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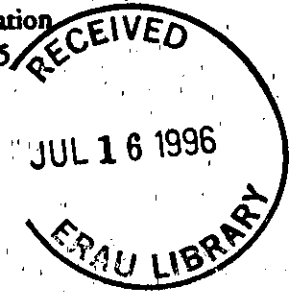
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Office of Aviation Medicine  
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# The Use of Contact Lenses in the Civil Airman Population

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| 15. Supplementary Notes<br>This work, performed under task AM-A-89-PHY-144, was initiated after a request by the National Research Council, Committee on Vision, to provide a briefing on the FAA's experience with contact lenses to the Committee's Working Group on Contact Lens Use in Adverse Environments. Dr. Nakagawara presented a paper to the Working Group at the University of California, Berkeley in March 1989.  |  |   |
| 16. Abstract<br>Federal Aviation Regulations permit the routine use of contact lenses by civilian pilots to satisfy the distant visual acuity requirements for obtaining medical certificates. Specific information identifying the prevalence of both defective distant vision and contact lenses in the civil airman population is required to guide future medical certification decisions, policy changes, and education safety programs to aviation personnel. A descriptive, retrospective epidemiologic study was performed of active airmen by 5-year intervals for a 20-year period (1967-1987) using FAA databases and publications. The percentage of airmen who use contact lenses quadrupled during the study period. When stratified by class of medical certificate and age, the prevalence rates for airmen with first-class medical certificates and older airmen showed the largest increases. The increasing use of contact lenses and the variety of design, materials, and applications which may be employed by the pilot population mandate ongoing review for adverse changes and safety consequences. |  |   |
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# THE USE OF CONTACT LENSES IN THE CIVIL AIRMAN POPULATION

## INTRODUCTION

The Federal Aviation Administration (FAA) and its predecessors have been responsible for the medical certification of all United States and some international civil airmen since 1927. All civilian pilots in the U.S. must maintain a current medical certificate of the appropriate class to validate any pilot's license they hold. Medical standards are contained in Part 67 of the Federal Aviation Regulations (FAR) (1). The FAA publishes a "Guide for Aviation Medical Examiners," which provides procedural guidelines for testing pilot applicants (2).

The classes of medical certificates for civilian pilots include:

- 1) First Class - Airline Transport Pilot,
- 2) Second Class - Commercial Pilot, Flight engineer, and Flight Navigator, and
- 3) Third Class - Private Pilot (2).

Prior to 1976, civilian airmen were not allowed to use contact lenses while flying unless a waiver had been issued by the FAA. If an applicant did not meet the medical standards for the certificate class applied for, a Statement of Demonstrated Ability (SODA) could be issued by the FAA (2). For example, if an applicant had no prior SODA for a failed vision standard, further consideration for a waiver by the FAA could be initiated by submitting a report of an eye evaluation (FAA Form 8500-7, "Report of Eye Evaluation") (2). After Amendment 67-10 to the FAR, effective on December 21, 1976, permitted the routine use of contact lenses to satisfy the distant visual acuity requirements of Part 67, the SODA process was eliminated in most instances. (Note: Distant visual acuity requirements for the different classes of medical certificates are found in Table 1.) (2).

Several epidemiologic studies have been performed by the FAA on the association of contact lenses to aviation accident risk. Dille and Booze in a 1975 study found the use of contact lenses had only marginal significance (i.e., significant at  $p < .10$ ) for increased accident rates (3). In a follow-up study of accident rates of civil airmen in 1976, use of contact lenses was associated with significantly (i.e., significant at  $p < .01$ ) more accidents (4). However, in a 1979 study of general aviation accident airmen, contact lens wearers had less than average accident experience (i.e., not significant at  $p < .10$ ) in contrast to previous studies (5). Therefore, evidence on the association of contact lens wear to aviation accident risk has been inconclusive.

Despite lack of conclusive accident risk, contact lens use merits constant vigilance by the FAA. Civil aviators may experience problems with contact lenses while flying, such as irritation while using full-face self-contained breathing apparatus or other protective devices; dislodged lenses while performing acrobatic maneuvers; visual performance decrement in aviation physiologic environments (e.g., hypoxia, hypobaria, low relative humidity); additional demands on accommodation inherent from contact lenses to presbyopic airmen; and compromised flight operations when using certain lens designs. Furthermore, according to a study by the Consumer Product Safety Commission, it was estimated that more than 30,000 injuries, including reports of contusions, foreign bodies, lacerations, etc., related to contact lens wear occurred in 1988 (6), implying inherent hazards of such devices.

To guide future medical certification decisions, FAA policy changes, and education safety programs to aviation personnel on contact lenses, current information on the use of such devices by pilots is essential. This report provides the results of a descriptive, retrospective epidemiologic study of active airmen, by 5-year intervals for the study period 1967-87 to identify the prevalence of both defective distant vision and contact lens use in the civil airman population.

## METHODS

The protocol for this study included the determination of three basic categories of data:

(1) Frequency of airmen with defective distance vision was extracted from the "Frequency of Restrictions Among Active Airmen by Class and Sex" Table in the Aeromedical Certification Statistical Handbook (AC 8500-1) (7), which is published annually by the Civil Aeromedical Institute's (CAMI) Aeromedical Certification Division. Totals for specified years (1967 -1976) were calculated by adding the following restriction categories:

- a) Must wear glasses for distance vision while flying;
- b) Must wear glasses for near and distance vision while flying;
- c) May wear contact lenses while flying; and
- d) May wear contact lenses while flying; glasses must be available.

Frequency of airmen with defective distant vision for the specified years (1977-1987) was calculated by adding the following restriction categories:

- a) Must have corrective lenses;
- b) Must have glasses for near and distance vision;
- c) Must wear lenses for distance vision and possess glasses for near vision; and
- d) Must wear corrective lenses; extra pair must be available.

(2) Airmen who use contact lenses (pathology code 161) to correct their distance vision was provided on computer printouts supplied by the Aeromedical Certification Division's Statistics and Records Branch. Staff members of the Aeromedical Research Division's Vision Research Section, extracted totals of airmen issued certificates with the FAA-specific pathology code 161 from these hard copy printouts. (Note: Prior to Amendment 67-10 to the FAR, airmen who wore contact lenses were assigned a pathology code (i.e., 161) to their medical certificate. This code elicited a waiver for certification by the FAA's Aeromedical Certification Division, Civil Aeromedical Institute in Oklahoma City, Oklahoma. However, despite the change in Part 67 of the FAR, this same pathology code is still assigned to the contact lens wearing medical certificate applicant, although it is no longer considered a pathology and will not elicit a denial for a certificate when contact lenses are needed to correct for distant vision (8). Unfortunately, because the submittal of FAA Form 8500-7 by the examining physician performing the physical is no longer required, important variables such as lens materials (polymethylmethacrylate, gas permeable, hydrophilic), designs, care systems, duration of wearing experience, past or present occurrences of contact lens-related problems, etc., are not normally available.

(3) Prevalence rates per/1000 airmen by both class and age in the total airman population were calculated using the population frequencies from the preceding year as the denominator. These frequencies, which were also extracted from the annual issues of the Aeromedical Certification Statistical Handbook, AC 8500-1, were considered most representative of the average population of the year of interest. (Note: The total frequencies of airmen in 1967 with pathology code 161 by class of medical certificate and by age were

unequal. All frequencies in other years of the study were equal for both variables. For completeness sake, the unequal frequencies in 1967 are presented.)

## RESULTS

On reviewing the civil airman with defective distant vision for the study period in 5-year intervals (Figure 1), the percentage of airmen with distant vision restrictions increased by 1.4 times during the study period (in 1967, pilots with defective distant vision constituted 25.66% of the total population; in 1987, that same group was 36.50% of the total population). On comparing prevalence rates of defective distant vision by class of medical certificate held (Figure 2), first-class airmen increased by 2.8 times (16.0/1000 airmen in 1967 to 45.2/1000 airmen in 1987); second-class airmen increased by 1.6 times (75.1/1000 airmen in 1967 to 116.9/1000 airmen in 1987); and third-class airmen increased by 1.2 times (165.6/1000 airmen in 1967 to 202.9/1000 airmen in 1987) during the study period.

On examining civil airman with pathology code 161 for the study period in 5-year intervals (Figure 3), the percentage of airmen that use contact lenses increased by 4.0 times during the study period (in 1967, pilots who wore contact lenses constituted .79% of the total population; in 1987, that same group was 3.13% of the total population). On comparing prevalence rates of pathology code 161 by class of medical certificate held (Figure 4), first-class increased by 29.5 times (.2/1000 airmen in 1967 to 5.9/1000 airmen in 1987); second-class airmen increased by 7.7 times (1.2/1000 airmen in 1967 to 9.2/1000 airmen in 1987); and third-class airmen increased by 2.5 times (6.5/1000 airmen in 1967 to 16.2/1000 airmen in 1987) during the study period.

On evaluating prevalence of pathology code 161 by age (Figure 5), airmen over 40 years of age increased by 6.4 times (4.0/1000 airmen in 1967 to 25.6/1000 airmen in 1987), while airmen under 40 years of age increased by 3.3 times (10.7/1000 airmen in 1967 to 35.7/1000 airmen in 1987) during the study period.

## DISCUSSION AND CONCLUSIONS

Contact lens use by civilian airmen has increased substantially over the study period. While the percentage of the total civil airman population with defective distant vision restrictions increased 1.4 times over the 20-year study period, the percentage of airmen with contact lenses increased 4 times over the same period. The prevalence rates for defective distant vision indicate that first-class airmen increased approximately twice as fast as for either second- or third-class during the study period. The prevalence rates for contact lens use indicate that first-class airmen increased usage by approximately 4 times as fast as second- or third-class airmen during the study period. Furthermore, the prevalence rates for contact lens use by age indicate airmen over 40 years of age increased usage approximately 2 times as fast as airmen under 40 years of age during the study period.

It is estimated that 54% of the United States' population, or 132 million people used some sort of vision corrective lenses in 1987. About 16% of these (approximately 21.5 million or about 8.8% of the total U.S. population) wore contact lenses to correct their vision (9). As of January 1, 1988, there were 685,552 active airmen of which some 48% (326,757) required lens correction for some visual deficiency (10), and approximately 37% (252,852) to correct defective distant vision. Although the prevalence of contact lenses used has increased in the civil airman population, the majority of airmen who require distance corrections in order to qualify for an airman medical certificate use eye glasses to satisfy their vision requirements. 3.13% of the civil airman population wore contact lenses in 1987, indicating

the percentage of contact lens wearers in that population is considerably less than the estimated 8.8% in the United States population.

The reduced percentage of corrective lens use in the active airman population (48%) compared to the U.S. population (54%) may be due to pre-screening of pilot applicants. However, the larger difference in use of contact lenses in the civil airman population compared to the U.S. population may be explained by a number of factors, including:

1) A bias by airmen as a result of past problems in obtaining waivers to fly with contact lenses;

2) Aging (>50 years of age: 9.50% in 1966; 16.98% in 1976; and 21.67% in 1986) of the airman population (11) (Note: It has been estimated that 80% of the contact lens wearers are between the ages of 18 and 44 (12).);

3) The higher frequency of males in the airman population (15.53:1 ratio of males:females in 1986 (11) (Note: A Food and Drug Administration survey of U.S. contact lens wearers estimated that females wear 68% of all contact lenses (12).);

4) The restriction of contact lenses to correct distant vision only; and

5) The incompatibility of contact lenses with certain flight activities.

In conclusion, although a small percentage of the total airman population, contact lens wearers are increasing in prevalence. The faster increase in contact lens use observed in professional pilots (first-class) compared to general aviation pilots (third-class) is contrary to standard pathology code prevalence in the civil airman population (13), while the faster increase in contact lens use observed in the older age pilot category (>40 years) compared to younger pilots is contrary to the normal pattern of use in the U.S. population. These trends may indicate that airmen using contact lenses are generally satisfied with their vision performance even within the more demanding flight conditions of air transport and continue to employ them, even with the additional demands on accommodation inherent from contact lenses to presbyopic airmen. The increased use of contact lenses in the pilot population mandates ongoing aeromedical certification review, especially with the variety of designs, materials, and applications in flight to ensure the continued safe use of such devices by airmen in the national airspace system.

## REFERENCES

1. Code of Federal Regulations. Title 14, Part 67. 1988.
2. Guide for aviation medical examiners. Federal Aviation Administration, Office of Aviation Medicine. 1981.
3. Dille JR, Booze CF Jr. The 1975 accident experience of civilian pilots with static physical defects. 1977. FAA Office of Aviation Medicine Report No. FAA-AM-77-20.
4. Dille JR, Booze CF Jr. The 1976 accident experience of civilian pilots with static physical defects. 1979. FAA Office of Aviation Medicine Report No. FAA-AM-79-19.
5. Dille JR, Booze CF Jr. The prevalence of visual deficiencies among 1979 general aviation accident airmen. 1981. FAA Office of Aviation Medicine Report No. FAA-AM-81-14.
6. United States Consumer Product Safety Commission, Directorate for Epidemiology. National Injury Information Clearinghouse. Product-Calendar Year 1988-Estimates Report. Washington, D.C. 1989.
7. Aeromedical certification statistical handbook. Federal Aviation Administration, Office of Aviation Medicine. 1967-87. AC 8500-1.
8. Aeromedical certification systems manual. Federal Aviation Administration, Office of Aviation Medicine. 1984.
9. Bennett I. State of the ophthalmic industry. New York City, NY: Advisory Enterprises, 1988.
10. Booze CF Jr. Prevalence of disease among active civil airmen. 1988. FAA Office of Aviation Medicine Report No. FAA-AM-89-2.
11. Nakagawara VB. The relevance of vision defects in the medical certification of civilian airman. In: Goss DA, Edmondson LL, eds. Proceedings of the 1988 Northeastern State University Symposium on Theoretical and Clinical Optometry. March 25, 1988. Tahlequah, OK, 1988; 59-71.
12. Herman CL. An FDA survey of U.S. contact lens wearers. *Contact Lens Spectrum*. 2(7):89-92, 1987.
13. Booze CF Jr. Prevalence of selected pathology among currently certified active airman. 1981. FAA Office of Aviation Medicine Report No. FAA-AM-81-9.



**TABLE 1**

**Distant Visual Acuity Requirements  
For Civilian Pilots**

|  |   |
|--|---|
| <b>First-Class<br/>(Airline Transport)<br/>Second-Class<br/>(Commercial)</b> | 20/20 in each eye separately without correction or at least 20/200 in each eye separately corrected to 20/20 or better with corrective lenses (glasses or contact lenses) |
| <b>Third-Class<br/>(Private)</b>   | At least 20/50 without correction; or if vision is poorer than 20/50, must correct to 20/30 or better with corrective lenses (glasses or contact lenses)                  |

*(From Guide for Aviation Medical Examiners)*

**FIGURE 1**

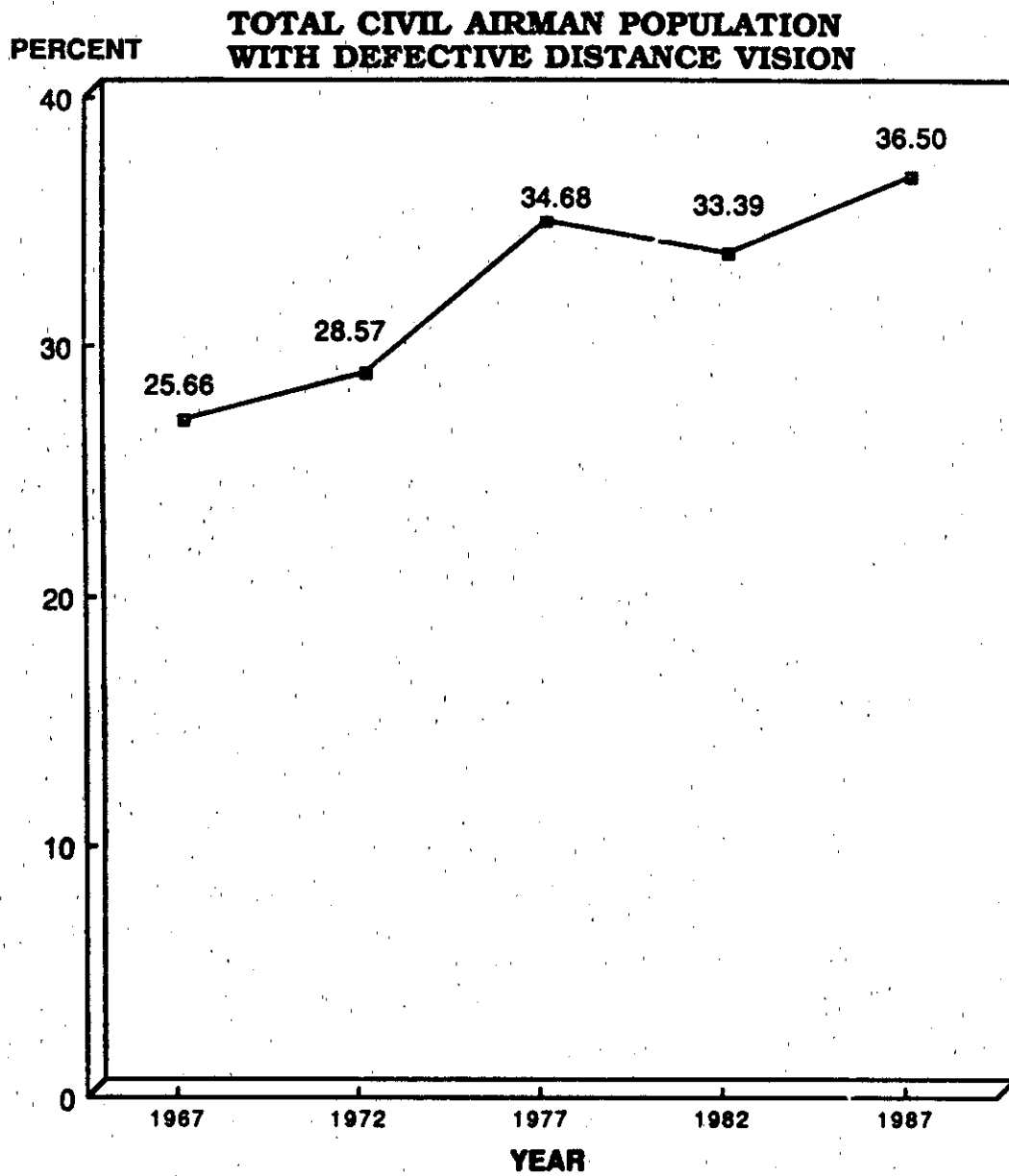
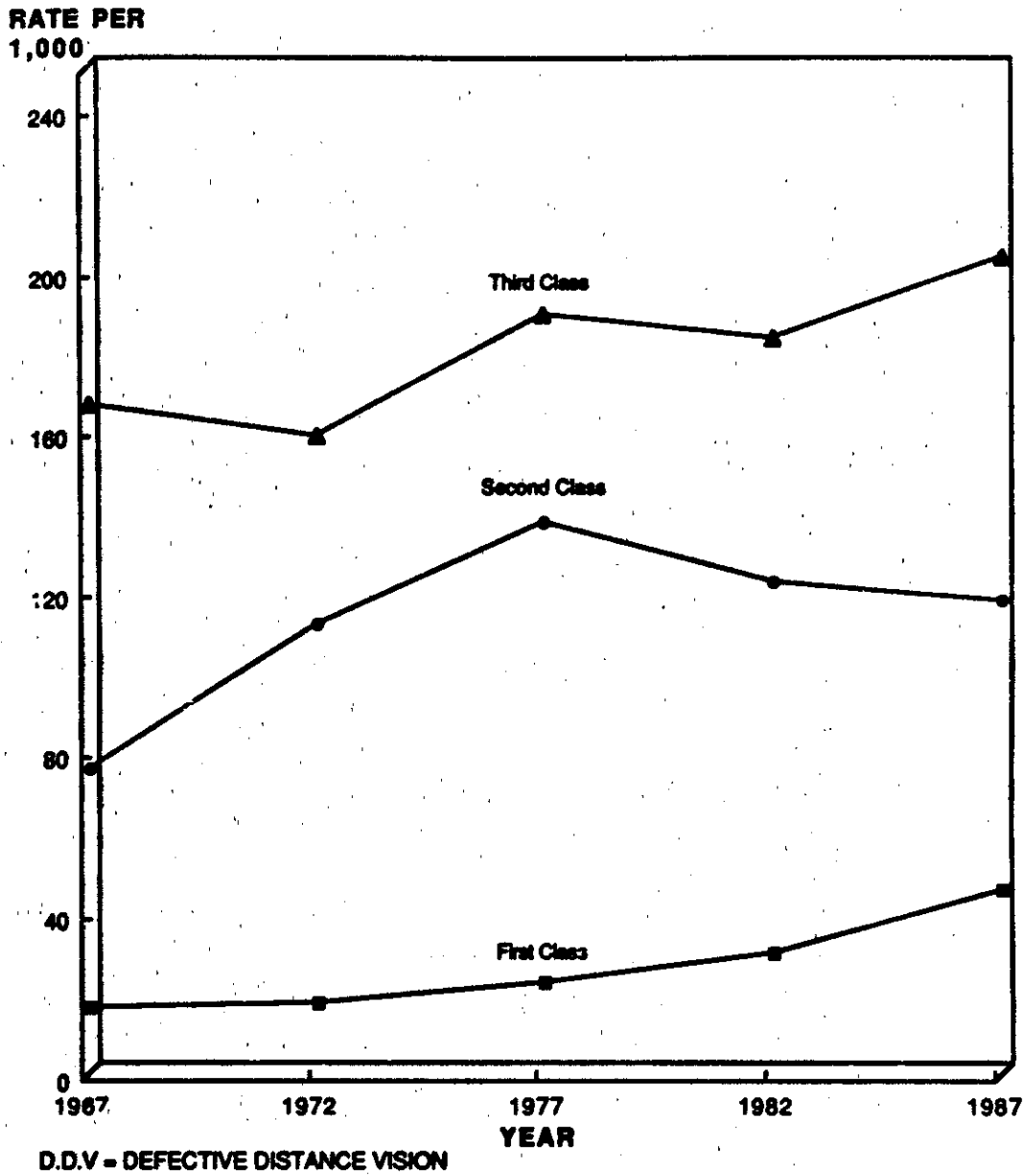


FIGURE 2

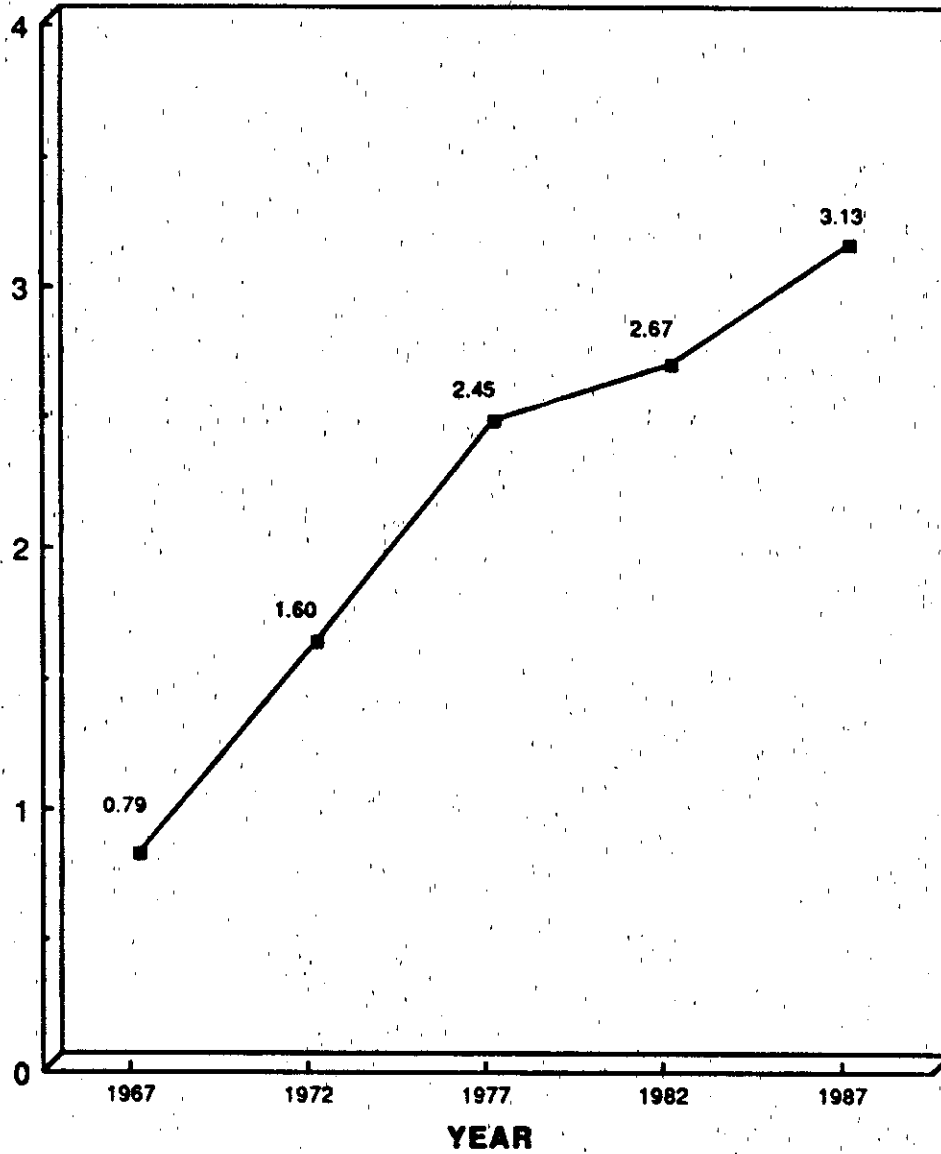
PREVALENCE OF D.D.V./1000 AIRMEN BY CLASS



**FIGURE 3**

**TOTAL CIVIL AIRMAN POPULATION  
WITH PATHOLOGY CODE 161**

**PERCENT**



Path Code 161 = Contact Lenses

FIGURE 4

PREVALENCE OF PATH. CODE 161/1000 AIRMEN BY CLASS

RATE PER  
1,000

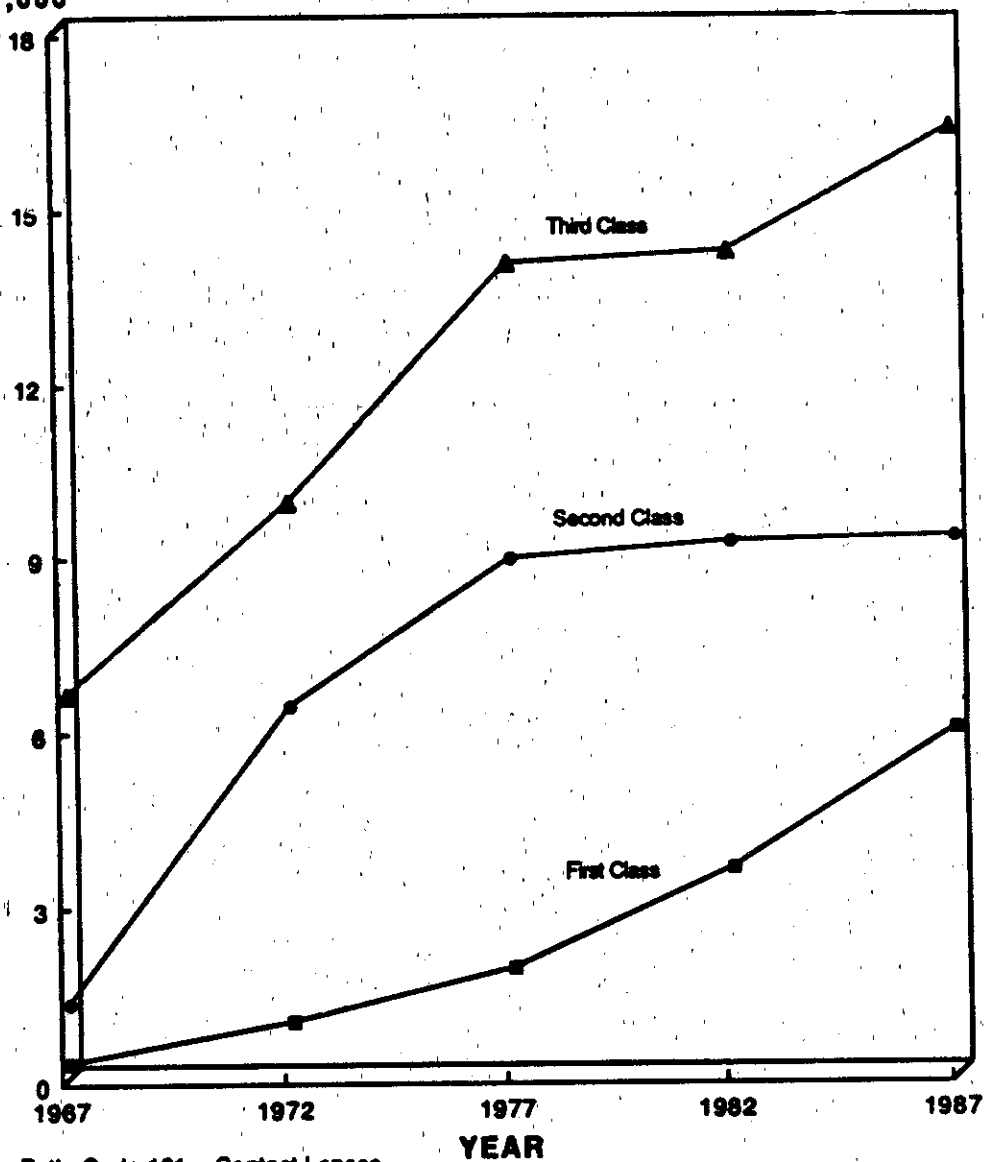
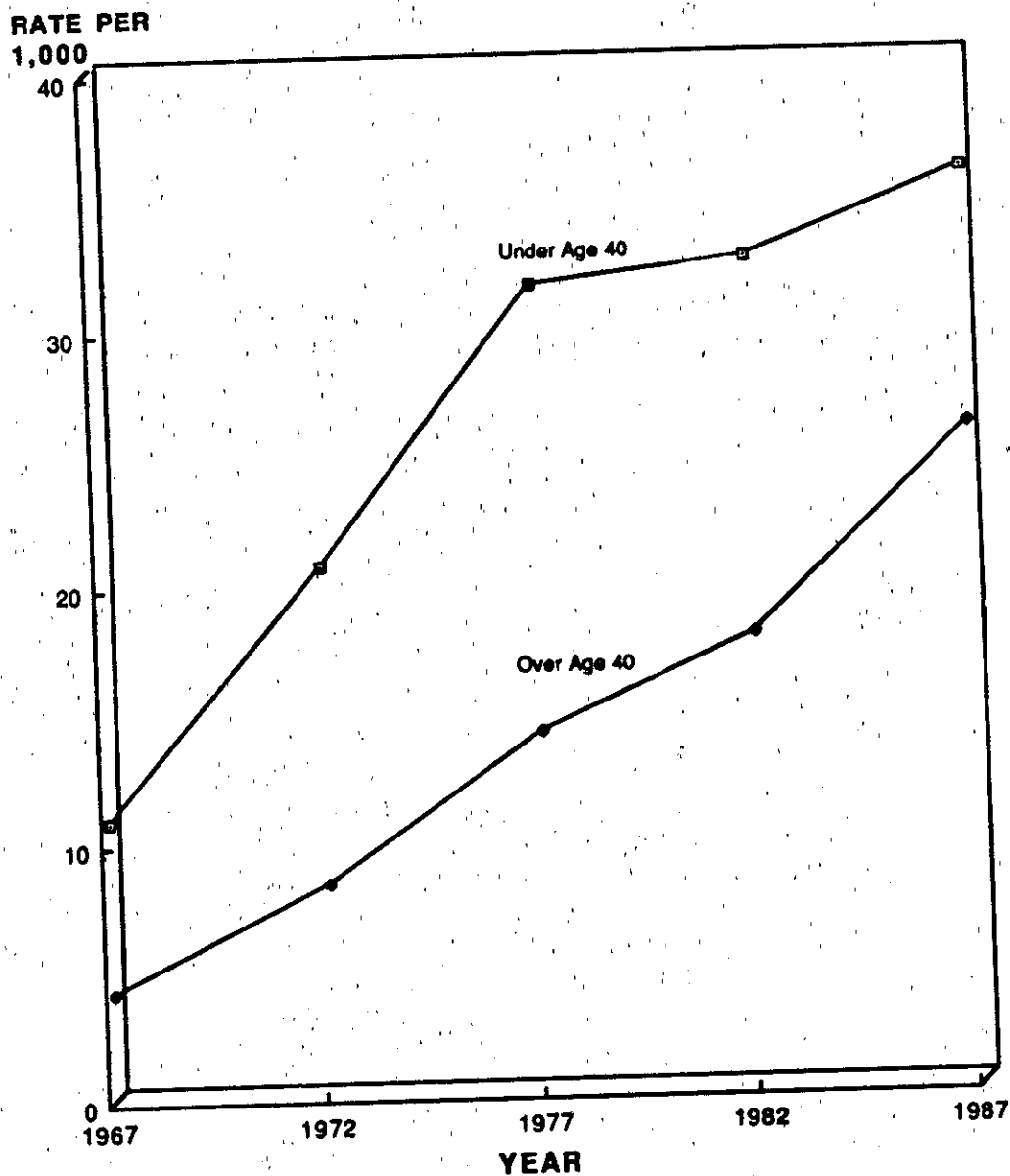


FIGURE 5

PREVALENCE OF PATH. CODE 161/1000 AIRMEN BY AGE



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