of opportunity for an adequate education would often be a denial of opportunity to succeed in life, that separation of the races in the schools solely on the basis of race must necessarily generate feelings of inferiority in the disfavored race adversely affecting education as well as other matters, and therefore that the equal protection clause was violated by such separation.
>
> (United States Government Public Office, 2016)

Regarding public education, the Court concluded that the doctrine of *separate but equal* had no place.

Title IX

In education, Title IX redefined the equal protection clause in 1972. In essence, the intent of Title IX was to prohibit discrimination on the basis of sex in any educational setting which was funded by federal dollars. Thus, Title IX applies to all elementary and secondary schools, community colleges, and universities. Finally, Title IX is often thought of in regards to equity in athletics; however, academics are also under the Title IX umbrella.

Workforce Participation

Another area of influence for Title IX is the workforce. The workforce is trained in schools, colleges, and universities. Thus, Title IX applies directly to a partnership of educational activities, and indirectly to the workforce. The individuals engaged in or available for work are called the workforce. The workforce in a country or area is the total population employed in military and civilian jobs (Toossi, 2002). The overall workforce participation rates have increased since the 1950s; and today the workforce is older, more diversified, and increasingly made up of women (Schaefers, Epperson, & Nauta, 1997). The size of the workforce was 62 million in 1950, of which about 44 million were men and 18 million were women. The workforce more than doubled during 1950-2000, with almost 141 million, with 75 million men and 66 million women. (Schaefers et al., 1997). The participation rate of women in the workforce was 34% in 1950, 38% in 1960, 43% in 1970, 52% in 1980, 58% in 1990, and 60% in 2000, with a projected 62% in 2010. Furthermore, the workforce is projected to reach 192 million between 2000-2050 with 100 million men and 92 million women (Toossi, 2002). In the 1940s, women began entering the U.S. workforce in notable numbers. Since that time, women's career progress has received more attention, and various factors have been examined, such as women's enrollment in college (Schaefers et al., 1997).

Many factors have contributed to the rapid growth of the participation rates of women. For instance, after World War II, the U.S. economy grew quickly, along with expanded productivity, an increased standard of living, and growth of college enrollments. In addition, the civil rights movement, legislation establishing equal opportunity in employment practices, and the women's right movement produced an atmosphere that was more favorable for women to work outside the home. The culmination of these factors created strong incentives for women to engage in the workforce, which drastically affected their participation rates (Toossi, 2002). However, according to the U.S. House of Representatives Committee on Science and Technology Subcommittee on Research and Science Education (2009), as of 2008, women represented more than 50% of all bachelor's degrees and only constituted 25% of the Science, Technology, Engineering, and Math (STEM) workforce in the United States. In 1994, Strenta, Elliott, Matier, Scott, and Adair sought to understand the attrition rates in science, math, engineering, (SME) among students who enrolled in four prestigious universities, with a special focus on the disproportionate attrition of women from science. They reported the persistence rate of men in SME majors was 66% compared to 48% for women (Strenta, Elliot, Matier, & Scott, 1994).

College Participation

The lack of female interest in SME career pathways occurs at the pre-collegiate, undergraduate, graduate, and their professional lives (Rayman & Brett, 1995; Schaefers et al., 1997). A comprehensive report on the status of women in postsecondary education was published in 2015 by the National Science Foundation (NSF). The data from the report came from surveys conducted by the NSF, the U.S. Department of Education, the U.S. Department of Commerce, and the U.S. Department of Labor. The report stated that 57% of all bachelor's degrees and approximately half of all science and engineering (S&E) bachelor's degrees since the late 1990s have been earned by women (NSF, NCSES, 2015). The National Center for Science and Engineering Statistics (NCSES) reported women's involvement in S&E fields is the highest in psychology, with more than 70% female graduates. In addition, since 1993, the proportion of women in biosciences and social science has increased from 49% to 58% in bachelor's, master's, and doctoral degrees (NSF, NCSES, 2015).

In the fields of mathematics and statistics, men earn relatively more degrees, especially at the doctoral level, than women. Also, women's representation in mathematics and statistics is more pronounced at the bachelor's and master's levels, reaching about 40% (NSF, NCSES, 2015). Even so, women have earned relatively more degrees in mathematics and statistics since 2002, and the number of women bachelor's degrees has declined. In physics, the number of women earning degrees has increased. However, the proportion of women in this field is the smallest of all the physical sciences, with an average of 20 percent in all degree levels (NSF, NCSES, 2015). Furthermore, during the past 20 years, the proportion of women earning degrees in physics has increased at the doctoral level; but the number of women in this field still remains small. Finally, according to the American Mathematical Society's 2013 Annual Survey of the Mathematical Sciences in the U.S., 31% of new doctoral degrees awarded by departments of mathematics and science were awarded to woman.

The United States Department of Education developed Title IX to protect people from discrimination based on sex. Title IX states, "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance" (U.S. Department of Education, 2014, para. 2). Title IX encompasses state and local agencies that receive Department of Education funding. These agencies consist of school districts, colleges and universities, and for-profit schools.

Some of the best statistical data regarding women in math and science is from the NSF. This may be credited to microbiologist Rita Colwell, a former director of the foundation, and other staff members (Kohlstedt, 2004). In October 2002, U.S. Senator Ron Wyden, chair of the Science, Technology, and Space subcommittee in the Senate, held hearings on the topic of the progress of women in math, science, and technology in the 30 years since Title IX had become law (Kohlstedt, 2004). The Department of Education's representative, W. Todd Jones, announced that progress had been made, and presented data showing increase (Kohlstedt, 2004). However, women who testified were not satisfied, and after a series of questions, Jones stated that no recent compliance studies had been conducted:

> The women then pressed various issues, pointing out the declining numbers of women in computer science, family issues still confronting women, and the failure of universities to follow through on earlier ambitious plans for diversity. They once again urged the Department of Education to hold universities accountable lack of progress in making resources available to women and made sure that sex issues were put on the table. (Kohlstedt, 2004, p. 20)

One of the reasons Title IX was developed was to ensure sex discrimination diminished; yet, there are differences in educational achievement. Although, during the last few decades, current university-level research demonstrated that female completion rates were increasing and exceeding males. For example, in 1995 there was no significant difference between male and female 25 to 29 years-olds who had achieved a master's degree or higher; but in 2013, 9% of females had earned a master's degree or higher, compared with 6% of males (U.S. Department of Education, National Center for Educational Statistics, 2014). However, a limited number of studies have been conducted to see if Title IX has affected female award recipients in science (Jagsi, DeCastro, Griffith, Rangarajan, Churchill, Stewart & Ubel, 2011; Lincoln, Pincus, Koster & Leboy, 2012). Therefore, a review of scientific awards by women should be investigated.

The lack of women represented in scientific fields is troubling. Researchers have examined adolescent girls' attitudes toward science and their self-efficacy beliefs. Self-concept research examines how women perceive themselves from two aspects: their view of self and their field of study Self-concept is primarily an accumulation of a woman's experiences within various environments, and her relations with others within those environments (Pascarella, Smart, Ethington, & Nettles, 1987). Women reported their field of study requires them to think in *masculine* ways if they desired to succeed (Gilbert & Calvert, 2003; Stage & Maple, 1996). Sax (2008) reported majoring in physical science or engineering could produce increased stress in students. Vogt, Hocevar, and Hagedorn (2007) found that women perceived there was increased pressure on them to perform academically, in order to show that they deserve to be in a male-dominated program. Female students' expectations in science and math were reported to be less than those their male counterparts (Leslie, McClure, & Oaxaca, 1998).

Ware, Steckler, and Leserman (1985) studied a group of men and women who communicated an interest in obtaining a degree in science prior to their freshman year. When they began college, both groups of students had comparable educational backgrounds and had shown similar academic achievements. By the end of their freshman year, 50% of the women and 69% of the men chose a science major, explaining many challenges they had with the subject matter. Of particular note was that undergraduate women communicated a lower perceived proficiency for math and science careers when compared to careers in education, social services, and medicine (Morgan, Isaac, & Sansone, 2001). This aligns with Brainard and Carlin (1998) who noted that obstacles related to academic success in science include images of lower self-assessment of abilities for females when compared to their male counterparts.

In a related report by Hall and Sandler (1982), they first coined characterized the environment in the science classroom for women as *chilly*. They theorized that, although women were granted increased access to higher education, due to Title IX, they still did not possess equality. However, instead of assigning blame, Hall and Sandler (1982, 1984) speculated the chilly environment toward women was the cause of inequality. If men and women are valued differently based upon their sex, a chilly environment is created. Within the academic arena, Hall and Sandler (1984) noted that faculty, staff, and students of both sexes maintain this behavior through various measures including: viewing a male's primary role as academic and a female's primary role as helper, expecting stereotypical aggressive conduct from men and submissive conduct from women, expecting a greater value of work to be completed by men than by women, and observing male behavior as the norm.

In light of Hall and Sandler's report, Drew and Work (1998) suspected the chilly climate could have been a challenge from the past. They desired to expand the scope of Hall and Sandler's report by exploring the results of the 1994 College Student Experience Questionnaire (CSEQ). The CSEQ data secured information from 15,960 students from numerous universities and majors. In addition, 62% of the participants were women. On the contrary, Drew and Work (1998) reported no evidence that the chilly environment occurs in the classroom. Women stated they had more communication with faculty than men, engaged in the classroom more than men, and made equal to or above in personal and intellectual growth than men.

Scholarly Prizes

Scholarly prizes of note in the scientific field include the Nobel, the National Academy of Sciences Award, and the National Science Foundation Award. Each are treated separately with regard to the relative representation of female recipients.

Nobel. Of all the scientific and scholarly prizes awarded in the past century, the Nobel Prize is perhaps the most prestigious and acclaimed. In his will, Alfred Nobel left the majority of his wealth to the establishment of five prizes. Regarding the prizes, the will specifically stated that "prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind" (Nobel, 2014, The Establishment of the Nobel Prize, para.1). Furthermore, the will stated that, regarding the award of prizes, no consideration be given to the nationality of the candidates. The annual prizes were divided into five categories: physics, chemistry, physiology or medicine, literature, and peace. The first Nobel prizes were awarded in 1901 (Nobel, 2014). The will articulated that the prizes for chemistry and physics are awarded by the Swedish Academy of Sciences, the physiology or medicine prize be awarded by the Karolinska Institute, literature by the Academy in Stockholm, and the peace award be a committee of five people elected by the Norwegian Storting (Nobel, 2014).

The selection process for all Nobel awards is driven by a committee. For an individual to be considered for an award, he/she must be nominated by a person who meets the nomination criteria and/or selected by a member of the governing Nobel committee (Nobel, 2014). All Nobel awards follow a similar process in selecting the Nobel Laureates. In September, nomination forms are distributed and must be submitted to each Nobel committee by February. Subsequently, each committee sends the names of preliminary candidates to experts for their assessment during the months of March through May. Next, from June through August, a report is compiled with recommendations, and submitted to the Academy and or Institute for each award field. During the month of September, the Nobel committee submits recommendations of the final candidates. Also, in October, the Nobel Laureates are chosen, and the names are announced. Finally, the Laureates receive their prize amount, medal, and diploma in December (Nobel, 2014).

The significance of the Nobel award is multifaceted. First, award recipients are individuals who take chances to explore a new perspective, despite the initial odds of success.

Next, they question established conclusions. For example, during 2001-2009, numerous important discoveries were made. P. Lauterbur and P. Mansfield developed magnetic resonance imaging (M.R.I.), a technology that has saved thousands of lives (Shalev, 2010). Laureates A. Hershko, A. Ciechanover, and I. Rose lead biochemistry teams that discovered how the human body kills broken protein in cells to defend itself against diseases. This advancement in understanding is being utilized in treating cancer and cystic fibrosis (Shalev, 2010). Finally, A. Fert and P. Grunberg were acknowledged for the discovery of magneto resistance by using the rules of quantum mechanics. These laureates' research allows large amounts of information to be stored on small disks, such as IPods and MP3s (Shalev, 2010).

National Academy of Science Award. Along with the Nobel Prize, another distinguished award is presented by the National Academy of Sciences (NAS). One of these awards, within NAS is the Public Welfare Medal. The (NAS) was inaugurated on March 3, 1863 during the Civil War. The NAS was established during the 1850s by a group of scientists, primarily from Massachusetts. The group requested help from Massachusetts Senator Henry Wilson, who helped draft a bill (NAS, 2014). Then, Wilson presented the bill to the Senate on February 20, 1863, where it was passed on March 3, 1863. The bill was approved by the House of Representatives later that day, and was immediately signed by President Lincoln (NAS, 2014).

The selection process of the NAS is propelled by nominations that produce memberships. Furthermore, the nomination process is outlined by NAS with the following criteria, and must be submitted for all awards: First, a letter is received from the nominator and must be submitted outlining the candidate's work and why he/she should be selected. Next, a curriculum vitae—a bibliography listing of the nominees most significant publications—and a suggested citation must be submitted (NAS, 2014). Finally, two letters of support are required and must be written by individuals from institutions outside both the nominator and the nominee's institution.

Members are elected to NAS, and only NAS members may propose candidate nominations. Upon nomination, the candidate is evaluated through an extensive and careful process that results in a final ballot at the NAS annual meeting (NAS, 2014). The NAS has a membership is approximately 2,250, and almost 440 foreign associates, of whom nearly 200 have received Nobel prizes (NAS, 2014).

The significance of the NAS has two main components: government and research. Since its inception, NAS has provided services to the U.S. government. For example, during World War I, NAS members (then only 150) were not able to maintain the request for military advice from the government (NAS, 2014). Thus, in 1916, NAS began the National Research Council with a request from President Wilson. The purpose of the council was to recruit experts from the scientific and technological communities to help with the NAS's advisory work for the government. Wilson acknowledged the value of scientific advice, and issued an executive order, at the end of World War I, requesting the NAS to carry on the National Research Council (NAS, 2014). Succeeding executive orders by President Eisenhower in 1956 and President Bush in 1993 have demonstrated the importance of the National Research Council (NAS, 2014).

National Science Foundation Award. Besides the Nobel and NAS, another notable award is presented by the National Science Foundation (NSF). The NSF is an independent Federal agency produced by the 1950 Science Foundation Act. NSF was created to promote the progress of science and support research and education in science and engineering (NSF, 2014). Research is supported by grants and agreements to approximately 2,000 colleges, K-12 school systems, businesses, and other research organizations in the U.S. NSF provides 25% of federal support to academic institutions for basic research (NSF, 2014).

The NSF developed a document called the Proposal & Award Policies & Procedures Guide (PAPPG), which encompasses documents relating to the proposal and award process, consisting of two parts. The NSF Grant Proposal Guide (GPG) contains NSF's proposal requirements and submission guidelines. The NSF Award and Administration Guide (AAG) provides guidance on managing and monitoring the award and administration of grants by NSF (NSF, 2014).

The following criteria must be outlined and defined in the proposal: (1) objectives and scientific, engineering, or educational significance of the proposed work; (2) suitability of the methods to be utilized; (3) qualifications of the examiner and the grantee organization; (4) effect of the activity on the structure of science, engineering and education; and (5) amount of funding needed (NSF, 2014). NSF accepts proposals from all qualified scientists, engineers, and educators. Additionally, NSF encourages women, minorities, and persons with disabilities to engage in its programs.

The NSF proposal processing and review incorporates the several steps: First, the proposals are designated to a NSF program officer that ensures all NSF requirements have been met. Next, the proposals are reviewed by a scientist, engineer, or educator, and three to 10 individuals as ad hoc reviewers, who are experts in a particular field. Subsequently, the program officer makes a recommendation that is reviewed by a division director. Finally, a Grants and Agreement Officer oversees a review of business, financial, and policy implications, and the award is finalized (NSF, 2014). This entire process, from proposal preparation to award, is completed in 10 months.

The NSF awards help researchers to create knowledge in science, engineering, education, and technology. In addition, multiple discoveries and innovations have begun with NSF support in the following research areas: Arctic and Antarctic, Astronomy and Space, Biology, Chemistry and Materials, Computing, Earth and Environment, Education, Engineering, Mathematics, Nanoscience, People and Society, and Physics. For example, within the Biology research, a discovery of a protein may lead to the treatment for malaria, a wildlife species may provide ideas to spread antibiotic resistance in Africa, and methane-eating microorganisms may help regulate emissions from wetlands (NSF, 2014).

Statement of the Problem

Title IX has been studied within the context of athletics (NFHS, 2015, NCAA, 2015; IOC, 2016). However, it has not been explored in the academic context (U.S. DOE, NCES, 2011, College Board, 2013, and NSF, NCSES, 2015), particularly those awards which are national and international.

There is ample evidence regarding Title IX and the increase of women participating in higher education, including graduate and doctoral programs. In other words, Title IX has been studied within the context of athletics and academics, based upon inequality, i.e. bias and discrimination. Also, a limited amount of research has explored female award recipients. Specifically, existing research has not examined the pinnacle of academic performance in the form of national and international awards.

Purpose of the Study

This research seeks to explore the demographic characteristics of major award recipients in the field of science. However, it does not focus on inequality, but rather equality. The study seeks to determine if a fair playing field and equal opportunity for women in academics has improved since Title IX. Furthermore this study examines demographic characteristics of Nobel Prize, the National Academy of Sciences (NAS) Award, and the National Science Foundation (NSF) Award recipients, including sex, age, and highest degree obtained. The study tests whether or not there is a significant difference with respect to sex, terminal degree type, and age at the time of award obtainment. Also, the study tests if the age when terminal degree was awarded can predict early career award obtainment. The Nobel, NAS, and NSF awards will be examined by demographic characteristics (sex, age, and degree). By exploring sex, degree, age, terminal degree type, and age when terminal degree was awarded could predict late award obtainment.

Research Questions

In order to determine if a significant difference exists in demographic characteristics, this study focused on three specific science awards. The Chemistry Award within the scientific category of the Nobel, the Public Welfare Medal which is awarded for extraordinary use of science for the public good by the NAS, and the National Medal of Science, within the discipline of Physical Science, which is awarded by the NSF. The following research questions were developed to address the purpose of this study:

1. What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the Nobel Prize in Chemistry between the years 1975-2015?
2. What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the NAS Public Welfare Medal between the years 1975-2015?
3. What are the demographic characteristics (sex, age when presented the award, period of

time between highest degree and award, and type of terminal degree) of award recipients for the NSF National Medal Science discipline of Physical Science between the years 1975-2015?

4. Can sex and age when terminal degree was awarded predict early career award obtainment of major scientific awards?

Theoretical Framework

Social cognitive theory (Bandura, 2005) guides the study. This theory states knowledge acquisition may be related to observing others' social interactions and experiences. In this theoretical perspective, sex conceptions and roles are the products of a broad network of social influences operating interdependently in a variety of societal subsystems (Bussey & Bandura, 1999).

Method of the Study

A quantitative research design identifies demographic characteristics of awardee receipts from the following formal awards: Nobel, NAS, and NSF. It tests if sex, degree type, and age when degree was awarded predict award recipients in science. Central to the study, which is conducted with existing data, is the exploration of relationships between variables. Though not seeking to show causality, the study explores these relationships, preparing the way for further research.

Data Gathering

The data for this study consist of formal award receipts from three databases, including the Nobel Prize in Chemistry, Public Welfare Medal awarded by NAS, and the National Medal of Science, within the discipline of Physical Science, awarded by NSF. The population includes the recipients from the Nobel, NAS, and NSF. The data focuses on a time period of 40 years from 1975-2015. The Nobel Prize in Chemistry, Public Welfare Medal, and National Medal of Science, within the discipline of Physical Science, are each awarded annually; however, each award may be given to more than one individual. For example, from 1952 to 2008, the Nobel Prize in Chemistry has been awarded to 101 individuals (Shalev, 2010). The data include demographic characteristics of each awardee from the Nobel, NAS, and NSF.

The Nobel Prize in Chemistry, Public Welfare Medal awarded by NAS, and the National Medal of Science, within the discipline of Physical Science, awarded by NSF data were retrieved from the following list of sources: the Nobel Prize website (Nobel Prize, 2014), the book *100 + Years of Nobel Prizes and More* (Shalev, 2010), the NAS website (NAS, 2014) and NSF website (NSF, 2014).

Data Analysis

Data from awardees between the years 1975-2015 were recorded into three categories: the Nobel Prize for Chemistry, the Public Welfare Medal, and the National Medal of Science. For Research Question One, Two, and Three, I collected the demographic characteristics for the Nobel Prize in Chemistry, the NAS Public Welfare Medal, and the NSF National Medal Science discipline of Physical Science for the given time period. Descriptive statistics were incorporated for the awardees, and classified into the following categories: sex, age when awarded, and highest degree attained. A database was created in a table with a frequency count for each group. Since the study involved looking at sex differences and differences across highest degree attained, a logistical regression model was utilized, allowing for multiple variables to be examined simultaneously. Finally, this data can help determine if sex, degree type, and age may predict late career award obtainment as posed in Research Question Four.

Significance of the Study

Significance of the study will be explored in terms of research, theory, and practice. While this study offers no new survey data or experimental findings, it provides insight into an area of growing disparity between males and females, pointing the way to future study.

Research

The significance of this research is in the potential to determine if a compelling demographic difference exists in awardees over time. It identifies sex, age when awarded, and the period of time between highest degrees awarded of formal research awards. In addition, it determines if sex, terminal degree type, and age when terminal degree was awarded predict early career award obtainment. Finally, results of this study may be able to help aide sex diversity in science by examining the analysis of publication records as recommended by Zeng (2014).

Theory

Social Cognitive Theory may be observed through social interactions and experiences. Additionally, perceptions of gender roles are a product of influence by society, and a limited connection to performance has been linked to this theory. Therefore, this study explores social cognitive theory in a unique context.

Practice

The current study touches on issues of equity that have implications spanning the K-16 grades. By examining gender representation of award recipients, the present study sheds light on patterns from secondary and higher education, particularly within STEM-related fields. Implications in the area of leadership are also apparent, since recipients of major scientific awards represent the leaders in the field. Additionally, this study may aide sex diversity in science by examining award records as recommended by Zeng (2014). Zeng (2014) explored a sex discrepancy, for women, in career performance in STEM disciplines by examining key structural factors which lead to current sex challenges in STEM.

Organization of Dissertation Chapters

Chapter 1 of the dissertation provides an introduction to the study, detailing research methodology, theoretical framework, and design choices. In addition, it details how women have been historically underrepresented in the field of science, the Nobel Prize in Chemistry, the Public Welfare Medal awarded by NAS, and the National Medal of Science, within the discipline of Physical Science, awarded by NSF. Chapter 2 contains a review of the literature related to the underrepresentation of women and science in terms of participation in higher education and receiving awards in scientific fields. It provides a quantitative data in the area of higher education, along with a descriptive history of each award. It also expands the discussion to include participation of girls in advanced coursework, representation of women in interscholastic athletics at the college level, and the participation of women in the Olympic Games. Chapter 3 contains the procedures of the study, including a summary of the Nobel, NAS, and NSF, a description of the instrument, the data, and a summary of the analysis of the data. Chapter 4 contains presentation and analysis of data, supported by tables. Chapter 5 contains the summary of the study, key findings, implications, and recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

This review of literature explores the underrepresentation of women in scientific fields, with emphasis on the long-term effects of Title IX. Specifically, it addresses underrepresentation in the following areas, including high school credits, completion in Science, Technology, Engineering, and Math (STEM)–related degrees, the K-12 superintendency, and higher education leadership (provost, university president). Title IX, 1972 was designed to protect individuals from discrimination based upon sex in educational programs which receive federal dollars. The most common perception of Title IX is in the context of athletics. However, this law encompasses educational programs which would also include academics. Therefore, any education program would encompass academic as well as athletics. From this foundation, I connect the research to a more targeted exploration of the representation of women as recipients of major scientific awards, such as the American Association for the Advancement of Science (AAAS), Mathematical Association of America (MAA), American Medical Association (AMA), Nobel, NAS, and NSF awards. In addition to contextual material on the various awards, their origins and selection process, I examine research exploring the relative representation of sexes according to academic degree completion. Finally, I explore existing research on women's underrepresentation in the aforementioned areas from the lens of social cognitive theory, making explicit gaps in the literature that justify the present study.

Title IX Explained

The Department of Education developed Title IX in 1972 to prohibit sex discrimination in educational programs that receive federal aid. The law states: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance" (U.S. Department of Education, 2014). Title IX encompasses K-12 education, colleges, and universities, mandating that each entity receiving federal funds evaluate their policies and adopt procedures to comply with these regulations. When Congress passed Title IX, the purpose of the law was to help women achieve equality in all aspects of education. However, since 1972, the majority of Title IX focus cases have focused on athletic participation.

While Title IX focused on educational inequities in general, *A Nation at Risk* (1983) identified specific areas in need of attention. This report became significant to future reform in education. Within the report, an area of concern was the quality of teaching and learning in public, private, colleges, and universities. In addition, U.S. schools and colleges were compared to other advanced nations and the relationship between students' learning in high school and college admission requirements. Within the report, it was recommended that high school graduation requirements for science and math increase to three years. Additionally, a hearing testimony stated math and science are the foundation of education from elementary to high school (U.S. NCEE, 1983).

In 2002, the Department of Education (ED) designated an agency to examine Title IX and to determine if the athletic portion of the law should be revised. The Commission on Opportunity in Athletics presented a report to the Secretary of Education in 2003. In response to the report, ED developed new guidance in 2003 and 2005 which analyzed Title IX policy and incorporated the following three-part test:

> (1) Whether intercollegiate level participation opportunities for male and female students are provided in numbers substantially proportionate to their respective enrollments; or (2) Where the members of one sex have been and are underrepresented among intercollegiate

> athletes, whether the institution can show a history and continuing practice of program expansion, which is demonstrably responsive to the developing interest and abilities of the members of that sex ; or (3) Where the members of one sex are underrepresented among intercollegiate athletes, and the institution cannot show a continuing practice of program expansion such as that cited above, whether it can be demonstrated that the interests and abilities of the members of that sex have been fully and effectively accommodated by the present program. (Congressional Research Service, 2012, p. 6)

However, in 2010 the three-part test was withdrawn.

Recently, Congress has focused how Title IX could be expanded to improve the representation of women in STEM disciplines. For example, a report by the U.S. Government Accountability Office (2015) focused on women in STEM research and Title IX compliance. The Committee on Science, Space and Technology requested information regarding the representation of women in STEM research. According to the report, while women have increased in academic areas, they are behind men in STEM fields. This report concluded that women are underrepresented in STEM research, and stated that agencies which receive federal dollars need to conduct Title IX compliance reviews (U.S. Government Accountability Office, 2015). According to this report, almost $25 billion in federal funding in STEM disciplines was awarded to colleges and universities in 2014. Furthermore, STEM research was supported by federal agencies such as NASA, NIH, and NSF. This is significant since these grant-writing agencies comprise approximately 90% of federal STEM research (U.S. GAO, 2015). Finally, the report focused on core STEM fields where women are underrepresented, including engineering, life sciences, physical sciences.

Title IX and Athletics

Since Title IX impacts any educational program which receives federal funding, this law encompasses academics and athletics. Therefore, athletics will be explored in the context of high school, universities, and the Olympics.

High School Athletics

The National Coalition for Women and Girls in Education (NCWGE) produced a report in 2012 titled *Title IX at 40: Working to Ensure Gender Equity in Education.* Some of the key findings included the exponential growth of female participation in athletics, both at the high school and college levels. Additionally, participation in sports sustains immediate and long-term benefits (NCWGE, 2012). Some of these benefits include: an increase in grades, health, and female athletes are less likely to participate in inappropriate behavior. According to the report, at the high school level during the 1971-1972 school year, 300,000 girls participated in athletics, representing 7% of overall participation. In the 2014-2015 school year, participation of girls grew to 3,287,735, representing 42% of all high school athletes (NFHS, 2015). Table 2.1 provides historical data of high school athletics participation rates of boys and girls from 1971-1972 to 2014-2015.

Table 2.1

High School Athletics Participation Rates for Boys and Girls: 1971-2015

Year	Boys	Girls	Total	% Girls
1971-72	3,666,917	294,015	3,960,932	7.4%
1972-73	3,770,621	817,073	4,587,694	17.8%
1973-74	4,070,125	1,300,169	5,370,294	24.2%
1975-76	4,109,021	1,645,039	5,754,060	28.6%
1977-78	4,367,442	2,083,040	6,450,482	32.3%
1978-79	3,709,512	1,854,400	5,563,912	33.3%
1979-80	3,517,829	1,750,264	5,268,093	33.2%
1980-81	3,503,124	1,853,789	5,356,913	34.6%
1981-82	3,409,081	1,810,671	5,219,752	34.7%
1982-83	3,355,558	1,779,972	5,135,530	34.7%
1983-84	3,303,599	1,747,346	5,050,945	34.6%
1984-85	3,354,284	1,757,884	5,112,168	34.4%
1985-86	3,344,275	1,807,121	5,151,396	35.1%
1986-87	3,364,082	1,836,356	5,200,438	35.3%
1987-88	3,425,777	1,849,684	5,275,461	35.1%
1988-89	3,416,844	1,839,352	5,256,196	35.0%
1989-90	3,398,192	1,858,659	5,256,851	35.4%
1990-91	3,406,355	1,892,316	5,298,671	35.7%
1991-92	3,429,853	1,940,801	5,370,654	36.1%
1992-93	3,416,389	1,997,489	5,413,878	36.9%
1993-94	3,472,967	2,130,315	5,603,282	38.0%
1994-95	3,536,359	2,240,461	5,776,820	38.8%
1995-96	3,634,052	2,367,936	6,001,988	39.5%
1996-97	3,706,225	2,474,043	6,180,268	40.0%
1997-98	3,763,120	2,570,333	6,333,453	40.6%
1998-99	3,832,352	2,652,726	6,485,078	40.9%
1999-00	3,861,749	2,675,874	6,537,623	40.9%
2000-01	3,921,069	2,784,154	6,705,223	41.5%
2001-02	3,960,517	2,806,998	6,767,515	41.5%
2002-03	3,988,738	2,856,358	6,845,096	41.7%
2003-04	4,038,253	2,865,299	6,903,552	41.5%
2004-05	4,110,319	2,908,390	7,018,709	41.4%
2005-06	4,206,549	2,953,355	7,159,904	41.2%
2006-07	4,321,103	3,021,807	7,342,910	41.2%
2007-08	4,372,115	3,057,266	7,429,381	41.2%
2008-09	4,422,662	3,114,091	7,536,753	41.3%
2009-10	4,455,740	3,172,637	7,628,377	41.6%
2010-11	4,494,406	3,173,549	7,667,955	41.4%
2011-12	4,484,987	3,207,533	7,692,520	41.7%
2012-13	4,490,854	3,222,723	7,713,577	41.8%
2013-14	4,527,994	3,267,664	7,795,658	41.9%
2014-15	4,519,312	3,287,735	7,807,047	42.1%

University Athletics

Parallel to the statistics relating to participation in high school athletics, the NCAA (National Collegiate Athletic Association) produced a report in 2015 titled, *NCAA Sports Sponsorship and Participation Rates Report, 1981-82 and 2014-2015.* Within this report, an overall participation summary of men and women sports and recreation programs of universities and colleges was provided between 1956-1957 and 1981-82. Furthermore, participation rates were collected at five year intervals. However, the data were not collected in the same manner as the data from 1982 to 2015, as it included recreational programs. Therefore, prior to 1982, the data are not directly comparable to the data in the report between 1956 and 1980. Also, only the years 1981-2015 will be examined, due to the data discrepancy. According to the NCAA report, during the 1981-1982 school year, 64,390 women participated in athletics, representing 28% of total participation. In the 2014-2015 school year, female participation increased to 209,472, comprising 43% of all college athletes (NCAA, 2015). Table 2.2 provides historical data of NCAA athletes' participation rates of men and women from 1981 to 2015.

Table 2.2

NCAA Athletic Participation Rates for Men and Women: 1981-2015

Year	Men	Women	Total	% Women
1981-82	167,055	64,390	231,445	27.8%
1982-83	176,822	78,027	254,849	30.6%
1983-84	186,008	82,452	268,460	30.7%
1984-85	197,446	89,072	286,518	31.1%
1985-86	196,437	92,192	288,629	31.9%
1986-87	187,561	89,640	277,201	32.3%
1987-88	176,396	88,266	264,662	33.4%
1988-89	178,521	90,180	268,701	33.6%
1989-90	175,539	88,206	263,745	33.4%
1990-91	182,836	92,473	275,309	33.6%
1991-92	183,675	94,922	278,597	34.1%
1992-93	184,732	97,978	282,710	34.7%
1993-94	186,939	102,994	289,933	35.5%
1994-95	186,607	107,605	294,212	36.6%
1995-96	206,385	125,250	331,635	37.8%
1996-97	199,391	129,289	328,680	39.3%
1997-98	200,030	133,445	333,475	40.0%
1998-99	207,685	145,873	353,558	41.3%
1999-00	208,481	146,617	355,098	41.3%
2000-01	214,154	155,698	369,852	42.1%
2001-02	209,890	153,601	363,491	42.3%
2002-03	214,464	158,469	372,933	42.5%
2003-04	214,854	160,997	375,851	42.8%
2004-05	219,744	164,998	384,742	42.9%
2005-06	224,926	168,538	393,509	42.8%
2006-07	230,259	172,534	402,793	42.8%
2007-08	236,774	175,994	412,768	42.6%
2008-09	240,822	180,347	421,169	42.8%
2009-10	245,875	184,426	430,301	42.9%
2010-11	252,946	191,131	444,077	43.0%
2011-12	257,690	195,657	453,347	43.2%
2012-13	262,249	200,953	463,202	43.4%
2013-14	267,604	205,021	472,625	43.4%
2014-15	273,061	209,472	482,533	43.4%

Olympic Participation

As the progression continues for athletes at the university level, the pinnacle arena is the Olympic Games. The International Olympic Committee (IOC) produced a report in 2016 titled

Factsheet Women in the Olympic Movement. Within the report, the IOC discussed such topics as women in the Olympics games, introduction of women sports, and education and training for women (IOC, 2016). In addition, women's participation in the Olympic Games was gathered and reported by year. According to the IOC report, in 1972 only 1,264 women participated in the Olympics, representing only 15% of total athletes. However, in the 2012 Olympics, the number of women had increased to 4,676, comprising 44% of overall participants (IOC, 2016). Table 2.3 provides historical data of Olympic athletes participation rates of men and women from 1972 to 2012.

Table 2.3

Olympic Athletes' Participation Rates for Men and Women: 1972-2012

Year	Men	Women	Total	%Women
1972	6976	1264	8240	15.3%
1976	5716	1491	7207	20.7%
1980	4904	1347	6251	21.5%
1984	6261	1840	8101	22.7%
1988	7325	2495	9820	25.4%
1992	7965	3192	11157	28.6%
1994	1215	522	1737	30.1%
1996	6806	3512	10318	34.0%
1998	1389	787	2176	36.2%
2000	6582	4069	10651	38.2%
2002	1513	886	2399	36.9%
2004	6296	4329	10625	40.7%
2006	1548	960	2508	38.3%
2008	6305	4637	10942	42.4%
2010	1522	1044	2566	40.7%
2012	5892	4676	10568	44.2%

In summary, high school participation in athletics increased from 7% in 1971-1972 to 42% in 2014-2015. The NCAA participation for female athletes increased from 28% in 1981-1982 to 43% in 2014-2015. Finally, Olympic participation for female athletes increased from 15% in 1972 to 44% in 2012.

Title IX and Academics

The influence of Title IX is explored in terms of high school grade point average, high school credits earned, participation in Advanced Placement courses, and college degree completion. In addition, tables will show the relative representation of males and females in each of these areas.

High School Credits and GPA Earned in Math and Science

While Title IX and *A Nation at Risk* (1983) brought attention to biases in representation in educational practices based upon sex, other more recent reports have focused on inequities at high school. The NCES has produced a report regarding America's High School Graduates (U.S. DOE, NCES, 2011). This report, also referred to as the Nation's Report Card, provides statistical data about academic achievement in the U.S. Some of the data focus on high school credits earned in math and science. According to the report, the average credits earned in math and sciences have increased, and are have comparable representation by gender. For example, in 1990, 6.1 high school credits were earned by males, and 6.0 credits were earned by females in math and science respectively. In 2000, 6.9 high school credits were earned by males, and 6.8 credits were earned by females in math and science. Finally, in 2009, 7.4 high school credits were earned by both males and females in math and science (U.S. DOE, NCES, 2011).

Another aspect of this report focuses on grade point average (GPA), showing that females earn a relatively higher numerical value than males. In 1990, the average GPA for males was 2.59 and 2.77 for females. In 2000, the averages were 2.83 for males and 3.05 for females respectively, while in 2009, the averages were 2.90 for males and 3.10 for females (U.S. DOE, NCES, 2011).

High School Credits in STEM Courses

Along with high school credits and GPA, another area of interest is the trend of participation in STEM courses by high school graduates. The Nation's Report Card (2009) categorized STEM courses into the following three areas: advanced math, advanced science and engineering, and STEM-related technical courses. In 1990, 57% of graduates earned credit in advanced math, 61% in advanced science and engineering, and 29% in STEM-related technical. In 2000, 74% earned credits in advanced math, 76% in advanced science and engineering, and 37% in STEM-related technical. In 2009, 84% earned credits in advanced math, 86% in advanced science and engineering, and 31% in STEM-related technical (U.S. DOE, NCES, 2011). More specifically, the credits earned in advanced science and engineering courses varied by sex. For example, relatively more males earned credits in physics than females, 41% to 36%. However, in chemistry, more females earned credits than males, 72% to 67% (U.S. DOE, NCES, 2011).

AP Courses

Another factor relating to STEM participation is relative representation in Advanced Placement (AP) courses. The College Board AP program offers multiple courses to high school students, allowing them the opportunity to earn college credit by passing an AP test. In a report prepared by the College Board, *the 10^th^ Annual Report to the Nation*, examines the past 10 years of participation and performance in AP. Furthermore, the report provides percentages by sex across a range of AP tests.

Based upon College Board data (2013), females represent a disproportionate number of total students enrolled in AP liberal arts courses. For example, 16,969 students sat for the 2013 AP Art History exam, with 34% male and 66% female (College Board, 2013). This pattern is similar in the 2013 AP English Literature, where of the 325,108 tested students, 37% were male and 63% were female (College Board, 2013).

In the sciences, the gap between the sexes is comparable, except in Physics. For example, of the 162,381 who sat for the 2013 AP Biology test, 41% were male and 59% were female (College Board, 2013). Similarly in AP Chemistry, of 107,431 total tests, 53% were male and 47% were female (College Board, 2013). However, this balance is shifted in Physics B, where of 68,802 total tests, 65% male and 35% female (College Board, 2013). In the Physics C, of 14,045 total exams, 77% were male and 23% were female (College Board, 2013). Finally, in Physics C, of 2013 31,959 total tests, 74% were male and 26% were female (College Board, 2013).

Degree Completion

The NSF has helped produce a report regarding women, minorities, and persons with disabilities in science and engineering approximately every two years since 1994 (NSF, 2015). This report provides statistical data about the above three groups in science and other areas. According to the report, women and underrepresented minorities contribute a large portion of the U.S. population--approximately 50% of the population between the ages of 18-64 in 2012 (NSF, NCSES, 2015). Substantial data were collected over various topics including enrollment, field of degree for women, and field of degree for minorities, along with the number of bachelor's, master's, and doctoral degrees awarded to women.

The data from the report focused on the 10 years between 2002 and 2012. Bachelor's degrees awarded to women in all fields increase from 753,330 (2012) to 1,038,472 (2012). Master's degree awarded to women in all fields increased from 285,336 in 2012 to 454,986 in 2012. Similarly, doctoral degrees awarded to women in all fields increased from 20,551 (2002) to 30,767 (2012) (NSF, NCSES, 2015). Furthermore, doctoral degrees in all fields for women increased from 46.4% (2002) to 49.6 % (2012) (NSF, NCSES, 2015). More specifically, bachelor degrees awarded to women in science and engineering fields increased from 211,308 (2002) to 297,539 (2012). Table 2.4 provides historical data of bachelor's degrees awarded to men and women in physical sciences, chemistry, and physics between 2002 and 2007.

Table 2.4

Bachelor's Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2002-2007

Field	**Sex**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Physical Sciences	Men	8,023	8,231	8,221	8,590	9,437	10,021
Physical Sciences	Women	5,974	5,879	5,998	6,415	6,953	6,986
Chemistry	Men	4,716	4,649	4,548	4779	5,253	5,636
Chemistry	Women	4,723	4,680	4,752	5,144	5,634	5,614
Physics	Men	2,817	3,076	3,233	3,299	3,621	3,846
Physics	Women	824	837	907	900	945	1,024

Table 2.5 provides historical data of bachelor's degree awards in physical sciences, chemistry, and physics between 2008 and 2012.

Table 2.5

Bachelor's Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2008-2012

Field	**Sex**	**2008**	**2009**	**2010**	**2011**	**2012**
Physical Sciences	Men	10,368	10,491	10,804	11,404	12,137
Physical Sciences	Women	7,284	7,451	7,598	7,794	8,284
Chemistry	Men	5,923	6,038	6,176	6,560	6,984
Chemistry	Women	5,909	6106	6,162	6,328	6,730
Physics	Men	3,888	3,917	3,985	4,220	4,495
Physics	Women	988	925	1,015	1,001	1,062

Master's degrees awarded to women in the science and engineering fields increased from 43,711 in 2002 to 73,561 in 2012. Table 2.6 provides historical data of master's degrees awarded to men and women in physical sciences, chemistry, and physics between 2002 and 2007.

Table 2.6

Master's Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2002-2007

Field	**Sex**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Physical Sciences	Men	2,299	2,342	2,517	2,540	2,652	2,680
Physical Sciences	Women	1,326	1,318	1,513	1,524	1,626	1,563
Chemistry	Men	1,015	1,001	1,106	973	1,073	1,139
Chemistry	Women	852	829	950	939	1,024	1,005
Physics	Men	1,067	1,140	1,224	1,372	1,414	1,375
Physics	Women	286	313	413	422	439	417

Table 2.7 provides historical data of master's degrees awarded in physical sciences, chemistry, and physics between 2007 and 2012.

Table 2.7

Master's Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2008-2012

Field	**Sex**	**2008**	**2009**	**2010**	**2011**	**2012**
Physical Sciences	Men	2,809	2,587	2,702	2,816	3,020
Physical Sciences	Women	1,565	1,514	1,621	1,657	1,689
Chemistry	Men	1,201	1,134	1,120	1,243	1,361
Chemistry	Women	1,035	997	1,055	1,081	1,132
Physics	Men	1,421	1,286	1,400	1,367	1,470
Physics	Women	378	371	410	404	409

Doctoral degrees awarded to women in science and engineering fields Increased from 9,313

(2002) to 14,524 (2012) (NSF, NCSES, 2015). Table 2.8 provides historical data of doctoral degrees awarded to men and women in physical sciences, chemistry, and physics between 2002 and 2007.

Table 2.8

Doctoral Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2002-2007

Field	**Sex**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Physical Sciences	Men	2,358	2,446	2,432	2,628	2,817	2,927
Physical Sciences	Women	889	932	913	992	1,169	1,282
Chemistry	Men	1,346	1,451	1,411	1456	1,609	1,642
Chemistry	Women	691	707	694	770	893	964
Physics	Men	926	899	940	1,072	1,107	1,177
Physics	Women	170	190	179	182	234	265

Table 2.9 provides historical data of doctoral degrees awarded in physical sciences, chemistry, and physics between 2007 and 2012.

Table 2.9

Doctoral Degrees Awarded in Physical Sciences, Chemistry, and Physics: 2008-2012

Field	**Sex**	**2008**	**2009**	**2010**	**2011**	**2012**
Physical sciences	Men	2,971	3,031	2,955	3,142	3,145
Physical sciences	Women	1,234	1,385	1,371	1,418	1,444
Chemistry	Men	1,594	1,628	1,570	1,638	1,602
Chemistry	Women	901	1024	994	1,047	1,028
Physics	Men	1,227	1,287	1,265	1,368	1,402
Physics	Women	280	293	305	302	350

The overall percentage of doctoral degrees awarded to women in science and engineering fields increased from 38.4% in 2002 to 41.1 % in 2012 (NSF, NCSES, 2015).

Title IX and Leadership

Along with degree completion, which is one of the first steps when examining the career trajectory of women, another impact of Title IX is the careers of women in leadership roles. In the K-16 educational setting, the pinnacle leadership positons are the superintendent and university president. Therefore, an examination of these two leadership roles of women may ensure a deeper understanding of the full impact of Title IX. Finally, I will discuss the leadership role of women in the university setting followed by the superintendent.

Women as University Leaders

Leadership has adapted at some four-year graduate research universities and community colleges (Bornstein, 2008; DiCorce, 1995; Eddy & Cox, 2008). A body of research has demonstrated the underrepresentation of women in higher education leadership positions

(Aguirre, 2000; Amey & VanDerLinden, 2002; Kosoko-Lasaki, Sonnino & Voytok, 2006). (This could be explained by the fact that women continue to face a glass ceiling, a perceived barrier through which few women proceed, which limits their professional progress to the highest position in the academic leadership role.

Numerous books and research articles have been written exploring the challenges and limitations that have historically restricted women from reaching presidential leadership at their institutions (Giannini, 2001; Jackson & Harris, 2007; Townsend, 1995; Turner, 2007). These researches list factors that restrict entry into those top university positions, including pipeline issues, work-family dynamics, cultural constraints, and organizational barriers. Other components include race and sex discrimination, lack of encouragement and networking, and trustee relationship. Additionally, family responsibilities may be challenging to women to the extent that it presents barriers for relocation (Jackson & Harris, 2007). Also, males tend to be overrepresented in disciplines such as math, science, and engineering (Giannini, 2001).

Speaking to the issue of gender inequality in higher education leadership positions, the American Council on Education (2012) examined presidents from various sectors of American higher education, reporting that the proportion of female college presidents had increased from 23% in 2006 to 26% in 2011 (ACE, 2014). However, women still remain disproportionately underrepresented in the presidencies of American colleges and universities. For example, ACE reported women presidents by the following institution type: doctorate-granting, master’s, bachelor’s, and associate’s between the years 1986 to 2011 (ACE, 2012). At doctorate granting universities representation of women presentments increased from 4% (1986) to 14% (206), and finally to 22% (2011).At master’s-granting universities, representation of women presentments increased from 10% (1986) to 22% (2006), and eventually to 23% (2011). At baccalaureategranting universities, representation of women presentments increased from 16% (1986) to 23% (2006 and 2011). Finally, at associate-granting institutions, representation of women presentments increased from 8% (1986) to 29% (2006), and eventually to 33% (2011) (ACE, 2012).

To further understand this underrepresentation, Turner (2007) presented biographical outlines of three women college presidents. Additionally these women are noted as the first Mexican American, Native American, and Asian Pacific/Asian American college presidents in the United States. Turner (2007) incorporated a qualitative method which consisted of a 90-minute interview, transcripts of a 20-minute presentation by each president, and a two-day shadowing by Turner at each university. In addition, each president was video and audio taped. Finally, each president articulated their career path, meaningful life events, and influences which led them to be president. Findings included the importance of goal setting for self and the university, having vision and values, supporting the community, and maintaining their identity. For example, all three women referenced their campus and how their leadership style matched the campus and community (Turner, 2007). Another common aspect was key relationships which helped their perseverance toward the presidency. These relationships included family members, peer women, and other professionals on their campuses. Finally, Turner (2007) reported the importance of family to all three presidents which helped produce energy and balance to their lives.

Women in the Superintendency

Patterns of underrepresentation described for university leaders apply in a similar manner to K-12 superintendents. The American Association of School Administrators (2011) identified five key characteristics needed by a superintendent: (1) effective communicator, (2) manager, (3) instructional leader, (4) statesman/democratic leader, and (5) an applied social scientist. However, among these key characteristics, effective communicator was noted as the paramount requirement. As federal and state policies become more complex, board members depend on the leadership of the superintendent to decipher and be responsible for local decisions (Kowalski, McCord, Peterson, Young, & Ellerson 2011). The ability of the superintendent to communicate, whether productive or ineffective, has a direct correlation to policies and student success.

To exemplify the path of women to the superintendency, what follows are data relating to representation as teachers and school administrators. In 2004, 72% of school teachers were women. From the years 1993 to 2004, the representation of women elementary school principals increased from 41% to 56%. During the same time period, the representation of women secondary school principals increased from 14% to 26%. However, the representation of female superintendence has shown growth in recent years, moving from 8.9% (1910) to 1.2% (1982), followed by sharp increase to 24.1% in 2010 (Kowalski et al, 2011). Overall, women represent 72% of the educational workforce, and only 24% of superintendent roles. Research has suggested this discrepancy may be because female superintendents have more experience in the classroom, and began their administrative journey in elementary settings (Glass, Bjork, & Brunner, 2000). Newton (2006) argued that the recruitment and selection process focus on the knowledge, experiences, and skills historically related with men. Furthermore, members of the search committee define the superintendency in two major roles: instructional and political. Newton (2006) stated that political leaders interact with state and local agencies, negotiate needed resources, and reconcile differences in the community. Also, during the last century, society has perceived this political leader as a male. Finally, this process needs to put emphasis on all major components of the job, and place a higher importance on experiences (Newton, 2006).

Women as Recipients of Major Scientific Awards

The pattern of underrepresentation in academic careers has been shown to persist in how women educational leaders have been recognized in higher education leadership and K-12 superintendency roles. Along with careers, women have been underrepresented as recipients of major academic awards (Raise Project, 2016). Individuals who receive awards are considered to be leaders in their fields and receive the highest level of recognition. The RAISE Project claims to be the world's largest awardees database (Raise Project, 2016). It lists over 2,200 STEM and medicine awards, and calculates the distribution between men and women. This organization was founded in 1993 by a group of professional women, and was solidified in 2005, after the National Medal of Science Awards was awarded, and they noted no women received an award (Raise Project, 2016). The methodology of the RAISE Project included systematic search of websites for posted awards, followed by classification into the following categories: awardees, award, year of award, awarding body, and the sex of the individual. Furthermore, the sources of data for specific fields are from the NSF for STEM and the American Association of Medical Colleges for Medicine (Raise Project, 2016).

According to the RAISE Project, an overview of the awards in their database consist of the following; 2,245 total awards, 1,759 STEM awards, 363 medical awards, 1,738 single recipient awards, 369 group recipients awards, and 117 women only awards (Raise Project, 2016). The number of doctoral degrees earned by women has increased during the past years. However, the percentage of awards presented to women has remained below the percent of earned PhD in STEM. For example, in 1981, the percentage of women with individual plus group awards was 3.6%, while in that same year, 22.8% of women earned a PhD in STEM

(Raise Project, 2016). In 2000, the percentage of women with individual plus group awards was 14.3%, while 12.4 % were awarded an individual award, and in that same year, 36% of women earned a PhD in STEM (Raise Project, 2016). In 2014, the percentage of women with individual plus group awards was 20.3%, while 19% were awarded an individual award, and during that same year, 40.8% of women earned a PhD in STEM (Raise Project, 2016).

The following organizations award individuals in various disciplines, some of which include math, medical, or sciences. From 1981 to 2015 numerous men and women received awards annually by each organization. The American Association for the Advancement of Science (AAAS) awarded no women and two men in 1981; in 2000, four women and nine men; and in 2015, 10 men and three women (Raise Project, 2016). The Mathematical Association of America (MAA) awarded 14 men and no women in 1981; in 2000 18 men and five women; and in 2015, 25 men and 13 women (Raise Project, 2016). The American Medical Association (AMA) awarded seven men and one woman in 1981; in 2000, four men and one woman; and in 2015 seven men and two women (Raise Project, 2016). The National Academy of Sciences (NAS) awarded 10 men and no women in 1981; in 2000, 12 men and three women; and in 2015, 10 men and eight women (Raise Project, 2016). The National Science Foundation (NSF) awarded two men and no women in 1981; in 2000, 10 men and three women; and in 2015, six men and three women (Raise Project, 2016). The Nobel (Chemistry, Economic Sciences, Physics, and Physiology or Medicine) awarded nine men and no women in 1981; in 2000, 11 men and no women; and in 2015, eight men and one woman (Raise Project, 2016).

AAAS Award. The American Association for the Advancement of Science began in 1848, and was one of the first organizations to promote science at the national level. Currently, AAAS is an international non-profit entity which has a desire to advance science for the benefit of humanity and awards individuals who make contributions to science (AAAS, 2016). Regarding the sex of AAAS awardees, between 1981 and 1994, multiple years had no women representation, and a total of 11 women were awarded. However, between 1995 and 2015 on average, five women per year were given an award, with 17 women being awarded in 2010 (Raise Project, 2016).

MAA Award. The Mathematical Association of America (MAA) was established in 1915 with roots dating back to 1894, and the beginning of the American Mathematical Monthly. Today, MAA is a member-driven organization with a primary purpose to advance mathematical sciences at the collegiate level (MAA, 2016). Regarding the sex of MAA awardees, between 1981 and 1994 a total of 26 women were awarded. Also, between 1995 and 2015, on average seven women per year were given an award with 13 women being awarded in 2015 (Raise Project, 2016).

AMA Award. The American Medical Association (AMA) began in 1847 to increase scientific advancement, improve public health, and develop the doctor and patient relationship. Currently, AMA has a desire to improve the health of the U.S. by helping doctors and health teams increase health for all (AMA, 2016). Regarding the sex of AMA awardees, between 1981 and 1994, multiple years had no women representation, and a total of 11 women were awarded. Furthermore, between 1995 and 2015, on average one woman per year was given an award with multiple years of no women representation (Raise Project, 2016).

Nobel Prize. Regarding the sex of Nobel awardees, between 1981 and 1994, multiple years had no women representation, and a total of three women were awarded. Additionally, between 1995 and 2015, multiple years had no women representation, and a total of nine women were awarded, of which four were awarded in 2009 (Raise Project, 2016).

NAS Prize. Regarding the sex of NAS awardees, between 1981 and 1994, on average one woman per year earned an award, with a total of 12 women awarded. However, between 1995 and 2015, the average increased to four women per year, with eight being awarded in 2015 (Raise Project, 2016).

NSF Award. Regarding the sex of NSF awardees, between 1981 and 1994, on average one woman per year earned an award, with a total of 18 women awarded. Additionally, between 1995 and 2015, the average was two women per year, with four being awarded in 2015 (Raise Project, 2016).

Social Cognitive Theory

By showing literature on several areas of underrepresentation of girls/women, the above discussion highlights a span of the academic journey, including high school, college, degree completion, careers, and awards. Social cognitive theory (Bandura, 2005) may help explain this phenomenon. Bandura and colleagues developed this theory by observing aggressive behavior in children (Bandura, 2005). Pre-school-aged boys and girls observed a film of aggressive adult behavior toward an inflatable doll. The film showed an adult who punched, hammered, and kicked a plastic doll. The children who viewed the film were more likely to demonstrate aggression towards the doll. Also, seeing the adult express aggressive behavior increased the possibility of aggression in the children. Additionally, the behavior was observed in a school nursery at Stanford University. The children were placed in a room with other toys and an inflatable doll as Bandura and other colleagues watched. Bandura noted children learned the aggressive behavior only through observation. In other words, seeing an adult in the film demonstrate aggressive behavior increased the tendency of aggression in the children.

Bandura observed learning was important, and emphasized that people have self-control over their behaviors. Which is managed by their thought processes (Bandura, 2005). From this platform, Bandura described this cognitive process as *self-efficacy*. Thus, an individual's beliefs about their ability to perform a specific behavior in a particular setting will determine their success in the endeavor. For example, everyday life is filled with hardships and challenges. Bandura noted that individuals need a robust sense of self-efficacy in order to keep moving forward during times of struggle. Bandura (1988) wrote, "If efficacy beliefs always reflected only what people can do routinely they would rarely fail but they would not set aspirations beyond their immediate reach nor mount the extra effort needed to surpass their ordinary performances" (p. 8).

Along with observing aggressive behavior and self-control, another aspect of social cognitive theory is gender roles. During the inflatable doll observation, Bandura noted that boys had more hostility when exposed to hostile male models versus boys who were exposed to hostile female models. Female aggression was not as notable. Children become familiar with their community, and this socialization process is a major cause of gender differences between boys and girls. Bussey and Bandura (1999) identified multiple aspects of this process, such as how children categorize information and apply to self. Then their learning expands to behavioral attributes which develop patterns, and eventually a lifestyle. According to Bussey and Bandura (1999), another active role in developing gender roles was parents. Parents provide boundaries and examples, and identify acceptable conduct (Bussey & Bandura, 1999). Other areas which formulate gender roles include the media, schools, and peers (Bandura & Bussey, 1999).

The two main components of social cognitive theory are observed learning and self-efficacy beliefs (Bandura, 2005). In other words, what a person believes determines their actions. These actions will produce future beliefs and thoughts. Furthermore, the application of this theory has been applied to counseling, clinical psychology, cognitive functioning, and academic success (Bandura, 2005). Hackett and Lent (2008) suggest studies which focus on students' self-efficacy and school performance, which demonstrate how judgements are a central component when determining school achievement. Other social cognitive factors include self-regulation of learning, persistence, motivation and effort. According to Bandura:

> In the social cognitive view, vicarious outcomes affect motivation through two cognitive mechanisms. First, they create outcome expectations that can serve as positive or negative incentives for action. However, knowing what outcomes result from a given course of action is unlikely to spur observers to action if they doubt they can do it. Thus, motivation is also mediated by self-percepts of efficacy, the second mechanism.(Bandura, 1986, p.301)

Regarding Title IX and women, a point of connection to these vicarious outcomes may increase with observation. For example, as a high school girl watches the Olympics and views a female athlete demonstrating success, her own self-efficacy may increase, and she may be more likely to attempt a similar activity with confidence. Then, the high school student observes peers and connects to other domains; that is, she may transfer feeling of self-efficacy in one area to another, due to this vicarious effect. Therefore, the high school student is motivated by observed success, proceeds to college, and determines a career connection, and possibly becomes an Olympian.

As individuals examine careers, these outcomes and motivation are further developed. The social aspect of career choices profoundly impact personal well-being. Furthermore, participation in the workforce may have considerable social impact in other areas of life (Bandura, 1997; Karasek & Theorell, 1992; Maslach, 2001; Ozer, 1995).

Social Cognitive Theory and High School Degree Completion

Some studies have examined social cognitive theory to predict college and career readiness of girls. In a longitudinal study, Arnold (1993) focused on 81 students, 46 female and 35 male, who graduated in the top percentile from Illinois high schools. The students were interviewed annually during the first four years of college, then ten years after high school graduation. Ninety-three percent graduated from college, and 42% completed graduate degrees (Arnold, 1993). The study included some variables which were discussed such as achievement scores, intellectual self-esteem, family plans, and career values. Additionally, role expectations, aspirations, and commitment to family all played pivotal roles in educational success. Finally, the study explored the transition from high school to work for females and the influence of belief and role expectations.

A related study by Nauta and Epperson (2003) focused on science and math academic and career choices within the social cognitive framework. Data were collected from girls who were high school seniors in the form of a questionnaire. Three to five years later, researchers contacted the high school girls and inquired about their college major and college outcome expectations. This study reported social cognition, positive relationships, and self-determination impacted the choice of a college degree.

Social Cognitive Theory and Leadership

Bandura (1986) suggested self-efficacy could be described as the perception an individual has regarding their leadership capacity. Dickerson and Taylor (2000) reported the perceived self-efficacy of college women and their preference to avoid leadership requirements. Women with a high opinion of themselves were more comfortable with leadership tasks, such as providing direction and planning group activities (Dickerson & Taylor, 2000). In other words, this research supports Bandura's theory that individuals have a higher probability to complete a task when they perceive they will be successful (Bandura, 1986). Lips (2001) designed open-ended questions for college students to answer regarding leadership roles. Students were asked to answer the questions as if they were a business, political, or educational leader. The findings showed young women were more focused on relationships rather than the leadership role. Lips (2001) further reported that the anticipation of potential problems in relationships caused these women to not desire these leadership roles.

Summary of the Chapter

The literature review discussed underrepresentation of women by focusing on the results of Title IX, both in athletics and academics. Research was presented on athletic participation ranging from high school to college, to the Olympic Games. With respect to Title IX and academics, research examined participation in advanced academics at the high school level, college degree completion, and leadership within higher education. Additionally, particular attention focused on women as major scientific award recipients, representing the pinnacle of their field. Finally, literature explored how social cognitive theory (Bandura, 1986) explained the path of women after Title IX, with emphasis upon its relevance for the high school completion and career trajectory of women.

CHAPTER 3

RESEARCH METHODOLGY

As a result of women entering the workforce in the 1940s, women's enrollment in college, degree focus, and career choices have been examined (Schaefers, Epperson, & Nauta, 1997). Throughout the years, women have majored in various fields; for example, education, psychology, science, and math. Recently, according to the National Science Foundation (NSF), women's interest in science and engineering, along with the number of women earning degrees in science, has increased. The U.S. Department of Education developed Title IX to protect individuals from discrimination based upon sex. Numerous reports and studies have examined the impact of Title IX and the various aspects of underrepresentation of women in science. However, few studies have explored if Title IX has impacted female award recipients in science. Therefore, the current study focuses on the demographic characteristics, including sex, age, and highest degree obtained, of the award recipients, expanding the literature to include what represents the pinnacle of achievement in the sciences.

Research Design

The purpose of this study is to determine if demographic characteristics have impacted award recipients in science. It also tests if there is a significant difference based on sex, terminal degree type, and age at award obtainment. Additionally, the study tests if sex and age when terminal degree was awarded can predict early career award obtainment. This quantitative study used existing data and identified demographic characteristics of awardee receipts from three entities, Nobel, National Academy of Sciences (NAS), and National Science Foundation (NSF). More specifically, to determine if a compelling difference exists in demographic characteristics, this study focused on three specific science awards: the Chemistry Award within the scientific category of the Nobel, the Public Welfare Medal which is awarded for extraordinary use of science for the public good by the NAS, and the National Medal of Science, within the discipline of physical science, which is awarded by the NSF. The following research questions were developed to address the purpose of this study:

1. What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the Nobel Prize in Chemistry between the years 1975-2015?

2. What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the NAS Public Welfare Medal between the years 1975-2015?

3. What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the NSF National Medal Science discipline of Physical Science between the years 1975-2015?

4. Can sex and age when terminal degree was awarded predict early career award obtainment of major scientific awards?

Because the inception of Title IX was in the year 1972, the data for the awards were extracted from 1975 to 2015. The methodology for the award data sources, sampling procedures, data processing, and analysis are discussed below.

Quantitative Methodology

Quantitative research as a rule incorporates scientific methods. Some of these methods include development of hypotheses, creation of instruments for measuring outcomes, variables, collection of data, and analysis of data. A hypothesis is a test based upon decisions that measure a specific population (Bluman, 2008). Within quantitative research, variables are numerical, and may be ordered or ranked. For example, age is a numerical variable, and individuals may be ranked by their age.

Quantitative methodology is derived and guided by an empirical approach with multiple assumptions. Gall, Gall and Borg (2007) noted some assumptions, including: social reality which is constant with the perimeters of time, settings, and includes social aspects, which are viewed from a mechanistic perspective. Additionally, some general characteristics of quantitative research includes the following: examination of samples which represent populations, incorporation of statistical methods to analyze data, identification of preconceived thoughts to determine which data to be collected, and preparation of reports of research findings.

The current study examines demographic characteristics of awardees and a prediction regarding early career award obtainment. The demographic characteristics utilize empirical observation and mathematical expression. Also, a hypothesis with reference to early career award obtainment was designed in the study. Therefore, a quantitative method was integrated.

Data Sources

Ex post facto research may be used in experimental research to test hypotheses (Cohen, Manion, & Morrison, 2013). By studying facts which have occurred, research can be conducted on the influence of one variable on another (Cohen, Manion, & Morrison, 2013). Ex post facto research incorporates preexisting data, allowing one to test relationships between variables.

The data sources were retrieved from three databases the Nobel, NAS, and NSF. The data population includes the recipients of the Noble Prize in Chemistry, Public Welfare Medal awarded by NAS, and the National Medal of Science, within the discipline of Physical Science, awarded by NSF. Each prize is awarded annually, and the data focus on a time period of 40 years from 1975-2015. The data were entered in SPSS Version 23, allowing for descriptive statistics and logistical regression analysis. Descriptive statistics includes the collection, alignment, explanation, and presentation of data (Bluman, 2008). Logistic regression emphasizes the possibility of a proposed outcome when a dependent variable is divided into parts and scored as 0 or 1 (Tabachnick & Fidell, 2007). For the purpose of this study, the sex was coded as males (0) and females (1). The dependent variable was early career award obtainment, defined in this study as less than or equal to 30 years.

Logistic regression was chosen because the dependent variable could only have two possible options. In other words, the early career award obtainment can only be met with a *yes* or *no* answer. Research Questions 1-3 employed descriptive statistics, and question four utilized logistic regression. Logistic regression is appropriate because it lacks restrictions of many statistical tests and can be leveraged to analyze complex data sets (Tabachnick & Fidell, 2007). However, challenges may occur if limited numbers of variables exist. Also, logistical regression assumes a linear relationship between variables.

Sampling Procedures

The Nobel is awarded to distinct individuals who have benefited humanity. Award recipients of the Nobel include individuals who continue to explore areas of interest within their field in spite of hardships. The Nobel is a prestigious award, and laureates impact the science learning community, often in the areas of technology or medicine. The NAS provides research for the U.S. government, including scientific and technological innovations to benefit the military. Furthermore, the National Research Council was developed by the NAS, which was developed to promote the progress of science, and support research and education in science and engineering. Finally, due to Title IX being implemented in 1972, the award data gathered for the present study focused on the time period from 1975 to 2015.

Data Processing

The data were collected from the Nobel, NAS, and NSF websites, awardee affiliated universities, and published articles, and entered into the 2010 version of Microsoft Excel. The spreadsheet included following categories: name, sex, age when awarded highest degree, type of highest degree, period of time between highest degree, award type, award year, age when given an award, and early or late. Each degree was coded using the following system; 0 high school, 1 bachelor degree, 2 master degree, 3 PhD, 4 doctor of science, 5 doctor of engineering, 6 doctor of chemistry, 7 MD, 8 JD, 9 doctor of physics, and 10 doctor of theology. A total of 225 awards have been conferred during this 40 year period by the Nobel, NAS, and NSF. During this time period, 86 Nobel Prizes in Chemistry, 42 Public Welfare Medals, and 97 National Medals of Science have been awarded. Some awards are received by multiple recipients.

The age the awardee received their degree was calculated as the difference between their birth year and the year the degree was earned. The time between the degree and award was the difference in the award year and the degree year. Finally, career award obtainment was determined by the number of years between the degree and award. If the number was 30 or less, it was considered early, and 31 and beyond was late.

Analysis

Within the study, I seek to test if sex and age can predict early career obtainment of major scientific awards. Furthermore, a null hypothesis was incorporated, indicating no significant difference based upon gender when predicting early career award obtainment. The alternate hypothesis was that there would be no significant difference based upon age when predicting early career award obtainment. Finally, the frequency of awards for the Nobel, NAS, and NSF were provided along with descriptive statistics.

Recipients of the Nobel Prize in Chemistry (*N* = 86), the NAS (*N* = 42), and the NSF (*N* = 97) were collected during the period of 1975 to 2015**.** Means and standard deviations were reported for the following variables: the age of the awardee at their terminal degree, the number of years between their terminal degree and award, and their age when given the award. Also, logistic regression was performed to determine if gender and age could predict career award obtainment. These variables were chosen within the framework of Social Cognitive theory, providing a lens through which to view the data.

Summary of the Chapter

In this chapter, I discussed the research methodology for the study. The chapter context included research methods, research design, quantitative methodology, data sources, sampling procedures, data processing, and the analysis process of the three awards. Chapter Four includes the findings, and incorporating descriptive statistics and logistic regression analysis to determine if gender and age can predict early career award obtainment.

CHAPTER 4

FINDINGS AND ANALYSIS

The purpose of this study is to examine the extent to which Title IX has helped with the underrepresentation of women in science. More specifically, the study considers if Title IX has impacted female award recipients in science. Thus, the research focused on the demographic characteristics of sex, age, and highest degree obtained. Furthermore, the research considered if sex and age when terminal degree was awarded can predict early career award obtainment. Numerous reports and studies have examined the impact of Title IX and the various aspects of underrepresentation of women in scientific fields. However, few studies have explored if Title IX has impacted female award recipients in science. Therefore, data on the demographic characteristics of sex, age, and highest degree obtained of the award recipients could contribute to existing literature and informs future research.

Overview of Procedures

To answer research questions 1-3, descriptive statistics were utilized to analyze the data from the Nobel, NAS, and NSF. To answer research question four, logistic regression was used to determine if early award obtainment can be predicted by sex and age of terminal degree obtainment. The independent variables were sex and age when terminal degree was completed. The age was calculated by determining the difference of the awardees birth year and year of degree completion. Finally, career award obtainments were calculated by the number of years between the degree and award. *Early* obtainment was identified by a period of 30 years or less, while *late* obtainment was identified by 31 years or more.

Descriptive Statistics

One of the demographic characteristics in the research questions was sex. Thus, within the data of Nobel, NAS, and NSF, the number of men and women was recorded. Regarding the Nobel Prize in Chemistry, only one woman has received the Noble Prize between 1975-2015. Ada E. Yonath was born in Jerusalem in 1939, and attended the Hebrew University of Jerusalem for her bachelor's and master's degrees in chemistry, biochemistry, and biophysics (Nobel, 2016). Additionally, she earned a PhD in 1968 from Weizmann Institute of Science in Israel. She was 70 years old when awarded the Nobel Prize in 2009.

The Public Welfare Medal awarded by the NAS has been awarded to 42 individuals from 1975 to 2015, eight of whom were women (19%). Leona Baumgartner (1977), Ida M. Green (1979), Mina Rees (1983), Shirley M. Malcom (2003), Maxine F. Singer (2007), Norman P. Neureiter (2008), Eugenie C. Scott (2010), and Melinda Gates (2013) were the female recipients during this 40-year period. Five of the eight women (62.5%) have earned a PhD, one completed an MD, one completed a master's degree, and one completed high school.

The National Medal of Science within the discipline of Physical Science and awarded by the NSF has been awarded to 97 individuals from 1975 to 2015, seven of whom (7%) were women. Chien-Shiung Wu (1975), Margaret E. Burbidge (1983), Vera C. Rubin (1993), Fay Aizenberg-Selove (2007), Esther M. Conwell (2009), Sandra M. Faber (2011), and Shirley A. Jackson (2014) were the female recipients during this 40-year period. All eight of the women have earned a PhD.

Table 4.1 provides historical data of the sex of awardees for the Nobel, NAS, and NSF between 1975 and 2015 and is relevant for Research Questions #1, 2, and 3. More specifically, it focuses on the Nobel Prize in Chemistry, the Public Welfare Medal, and the National Medal of

Science within the discipline of physical science. A total of 225 awardees were examined, including 209 men (93%) and 16 women (7%). Only one woman received the Nobel Prize in Chemistry from 1975-2015.

Table 4.1

Sex of Awardees of Nobel, NAS, and NSF: 1975-2015

Sex	**Nobel**	**NAS**	**NSF**	**Total**
Men	85	34	90	209
Women	1	8	7	16
Total	86	42	97	225

Research Question #1:

What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the Nobel Prize in Chemistry between the years 1975-2015?

Table 4.2 is a representation of data to support Research Question #1, and provides following data from the Nobel website, universities, and academic journals, including the age when awarded degree, the number of years between the degree and award, and the age when awarded the Nobel Prize in Chemistry. Additionally, the table provides the mean and standard deviation for the above referenced categories, focusing on the years 1975-2015. This period is significant because it reflects prizes awards after Title IX became law in 1972.

Table 4.2

Nobel Prize in Chemistry: 1975-2015 (N=86)

Category	**Mean**	**SD**
Age Awarded Degree	27.3	3.9
Years Between Degree and Award	35.9	11.2
Age Received Award	63.1	10.7

Table 4.3 provides the age of the awardees from the Nobel by categories of every 10 years between 1975 and 2015. Of the 86 award recipients, 99% were male and 1% female. Additionally, 37% received their award between the ages of 60-69, while 28% received their award between 50 and 59, and 16% received their award between the ages of 70-79. Range of ages for recipients varied significantly. For example, Hartncit Michel was the youngest individual to be awarded the Nobel Prize in Chemistry in 1988 (40 years old, while John B. Fenn was the oldest to be awarded in 2002 (85 years old).

One of the reasons Title IX was developed was to ensure sex discrimination diminished. Additionally, Title IX has been studied within the context of athletics, and has had a consistent increase in female participation at the high school, university, and the Olympics. However, the impact of Title IX has not been explored in academics, specifically science awards at the national and international level. Thus, I decided to focus on the international Nobel Prize in Chemistry. Additionally, Chemistry was chosen due to the previously reported data regarding doctoral degrees awarded to men and women. Out of the examined scientific fields, chemistry had the highest percentage of women earning a doctorate (39%). Subsequently, I examined which country was credited with this award from 1975-2015, and focused on the United States, since

Title IX became law in that country. Of the 86 award recipients, the United States was credited with 52 (60%), and only one female, Ada E. Yonath, received the award between 1975 and 2015 (Shalev, 2010; Nobel, 2016).

Table 4.3

Age at Award, Nobel Prize in Chemistry: 1975-2015 (N=86)

Age	**Male**	**Female**	**Total**
40-49	9	0	9
50-59	24	0	24
60-69	32	0	32
70-79	13	1	14
80-89	7	0	7
Total	**85**	**1**	**86**

Research Question #2:

> What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the NAS Public Welfare Medal between the years 1975-2015?

Eight women have received the NAS Public Welfare Medal award from 1975 to 2015, the youngest of whom was 18 and the oldest was 32 years old when awarded their degree. The average age of the women was 26.2, reflecting a one-year difference from the cumulative average. Regarding the time between degree and award, the most was 61 and the least was 26 years. The mean for years between degrees for the women was 43.5, representing 1.3 years less than the overall average. The youngest woman was 49, and the oldest was 81 years old when awarded. The average age of the women was 69.6, representing a difference of 2.4 years from the cumulative average. The Public Welfare Medal was awarded to women in 1977, 1979, 1983, 2003, 2007, 2008, 2010 and 2013. In other words, from 1975 to 2005, only four women received the award. However, from 2005 to 2015, four women have received the award. Table 4.4 is a representation of data to support Research Question #2, and provides a summary of the mean and standard deviation for age, years between degree and award, and age they received the NAS Public Welfare Medal from 1975-2015.

Table 4.4

NAS, Public Welfare Medal: 1975-2015 (N=42)

Category	**Mean**	**SD**
Age Awarded Degree	27.2	7.7
Years Between Degree and Award	44.8	12.5
Age Received Award	72	11.7

Table 4.5 provides the age of the awardees from the NAS by categories of every 10 years between 1975 and 2015. Of the 42 award recipients, 81% were male and 9% female. Furthermore, 45% received their award between the ages of 70-79%, 19% received their award between the ages of 60-69, and 14% was represented in two age categories 50-59 and 80-89. Melinda Gates was the youngest individual to be awarded the NAS, Public Welfare Medal in 2013 and was 49 years old. Arnold O. Beckman was the oldest individual to be awarded in 1999 and was 99 years old.

Table 4.5

Age at Award, NAS, Public Welfare Medal: 1975-2015 (N=42)

Age	**Male**	**Female**	**Total**
40-49	0	1	1
50-59	5	1	6
60-69	7	1	8
70-79	15	4	19
80-89	5	1	6
90-99	2	0	2
Total	**34**	**8**	**42**

Research Question #3:

What are the demographic characteristics (sex, age when presented the award, period of time between highest degree and award, and type of terminal degree) of award recipients for the NSF National Medal Science discipline of Physical Science between the years 1975-2015?

Seven women have received the NSF National Medal of Science award within the discipline of Physical science from 1975 to 2015. The youngest woman was 24, and the oldest was 28 years old when awarded their degree. The average age of the women was 25.9, which is the same as the cumulative average. Time between degrees was at most 61 and at least was 40 years. The mean of the years between degrees for the women was 44.9, representing 1.5 years more than the overall average. The youngest woman was 63 and the oldest was 87 years old when awarded, while the average age of the women was 70.7, representing a difference of 1.2

years from the cumulative average. The National Medal of Science within the discipline of Physical science was awarded to women in 1975, 1983, 1993, 2007, 2009, 2011, and 2014. Approximately one award every ten years was awarded from 1975-2005. However, during 2005-2015, an award was received by women generally every two years. Table 4.6 is a representation of data to support Research Question #3, and provides a mean and standard deviation of the NSF National Medal of Science for age when awarded degree, the number of years between the degree and award, and the age when awarded within the discipline of physical Science from 1975-2015.

Table 4.6

NSF, National Medal of Science within the Discipline of Physical Science: 1975-2015 (N=97)

Category	**Mean**	**SD**
Age Awarded Degree	26	2.8
Years Between Degree and Award	43.4	10
Age Received Award	69.5	9.5

Table 4.7 provides the age of the awardees from the NSF by categories of every 10 years between 1975 and 2015. Of the 97 award recipients, 93% were male and 7% were female. Also, 40% received their award between the ages of 60-69, 29% received their award between the ages of 70-79, and 18% between the ages of 80-89. Paul Chu (Ching-Wu) was the youngest individual to be awarded the NSF, National Medal of Science within the discipline of the Physical Science in 1988 at the age of 47. Arnold O. Beckman and Gilbert F. White were the oldest to be awarded in 1989, both 89 years old.

Table 4.7

Age at Award, NSF, National Medal of Science discipline of Physical Science: 1975-2015 (N=97)

Age	Male	Female	Total
40-49	2	0	2
50-59	11	0	11
60-69	34	5	39
70-79	28	0	28
80-89	15	2	17
Total	**90**	**7**	**97**

Table 4.8 includes a summary relevant to Research questions 1, 2, and 3, showing sex and the number of early and late awardees for the merged data set of Nobel, NAS Public Welfare Medal, and the NSF National Medal of Science within the discipline of physical science between 1975 and 2015. Career award obtainments were calculated by the number of years between the degree and award. *Early* obtainment was identified by a period of 30 years or less, while *late* obtainment was identified by 31 years or more. Of the 209 male award recipients, 43 received their award early (21%), while 166 (79%) received their award late. Similarly, of the 16 female award recipients, two received their award early (13%), while 14 (87%) received their award late.

Table 4.8

Sex, Early or Late Awardees for Nobel, NAS, and NSF: 1975-2015 (N=225)

Sex	**Early**	**Late**	**Total**
Male	43	166	209
Female	2	14	16
Total	45	180	225

Table 4.9 provides the age of the awardees and a summary of the Nobel, NAS, and NSF by categories of every 10 years between 1975 and 2015. Of the 225 award recipients, 93% were male and 7% female. In addition, all three awards represented multiple age brackets, with ranges of 50-59, 60-69, 70-79, and 80-89. The ranges, 60-69 and 70-79, were represented in all three with 60-69 leading in the Nobel and NSF. Other age groups which were present included 50-59 and 80-89. The 50-59 range was present in the Nobel and NAS, while the 80-89 was present in NAS and NSF.

Table 4.9

Summary of Age at Award, Nobel Prize in Chemistry, NAS, Public Welfare Medal, and NSF, National Medal of Science discipline of Physical Science: 1975-2015 (N=225)

Age	**Male**	**Female**	**Total**
40-49	11	1	12
50-59	40	1	41
60-69	73	6	79
70-79	56	5	61
80-89	27	3	30
90-99	2	0	2
Total	**209**	**16**	**225**

Predictive Modeling

A logistic regression analysis was conducted to determine if sex and age when terminal degree was awarded could predict early career award obtainment with a total of 225 awardees. Coding for the dependent variable of early or late career award included a 0 or 1, based upon the number of years between the degree and award. *Early* obtainment was identified by a period of 30 years or less and coded as 0, while *late* obtainment was identified by 31 years or more and coded as a 1. Also, coding for the independent variable of sex was a 0 or 1, with 0 for men and 1 for women.

Research Question #4:

Can sex and age when terminal degree was awarded predict early career award obtainment of major scientific awards?

Table 4.10 shows logistical regression results and the extent to which award obtainment was predicted by sex and age.

Table 4.10

Logistic Regression: Career Award Obtainment by Awardees

Independent	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Sex	0.535	0.789	0.459	1	0.498	1.708
Age Terminal Degree Awarded	-0.198	0.055	13.207	1	0.001	0.82
Constant	6.744	1.507	20.025	1	0.001	848.691

Thus only one variable, the age when degree awarded, was found to predict early award receipt. Table 4.10 provides a summary and identifies an odds ratio: for every one year increase in age when terminal degree awarded, there is an 18% decrease in probability of obtaining an early career award. However, a caveat needs to be mentioned, that a small number of women award recipients made logistic predictions difficult.

Discussion

The key findings which emerged from the study, within the context of the research questions, focused on the age and sex of award recipients for the Nobel Prize in Chemistry, the NAS Public Welfare Medal, and the NSF National Medal of science within the discipline of Physical Science. Additionally, the time period focused on the years 1975 to 2015, indicated the years just after adoption of Title IX. Finally, the study examined if sex and age when terminal degree was awarded could predict early career obtainment of major scientific awards. The Discussion is organized by categories, including age, the academic journey, sex, and incremental increase.

Age

Regression analysis indicated the age when terminal degree was awarded predicted early career award obtainment. The data in the category included the age of the awardee when awarded their terminal degree, their age between the terminal degree and award, and their age when awarded. Data were recorded and scored for the Nobel, NAS, and NSF. For example, within the Nobel, the average age of men and women when awarded their degree was 27.3 years, for the NAS the average was 27.2, and the NSF was 26. The combined mean of men and women for years between the degree and award for the Nobel was 35.9 years, with NAS NSF showing 44.8 and 43.4 years respectively. Furthermore, the age when awarded the terminal degree, age between degree and award, and age when awarded for the Nobel, NSF, and NSF was examined. Regarding the Nobel, the average age when awarded the terminal degree for men was 27.2, and for women was 29. For the NAS, the average age for men was 27.5 and 26.3 for women. The average age for the NSF award was 26 for men and 25.9 for women. Regarding the Nobel, the average age between final degree and award was 35.8 for men and 41 for women. For the NAS, the average age for men was 45.1 and 43.5 for women. The average age for the NSF award was 43.3 for men and 44.9 for women.

The average age when awarded the Nobel Prize was 63 for men and 70 for women. For the NAS, the average age for men was 72.6 and 70 for women. The average age for the NSF award was 69.4 for men and 70.7 for women. The cumulative average of the age of men and women when awarded the award was 63.1 years for the Nobel, 72 years for the NAS, and 69.5 years for the NSF. Thus, the average age when presented the award is 68.2 years.

Regarding Title IX, which began in 1972, to date is 44 and the average for award recipients is 68 years. In other words, when you determine the mean of the age of males and females from the Nobel, NAS, and NSF it is 68. Therefore, since Title IX has been in existence for 44 years, and the average age for award recipients is 68, it would stand to reason the current award recipients are at an advanced stage of their academic careers. Additionally, in the athletic arena, the peak performance age would be when the athlete is in their 20s. However, according to this study, the peak performance age in the academic area is the 60s. This is a plausible explanation concerning why the data show Title IX athletics has a significant increase in women participation, while the pattern for women in academic fields is less pronounced.

Academic Journey

Female students embark on an academic journey from high school, college, career, and ultimately, reach the top of their field, signified by qualification for major scientific awards. In high school, they obtain credits for graduation and complete coursework in math and science. Additionally, these students earn high school credit in STEM and AP courses. At the college level, women have increased in the number degrees in physical sciences, chemistry, and physics. Furthermore, women have made advancement in careers as leaders at both the superintendency and university levels. Finally, this pattern has continued for women as recipients of major scientific awards.

Sex

The findings showed that sex was not a predictor of early career award obtainment. However, data from other areas, specifically participation in high school and college athletics, participation in the Olympic Games, and university degree completion show a distinct pattern where the relative representation of women increased since the inception of Title IX. Patterns within these areas are discussed and compared to similar data with respect to major scientific awards.

From multiple studies and tables presented in the Literature Review, one can see that Title IX has had a progressive impact in both athletics and academics. Recall Table 2.1 (p.22), which showed that girls' participation rate in high school athletics rose significantly from 1971-1972 (7.4%) to 2014-2015 (42.1%). These patterns continue at the university level, based upon data in Table 2.2 (p. 24), which shows that women participation rate rose from 1981-1982 (27.8%) to 2014-2015 (43.4%). Finally, Table 2.3 (p.25) showed that which showed that women participation rate in the Olympic Games rose significantly from 1972 (15.3%) to 2012 (44.2%). As the participation rates have increased in athletics, a similar pattern emerges in academics. Recall in the Literature Review how degree completion for bachelors, masters, and doctorate was compared in the fields of physical sciences, chemistry, and physics from 2002 to 2012.

Physical sciences. In the field of physical science, recall Table 2.4 (p.29) and Table 2.5 (p.30), which showed that relative bachelor's degree completion for women decreased from 2002 (42.7%) to 2012 (40.6%). In Physical Science, recall Table 2.6 and Table 2.7 (p.31), which showed that relative master's degree completion for women slightly decreased from 2002 (36.6%) to 2012 (35.9%). In Physical Science, recall Table 2.8 (p.32) and Table 2.9 (p.33), which showed that relative doctoral degree completion for women increased from 2002 (27.4%) to 2012 (31.5%).

Chemistry. In the field of Chemistry, recall Table 2.4 (p.29) and Table 2.5 (p.30), which showed that relative bachelor's degree completion for women decreased slightly from 2002 (50%) to 2012 (49.1%). In Chemistry, recall Table 2.6 and Table 2.7 (p.31), which showed that master's degree completion for women remained constant from 2002 (45.6%) to 2012 (45.4%). In Chemistry, recall Table 2.8 (p.32) and Table 2.9 (p.33), which showed that relative doctoral degree completion for increased from 2002 (33.9%) to 2012 (39.1%).

Physics. In Physics, recall Table 2.4 (p.29) and Table 2.5 (p.30), which showed that relative bachelor's degree completion for decreased from 2002 (22.6%) to 2012 (19.1%). In Physics, recall Table 2.6 and Table 2.7 (p.31), which showed that master degree completion for women remained constant from 2002 (21.1%) to 2012 (21.8%).In Physics, recall Table 2.8 (p.32) and Table 2.9 (p.33), which showed that doctoral degree completion for women increased from 2002 (15.5%) to 2012 (20%).

Therefore, degree completion by women at the doctoral level has increased in all three fields, with the most significant increase in Chemistry. Thus as the pattern continues regarding an increase in women's relative participation in the athletic aspect of Title IX, i.e. high school, college, and Olympics. One explanation is the participation for women has increased in athletics concerns the peak performance age of individuals in their 20s. Additionally, the data show the academic aspect has also increased in terms of completed doctoral in the referenced fields of physicals, chemistry, and physics. Thus, one might speculate the current gap in the science award aspect is due to the time since the inception of Title IX. Therefore, we could suggest that the academic aspect would follow, since, according to this study, recipients were awarded in their 60s, a time when they are at the height of their academic powers, and also have sufficient time to produce a trail of academic work. Along these lines, future female award winners are currently early in their career, and the effects of Title IX are still taking shape in this context. Another indication of this progress is the increase of the number of women awardees within the last decade. One could suggest that the effects of Title IX are gradually moving from athletics to academics, and increases in the relative representation of woman at the top of scientific fields is approaching what could be call a *tipping point*, as described by Malcom Gladwell (2000):

These three characteristics – one, contagiousness; two, the fact that little causes

> can have big effects; and three that change happens not gradually but at one dramatic moment . . . Of the three, the third trait – the idea that epidemics can rise or fall in one dramatic moment–is the most important, because it is the principle that makes sense of the first two and that permits the greatest insight into why modern change happens the way it does. The name given to that one dramatic moment in an epidemic when everything can change all at once is the Tipping Point. (p. 9)

The *tipping point* is analogous to a bell curve. At the bottom of the bell curve, on the left side, is contagiousness; in the middle is the possibility of sudden change. As the bell curve begins to decrease, you start a new bell curve since when change occurs it, is a climactic moment. Thus, the tipping point is the juncture of critical mass, the boiling point, the entrance.

Incremental increase

Regarding the Nobel, NAS, and NSF between the years 1975 to 2015, the tipping point has begun to occur. The Nobel Prize in Chemistry, an international award, has only been awarded to one female, Dr. Ada E. Yonath (Nobel, 2016). The NAS, Public Welfare Medal in the United States has had four women awarded from 1975 to 2005, and four also from 2005 to 2015. During the last 10 years, the same numbers of women have been awarded as in the previous 30 years. For the NSF, National Medal of Science within the discipline of Physical Science awarded in the United States, from 1975 to 2005, one woman was awarded every 10 years. From 2005 to 2015, an award was received by women generally every two years. During the past 30 years, women received an award every 10 years, with this pattern increasing to one award every two years.

Findings of the current study indicate that within the context of athletics and academics at each progressive stage, Title IX has had a positive impact on girls' and women's participation. Regarding athletics, high school, college, and Olympic participation has continually increased since 1972. In academics, women have systematically increased participation in the sciences at all levels, culminating in receiving top scientific awards. However, the rate of increase has been more pronounced in the context of athletics.

Another explanation for this trend may be Bandura's Social Cognitive Theory. From the social cognitive perspective, self-efficacy helps produce vicarious outcomes. Furthermore, self-efficacy has two aspects, including self-control and thought process (Bandara, 1986). Self-control is a product of our thoughts, decisions, actions, and habits. And our thought process, our belief, impacts our actions and success. Therefore, our future thoughts and beliefs have a negative or positive outcomes, and can be profoundly influenced by vicarious experiences, such as witnessing an individual from similar circumstances achieve impressive success in athletics of academics.

For example, the only female Nobel Laureate in Chemistry from 1975-2015, is Ada E. Yonath. Dr. Yonath was born in Jerusalem, Israel to a poor family which rented a four-bedroom apartment with two additional families. Yet, despite her circumstances, her surroundings did not dampen her enormous curiosity. Additionally, her parents were raised in Judaism and learned the Hebrew language. Dr. Yonath went to school based up these principles and also learned Hebrew. Her father died when she was 11 years old, and her mother, encouraged her desire to continually learn (Nobel, 2016). Thus, in Dr. Yonath's life, her parents and specifically her mother, had a positive vicarious effect on her learning, belief, and life.

Summary of the Chapter

Chapter 4 included the presentation and analysis of data relating to predictors of scientific award attainment. It provided descriptive and predictive modeling to demonstrate the significance of relationships between these variables. In addition, the chapter included a discussion to broaden the application of the findings. Chapter 5 includes a summary of the study, along with key findings, implications, and suggestions for future research.

CHAPTER 5

CONCLUSION

> "So God created humankind in his own image; in the image of God he created him: male and female he created them." Genesis 1:27 (Complete Jewish Bible)

> For in the union with the Messiah, you are all children of God through this trusting faithfulness; because as many of you as were immersed into the Messiah have clothed yourselves with the Messiah, in whom there is neither Jew nor Gentile, neither slave nor freeman, neither male nor female; for in the union with the Messiah Yeshua, you are all one. (Galatians 3:26-28, *Complete Jewish Bible*)

As a society, we desire, defend, and argue for equity in any and all areas. Sometimes the law attempts to mandate equity and provide some boundaries. Yet, how does the law govern the thoughts, intentions, and actions of the heart? Thus, we need to broaden our understanding of equity. Equity is not an educational issue, nor is it a physiological issue; rather equity is a spiritual issue.

Summary of the Study

The purpose of the study was to examine the impact of Title IX from an academic viewpoint. While Title IX helped with the underrepresentation of women in athletics and participation in academic programs, the current study explores that effect in the area of scientific awards representing the pinnacle of the field. The primary sources were derived from the Nobel, NAS, and NSF databases. The research questions focused on the demographic characteristics of sex, age, and highest degree obtained. In addition, a research question focused upon these demographic characteristics and a potential correlation with early career award obtainment.

Key Findings

Within the context of the Nobel Prize for Chemistry, NAS Public Welfare Medal, and the NSF National Medal of Science within the discipline of Physical Science from 1975 to 2015, a total of 225 awards have been granted. Of the 225 award recipients, 93% were male and 7% female. Recall only one female, Dr. Ada Yonath, has received the Nobel Prize in Chemistry during the examined years. In the period of 1975 to 2015, the NAS Public Welfare Medal it has been awarded to 42 individuals, eight whom (19% were women). Finally, the NSF, National Medal of Science within the discipline of Physical Science has been awarded to 97 individuals from 1975 to 2015; seven of the 97 (7%) were women.

Age

Regression analysis revealed age to be a predictor of early award obtainment. Within the context of the research questions, the following aspects of age were examined: the age of the awardee when awarded their terminal degree, their age between the terminal degree and award, and their age when awarded. For the Nobel, the difference of age for men and women when awarded their terminal degree was 1.8 years. For the NAS, the difference in age was 1.2 years and the difference in age for the NSF was 0.1 years. For the Nobel Prize, the average age of men was 5.2 years above that of women. For both the NAS and NSF, the difference in age was 1.6 years with a seven year gap between men and women. For the NAS, the difference in age was 2.6 years, and the difference in age for the NSF was 1.3 years. The age when the terminal degree was awarded was a statistically significant predictor of early career award obtainment. Awardees' age when they received the terminal degree could predict if they would receive a major scientific award early or late in their career.

Sex

The findings of this study revealed sex was not a predictor of early career award obtainment. However, since the adoption of Title IX, there is a compelling pattern of incremental increase in the relative representation of women in athletics and academics. For example, girls' participation rate in athletics at the high school level increased by 34.7% from 19711972 to 2014-2015. Between 1981-1982 and 2014-2015, women's participation at the university level increased by 15.6%. Women's relative participation in the Olympic Games has increased by 28.9% from 1972 to 2012. From an academic standpoint, women's degree completion was compared between 2002 and 2012, for bachelor's, master's, and doctoral degrees in the fields of physical sciences, chemistry, and physics. Relative completion of bachelor's degree completion for women in physical sciences from 2002 to 2012 has decreased by 2.1%, 0.7% for master's degrees, and 4.1% for doctoral degrees. In the field of chemistry, relative representation of bachelor's degree for women decreases by 0.9% between 2002 and 2012, with a slight decrease in master's degree completion by 0.2%, an increase of 5.2% for doctoral degrees. Finally, in the field of Physics, bachelor's degree completion for women has decreased by 3.5% from 2002 to 2012, while master's degree completion for women had a marginal increase of 0.7%, and doctoral degree completion for women has increased by 4.5%.

Implications

The current study produced implications that relate to issues of gender equity in a range of context. The study examined the demographic characteristics awardees of major scientific awards. I present implications in three separate sections in terms of research, theory, and practice.

Implications for Research

Title IX is having a positive incremental effect on the relative representation of women receiving major scientific awards. Recall, Title IX to date is 44 and the mean for all examined awards recipients age is 68. The difference of the average age of award recipients and when Title IX became a law is 24 years. Thus, the future female award recipients are entering the prime of their careers and are in the field conducting research. The next two decades should produce an exponential increase in the number of major scientific awards earned by women. Furthermore, this study examined awardees during a 40-year period, and focused on the pinnacle of scientific awards, which is the apex of greater representation of women in science. This study focused on the most prestigious scientific awards to provide a broad understanding of the impact of Title IX on gender equity.

Implications for Theory

Bandura's social cognitive theory was applied to this study. From the social cognitive perspective, self-efficacy helps produce vicarious outcomes. Also, according to Bandura, self-efficacy is comprised of two aspects, including self-control and thought process. Based upon social cognitive theory, it has taken time overcome psychological and social barriers, pointing to a delayed, though consistent effect of Title IX. In addition, women who have earned these awards possess self-control, and have refined their thought process. They are leaders, who, in the spite of opposition, have dictated their thoughts, decisions, actions, and habits. Also, they have navigated through challenges, developing intrinsic motivation and perseverance. These women leaders have connected their potential with a purpose. In addition, this study incorporated social cognitive theory to help explain equity in various contexts. Although the theory was not tested directly with new data, I incorporated existing data in a unique manner. The findings in this study, with parallel data from athletics and academics, expose the theory to a broader application than has been exhibited in current research.

Implications for Practice

While additional data would be needed to determine if the incremental pattern from this study continues in other awards. a pattern of equity is occurring regarding women in science fields, and the gap is closing. This has occurred quicker in athletics, and has begun to take shape in academics. From a K-16 viewpoint, girls have greater access to science in the elementary, middle, and high school years. This academic pattern continues at the university level with an increase in doctoral degrees in science by women. Also, as more women enter and complete educational programs, they will gradually receive leadership roles. Therefore, in the coming years, women will rise to the top in various scientific fields, and eventually be awarded more prestigious scientific awards. Thus, as Title IX to date is 44 years old, and the median age of award recipients is 68 years, the maturity of this law will reach a critical mass, i.e. a tipping point, within the next two decades regarding women receiving awards at an exponential rate. Finally, it would be beneficial to conduct qualitative research on women in scientific fields who have received major scientific awards.

Limitations

Regarding the limitations for the study the following are three major constraints. First, is the number of awards. In the current study only three awards were examined within the context of the Nobel, NAS, and NSF. Next, is the number of awardees only being 225. This total number limited the amount of statistical data which could be analyzed. Therefore, by expanding the total number of awardees additional data analysis could be conducted. Finally, the forty year period from 1975 to 2015 could be expanded to aide in the total number of major scientific awards.

Recommendations for Future Research

Other research needs to be conducted expanding the awardees and awards of this study. Recall the RAISE Project has an overview of more than 2,000 awards, including but not limited to STEM and medical fields. This could be a starting point to determine names, and then determine the demographic characteristics of award recipients. Regarding qualitative research, women could be interviewed who have reached the pinnacle in their scientific field, and the application of social cognitive theory could be tested more directly. Also, future research could consist of a closer examination of graduate science programs during the past 40 years. This research would focus on which programs and scientific fields are being entered, what patterns emerge, and why. Perhaps a meaningful source of data could be college admission directors and academic deans. This type of study could reveal a new direction of investigation. From the high school perspective, perhaps girls are not adequately informed by their counselors and teachers with respect to potential academic fields to pursue. A study could examine enrollment patterns of girls in AP science courses, and potentially connect to degree completion. Also, a study could consider the representation of eighth grade girls in Algebra I, which has been shown to be a gateway course (Walters, 2014). In addition, multiple levels in the K-16 educational process have been and will continue to be affected by Title IX. Finally, this points to a need for holistic research which would encompass a spiritual aspect rather than viewing the phenomenon in isolation.

Title IX has directly impacted the number of female science award recipients. The law has provided a parameter to ensure fairness occurs in every aspect of education. Thus, Title IX, enacted four decades ago, continues to have a positive impact regarding discrimination on the basis of sex. The current study suggests the representation of women in the top of scientific fields will reach a tipping point during the next two decades. Due to the workforce becoming more diversified, and the drastic increase of girls and women participating in athletics, women have more equity. Additionally, in the academic arena, as the representation of girls, young ladies, and women continue to increase as professionals, advanced professionals, and leaders, a climactic moment will occur. Furthermore, the pace of this change will gain great momentum as society begins to remember it has been aligned to the image of the Messiah, through a union of trusting, into a community of unity. Thus, one of the purposes of trusting is to enlarge the capacity of a nation to contain Him in much greater measures than has been before.

APPENDIX A

NOBEL PRIZE DATA 1

NOBEL PRIZE DATA 1

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Ada E. Yonath	Nobel	1	29	3	41
John Warcap Cornforth	Nobel	0	24	3	34
Vladimir Prelog	Nobel	0	23	4	46
William Nun Lipscomb	Nobel	0	27	3	30
Ilya Prigogine	Nobel	0	24	6	36
Peter Denis Mitchell	Nobel	0	31	3	27
Herbert Charles Brown	Nobel	0	26	3	41
Georg Fridriech Kari Wittig	Nobel	0	35	3	47
Paul Berg	Nobel	0	26	3	28
Walter Gilbert	Nobel	0	25	6	23
Frederick Sanger	Nobel	0	25	3	37
Fenichi Fukui	Nobel	0	23	3	40
Roald Hoffman	Nobel	0	25	3	19
Aaron Klug	Nobel	0	27	3	29
Henry Taube	Nobel	0	25	3	43
Robert Bruce Merrifield	Nobel	0	28	3	35
Herbert Aaron Hauptman	Nobel	0	37	3	31
Jerome Karie	Nobel	0	26	3	41
Dudley Robert Herschbach	Nobel	0	26	3	28
Yuan Tseh Lee	Nobel	0	29	3	21
John Charles Polanyi	Nobel	0	23	3	34
Donald James Cram	Nobel	0	28	3	40
Jean-Marie Pierre Lehn	Nobel	0	24	3	24
Charles John Pedersen	Nobel	0	23	2	60
Johann Deisenhofer	Nobel	0	31	3	14
Robert Huber	Nobel	0	26	3	25
Hartmut Michel	Nobel	0	29	3	11
Sidney Altman	Nobel	0	28	3	22
Thomas Robert Cech	Nobel	0	28	3	14
Elias James Corey	Nobel	0	23	3	39
Richard Robert Ernst	Nobel	0	29	3	29
Rudolph Arthur Marcus	Nobel	0	23	3	46
Kary Banks Mullis	Nobel	0	28	3	21
Michael Smith	Nobel	0	24	3	37
George Andrew Olah	Nobel	0	50	3	17
Paul J. Crutzen	Nobel	0	35	3	27
Mario J. Molina	Nobel	0	29	3	23

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
F. Sherwood Rowland	Nobel	0	25	3	43
Robert F. Curl Jr.	Nobel	0	24	3	39
Sir Harold W. Kroto	Nobel	0	25	3	32
Richard E. Smalley	Nobel	0	30	3	23
Paul D. Boyer	Nobel	0	25	3	54
John E. Walker	Nobel	0	28	3	28
Jens C. Skou	Nobel	0	36	7	43
Walter Kohn	Nobel	0	25	3	50
John A. Pople	Nobel	0	28	3	47
Ahmed H. Zewail	Nobel	0	28	3	25
Alan J. Heeger	Nobel	0	25	3	39
Alan G. MacDiarmid	Nobel	0	26	3	47
Hideki Shirakawa	Nobel	0	30	5	34
William S. Knowles	Nobel	0	25	3	59
Ryoji Noyori	Nobel	0	29	5	34
K. Barry Sharpless	Nobel	0	27	3	33
John B. Fenn	Nobel	0	23	3	62
Koichi Tanaka	Nobel	0	24	1	19
Kurt Wuthrich	Nobel	0	26	3	38
Peter Agre	Nobel	0	25	7	29
Roderick MacKinnon	Nobel	0	26	7	21
Aaron Ciechanover	Nobel	0	28	7	29
Avram Hershko	Nobel	0	32	3	35
Irwin Rose	Nobel	0	26	3	52
Yves Chauvin	Nobel	0	24	1	51
Robert H. Grubbs	Nobel	0	26	3	37
Richard R. Schrock	Nobel	0	26	3	34
Roger D. Kornberg	Nobel	0	25	3	34
Gerhard Ertl	Nobel	0	29	3	42
Osamu Shimomura	Nobel	0	32	3	48
Martin Chalfie	Nobel	0	30	3	31
Roger Y. Tsien	Nobel	0	25	3	31
Venkatraman Ramakrishnan	Nobel	0	24	3	33
Thomas A. Steitz	Nobel	0	26	3	43
Richard F. Heck	Nobel	0	23	3	56
Ei-ichi Negishi	Nobel	0	28	3	47
Akira Suzuki	Nobel	0	29	3	51
Dan Shechtman	Nobel	0	31	3	39
Robert J. Lefkowitz	Nobel	0	23	7	46

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Brian K. Kobilka	Nobel	0	26	7	31
Martin Karplus	Nobel	0	23	3	60
Michael Levitt	Nobel	0	25	3	41
Arieh Warshel	Nobel	0	29	3	44
Eric Betzig	Nobel	0	28	3	26
Stefan W. Hell	Nobel	0	28	3	24
William E. Moerner	Nobel	0	29	3	32
Tomas Lindahl	Nobel	0	29	3	48
Paul Modrich	Nobel	0	27	3	42
Aziz Sancar	Nobel	0	31	3	38

APPENDIX B

NOBEL PRIZE DATA 2

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Ada E. Yonath	Nobel	1	2009	70	1
John Warcap Cornforth	Nobel	1	1975	58	1
Vladimir Prelog	Nobel	1	1975	69	1
William Nun Lipscomb	Nobel	1	1976	57	0
Ilya Prigogine	Nobel	1	1977	60	1
Peter Denis Mitchell	Nobel	1	1978	58	0
Herbert Charles Brown	Nobel	1	1979	67	1
Georg Fridriech Kari Wittig	Nobel	1	1979	82	1
Paul Berg	Nobel	1	1980	54	0
Walter Gilbert	Nobel	1	1980	48	0
Frederick Sanger	Nobel	1	1980	62	1
Fenichi Fukui	Nobel	1	1981	63	1
Roald Hoffman	Nobel	1	1981	44	0
Aaron Klug	Nobel	1	1982	56	0
Henry Taube	Nobel	1	1983	68	1
Robert Bruce Merrifield	Nobel	1	1984	63	1
Herbert Aaron Hauptman	Nobel	1	1985	68	1
Jerome Karie	Nobel	1	1985	67	1
Dudley Robert Herschbach	Nobel	1	1986	54	0
Yuan Tseh Lee	Nobel	1	1986	50	0
John Charles Polanyi	Nobel	1	1986	57	1
Donald James Cram	Nobel	1	1987	68	1
Jean-Marie Pierre Lehn	Nobel	1	1987	48	0
Charles John Pedersen	Nobel	1	1987	83	1
Johann Deisenhofer	Nobel	1	1988	45	0
Robert Huber	Nobel	1	1988	51	0
Hartmut Michel	Nobel	1	1988	40	0
Sidney Altman	Nobel	1	1989	50	0
Thomas Robert Cech	Nobel	1	1989	42	0
Elias James Corey	Nobel	1	1990	62	1
Richard Robert Ernst	Nobel	1	1991	58	0
Rudolph Arthur Marcus	Nobel	1	1992	69	1
Kary Banks Mullis	Nobel	1	1993	49	0
Michael Smith	Nobel	1	1993	61	1
George Andrew Olah	Nobel	1	1994	67	0
Paul J. Crutzen	Nobel	1	1995	62	0

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Mario J. Molina	Nobel	1	1995	52	0
F. Sherwood Rowland	Nobel	1	1995	68	1
Robert F. Curl Jr.	Nobel	1	1996	63	1
Sir Harold W. Kroto	Nobel	1	1996	57	1
Richard E. Smalley	Nobel	1	1996	53	0
Paul D. Boyer	Nobel	1	1997	79	1
John E. Walker	Nobel	1	1997	56	0
Jens C. Skou	Nobel	1	1997	79	1
Walter Kohn	Nobel	1	1998	75	1
John A. Pople	Nobel	1	1998	73	1
Ahmed H. Zewail	Nobel	1	1999	53	0
Alan J. Heeger	Nobel	1	2000	64	1
Alan G. MacDiarmid	Nobel	1	2000	73	1
Hideki Shirakawa	Nobel	1	2000	64	1
William S. Knowles	Nobel	1	2001	84	1
Ryoji Noyori	Nobel	1	2001	63	1
K. Barry Sharpless	Nobel	1	2001	60	1
John B. Fenn	Nobel	1	2002	85	1
Koichi Tanaka	Nobel	1	2002	43	0
Kurt Wuthrich	Nobel	1	2002	64	1
Peter Agre	Nobel	1	2003	54	0
Roderick MacKinnon	Nobel	1	2003	47	0
Aaron Ciechanover	Nobel	1	2004	57	0
Avram Hershko	Nobel	1	2004	67	1
Irwin Rose	Nobel	1	2004	78	1
Yves Chauvin	Nobel	1	2005	75	1
Robert H. Grubbs	Nobel	1	2005	63	1
Richard R. Schrock	Nobel	1	2005	60	1
Roger D. Kornberg	Nobel	1	2006	59	1
Gerhard Ertl	Nobel	1	2007	71	1
Osamu Shimomura	Nobel	1	2008	81	1
Martin Chalfie	Nobel	1	2008	61	1
Roger Y. Tsien	Nobel	1	2008	56	1
Venkatraman Ramakrishnan	Nobel	1	2009	57	1
Thomas A. Steitz	Nobel	1	2009	69	1
Richard F. Heck	Nobel	1	2010	79	1
Ei-ichi Negishi	Nobel	1	2010	75	1
Akira Suzuki	Nobel	1	2010	80	1
Dan Shechtman	Nobel	1	2011	70	1
Robert J. Lefkowitz	Nobel	1	2012	69	1

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Brian K. Kobilka	Nobel	1	2012	57	1
Martin Karplus	Nobel	1	2013	83	1
Michael Levitt	Nobel	1	2013	66	1
Arieh Warshel	Nobel	1	2013	73	1
Eric Betzig	Nobel	1	2014	54	0
Stefan W. Hell	Nobel	1	2014	52	0
William E. Moerner	Nobel	1	2014	61	1
Tomas Lindahl	Nobel	1	2015	77	1
Paul Modrich	Nobel	1	2015	69	1
Aziz Sancar	Nobel	1	2015	69	1

APPENDIX C

NAS PUBLIC WELFARE DATA 1

PUBLIC WELFARE DATA 1

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Leona Baumgartner	Pub.Welfare	1	32	7	43
Ida M. Green	Pub.Welfare	1	18	0	61
Mina Rees	Pub.Welfare	1	29	3	52
Shirley M. Malcom	Pub.Welfare	1	28	3	29
Maxine F. Singer	Pub.Welfare	1	26	3	50
Norman P. Neureiter	Pub.Welfare	1	25	3	51
Eugenie C. Scott	Pub.Welfare	1	29	3	36
Melinda Gates	Pub.Welfare	1	23	2	26
Emilio Q. Daddario	Pub.Welfare	0	24	8	34
Donald A. Henderson	Pub.Welfare	0	26	7	24
Cecil H. Green	Pub.Welfare	0	24	2	55
Walter S. Sullivan	Pub.Welfare	0	22	1	40
Russell E. Train	Pub.Welfare	0	28	8	33
Paul Grant Rogers	Pub.Welfare	0	27	8	34
Theodore M. Hesburgh	Pub.Welfare	0	28	10	39
I.I. Rabi	Pub.Welfare	0	29	3	58
William D. Carey	Pub.Welfare	0	26	2	44
Dale R. Corson	Pub.Welfare	0	24	3	49
John E. Sawyer	Pub.Welfare	0	24	2	47
David Packard	Pub.Welfare	0	26	2	51
C. Everett Koop	Pub.Welfare	0	31	4	43
Victor F. Weisskopf	Pub.Welfare	0	23	9	60
Philip H. Abelson	Pub.Welfare	0	26	3	53
Jerome B. Wiesner	Pub.Welfare	0	25	3	53
Carl Sagan	Pub.Welfare	0	26	3	34
Harold Amos	Pub.Welfare	0	34	3	43
William T. Golden	Pub.Welfare	0	70	2	17
George W. Thorn	Pub.Welfare	0	23	7	68
David A. Hamburg	Pub.Welfare	0	22	7	51
Arnold O. Beckman	Pub.Welfare	0	28	3	71
Gilbert F. White	Pub.Welfare	0	31	3	58
David A. Kessler	Pub.Welfare	0	28	7	22
Norman E. Borlaug	Pub.Welfare	0	28	3	60
Maurice F. Strong	Pub.Welfare	0	18	0	57
William H. Foege	Pub.Welfare	0	25	7	44
Norman R. Augustine	Pub.Welfare	0	24	2	47

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Neal F. Lane	Pub.Welfare	0	30	3	41
Ismail Serageldin	Pub.Welfare	0	28	3	39
Harold T. Shapiro	Pub.Welfare	0	29	3	48
Bill Gates	Pub.Welfare	0	18	0	40
John E. Porter	Pub.Welfare	0	26	8	53
Neil deGrasse Tyson	Pub.Welfare	0	33	3	24

APPENDIX D

NAS PUBLIC WELFARE DATA 2

PUBLIC WELFARE DATA 2

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Leona Baumgartner	Pub.Welfare	2	1977	75	1
Ida M. Green	Pub.Welfare	2	1979	76	1
Mina Rees	Pub.Welfare	2	1983	81	1
Shirley M. Malcom	Pub.Welfare	2	2003	57	0
Maxine F. Singer	Pub.Welfare	2	2007	76	1
Norman P. Neureiter	Pub.Welfare	2	2008	78	1
Eugenie C. Scott	Pub.Welfare	2	2010	65	1
Melinda Gates	Pub.Welfare	2	2013	49	0
Emilio Q. Daddario	Pub.Welfare	2	1976	58	1
Donald A. Henderson	Pub.Welfare	2	1978	50	0
Cecil H. Green	Pub.Welfare	2	1979	79	1
Walter S. Sullivan	Pub.Welfare	2	1980	62	1
Russell E. Train	Pub.Welfare	2	1981	61	1
Paul Grant Rogers	Pub.Welfare	2	1982	61	1
Theodore M. Hesburgh	Pub.Welfare	2	1984	67	1
I.I. Rabi	Pub.Welfare	2	1985	87	1
William D. Carey	Pub.Welfare	2	1986	70	1
Dale R. Corson	Pub.Welfare	2	1987	73	1
John E. Sawyer	Pub.Welfare	2	1988	71	1
David Packard	Pub.Welfare	2	1989	77	1
C. Everett Koop	Pub.Welfare	2	1990	74	1
Victor F. Weisskopf	Pub.Welfare	2	1991	83	1
Philip H. Abelson	Pub.Welfare	2	1992	79	1
Jerome B. Wiesner	Pub.Welfare	2	1993	78	1
Carl Sagan	Pub.Welfare	2	1994	60	1
Harold Amos	Pub.Welfare	2	1995	77	1
William T. Golden	Pub.Welfare	2	1996	87	0
George W. Thorn	Pub.Welfare	2	1997	91	1
David A. Hamburg	Pub.Welfare	2	1998	73	1
Arnold O. Beckman	Pub.Welfare	2	1999	99	1
Gilbert F. White	Pub.Welfare	2	2000	89	1
David A. Kessler	Pub.Welfare	2	2001	50	0
Norman E. Borlaug	Pub.Welfare	2	2002	88	1
Maurice F. Strong	Pub.Welfare	2	2004	75	1
William H. Foege	Pub.Welfare	2	2005	69	1
Norman R. Augustine	Pub.Welfare	2	2006	71	1

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Neal F. Lane	Pub.Welfare	2	2009	71	1
Ismail Serageldin	Pub.Welfare	2	2011	67	1
Harold T. Shapiro	Pub.Welfare	2	2012	77	1
Bill Gates	Pub.Welfare	2	2013	58	1
John E. Porter	Pub.Welfare	2	2014	79	1
Neil deGrasse Tyson	Pub.Welfare	2	2015	57	0

APPENDIX E

NSF NATIONAL MEDAL DATA 1

NATIONAL MEDAL DATA 1

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Chien-Shiung Wu	Nat.Medal	1	24	3	39
Margaret E. Burbidge	Nat.Medal	1	24	3	40
Vera C Rubin	Nat.Medal	1	26	3	39
Fay Aizenberg-Selove	Nat.Medal	1	26	3	55
Esther M. Conwell	Nat.Medal	1	26	3	61
Sandra M. Faber	Nat.Medal	1	28	3	39
Shirley A. Jackson	Nat.Medal	1	27	3	41
Hans A. Bethe	Nat.Medal	0	22	3	47
Joseph O. Hirschfelder	Nat.Medal	0	26	3	38
Lewis H. Sarett	Nat.Medal	0	27	3	31
E. Bright Wilson, Jr.	Nat.Medal	0	25	3	42
Samuel A. Goudsmit	Nat.Medal	0	25	3	49
Herbert S. Gutowsky	Nat.Medal	0	29	3	28
Frederick D. Rossini	Nat.Medal	0	29	3	48
Verner E. Suomi	Nat.Medal	0	38	3	23
Henry Taube	Nat.Medal	0	25	3	36
George E. Uhlenbeck	Nat.Medal	0	27	3	49
Richard P. Feynman	Nat.Medal	0	24	3	37
Herman F. Mark	Nat.Medal	0	26	3	58
Edward M. Purcell	Nat.Medal	0	26	3	41
John H. Sinfelt	Nat.Medal	0	24	3	24
Lyman Spitzer, Jr.	Nat.Medal	0	24	3	41
Victor F. Weisskopf	Nat.Medal	0	23	3	48
Philip W. Anderson	Nat.Medal	0	26	3	33
Yoichiro Nambu	Nat.Medal	0	31	4	30
Edward Teller	Nat.Medal	0	22	3	52
Charles H. Townes	Nat.Medal	0	24	3	43
Maurice Goldhaber	Nat.Medal	0	25	3	47
Helmut E. Landsberg	Nat.Medal	0	28	3	49
Walter H. Munk	Nat.Medal	0	30	3	36
Frederick Reines	Nat.Medal	0	26	3	39
Bruno B. Rossi	Nat.Medal	0	22	3	56
Robert J. Schrieffer	Nat.Medal	0	25	3	27
Solomon J. Buchsbaum	Nat.Medal	0	28	3	29
Horace R. Crane	Nat.Medal	0	27	3	52
Herman Feshbach	Nat.Medal	0	25	3	44

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Robert Hofstadter	Nat.Medal	0	23	3	48
Chen Ning Yang	Nat.Medal	0	26	3	38
Philip H. Abelson	Nat.Medal	0	25	3	49
Walter M. Elsasser	Nat.Medal	0	23	3	60
Paul C. Lauterbur	Nat.Medal	0	33	3	25
George E. Pake	Nat.Medal	0	24	9	39
James A. Van Allen	Nat.Medal	0	25	3	48
David Allan Bromley	Nat.Medal	0	26	3	36
Paul Chu (Ching-Wu)	Nat.Medal	0	27	3	20
Walter Kohn	Nat.Medal	0	25	3	40
Norman F. Ramsey	Nat.Medal	0	25	3	48
Jack Steinberger	Nat.Medal	0	27	3	40
Arnold O. Beckman	Nat.Medal	0	28	3	61
Eugene N. Parker	Nat.Medal	0	24	3	38
Robert P Sharp	Nat.Medal	0	27	3	51
Henry M. Stommel	Nat.Medal	0	22	1	47
Allan M. Cormack	Nat.Medal	0	21	2	45
Edwin M. McMillan	Nat.Medal	0	26	3	57
Robert V. Pound	Nat.Medal	0	18	0	53
Roger R.D. Revelle	Nat.Medal	0	27	3	54
Arthur L. Schawlow	Nat.Medal	0	28	3	42
Edward C. Stone	Nat.Medal	0	29	3	26
Steven Weinberg	Nat.Medal	0	24	3	34
Eugene M. Shoemaker	Nat.Medal	0	32	3	32
Val L Fitch	Nat.Medal	0	31	3	39
Albert W. Overhauser	Nat.Medal	0	26	3	43
Frank Press	Nat.Medal	0	25	3	45
Hans G. Dehmelt	Nat.Medal	0	28	3	45
Peter Goldreich	Nat.Medal	0	24	3	32
Wallace S. Broecker	Nat.Medal	0	27	3	38
Martin Schwarzschild	Nat.Medal	0	24	3	61
Marshall N. Rosenbluth	Nat.Medal	0	22	3	48
George W. Wetherill	Nat.Medal	0	28	3	44
Don L. Anderson	Nat.Medal	0	29	3	36
John N. Bahcall	Nat.Medal	0	27	3	37
James W. Cronin	Nat.Medal	0	24	3	44
Leo P. Kadanoff	Nat.Medal	0	23	3	39
Jeremiah P. Ostriker	Nat.Medal	0	27	3	36

Name	Prize	Sex	AgeAwarded	HighestDegree	TimeBetwDegr
Gilbert F. White	Nat.Medal	0	31	3	58
Willis E. Lamb, Jr.	Nat.Medal	0	25	3	62
Marvin L. Cohen	Nat.Medal	0	29	3	37
Raymond Davis	Nat.Medal	0	28	3	59
Charles D. Keeling	Nat.Medal	0	26	3	47
Edward Witten	Nat.Medal	0	25	3	26
Jason W. Morgan	Nat.Medal	0	29	3	38
Richard L. Garwin	Nat.Medal	0	21	3	53
Riccardo Giacconi	Nat.Medal	0	23	3	49
Brent G. Dalrymple	Nat.Medal	0	26	3	40
Robert N. Clayton	Nat.Medal	0	25	3	49
Lonnie G. Thompson	Nat.Medal	0	28	3	29
Ralph A. Alpher	Nat.Medal	0	27	3	57
Daniel Kleppner	Nat.Medal	0	27	3	47
Charles P. Slichter	Nat.Medal	0	25	3	58
James E. Gunn	Nat.Medal	0	28	3	42
Berni Alder	Nat.Medal	0	23	3	60
Warren Washington	Nat.Medal	0	28	3	45
Yakir Aharonov	Nat.Medal	0	28	3	49
Sylvester J. Gates, Jr.	Nat.Medal	0	27	3	34
Sindey D. Drell	Nat.Medal	0	23	3	62
Burton Richter	Nat.Medal	0	25	3	56
Sean C. Solomon	Nat.Medal	0	26	3	41

APPENDIX F

NSF NATIONAL MEDAL DATA 2

NATIONAL MEDAL DATA 2

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Chien-Shiung Wu	Nat.Medal	3	1975	63	1
Margaret E. Burbidge	Nat.Medal	3	1983	64	1
Vera C Rubin	Nat.Medal	3	1993	65	1
Fay Aizenberg-Selove	Nat.Medal	3	2007	81	1
Esther M. Conwell	Nat.Medal	3	2009	87	1
Sandra M. Faber	Nat.Medal	3	2011	67	1
Shirley A. Jackson	Nat.Medal	3	2014	68	1
Hans A. Bethe	Nat.Medal	3	1975	69	1
Joseph O. Hirschfelder	Nat.Medal	3	1975	64	1
Lewis H. Sarett	Nat.Medal	3	1975	58	1
E. Bright Wilson, Jr.	Nat.Medal	3	1975	67	1
Samuel A. Goudsmit	Nat.Medal	3	1976	74	1
Herbert S. Gutowsky	Nat.Medal	3	1976	57	0
Frederick D. Rossini	Nat.Medal	3	1976	77	1
Verner E. Suomi	Nat.Medal	3	1976	61	0
Henry Taube	Nat.Medal	3	1976	61	1
George E. Uhlenbeck	Nat.Medal	3	1976	76	1
Richard P. Feynman	Nat.Medal	3	1979	61	1
Herman F. Mark	Nat.Medal	3	1979	84	1
Edward M. Purcell	Nat.Medal	3	1979	67	1
John H. Sinfelt	Nat.Medal	3	1979	48	0
Lyman Spitzer, Jr.	Nat.Medal	3	1979	65	1
Victor F. Weisskopf	Nat.Medal	3	1979	71	1
Philip W. Anderson	Nat.Medal	3	1982	59	1
Yoichiro Nambu	Nat.Medal	3	1982	61	0
Edward Teller	Nat.Medal	3	1982	74	1
Charles H. Townes	Nat.Medal	3	1982	67	1
Maurice Goldhaber	Nat.Medal	3	1983	72	1
Helmut E. Landsberg	Nat.Medal	3	1983	77	1
Walter H. Munk	Nat.Medal	3	1983	66	1
Frederick Reines	Nat.Medal	3	1983	65	1
Bruno B. Rossi	Nat.Medal	3	1983	78	1
Robert J. Schrieffer	Nat.Medal	3	1983	52	0
Solomon J. Buchsbaum	Nat.Medal	3	1986	57	0
Horace R. Crane	Nat.Medal	3	1986	79	1
Herman Feshbach	Nat.Medal	3	1986	69	1

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Robert Hofstadter	Nat.Medal	3	1986	71	1
Chen Ning Yang	Nat.Medal	3	1986	64	1
Philip H. Abelson	Nat.Medal	3	1987	74	1
Walter M. Elsasser	Nat.Medal	3	1987	83	1
Paul C. Lauterbur	Nat.Medal	3	1987	58	0
George E. Pake	Nat.Medal	3	1987	63	1
James A. Van Allen	Nat.Medal	3	1987	73	1
David Allan Bromley	Nat.Medal	3	1988	62	1
Paul Chu (Ching-Wu)	Nat.Medal	3	1988	47	0
Walter Kohn	Nat.Medal	3	1988	65	1
Norman F. Ramsey	Nat.Medal	3	1988	73	1
Jack Steinberger	Nat.Medal	3	1988	67	1
Arnold O. Beckman	Nat.Medal	3	1989	89	1
Eugene N. Parker	Nat.Medal	3	1989	62	1
Robert P Sharp	Nat.Medal	3	1989	78	1
Henry M. Stommel	Nat.Medal	3	1989	69	1
Allan M. Cormack	Nat.Medal	3	1990	66	1
Edwin M. McMillan	Nat.Medal	3	1990	83	1
Robert V. Pound	Nat.Medal	3	1990	71	1
Roger R.D. Revelle	Nat.Medal	3	1990	81	1
Arthur L. Schawlow	Nat.Medal	3	1991	70	1
Edward C. Stone	Nat.Medal	3	1991	55	0
Steven Weinberg	Nat.Medal	3	1991	58	1
Eugene M. Shoemaker	Nat.Medal	3	1992	64	1
Val L Fitch	Nat.Medal	3	1993	70	1
Albert W. Overhauser	Nat.Medal	3	1994	69	1
Frank Press	Nat.Medal	3	1994	70	1
Hans G. Dehmelt	Nat.Medal	3	1995	73	1
Peter Goldreich	Nat.Medal	3	1995	56	1
Wallace S. Broecker	Nat.Medal	3	1996	65	1
Martin Schwarzschild	Nat.Medal	3	1997	85	1
Marshall N. Rosenbluth	Nat.Medal	3	1997	70	1
George W. Wetherill	Nat.Medal	3	1997	72	1
Don L. Anderson	Nat.Medal	3	1998	65	1
John N. Bahcall	Nat.Medal	3	1998	64	1
James W. Cronin	Nat.Medal	3	1999	68	1
Leo P. Kadanoff	Nat.Medal	3	1999	62	1
Jeremiah P. Ostriker	Nat.Medal	3	2000	63	1

Name	Prize	AwardType	AwardYear	AgeAwarded	EarlyLate
Gilbert F. White	Nat.Medal	3	2000	89	1
Willis E. Lamb, Jr.	Nat.Medal	3	2000	87	1
Marvin L. Cohen	Nat.Medal	3	2001	66	1
Raymond Davis	Nat.Medal	3	2001	87	1
Charles D. Keeling	Nat.Medal	3	2001	73	1
Edward Witten	Nat.Medal	3	2002	51	0
Jason W. Morgan	Nat.Medal	3	2002	67	1
Richard L. Garwin	Nat.Medal	3	2002	74	1
Riccardo Giacconi	Nat.Medal	3	2003	72	1
Brent G. Dalrymple	Nat.Medal	3	2003	66	1
Robert N. Clayton	Nat.Medal	3	2004	74	1
Lonnie G. Thompson	Nat.Medal	3	2005	57	0
Ralph A. Alpher	Nat.Medal	3	2005	84	1
Daniel Kleppner	Nat.Medal	3	2006	74	1
Charles P. Slichter	Nat.Medal	3	2007	83	1
James E. Gunn	Nat.Medal	3	2008	85	1
Berni Alder	Nat.Medal	3	2008	83	1
Warren Washington	Nat.Medal	3	2009	73	1
Yakir Aharonov	Nat.Medal	3	2009	77	1
Sylvester J. Gates, Jr.	Nat.Medal	3	2011	61	1
Sindey D. Drell	Nat.Medal	3	2011	85	1
Burton Richter	Nat.Medal	3	2012	81	1
Sean C. Solomon	Nat.Medal	3	2012	67	1

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BIOGRAPHICAL INFORMATION

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