

## Epidemiology of Uncorrected Refractive Errors and Associated Risk Factors Among Military Personnel and Civilians at Lanud Sutan Sjarir Padang

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### Abstract

**Introduction:** Uncorrected refractive errors (URE) and presbyopia contribute significantly to avoidable visual impairment. **Objective:** This study assessed refractive disorders, URE, presbyopia, and associated demographic risk factors among screening participants at Lanud Sutan Sjarir Padang. **Method:** A cross-sectional study involving 1,098 participants used visual acuity testing, autorefraction, subjective refraction, and near vision assessments. Risk factors were analyzed using multivariable logistic regression. **Results and Discussion:** Refractive disorders affected 37.52% of participants, including myopia (24.41%), astigmatism (9.47%), and hyperopia (3.64%). URE prevalence was 18.21%, while presbyopia affected 33.52%. Military personnel had lower URE prevalence than civilians. Independent risk factors included age ( $aOR = 2.84$ ; 95% CI: 2.15–3.75), civilian status ( $aOR = 1.58$ ; 95% CI: 1.21–2.06), and female sex ( $aOR = 1.32$ ; 95% CI: 1.02–1.71). **Conclusion:** Routine eye screening should prioritize civilians and older adults, although findings may not represent the entire air base community.

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### **Introduction**

Uncorrected refractive errors (URE) and presbyopia represent a major global public health challenge, constituting the primary cause of distance and near visual impairment worldwide (Bourne et al., 2021; Steinmetz et al., 2021). The World Health Organization (WHO) estimates that globally at least 2.2 billion people have a vision impairment, with over 1 billion cases remaining preventable or unaddressed due to lack of basic spectacle correction (World Health Organization, 2020). According to reports from the Vision Loss Expert Group and the Global Burden of Disease (GBD) study, uncorrected refractive errors account for significant economic productivity losses and reduced quality of life, despite being easily remediable through low-cost refractive interventions (Flaxman et al., 2020; GBD 2019 Blindness and Vision Impairment Collaborators, 2021).

The epidemiological landscape of refractive errors displays substantial geographic variation, with Asia-Pacific and Southeast Asian regions exhibiting some of the highest burdens of myopia and refractive anomalies globally (Morgan et al., 2021). In Indonesia, national eye health strategy plans continue to prioritize uncorrected refractive errors as a major contributor to avoidable visual impairment across both urban and rural communities (Ministry of Health Republic of Indonesia, 2020). Population-based and clinic-based surveys in various Indonesian centers demonstrate a high proportion of uncorrected refractive anomalies and presbyopia, particularly affecting older age groups, females, and specific occupational cohorts (Dana, 2020; Sriyanti et al., 2023). At the regional level in Padang, West Sumatra, observational evidence confirms that refractive disorders account for a predominant share of ocular morbidity (Dzul kifli et al., 2024; Fitria et al., 2023).

Understanding the demographic factors associated with refractive errors and presbyopia is crucial for designing targeted public health strategies. Age is well-established as the primary non-modifiable determinant for presbyopia due to the progressive loss of crystalline lens accommodation, while also influencing shifts in spherical equivalent refractive status across adulthood (Fricke et al., 2020). Additionally, biological sex disparities and occupational background play important roles in influencing healthcare-seeking behavior, access to optical correction, and the overall burden of uncorrected refractive errors (Naidoo et al., 2019). Military air force base environments represent a specialized socio-demographic micro-community comprising active-duty military personnel and coexisting civilian residents (civilian employees and military dependents). When examining military populations, a key epidemiological consideration is the "healthy worker effect" (or healthy soldier selection effect). Active military personnel are subjected to strict visual acuity standards during initial recruitment screening and are maintained through mandatory periodic health examinations (*Pemeriksaan Kesehatan Berkala / Rikkes*) (Bower et al., 2021). This systematic selection bias inherently selects individuals with superior baseline visual health and ensures ongoing optical correction compared to the general civilian population. Conversely, civilian residents residing within the same air base ecosystem do not undergo mandatory vision screening and may exhibit different healthcare-seeking patterns, leading to a potentially higher burden of uncorrected visual conditions.

Although visual standards are strictly enforced in active military cohorts, empirical data comparing the prevalence of uncorrected refractive errors, presbyopia, and key demographic risk factors (age, gender, and military vs. civilian status) within Indonesian military air base communities remain scarce. Addressing this gap is essential to tailor

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ocular health services and screening outreach. Therefore, this study aims to investigate the prevalence of refractive disorders and uncorrected refractive errors based on visual acuity, as well as presbyopia, while identifying associated demographic risk factors (age, gender, and population status) among military personnel and civilians participating in a visual screening program at Lanud Sutan Sjahrir Padang.

### **Method**

This study employed a quantitative, observational, cross-sectional design to investigate the prevalence of uncorrected refractive errors (URE) and presbyopia and their associated demographic factors among military personnel and civilian residents at Lanud Sutan Sjahrir Padang, West Sumatra, Indonesia. This design enabled the simultaneous assessment of demographic factors and visual outcomes (Kelsey et al., 2020). Participants were recruited through total sampling during a visual health screening program. Inclusion criteria were military personnel or civilian residents aged  $\geq 18$  years who consented to complete optometric examinations. Individuals with ocular media opacities affecting refraction, previous major ocular trauma or intraocular surgery, or incomplete records were excluded.

Data were collected by qualified eye care professionals using standardized procedures. Demographic information included age, gender, and military or civilian status. Distance uncorrected visual acuity (UCVA) was assessed monocularly at 6 meters using a Snellen chart, followed by automated and subjective refraction to determine best-corrected visual acuity (BCVA). Myopia was defined as spherical equivalent (SE)  $\leq -0.50$  D, hyperopia as SE  $\geq +0.50$  D, and astigmatism as cylindrical power  $\leq -0.50$  D. URE was defined as UCVA  $< 6/18$  in the better eye, improving to  $\geq 6/18$  after correction (World Health Organization, 2020). Near vision was assessed binocularly at 40 cm using a Jaeger chart. Presbyopia was diagnosed in participants aged  $\geq 40$  years with near visual acuity worse than N6/J1 that improved to N6/J1 with convex lens correction (Fricke et al., 2020).

Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics summarized participant characteristics and the prevalence of refractive conditions with 95% confidence intervals (CIs). Chi-square tests assessed associations between demographic factors and visual disorders, while multivariable binary logistic regression estimated adjusted odds ratios (aORs) with 95% CIs. Statistical significance was set at  $p < 0.05$ . The study followed the Declaration of Helsinki, obtained approval from the Health Research Ethics Committee, secured written informed consent, and maintained participant confidentiality.

### **Result and Discussion**

#### **1. Result**

##### **Demographic Characteristics of Participants**

A total of 1,098 valid participants completed the visual health screening at Lanud Sutan Sjahrir Padang. The study population was categorized into active military personnel and civilian residents. Continuous numerical variables of demographic characteristics and baseline physical parameters are summarized in Table 1, formatted in accordance with the journal requirements.

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**Table 1**  
Characteristics of the Respondents

| No | Variable                            | Median | Standard Deviation (SD) | Min   | Max   |
|----|-------------------------------------|--------|-------------------------|-------|-------|
| 1  | Age (years)                         | 36.50  | 11.42                   | 18    | 68    |
| 2  | Distance UCVA Right Eye (LogMAR)    | 0.10   | 0.28                    | 0.00  | 1.30  |
| 3  | Distance UCVA Left Eye (LogMAR)     | 0.10   | 0.29                    | 0.00  | 1.30  |
| 4  | Spherical Equivalent (Diopters)     | -0.25  | 1.15                    | -6.00 | +3.50 |
| 5  | Cylindrical Power (Diopters)        | -0.25  | 0.62                    | -3.50 | 0.00  |
| 6  | Near Addition Lens Power (Diopters) | +1.50  | 0.58                    | +1.00 | +3.00 |

Table 1 presents the baseline demographic characteristics and continuous physical parameters of the 1,098 study participants, showing a median age of 36.50 years (SD = 11.42; range: 18–68 years). Visual acuity and refractive measurements revealed median distance uncorrected visual acuity (UCVA) values of 0.10 LogMAR in both eyes (SD = 0.28 for the right eye, SD = 0.29 for the left eye), with spherical equivalent values demonstrating a median of -0.25 Diopters (SD = 1.15; range: -6.00 to +3.50 D) and a median cylindrical power of -0.25 Diopters (SD = 0.62; range: -3.50 to 0.00 D). Among presbyopic participants requiring accommodation support, the near addition lens power showed a median of +1.50 Diopters (SD = 0.58; range: +1.00 to +3.00 D).

**Prevalence of Refractive Disorders vs. Prevalence of URE Based on Visual Acuity**

To provide a clear distinction between underlying optical refractive conditions and actionable visual impairment, outcomes were evaluated under two distinct diagnostic definitions:

- 1) Prevalence of Refractive Disorders (Refractive Status via Objective & Subjective Refraction):** Out of 1,098 examined participants, 62.48% (n = 686; 95% CI: 59.6–65.3%) were classified as emmetropic. Overall refractive disorders (myopia, astigmatism, or hyperopia) were present in 37.52% (n = 412) of participants. Myopia was the predominant refractive disorder affecting 24.41% (n = 268; 95% CI: 21.9–27.1%), followed by astigmatism at 9.47% (n = 104; 95% CI: 7.8–11.3%), and hyperopia at 3.64% (n = 40; 95% CI: 2.6–4.9%). Separately, presbyopia (near vision accommodation impairment) was present in 33.52% (n = 368; 95% CI: 30.7–36.4%) of the overall population (and 79.31% among those aged  $\geq 40$  years).

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### 2) Prevalence of Uncorrected Refractive Errors (URE) Based on Visual Acuity

**Table 2**  
Prevalence and Categorical Distribution of Refractive Anomalies and Population Status

| Variable                | Sub-category                    | Frequency (n) | Percentage (%) | 95% CI (%)  |
|-------------------------|---------------------------------|---------------|----------------|-------------|
| Population Status       | Military Personnel              | 486           | 44.26          | 41.3 – 47.2 |
|                         | Civilian Residents              | 612           | 55.74          | 52.8 – 58.7 |
| Gender                  | Male                            | 642           | 58.47          | 55.5 – 61.4 |
|                         | Female                          | 456           | 41.53          | 38.6 – 44.5 |
| Age Group               | 18–39 years                     | 634           | 57.74          | 54.8 – 60.7 |
|                         | ≥ 40 years                      | 464           | 42.26          | 39.3 – 45.2 |
| Refractive Error Status | Emmetropia                      | 686           | 62.48          | 59.6 – 65.3 |
|                         | Myopia ( $\leq 0.50$ D)         | 268           | 24.41          | 21.9 – 27.1 |
|                         | Astigmatism (Cyl $\leq 0.50$ D) | 104           | 9.47           | 7.8 – 11.3  |
|                         | Hyperopia ( $\geq 0.50$ D)      | 40            | 3.64           | 2.6 – 4.9   |
| Presbyopia Status       | Present                         | 368           | 33.52          | 30.7 – 36.4 |
|                         | Absent                          | 730           | 66.48          | 63.6 – 69.3 |

Table 2 presents the prevalence and demographic distribution of refractive anomalies among the 1,098 study participants. Civilian residents comprised the majority of the population (55.74%,  $n = 612$ ; 95% CI: 52.8–58.7%), while active military personnel accounted for 44.26% ( $n = 486$ ; 95% CI: 41.3–47.2%). Males constituted 58.47% ( $n = 642$ ; 95% CI: 55.5–61.4%) of the sample, and participants aged 18–39 years formed the predominant age group (57.74%,  $n = 634$ ; 95% CI: 54.8–60.7%). Regarding ocular refractive status, 62.48% ( $n = 686$ ; 95% CI: 59.6–65.3%) were emmetropic. Among distance refractive errors, myopia was the most common anomaly, affecting 24.41% ( $n = 268$ ; 95% CI: 21.9–27.1%) of participants, followed by astigmatism at 9.47% ( $n = 104$ ; 95% CI: 7.8–11.3%) and hyperopia at 3.64% ( $n = 40$ ; 95% CI: 2.6–4.9%). Additionally, presbyopia was present in approximately one-third of the overall cohort (33.52%,  $n = 368$ ; 95% CI: 30.7–36.4%).

### Proportional Trends Across Population Groups

The breakdown of refractive errors between military personnel and civilian populations showed a noticeable trend. Civilian residents demonstrated a higher proportion of uncorrected refractive errors compared to active military personnel. The distribution of specific refractive conditions by population sector is illustrated in Diagram.

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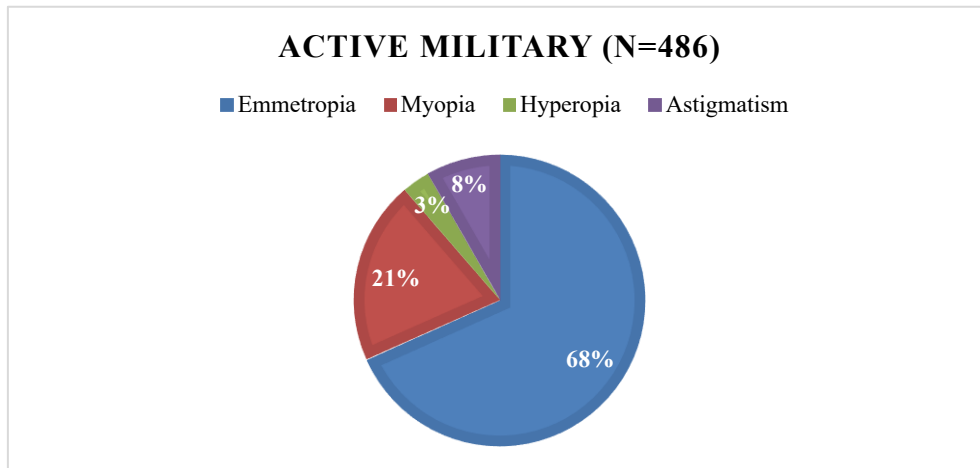


**Diagram 1.** Distribution of refractive status between active military personnel at Lanud Sutan Sjahrir Padang.

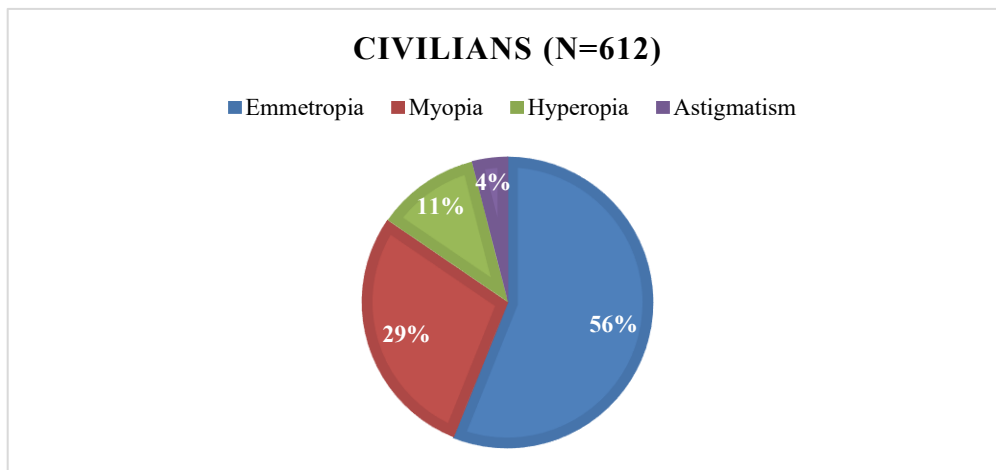


**Diagram 2.** Distribution of refractive status between civilian residents at Lanud Sutan Sjahrir Padang.

**Bivariate and Multivariable Risk Factor Analysis**

**Table 3**

Multivariable Binary Logistic Regression Analysis of Risk Factors for Uncorrected Refractive Errors

| Risk Factor Variable | Comparison Category             | Adjusted Odds Ratio (aOR) | 95% Confidence Interval (CI) | p-value |
|----------------------|---------------------------------|---------------------------|------------------------------|---------|
| Age Group            | ≥ 40 years vs. 18-39 years      | 2.84                      | 2.15 – 3.75                  | < 0.001 |
| Population Group     | Civilian vs. Military Personnel | 1.58                      | 1.21 – 2.06                  | < 0.001 |
| Gender               | Female vs. Male                 | 1.32                      | 1.02 – 1.71                  | 0.035   |

Multivariable binary logistic regression analysis revealed three independent demographic risk factors significantly associated with uncorrected refractive errors among respondents. Individuals aged  $\geq 40$  years demonstrated the strongest association,

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exhibiting nearly three times higher odds of presenting with uncorrected refractive errors compared to those aged 18–39 years (aOR = 2.84; 95% CI: 2.15-3.75;  $p < 0.001$ ). Population status also served as a significant predictor, where civilian residents had a 58% higher likelihood of uncorrected refractive conditions relative to active military personnel (aOR = 1.58; 95% CI: 1.21-2.06;  $p < 0.001$ ). Additionally, female gender was independently associated with an increased risk, with females showing 1.32 times higher odds of having uncorrected refractive errors than males (aOR = 1.32; 95% CI: 1.02-1.71;  $p = 0.035$ ).

### **2. Discussion**

Uncorrected refractive errors (URE) and presbyopia remain significant yet largely preventable public health challenges that impair visual clarity and overall quality of life (Bourne et al., 2021; World Health Organization, 2020). This study provides a comprehensive epidemiological evaluation of refractive disorders and URE within a specialized micro-community: a military air base setting comprising active-duty military personnel and coexisting civilian residents at Lanud Sutan Sjahrir Padang. By analyzing a validated cohort of 1,098 respondents, the findings reveal a prevalence of distance refractive disorders of 37.52%, a visual acuity-based URE prevalence of 18.21%, and a presbyopia prevalence of 33.52%, while demonstrating that age, civilian population status, and female gender serve as independent demographic risk factors.

### **Epidemiology and Pattern of Refractive Disorders**

The distance refractive profile observed in this study demonstrates that myopia is the predominant refractive anomaly (24.41%), followed by astigmatism (9.47%) and hyperopia (3.64%), while 62.48% of the cohort presented with emmetropia. The substantial burden of myopia aligns with global and regional epidemiological trends highlighting a persistent shift toward higher myopia prevalence, particularly across East and Southeast Asian populations (Morgan et al., 2021).

The clinical dominance of myopia over hyperopia in this community context reflects the age demographic structures of the screening cohort. In young adults aged 18–39 years (who constituted 57.74% of our sample), myopia accounts for the majority of refractive corrections. Conversely, the lower prevalence of hyperopia (3.64%) in this cohort is consistent with global population-based patterns, where hyperopic refractions are primarily observed in young pediatric populations prior to emmetropization or in elderly cohorts experiencing age-related lenticular shifts (Flaxman et al., 2020; Steinmetz et al., 2021). Astigmatism was identified in 9.47% of participants. Astigmatic errors arise predominantly from corneal toricity, where asymmetric curvature along different meridians prevents a single focal point on the retina. When uncorrected, even mild astigmatism ( $\geq 0.50$  D) induces significant asthenopic symptoms and visual fatigue (Bower et al., 2021; Modenese et al., 2021).

### **Presbyopia and Age-Related Accommodative Decline**

Presbyopia affected 33.52% ( $n = 368$ ) of the total sample, representing a major cause of unaddressed near visual impairment among individuals aged  $\geq 40$  years. The multivariable logistic regression analysis established age  $\geq 40$  years as the most potent independent risk factor for uncorrected distance refractive errors (aOR = 2.84; 95% CI:

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2.15-3.75;  $p < 0.001$ ), while near addition requirements strictly correlated with advancing age, exhibiting a median addition power of  $+1.50 \pm 0.58$  D.

The physiological onset of presbyopia is an inevitable, non-modifiable aging process characterized by the progressive loss of crystalline lens elasticity and sclerosis of the lenticular nucleus, accompanied by a decline in ciliary muscle contractile efficiency (Fricke et al., 2020). As the amplitude of accommodation decreases below the threshold required for comfortable near focusing ( $< 3.00$  Diopters), individuals experience transient blurred near vision, delayed accommodation convergence, and severe visual strain during prolonged reading or fine visual tasks (Fricke et al., 2020; World Health Organization, 2020). In low and middle-income settings, uncorrected presbyopia often remains unaddressed due to a lack of awareness, assuming near vision loss is an untreatable natural symptom of aging rather than a simple optical deficit correctable with near addition lenses (Fricke et al., 2020; Naidoo et al., 2019). The high burden of presbyopia observed among adults aged  $\geq 40$  years in this study underscores an urgent need to integrate routine near vision screenings and accessible presbyopic spectacle distribution into primary healthcare and military occupational health surveillance

### **The Healthy Worker / Selection Effect in Military Personnel**

A pivotal finding of this study is the significant disparity in both refractive error prevalence and uncorrected refractive error (URE) burden between active military personnel and civilian residents. Active military status was associated with significantly lower odds of presenting with URE (aOR = 1.58 for civilians relative to military;  $p < 0.001$ ). This disparity strongly reflects the healthy worker effect (or healthy soldier selection effect) well-documented in military occupational epidemiology (Bower et al., 2021). Active military personnel undergo rigorous pre-employment physical selection screenings where strict entry standards for uncorrected and corrected visual acuity are enforced. Individuals with severe refractive anomalies or disabling ocular conditions are naturally excluded during recruitment. Furthermore, active service members are subjected to mandatory periodic health surveillance (*Pemeriksaan Kesehatan Berkala / Rikkes*), which facilitates early detection and mandatory optical correction to maintain readiness. In contrast, the civilian subgroup comprising dependents, administrative workers, and local residents participating in the screening is not subject to initial health selection or mandatory routine eye examinations. This cohort is subject to age-related visual decline without routine institutional oversight, resulting in a higher proportion of unaddressed refractive conditions. Recognizing this selection bias is crucial when interpreting community-wide epidemiological data from military installations.

### **Gender Disparities in Refractive Errors**

Multivariable analysis demonstrated that female gender was independently associated with a higher likelihood of uncorrected refractive errors (aOR = 1.32; 95% CI: 1.02-1.71;  $p = 0.035$ ). Females exhibited a higher prevalence of refractive anomalies (41.23%) than males (34.89%). These findings align with global epidemiological reports indicating a disproportionate burden of uncorrected visual impairment and refractive anomalies among females across various geographic regions (Flaxman et al., 2020; Steinmetz et al., 2021). Biological and socio-environmental factors contribute to this disparity. Biologically, variations in axial length, anterior chamber depth, and hormonal

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influences across life stages (such as estrogen fluctuations during reproductive years and menopause) affect corneal curvature and lens hydration.

Environmentally and socially, women in suburban Indonesian communities frequently engage in intensive near-work activities (e.g., domestic sewing, administrative work, digital screen usage) while experiencing lower rates of outdoor physical activities, which are known to protect against myopia progression (Morgan et al., 2021). Furthermore, gender-based health-seeking disparities and economic prioritization within households may lead women to delay optical correction compared to primary wage earners, compounding the burden of uncorrected visual impairment (Naidoo et al., 2019; World Health Organization, 2020).

### **Strengths, Limitations, and Public Health Implications**

This study possesses notable strengths, including a large sample size ( $n = 1,098$ ), standardized optometric protocols using both objective autorefraction and subjective refraction, and the inclusion of a unique military-civilian comparative cohort. However, certain limitations must be acknowledged. First, the cross-sectional design precludes establishing direct temporal causality between risk factors and refractive error development. Second, cycloplegic refraction was not routinely performed due to field constraints during community screening, which may lead to a slight overestimation of myopia or underestimation of hyperopia in younger adults due to active accommodation (Morgan et al., 2021). Third, because this study evaluated voluntary participants within a targeted screening program, potential selection and participation biases exist, meaning the findings may not be fully representative of the entire air base population. Despite these limitations, the scientific and clinical implications of this study are substantial. Uncorrected refractive error is a major cause of avoidable visual impairment that can be fully corrected through cost-effective spectacle prescription (Bourne et al., 2021; World Health Organization, 2020). Strategic interventions should focus on three key pillars:

- 1) **Mandatory Routine Vision Screening:** Expanding periodic health checks (Rikkes) to include routine near visual acuity assessments for all personnel aged  $\geq 40$  years to detect presbyopia early.
- 2) **Community Outreach Screening Programs:** Establishing biannual vision screening camps for civilian dependents and surrounding residents at Lanud Sutan Sjahrir health centers.
- 3) **Presbyopia Mitigation & Optical Accessibility:** Providing subsidized or low-cost reading and distance spectacles to eliminate economic barriers to optical correction.

### **Conclusion**

This study demonstrates that refractive disorders and presbyopia constitute a notable visual health burden among participants of the eye screening program at Lanud Sutan Sjahrir Padang. Among the 1,098 examined participants, myopia was the predominant distance refractive disorder (24.41%), followed by astigmatism (9.47%) and hyperopia (3.64%), while presbyopia affected 33.52% of the overall cohort. Based on visual acuity thresholds (uncorrected visual acuity  $< 6/18$  in the better eye), uncorrected refractive error (URE) was identified in 18.21% of participants. Multivariable logistic regression established age  $\geq 40$  years (aOR = 2.84; 95% CI: 2.15–3.75;  $p < 0.001$ ), civilian status (aOR = 1.58; 95% CI: 1.21–2.06;  $p < 0.001$ ), and female gender (aOR =

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1.32; 95% CI: 1.02–1.71;  $p = 0.035$ ) as independent demographic risk factors for presenting with uncorrected refractive errors

Active military personnel exhibited a lower burden of URE compared to civilians, a finding largely attributable to the healthy worker selection effect and mandatory periodic health surveillance within military service. However, because the study evaluated voluntary participants within a targeted screening program, the observed prevalence rates may not be fully representative of the entire air base community due to potential participation bias. These findings highlight the necessity of expanding routine ocular screening outreach beyond active military health checks (*Rikkas*) to include civilian dependents and older age groups, thereby mitigating unaddressed visual impairment and promoting overall community eye health.

**Declaration of AI Assistance**

AI Tools including Chat GPT, Gemini, Claude AI were used during the preparation of this manuscript. The AI Tools were used for grammar checking, paraphrasing and translating. The Authors have checked the output of the tools

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