Journal of Aviation/Aerospace Education & Research

Volume 33 | Number 3 Article 4

2024

Diversity, Equity, and Inclusion: Trends in Representation of Women Professionals in the Aviation Industry

Caroline K. Marete Ph.D.
Purdue University, cmarete@purdue.edu

Cheng Wang Ph.D.
Minnesota State University, Mankato, cheng.wang@mnsu.edu

Scholarly Commons Citation

Marete, C. K., & Wang, C. (2024). Diversity, Equity, and Inclusion: Trends in Representation of Women Professionals in the Aviation Industry. *Journal of Aviation/Aerospace Education & Research, 33*(3). DOI: https://doi.org/10.58940/2329-258X.2069

Abstract

Diversity, equity, and inclusion (DEI) stands as an integral component of any successful organization. Historically, society has overlooked and underplayed DEI matters, resulting in the underrepresentation of minority groups, including women and people of color. In the past decade, underrepresentation of women and other minority groups in aviation workforce has received attention and raised concerns among industry stakeholders. To gain insight into the status of women in aviation, the authors analyzed the participation of females in aviation professions between 2016 and 2021. Data used in this study were retrieved from the 2023 U.S. Civil Airmen Statistics published by the Federal Aviation Administration (FAA). Descriptive and inferential statistical methods, including one-way analysis of variance (ANOVA), are used to analyze the trends and features of pilots and instructors holding different types of airmen certificates. The analysis delves into temporal, geographic, and age distributions. The temporal distributions reveal that the number and percentage of women in aviation professions have not significantly changed. From 2007 to 2021, female airline transport pilots (ATPs) marginally increased from 3.7% to 4.7%. Notably, there are statistically significant differences across the eight FAA regions, with the Alaskan region having the highest percentage of female pilots, instructors, and remote pilots, while the Central and Southwest regions exhibit the lowest percentages. In addition, a significant age-related disparity exists among female pilots, with a decline in female representation as the certification level advances. Given that the underrepresentation of women in aviation professions resulted from a mix of social, educational, organizational, and financial factors, recognition, understanding, embracement, and advocating for DEI issues could ultimately lead to increased equality, and a positive impact on the ongoing

workforce shortage in the aviation sector and the long-term sustainability of the aviation industry.

Keywords: aviation; women; pilots; workforce; diversity, equity, and inclusion (DEI)

Introduction

Since its inception in the early 20th century, the aviation industry has made significant strides on many fronts, from the use of the most modern technologies to taking mankind to the moon. Despite being among the most innovative and technologically advanced industries, the aviation industry remains behind in one important area – workforce diversity. Women in aviation remain an untapped group in diversifying the aviation workforce. Moreover, sustainability of the aviation industry is a topical issue among industry stakeholders. Issues such as developing alternative sustainable fuels, use of novel technologies and developing a diverse workforce to support a fast-growing industry are of concern for many stakeholders. Consequently, trends such as environmental, social, and governance, commonly referred as ESG reporting have become commonplace. Diversity, equity, and inclusion (DEI) initiatives are often included in ESG reporting and can provide insight into how a business is incorporating issues such as support for women in the workplace and other diversity issues. This information is valuable for both stakeholders and shareholders especially for aviation businesses that have been traditionally male dominated.

To gain insight into the current status of DEI in the aviation industry, the authors analyzed the participation of female professionals between 2016 and 2021. To obtain a comprehensive understanding, the authors sourced data from the 2023 U.S. Civil Airmen Statistics published by the Federal Aviation Administration ([FAA], 2023b). Statistical methods are used to examine the trends and features of pilots and instructors holding different types of

certificates, including student pilots, private pilots, commercial pilots, airline transport pilots (ATPs), certificated flight instructors (CFIs), ground instructors, and remote pilots. This article explores these trends and features across temporal, geographic, and age dimensions.

The findings from this study provide insight into the issues of DEI in aviation industry, specifically the participation of women in the aviation workforce. Findings from this study may be useful to aviation businesses seeking to increase diversity in the workplace. Furthermore, at a national level, the study sheds light on the continuing challenges of recruitment and retention of women in aviation professions.

Literature Review

Historically, society has overlooked and underplayed DEI matters, resulting in the underrepresentation of minority groups, including women and people of color (Yother et al., 2021). In the last decade, the underrepresentation of women and other minority groups in the workforce has received attention and raised concerns among industry stakeholders. Initiatives such as FAA National Outreach Program for Diversity and Inclusions (FAA, 2023a), International Civil Aviation Organization (ICAO) Global Aviation Gender Summit (ICAO, 2018, 2023), IATA 25 by 2025 (IATA, 2019) and European Union (EU) Ambassadors for Diversity in Transport (EU, 2017) are among the initiatives designed to promote diversity in the aviation industry. Notably, these initiatives were introduced in the recent past and their results are yet to be observed.

Despite numerous studies pointing to the benefits of a diverse workforce (Ferla & Graham, 2019; Opengart & Ison, 2016; Zhang, 2020), the number of women in aviation professions, including commercial pilots, maintenance technicians, management, and other aviation professions, has not significantly changed in the past three decades (Lutte, 2021). For

instance, in the last six decades, the percentage of women commercial pilots has increased at a rate of about one percent annually, and women mechanics at half that rate (Lutte, 2021). The slow growth in the representation of women in most aviation careers may be attributed to the aviation work culture which does not always favor women aviators. Although women have been involved in aviation and consistently demonstrated their capabilities as aviation professionals since the early days of flight, aviation professions have been viewed as a man's profession. This viewpoint has resulted in persistent male domination in most aviation professions due to various challenges at different career levels. For instance, in professional pilots' careers, while the number of women holding student and private pilot licenses is notably high, the number of women reduces the level of certification increases, indicating that more women than men abandon their piloting careers before they attain certifications, such as Airline Transport Pilot (ATP) (FAA, 2023a) that would allow them to join the industry as commercial pilots. A systematic literature review examining the gender gap in the aviation industry found themes such as lack of mentorship and role models for women, a lack of proper recruitment and retention programs, gender stereotyping, and masculine culture in the aviation community are among the factors that may be attributed to the current gender gap in the aviation industry (Marete et al., 2022).

The aviation industry has among the lowest numbers of minority representation in their workforces of any industry. For instance, less than 8% of commercial pilot certificate holders are women and less than 5% of Airline Transport Pilot (ATP) certificate holders are women (Lutte, 2021). The percentage of minority women, such as Black and Hispanic/Latino women, is much lower. Given these statistics, the low representation of women in aviation careers, and the

persistent slow increase in recruitment and retention of women aviators, requires actions by all stakeholders to promote and increase the number of women aviators.

Various aviation industry stakeholders have acknowledged the need for gender diversity and other forms of diversity in the aviation industry (EU, 2017; FAA, 2023a; IATA, 2019; ICAO, 2018, 2023). To better understand and increase participation of women in aviation industry, in 2021, the FAA convened the Women in Aviation Advisory Board (WIAAB), a group of experts tasked "to develop and provide independent recommendations and strategies to the FAA to explore opportunities to encourage female students and aviators to pursue a career in aviation" (FAA, 2021a, par. 1). The 2022 report of WIAAB calls for actions to increase the number of women in the aviation industry by highlighting five areas of action: change the culture, increase recruitment especially in the early phases of career, improve retention in the early stages of training, provide advancement opportunities at the mid-career and leadership levels, and increase data collection on issues that affect women (WIAAB, 2022). Other reports have been published to highlight the underrepresentation of women in aviation careers. These include Lutte (2019, 2021), Baeza et al. (2020), International Aviation Womens Association (IAWA) and Korn Ferry (2020), and Oliver Wyman and IAWA (2021). Notably, many diversity initiatives and publications have occurred in the last five to ten years; as such, it is yet to be seen if the recommendations and findings from these initiatives will have a real impact on increasing diversity, especially the participation of women in the aviation industry.

In addition to the proven benefits of gender diversity in terms of diversity of ideas and innovation, the rapid growth of the commercial aviation industry will require additional skilled labor force to keep the industry running. Despite interruptions from the COVID-19 pandemic, commercial aviation has experienced steady growth in the last decade and is expected to

continue this trajectory (IATA, 2022). Studies have shown that the imminent workforce shortage will affect the entire industry worldwide and across all professions. According to Costanza et al. (2023), the year 2027 will experience the worst shortage for aircraft mechanics. A study by Eno Center for Transportation (Eby & Lewis, 2019) indicates that the workforce shortage will affect the aviation industry globally. In addition, the Boeing 2022 Pilot and Technician Outlook (PTO) projects that "602,000 new pilots, 610,000 new maintenance technicians, and 899,000 new cabin crew members will be needed to fly and maintain the global commercial aviation fleet over the next 20 years" (Boeing Company, 2022). With the looming global aviation workforce shortage, it is imperative that the industry tap into a diverse talent pool. Opengart and Ison (2016) emphasize the need to tap underrepresented groups, such as women and other minority groups, to fill the current and projected aviation workforce shortage. Not only the projected workforce shortage may be alleviated by increasing diversity in recruitment and retention of women in aviation careers, but also key success factors such as higher productivity, improved job satisfaction, better customer experience, and higher profits earnings have been associated with diverse work environments (Zhang, 2020).

Undoubtedly, recruitment and support for women into aviation careers brings new perspectives to the aviation industry. However, the recruitment and retention of minorities, especially women in the aviation industry, are an ongoing challenge. Numerous studies have echoed the challenges faced by women in entering and persisting in aviation careers (Clark et al., 2018; Depperschmidt & Bliss, 2009; Lancia, 2017; Morrison & McNair, 2023; Newcomer, et al., 2018). Challenges, such as the masculine work culture and stereotypes of women in aviation, make it difficult for women to succeed as aviation professionals.

Lutte (2021) calls for more data collection initiatives to highlight the representation of women in aviation careers. Understanding the trends in representation of women in aviation careers is in line with Lutte's (2021) recommendation. As the trends become more visible, aviation stakeholders, such as airlines, airports, parts manufactures, maintenance repair and overhaul (MROs) and other stakeholders, can be held accountable for action (or lack of action) towards increasing diversity in the aviation workforce.

Methodology

The data utilized in this study were obtained from the 2023 U.S. Civil Airmen Statistics datasets published by the FAA (2023b). The annually published dataset contains active airmen statistics about both pilots and non-pilots. Each dataset contains the following statistics:

- Estimated active airmen and women airmen certificates
- Estimated active rotorcraft pilots and glider pilots by class of certificate
- Estimated active pilot certificates, instrument ratings, flight instructors by class of certificate, by FAA region, by state, and/or by age group
- Average age of active total and women pilots by category
- Total of women non-pilots airmen certification by FAA region and state
- Original/additional airmen certificates issued, approved, or disapproved by category and conductor
- Student certificates and instrument ratings issued

The FAA defines an airman as a man or woman certificated as a pilot, mechanic, or other aviation technician (Federal Aviation Act, 1958). An active airman is one who holds both an airman certificate and a valid medical certificate (FAA, 2023b).

The temporal scope of this study encompasses annual statistics from 2016 through 2021. The study focuses on active student pilots, private pilots, commercial pilots, ATPs, CFIs, ground instructors, and remote pilots. The statistics are analyzed with respect to FAA region and age group. Both descriptive and inferential statistical analysis are utilized. The one-way analysis of variance (ANOVA) is used to investigate whether there is statistical significance between the percentage of female pilots, a continuous dependable variable, and different types of certificates, as well as their geographic distribution, which are both categorical independent variables. By using one-way ANOVA, the means of the dependent variable across the different levels of the independent variable are compared to determine if there are statistically significant differences between them. The following null hypotheses are tested in this study (Kiernan, 2014):

- **H1**: There is no statistically significant difference in the percentage of female pilots holding different types of certificates (i.e., student pilots, private pilots, commercial pilots, ATPs, CFIs, and ground instructors.)
- **H2.1**: There is no statistically significant difference in the percentage of female pilots and instructors among the eight FAA regions.
- **H2.2**: There is no statistically significant difference in the percentage of female student pilots among the eight FAA regions.
- **H2.3**: There is no statistically significant difference in the percentage of female private pilots among the eight FAA regions.
- **H2.4**: There is no statistically significant difference in the percentage of female commercial pilots among the eight FAA regions.
- **H2.5**: There is no statistically significant difference in the percentage of female ATPs pilots among the eight FAA regions.

- **H2.6**: There is no statistically significant difference in the percentage of female CFIs among the eight FAA regions.
- **H2.7**: There is no statistically significant difference in the percentage of female ground instructors among the eight FAA regions.

The following section presents the results of the statistical analysis, followed by interpretations and discussion of these results.

Results and Discussion

This section presents the trends and features of female pilot, instructor, and remote pilot workforce by temporal, geographic, and age distribution. It further expounds upon the characteristics of each of these distributions and discusses potential strategies for effectively addressing these distinctive features.

Temporal Distribution

The trend of pilot, flight instructor, and ground instructor exhibits the same pattern for both men and women between 2007 and 2021, as shown in Figure 1 (see Appendix for all figures). The number of male pilots and instructors decreased from 2010 to 2015, followed by a subsequent increase from 2016 to 2021. For a three-year period spanning from 2013 to 2015, the number of female pilots and instructors remained relatively constant at approximately 51,000. Since 2016, there has been a consistent annual growth of approximately 1.1% in the number of female pilots and instructors. With regard to remote pilots, the FAA introduced the remote pilot certificate in 2016 (Small Unmanned Aircraft Systems, 2021). Since then, the population of remote pilots has witnessed exponential growth for both genders. The discernible trends of pilots, instructors, and remote pilots underscore the existing gender disparity within the aviation industry and emphasize the need to recruit more women in the early stages of their aviation journeys.

The significant gender gap in the aviation industry is shown in Figure 1. Figure 2 further illustrates the evolving trends in the rates of female pilots and instructors over the years. Between 2007 and 2021, the percentage of female student pilots exhibited the most substantial growth, surging from 11.3% to 14.6%. However, only about half of the female student pilots attain a private pilot certificate. Regarding female ATPs, the increase in the percentage was more gradual, inching up from 3.7%to 4.7%. The combined average percentage of women in roles as pilots and instructors merely reached 7.4%. Although the percentage of female pilots and instructors has gradually increased during the 15-year timeframe, this gender gap within the pilot and instructor sectors underscores the persistent challenges. It is noteworthy that women represent 46.9% of the general workforce in the U.S. (FAA, 2023). Therefore, the pronounced underrepresentation of women in various aviation professions is undeniable. To rectify this disparity and concurrently address the long-term workforce shortage looming over the aviation industry, proactive measures can be taken to encourage and support women's participation in aviation. One approach is for the industry to consider offering scholarships and financial aid specifically for women pursuing aviation education and flight training (WIAAB, 2022). In addition to scholarships, promoting STEM education and aviation programs in schools can play a pivotal role in increasing female representation in the aviation field. Introducing aviation-related curriculum and hands-on learning experiences at an early age can spark interest among young girls, inspiring them to explore aviation as a potential career path (Ward et al., 2019). These initiatives can serve as a catalyst for augmenting female participation in the aviation field.

Between 2007 and 2021, the average percentages of women student pilots and ATPs were 12.6% and 4.2%, respectively. Therefore, a one-way ANOVA test was conducted to determine whether there is statistical significance among different types of female pilots. Table 1

displays the results of the one-way ANOVA test for hypothesis 1 (see Appendix for all tables). The results indicate that there is statistical significance among the percentages of different types of pilots. In general, the more advanced the rating, the lower the percentage of female pilots certified in that rating.

Numerous factors potentially or partially impede women from getting advanced pilot certificates and ratings. One key factor is the challenge that female pilots encounter in maintaining an ideal work-life balance after becoming mothers. Typically, men usually have leisure time after work, while mothers tend to spend three or more hours daily on household chores and childcare upon returning home (McKinsey & Company, 2022). This substantial time commitment, equivalent to more than 20 hours per week or even exceeding the hours of a part-time job, is imposed on women despite women working under the same conditions as men at their workplaces. Another important factor that contributes to the low representation of female pilots is the negative working environment, such as industry prejudice against female pilots and physical harassment. Numerous cases of discriminatory practices and harassment against female pilots were reported. According to a study by Durbin et al. (2022), 42% of women reported that they had been treated differently at their workplace because of their gender, with many noting differential treatment from passengers, other crew members, or ground staff.

To address the exceedingly low percentage of female ATPs, one viable solution is to enhance female retention by fostering an industrial environment in which women can be valued. Airlines unions should negotiate and establish policies in their contracts aimed at encouraging female ATPs to remain in their profession. Policies such as paid maternity and parental leave, accommodations for nursing, and employer-sponsored childcare benefits are helpful for attracting and retaining female ATPs and other aviation professionals and ensure their long-term

career success. Moreover, employers should actively cultivate a diverse, equal, and inclusive workplace culture that effectively addresses and prevents gender biases and harassment. Nationwide, the federal government should establish an independent system for reporting all forms of workplace discrimination (WIAAB, 2022).

In the unmanned aircraft system (UAS) sector, a significant gender gap also exists, though the demand for remote pilots is soaring as industries are relying on drones. However, it is heartening to note that there was a substantial surge not only in the absolute number of female remote pilots but also in the percentage of female remote pilots, effectively doubling from 2016 to 2021. Figure 3 shows this positive trend, illustrating the rise in the percentage of female remote pilots from 3.9% to 7.6%. It is important to note that the low percentage of female remote pilots may be partially attributed to the regulations governing the remote pilot certification. Under 14 Code of Federal Regulations, Part 61 operators can obtain a remote pilot certificate by successfully completing an online training course and submitting an application. The FAA reported that 28% of remote pilots also hold a Part 61 certificate (FAA, 2023b).

Geographic Distribution

The percentage of female pilots and instructors across different FAA regions exhibits notable variations. Figure 4 displays the percentage of female pilots and instructors categorized by region and year. Remarkably, the Alaskan region had the highest percentage of female pilots and instructors, while the Central and Southwest regions consistently maintained the lowest percentages. In addition, the Alaskan region also shows a consistent increase in the percentage of female pilots and instructors, while all other regions experienced a decline in these percentages between 2017 and 2019. One-way ANOVA tests are conducted to further investigate the regional differences in female pilots and instructors. Table 2 shows the results of one-way ANOVA tests

hypotheses 2.1 to 2.7. The p-values indicate that there are statistically significant differences among the eight FAA regions. Furthermore, there are statistically significant differences in the percentage of female student pilots, private pilots, commercial pilots, ATPs, CFIs, and ground instructors across the FAA regions.

The variations in the percentage of female pilots across different regions can be explained by three major reasons. Firstly, the prevailing cultural norms and societal attitudes towards gender roles exert a considerable influence on the number and percentage of female pilots. Regions and states with more progressive and inclusive attitudes may attract and encourage more women to pursue careers in aviation. Secondly, the demand for air transportation and the presence of aviation employers within a given state affect the number of pilot job opportunities. States with a greater reliance on air transportation and a higher concentration of aviation enterprises become alluring destinations for pilots of all backgrounds, including women. In Alaska, over 80% of communities accessible solely by air transportation (FAA, 2021b), which means the state relies more heavily on aviation than any other in the U.S. This reliance extends from everyday commuting to emergency evacuations, rendering air transportation a fundamental component of many Alaskan communities. Consequently, the demand for pilots in Alaska may be substantially higher, thus impacting the percentage of female pilots and instructors in the Alaskan region. Additionally, the regional disparity may also be influenced by familial involvement (Johnson, 2023; Yorko, 2018). In many Alaskan families, flying is a shared passion and activity that brings family members together. Children are exposed to flying from a young age and are often encouraged to learn about aviation alongside their parents. This familial approach creates an environment where gender barriers are minimized and fosters a more inclusive and supportive atmosphere for women to pursue careers in aviation. Especially

noteworthy is the impact of female role models within the family. When daughters witness their mothers or female relatives actively engaged in piloting, they are more likely to perceive aviation as a realistic and achievable career path. This familial encouragement plays a crucial role in shaping girls' attitudes towards aviation, empowering them to pursue their aspirations without limitations based on gender stereotypes. The Alaskan region had not only the largest share of female pilots and instructors but also the highest percentage of female remote pilots. Figure 5 shows the percentage of female remote pilots by region and year. The data once again underscores the conspicuous disparity observed in the Central and Southwest regions, where the percentages of female remote pilots are lower than the national average. Intriguingly, in most FAA regions, the percentages of female remote pilots have consistently shown an upward trajectory over the years. However, the Alaskan region was the only region experiencing a decreased percentage of female remote pilots since the FAA introduced the remote pilot certification in 2016 (Small Unmanned Aircraft Systems, 2021).

Age Distribution

When examining the age distribution of pilots and instructors, both commonalities and differences emerge between male and female aviation professionals. Figures 6(a) and 6(b) show the five-year averages of the number of male and female pilots or instructors by age. Firstly, the number of student pilots peaks in the 20-29-year-old age range and significantly declines in the 30-39 and 40-49 age ranges. Similarly, the number of CFIs reaches its peak in the 30-39-year-old age range and gradually decreases with increasing age. These two trends indicate that most professional pilots begin their flight training as student pilots during their college years. After completing their flight training and obtaining the required certificates, these young aviators embark on careers as CFIs, instructing student pilots and accumulating flight hours before becoming airline pilots. Secondly, the trends of male and female private pilots are different. For

male private pilots, the numbers decrease in the 20-29 and 30-39-year-old ranges but experience a substantial increase in the 40-49 and 50-59 age ranges. This trend suggests that a significant number of male pilots gain their private pilot license in their 40s or 50s, flying for non-commercial or recreational purposes during their midlife. In contrast, female private pilots peak in the 20-29-year-old age range, with numbers gradually declining as they age. Moving on to the trends for male and female commercial pilots, they mirror those observed among private pilots. These distinctions between male and female pilots underscore that it is more common for males to obtain pilot licenses and actively participate in flight operations compared to their female counterparts. Lastly, the most notable difference in the trends of male and female pilots pertains to the number of ATPs by age distribution. The number of male ATPs consistently increases at a steady pace with advancing age, but this trend sharply declines in the 60-69 age range, primarily due to the retirement mandate for ATPs and commercial pilots at 65 years old. However, it is important to note that they can continue exercising their commercial privileges well beyond 65 years of age under both Part 91 and Part 135 operations. With regard to female ATPs, there is a substantial increase in the 20-29 age range, illustrating the entry of female pilots into the ATP community over the past decade. However, the numbers of female ATPs in the 40-49 and 50-59 age ranges are very close. This suggests that female ATPs may depart from their careers in their 40s due to work or family-related reasons, or it could indicate that the population of female ATPs within the aviation community was consistently low.

Figure 7 shows the average percentage of male and female pilots by certificate type and age group. Overall, regardless of certificate type, there is a consistent decline in the percentage of female pilots as age increases. This downward trend can be attributed to three primary factors. Firstly, a historical lack of opportunities for women in aviation, coupled with the industry's

historically male-dominated nature, has played a significant role. While significant efforts have been made in recent years to promote gender diversity in aviation, the industry has been slow to change (Ferla & Graham, 2019). This historical factor has had a long-term impact on the demographics of the pilots and results in fewer female pilots in the older generations of pilots. Secondly, as female pilots age, some choose to leave the profession or pursue alternative career paths. Various reasons contribute to this decision, including family considerations and the emergence of diverse career opportunities (McCarthy et al., 2015). In addition, fewer women enter aviation as a career at a young age due to several factors, including lack of exposure to aviation as a viable career option and gender stereotypes that discourage women from pursuing careers in male-dominated fields (Germain et al., 2012; Henneberry, 2018). To address these challenges and promote the participation of women in aviation, initiatives like the WIAAB report have proposed recommendations. These recommendations emphasize the importance of introducing aviation career paths to young children. Even seemingly minor actions, such as offering toys that depict women as aviators can make a significant difference in attracting more girls to aviation programs (WIAAB, 2022). Moreover, considering the short and long-term workforce shortage in the aviation industry, it becomes imperative for industry stakeholders to devise sustainable strategies for the recruitment and retention of historically marginalized groups, including women and racial minorities.

Figures 6(a), 6(b), and 7 show the consistent increase in both the number and percentage of female pilots in recent years. The compelling trend indicates that the air transportation industry has been attracting women to join the aviation workforce. Figures 8(a) and 8(b) show the average age of all active pilots and the average age of active female pilots. Both figures confirm the trend that women are increasingly embracing aviation careers as pilots or instructors.

As shown in Figures 8(a) and 8(b), the average ages of female pilots and instructors are notably lower than all pilots, regardless of the type of certificate. Furthermore, the figures reveal noteworthy declines in the average ages of private and commercial pilots, as well as CFIs, since 2018. These declines are far more pronounced among female pilots and instructors, underlining the industry's success in attracting a younger generation of women to aviation professions.

Figure 9 shows the average number of male and female remote pilots between 2016 and 2021 by age group. Considering that UAS operations is a relatively new field, it follows that most remote pilots, especially those engaged in non-recreational activities, tend to be relatively young.

While this study has revealed several interesting findings, it does have limitations. Firstly, the study focuses on the participation of female professionals between 2016 and 2021. This relatively short timeframe may not capture long-term trends or provide a comprehensive understanding of the historical context of women's participation in aviation professions. Future studies could extend the timeframe beyond 2016-2021 to provide a more comprehensive analysis of long-term trends in women's participation in aviation professions. Examining historical data over several decades could help identify patterns, shifts, and factors influencing changes in representation over time. Secondly, while this study examines regional differences in the representation of female aviation professionals within the U.S., it does not consider broader international trends or variations in DEI initiatives across different countries and regions. Future research could expand beyond the U.S. to include a global perspective on women's participation in aviation. Comparative studies across different countries and regions could highlight variations in DEI initiatives and their impact on female representation in the industry. Moreover, while the study acknowledges that the underrepresentation of women professionals in aviation is

influenced by various social, educational, organizational, and financial factors, it does not deeply explore or analyze these factors in detail. A more in-depth examination of these factors could provide valuable insights into potential barriers and opportunities for promoting diversity, equity, and inclusion in the aviation workforce.

Conclusion

The findings of this study underscore the persistent underrepresentation of women in aviation professions, particularly as pilots and instructors. Over the past 15 years, there has been minimal change in the numbers and percentages of women in these roles. Statistically significant differences exist across the eight FAA regions, with the Alaskan region having the highest representation of female pilots, instructors, and remote pilots, while the Central and Southwest regions lag behind. Moreover, the data reveal a significant age-related discrepancy among female pilots. As the rating level increases, the percentage of female pilots holding such certifications diminishes. The findings of this study are aligned with extant literature, emphasizing the need for concerted efforts to recruit and retain women professionals in aviation.

Addressing the gender gap in aviation requires a multi-dimensional approach, considering the various social, educational, organizational, and financial factors that contribute to this underrepresentation. Industry stakeholders should collaborate effectively to reduce inequality and ease the workforce shortage. Employers should foster environments that value and support women in aviation, while airlines can implement policies aimed at retaining female ATPs. Promoting aviation as a viable career choice for young children, particularly girls, can attract more female talent to the field. Offering scholarships and financial aid specific to women pursuing aviation degrees, as well as advocating for aviation programs in schools, are effective solutions (Luedtke, 1994; WIAAB, 2022). Additionally, the federal government can play a vital role by establishing a comprehensive reporting system to address workplace discrimination.

These collective actions will ultimately lead to a more diverse, equal, and inclusive aviation industry.

This research has provided insights into the temporal trends, geographic disparities, and age distributions of female pilots, instructors, and remote pilots. Future research could focus on other aviation professions, such as mechanics and aircraft dispatchers. It would also be worthwhile to compare the aviation industry with other fields such as engineering, information technology, and automotive industry. Fortunately, with recognizing, understanding, embracing, and advocating for improvements in DEI, many stakeholders are paving the way to a more diverse, equitable, and inclusive future for all within the aviation sector.

References

Baeza, L. M., Clark, M., Smith, A.-M., & Taylor, A.-M. (2020). *Propelling a gender balanced industry.* Korn Ferry. https://www.wiaacharter.com/wp-content/uploads/2020/11/Propelling-a-Gender-Balanced-Industry.pdf

Boeing Company. (2022). *Pilot and technician outlook 2023 - 2042*. https://www.boeing.com/commercial/market/pilot-technician-outlook

Clark, P. J., Newcomer, J. M., & Jones, A. M. (2018). Overcoming gender barriers in aircraft maintenance: Women's perceptions in the United States. *Collegiate Aviation Review*, *33*(2), 66–84. https://doi.org/10.22488/okstate.18.100505

Costanza, D., Prentice, B., Poitras, M., Bardygula, O., Fasano, B. Sargent, S., Hayes, L., & Franzoni, C. (2023). *Not enough aviation mechanics: Addressing this decade's shortage in aircraft maintenance*. Oliver Wyman. https://www.oliverwyman.com/our-expertise/insights/2023/jan/not-enough-aviation-mechanics.html

Depperschmidt, C. L., & Bliss, T. J. (2009). Female flight students: Perceptions of barriers and gender biases within collegiate flight programs. *Collegiate Aviation Review*, *27*(2), 18–27. https://doi.org/10.22488/okstate.18.100391

Durbin, S., Warren, S., & Munns, M. (2022). *RAes Webinar*: *What is the future for gender diversity in the pilot trainer role? Myth or reality?* [Webinar]. Royal Aeronautical Society. https://youtu.be/bQvJ7o0uPbs?si=5uJNZUJHvhihNhjB

Eby, B., & Lewis, P. (2019). *Aviation workforce challenges in the United States and the United Kingdom*. Eno Center for Transportation. https://enotrans.org/eno-resources/aviation-workforce-challenges-in-the-united-states-and-the-united-kingdom/

European Union. (2017). *Women in transport – EU platform for change*. https://transport.ec.europa.eu/transport-themes/social-issues-equality-and-attractiveness-transport-sector/equality/women-transport-eu-platform-change_en

Federal Aviation Act, 49 U.S.C. § 40102 et seq. (1958). https://www.govinfo.gov/content/pkg/USCODE-1994-title49/html/USCODE-1994-title49-subtitleVII.htm

Federal Aviation Administration. (2021a). *Advisory and rulemaking committees: Women in aviation advisory board*. United States Department of Transportation. https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/committee/browse/committeeID/817

Federal Aviation Administration. (2021b). *FAA invests $42 million in airports across Alaska*. United States Department of Transportation. https://www.faa.gov/newsroom/faa-invests-42-million-airports-across-alaska

Federal Aviation Administration. (2023a). *National outreach program for diversity and inclusion: Federal Women's Program (FWP)*. United States Department of Transportation. https://www.faa.gov/fwp

Federal Aviation Administration. (2023b). *U.S. civil airmen statistics*. United States Department of Transportation. https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics

Ferla, M., & Graham, A. (2019). Women slowly taking off: An investigation into female underrepresentation in commercial aviation. *Research in Transportation Business & Management, 31*. https://doi.org/10.1016/j.rtbm.2019.100378

Germain, M. L., Herzog, M. J. R., & Hamilton, P. R. (2012). Women employed in male-dominated industries: Lessons learned from female aircraft pilots, pilots-in-training and mixed-gender flight instructors. *Human Resource Development International, 15*(4), 435-453. https://doi.org/10.1080/13678868.2012.707528

Henneberry, D. (2018). *The sky's the limit: Factors that affect females' decisions to become professional pilots* [Doctoral dissertation, St John Fisher University]. St. John Fisher University Archive. https://fisherpub.sjf.edu/education_etd/393

International Air Transport Association. (2019). Advancing diversity, equity and inclusion with 25by2025. https://www.iata.org/en/about/our-commitment/25-by-2025/

International Air Transport Association. (2022). *Air passenger numbers to recover in 2024* [Press release]. https://www.iata.org/en/pressroom/2022-releases/2022-03-01-01/

International Aviation Womens Association, & Korn Ferry. (2020). *Soaring through the glass ceiling: Taking the global aviation industry to new heights through diversity and inclusion*. https://www.kornferry.com/content/dam/kornferry/docs/pdfs/aviation-glass-ceiling.pdf

International Civil Aviation Organization. (2018). *Global aviation gender summit 2018* [Webpage]. https://www.icao.int/Meetings/AviationGenderSummit/Pages/default.aspx

International Civil Aviation Organization. (2023). *Global aviation gender summit 2023* [Webpage]. https://www.icao.int/Meetings/global-aviation-gender-summit-2023/Pages/default.aspx

Johnson, A. (2023, May 22). The lifeline of flying: The pilots connecting remote communities in Alaska. *The Guardian*. https://www.theguardian.com/artanddesign/2023/may/22/its-almost-spiritual-the-female-pilots-connecting-remote-alaska

Kiernan, D. (2014). *Natural Resources Biometrics*. Open SUNY Textbooks.

Lancia, G. (2017). "We can and will do it!" Female perceptions of pilot as a career. *Collegiate Aviation Review, 35*(2), 54–67. https://doi.org/10.22488/okstate.18.100481

Luedtke, J. R. (1994). Analysis and results of national study on women in collegiate aviation. *Journal of Aviation/Aerospace Education & Research, 5*(1), 14-20. https://doi.org/10.15394/jaaer.1994.1137

Lutte, R. (2019). *Women in aviation: A workforce report*. Aviation Institute Publications. https://digitalcommons.unomaha.edu/aviationfacpub/6

Lutte, R. (2021). *Women in aviation: A workforce report 2021 edition*. Aviation Institute Publications. https://www.researchgate.net/publication/357032586_Women_in_Aviation_A_Workforce_Report_2021_Edition#fullTextFileContent

Marete, C., Zakharov, W., & Mendonca, F. A. C. (2022). A systematic literature review examining the gender gap in collegiate aviation and aerospace education. *Collegiate Aviation Review, 40*(1), 168–186. https://doi.org/10.22488/okstate.22.100209

McCarthy, F., Budd, L., & Ison, S. (2015). Gender on the flightdeck: Experiences of women commercial airline pilots in the UK. *Journal of Air Transport Management, 47*, 32-38. https://doi.org/10.1016/j.jairtraman.2015.04.001

McKinsey & Company. (2022). *Women in the workplace 2023*. https://womenintheworkplace.com/

Morrison, S. M., & McNair, A. W. (2023). Community, coalition building, and career decision-making self-efficacy: A case study of collegiate women in aviation. *Journal of Women and Minorities in Science and Engineering*, *29*(3), 25-56.

https://doi.org/10.1615/JWomenMinorScienEng.2022040346

Newcomer, J. M., Clark, P. J., Button, D. K., & Weiland, L. V. (2018). Gender diversity in aircraft maintenance: A cross-sectional triangulation of male perspectives. *Journal of Gender Studies, 27*(5), 509–521. https://doi.org/10.1080/09589236.2016.1243046

Oliver Wyman, & International Aviation Womens Association. (2021). *Lift off to leadership: Advancing women in aviation*. https://www.oliverwyman.com/our-expertise/insights/2021/sep/lift-off-to-leadership.html

Opengart, R., & Ison, D. (2016). A strategy for alleviating aviation shortages through the recruitment of women. *International Journal of Aviation Management*, *3*(2-3), 200–219. https://doi.org/10.1504/IJAM.2016.079953

Small Unmanned Aircraft Systems, 14 C.F.R. § 107 (2021). https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107

Ward, S., Beard, C., Retzlaff, S., Muia, M., Snyder, P., Martin, L., Kenville, K., & Gordon, D. (2019). *Developing innovative strategies for aviation education and participation.* Airport Cooperative Research Program. https://doi.org/10.17226/25528

Women in Aviation Advisory Board. (2022). *Breaking barriers for women in aviation: Flight plan for the future*. Federal Aviation Administration. https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information/documentID/5483

Yorko, S. (2018, June 7). Catch a ride to the Alaska range with one of these five female pilots. *Powder*. https://www.powder.com/stories/these-are-the-female-pilots-flying-skiers-into-the-alaska-range

Yother, T. L., Lucietto, A. M., Umberger, G., & Johnson, M. E. (2021, July). Women and BIPOC in aerospace: Where did they come from and how did they get here? [Paper presentation]. *2021 ASEE Virtual Annual Conference Content Access, Virtual Conference*. https://peer.asee.org/38104

Zhang, L. (2020). An institutional approach to gender diversity and firm performance. *Organization Science*, *31*(2), 439-457. https://doi.org/10.1287/orsc.2019.1297

Appendix

Tables and Figures

Table 1

Results of the One-Way ANOVA Test on Hypothesis

Hypothesis	Source	Sum of squares	Degree of freedom	Mean square	F	P-value
H1	Between groups	.058	5	.012	415.676	.000
	Within groups	.002	84	.000		
	Total	.060	89			

Table 2

Results of One-Way ANOVA Tests on Hypotheses 2.1 to 2.7

Hypothesis	Source	Sum of squares	Degree of freedom	Mean square	F	P-value
H2.1	Between groups	.008	7	.001	7.329	.000
	Within groups	.006	40	.000		
	Total	.013	47			
H2.2	Between groups	.025	7	.004	55.211	.000
	Within groups	.003	40	.000		
	Total	.028	47			
H2.3	Between groups	.004	7	.001	19.446	.000
	Within groups	.001	40	.000		
	Total	.006	47			
H2.4	Between groups	.003	7	.000	10.655	.000
	Within groups	.002	40	.000		
	Total	.005	47			
H2.5	Between groups	.006	7	.001	417.010	.000
	Within groups	.000	40	.000		
	Total	.006	47			
H2.6	Between groups	.007	7	.001	46.870	.000
	Within groups	.001	40	.000		
	Total	.007	47			
H2.7	Between groups	.009	7	.001	184.885	.000
	Within groups	.000	40	.000		
	Total	.009	47			

Figure 1

Number of Pilots and Instructors by Year and Gender

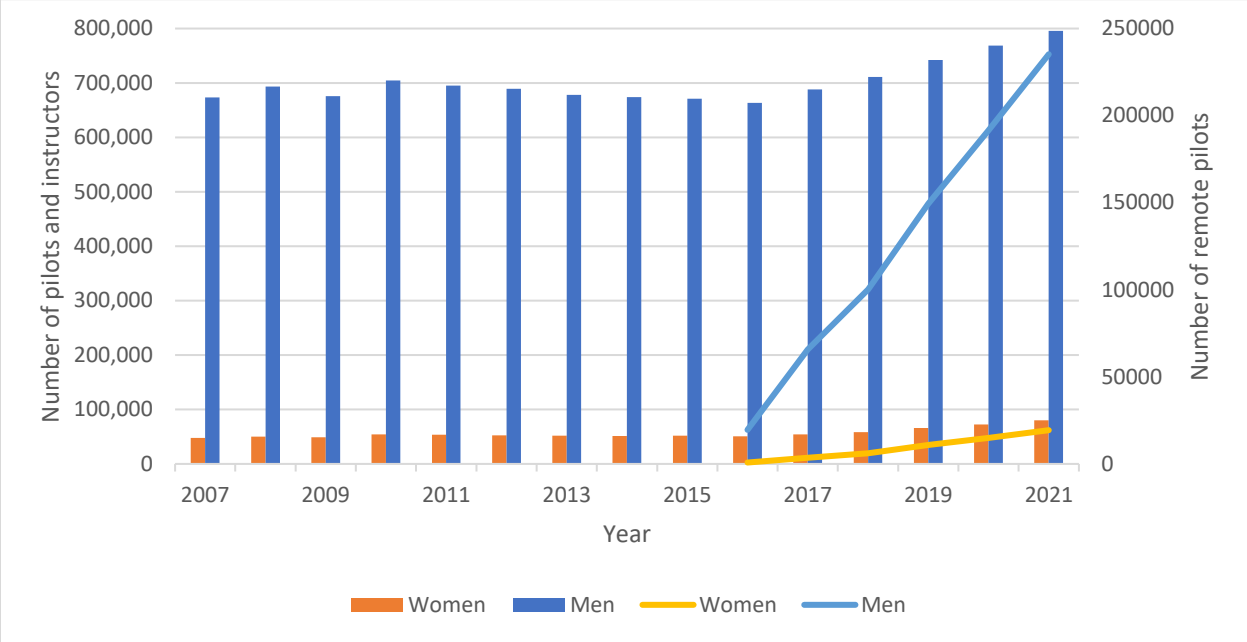

Figure 2

Percentage of Female Pilots and Instructors by Year

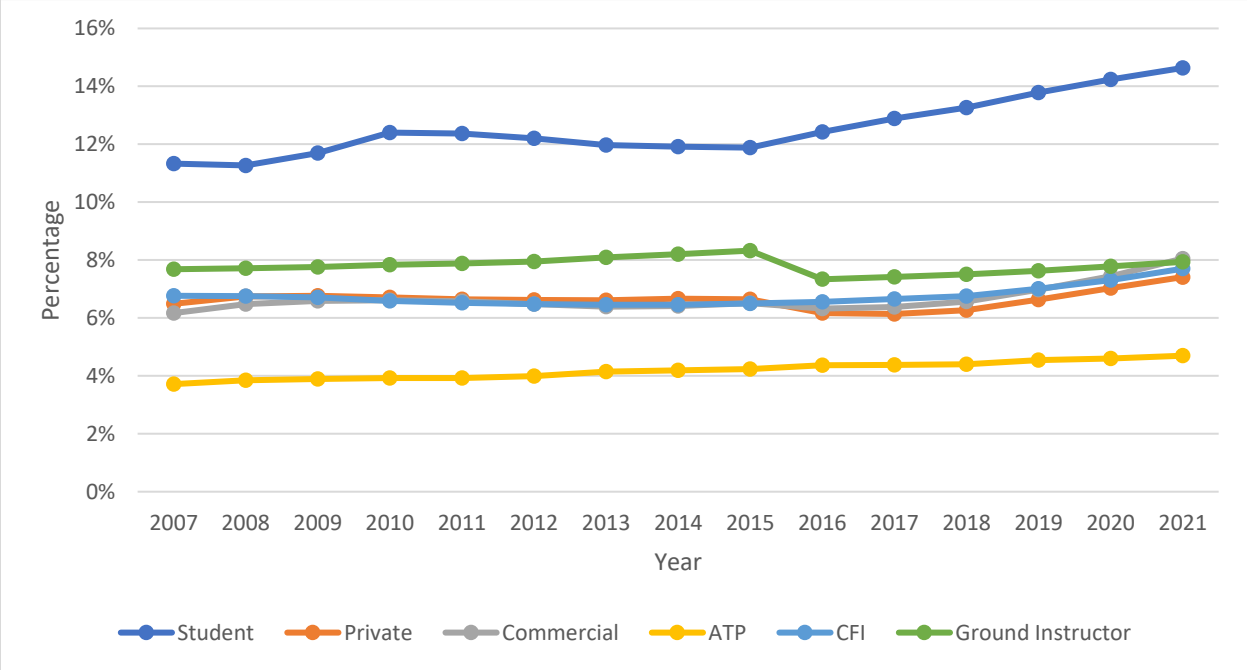

Figure 3

Number and Percentage of Female Remote Pilots by Year

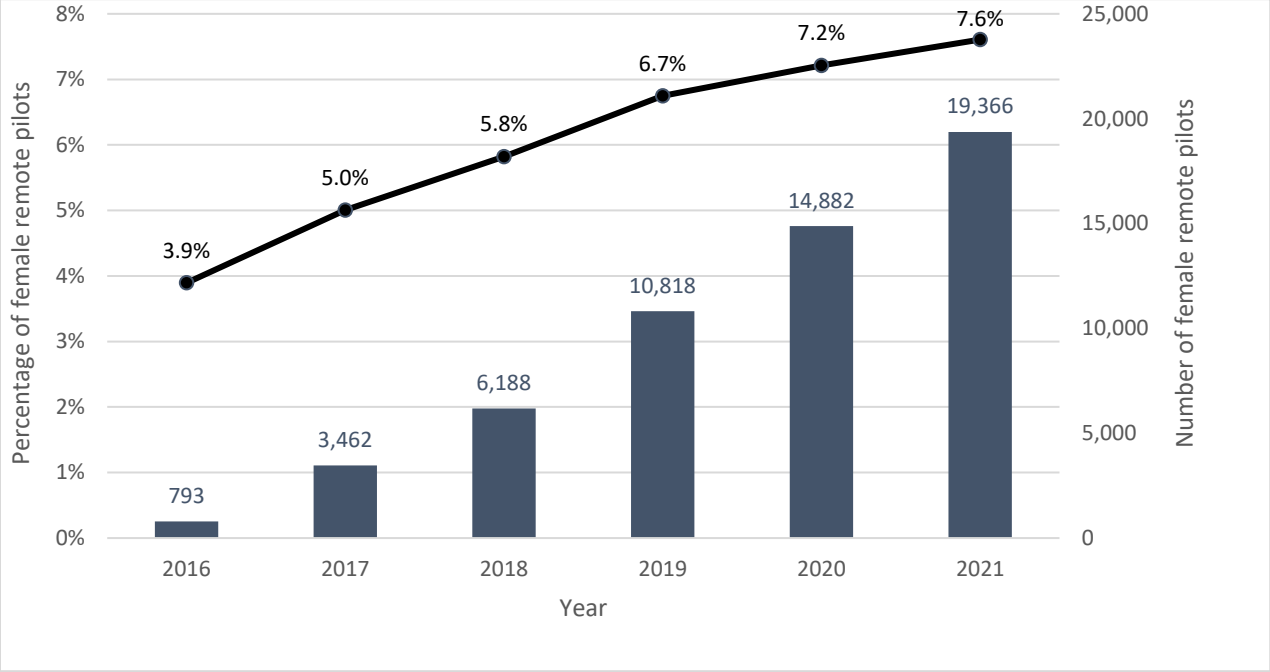

Figure 4

Percentage of Women Pilots and Instructors by Region and Year

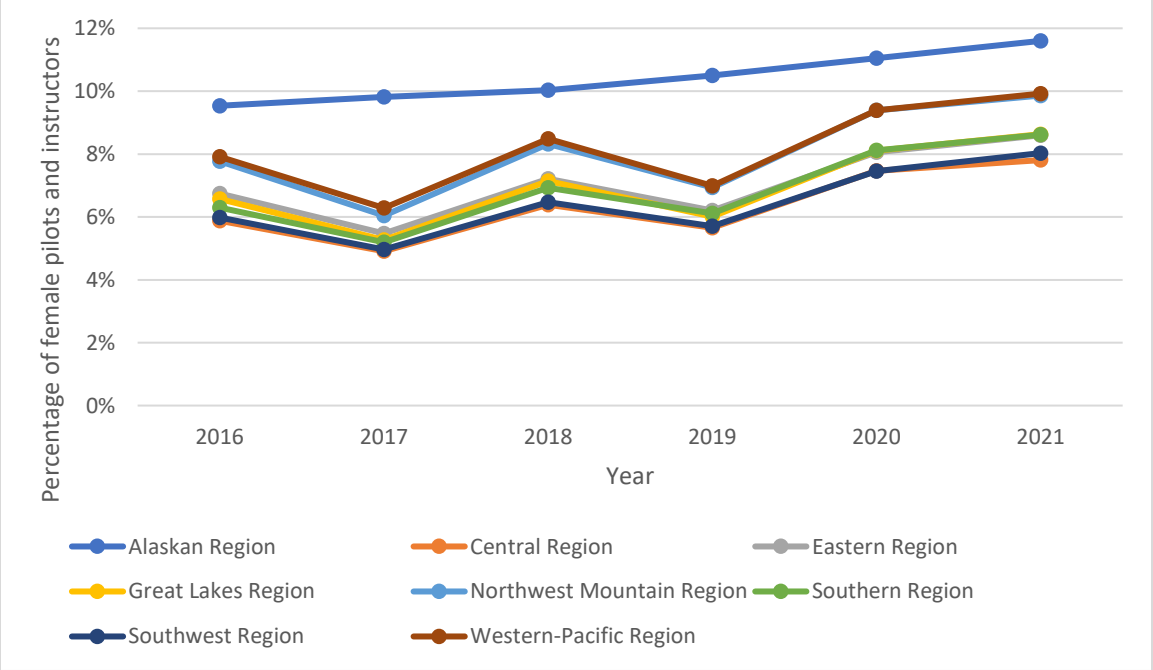

Figure 5

Percentage of Female Remote Pilots by Region and Year

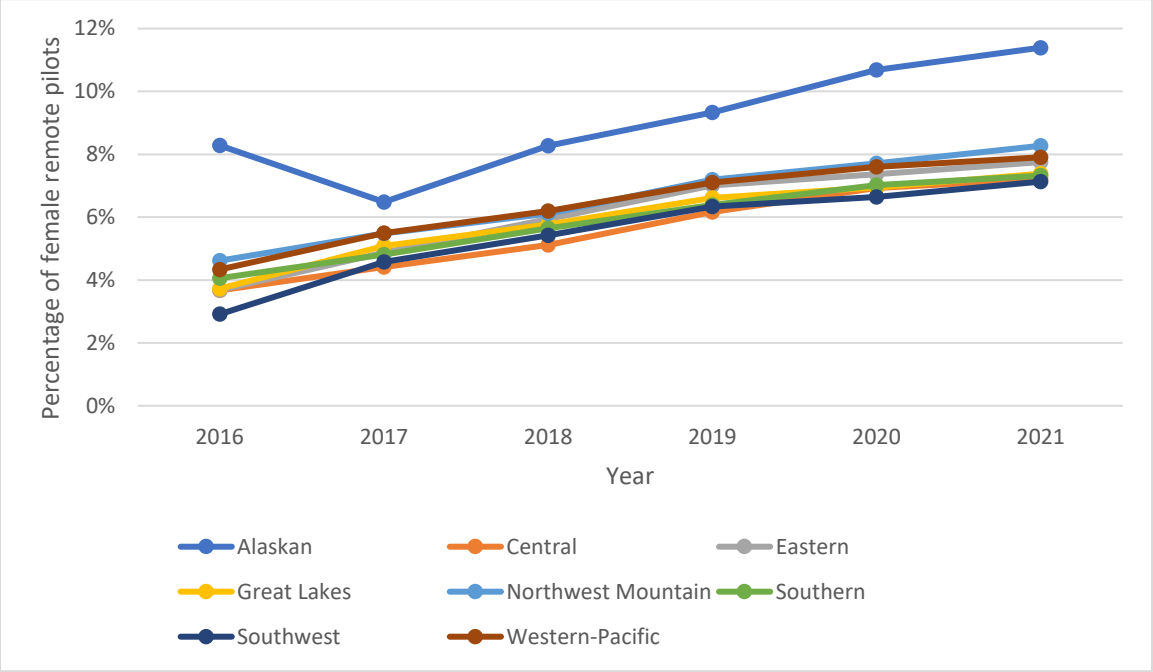

Figure 6(a)

Average Number of Male Pilots by Age Group (2016-2021)

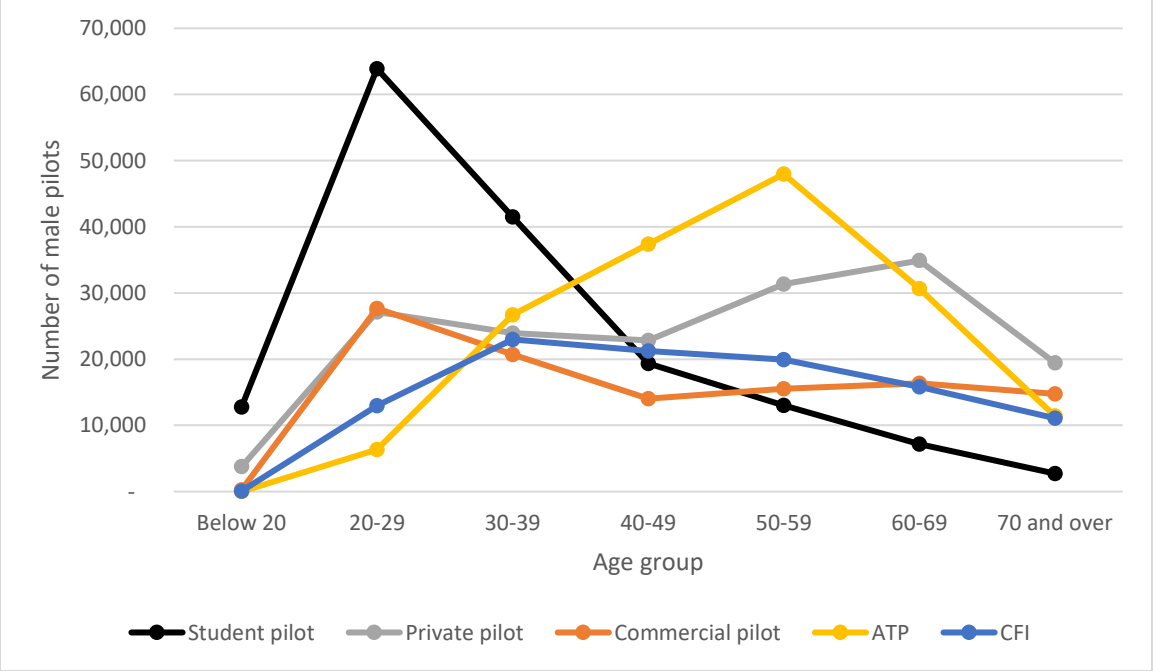

Figure 6(b)

Average Number of Female Pilots by Age Group (2016-2021)

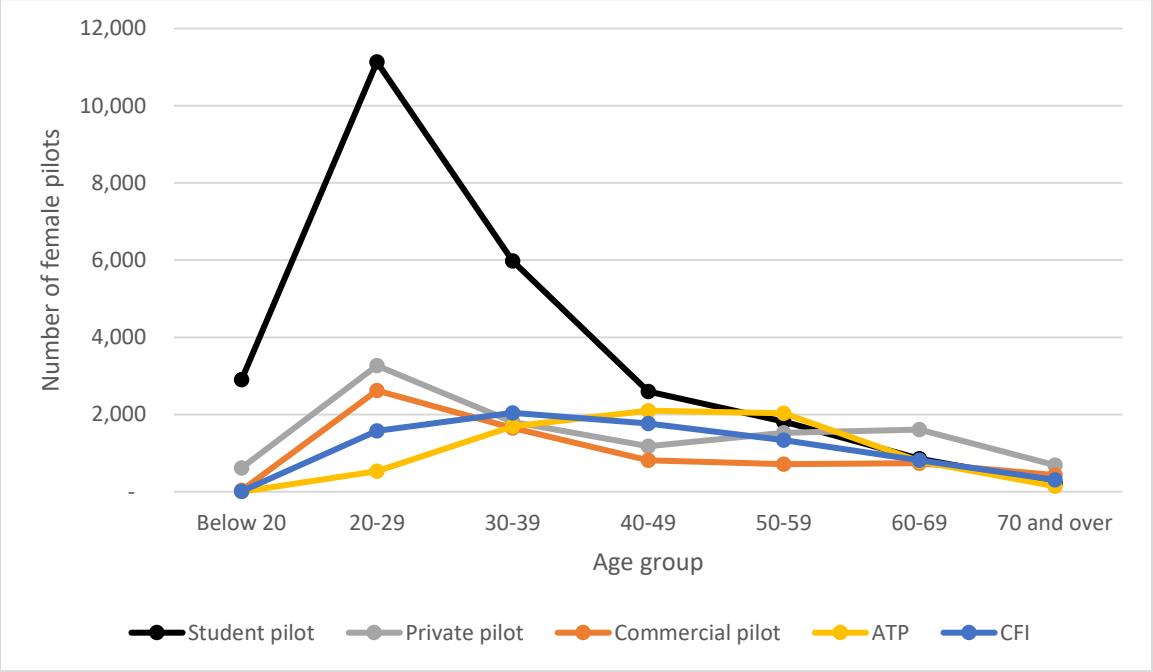

Figure 7

Average Percentage of Male and Female Pilots by Certificate Type and Age Group (2016-2021)

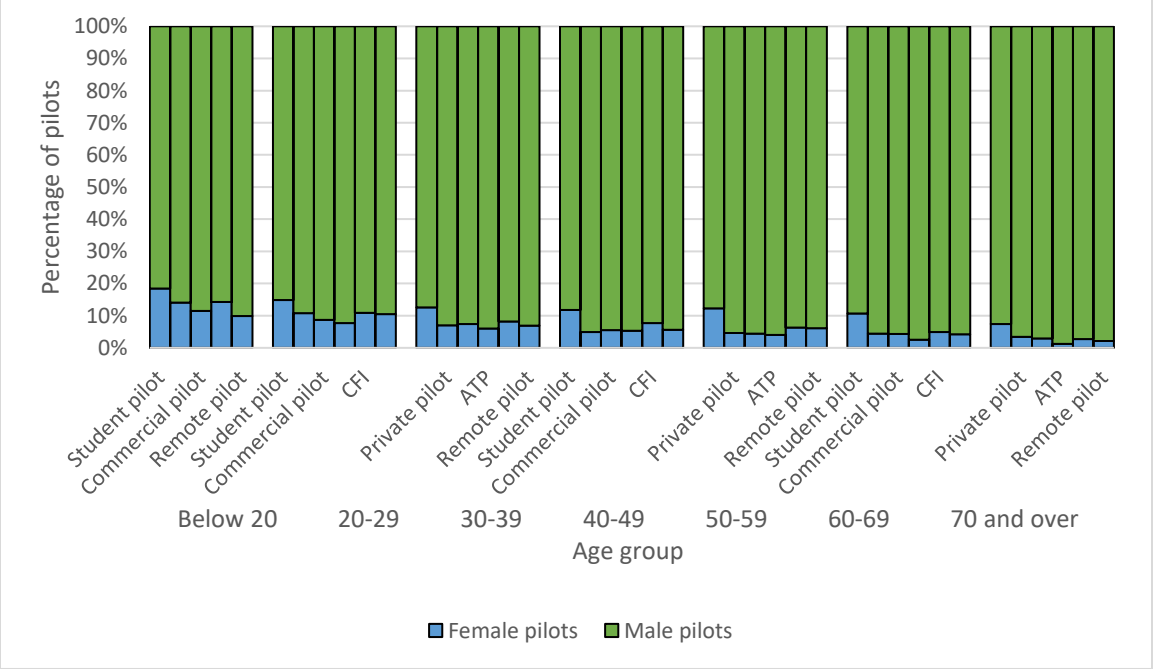

Figure 8(a)

Average Age of All Active Pilots

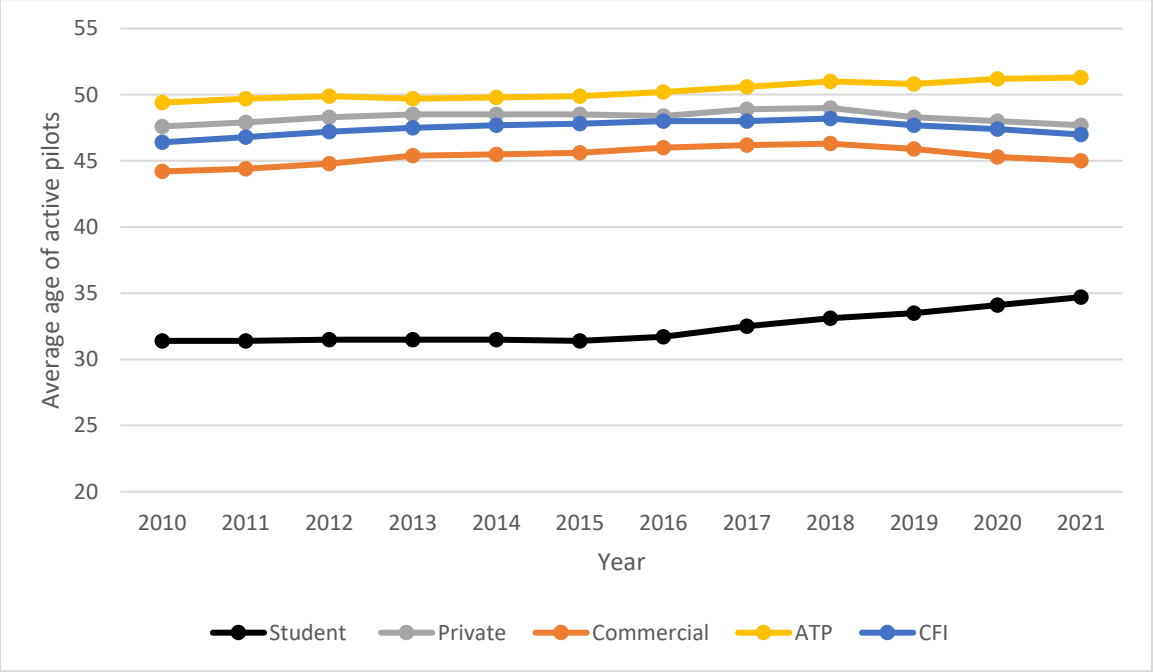

Figure 8(b)

Average Age of Active Female Pilots

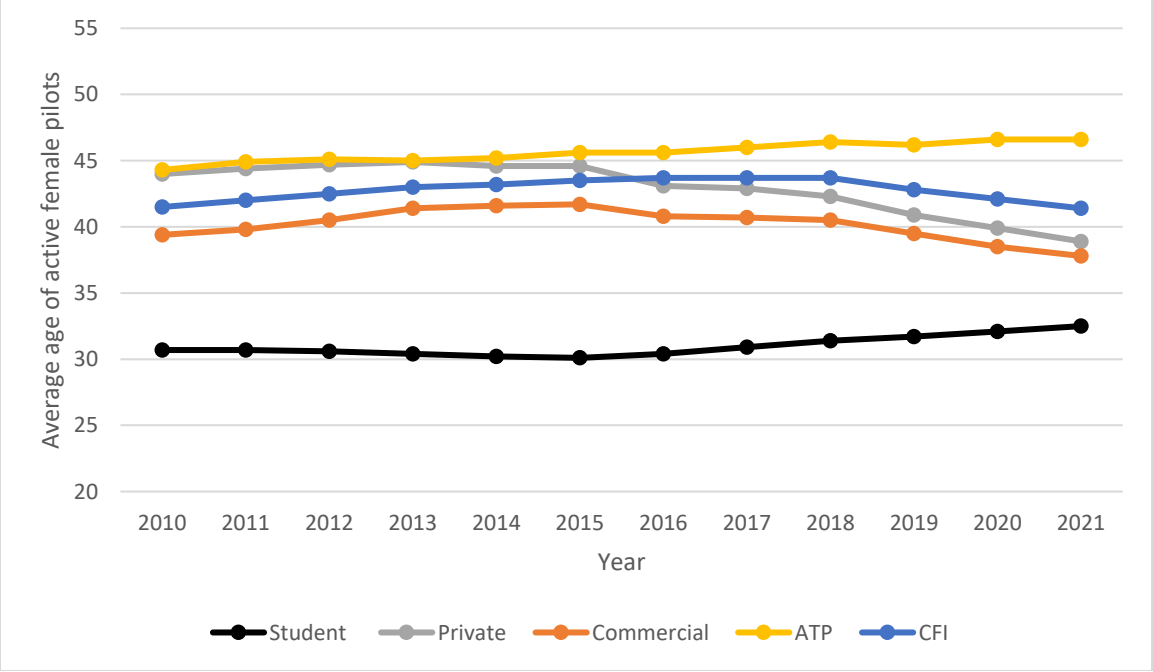

Figure 9

Average Number of Remote Pilots by Age Group (2016-2021)