

ARTICLE



Post-refractive surgery of Israeli Defense Forces recruits in 2005–2018—prevalence, combat unit drop-out rates and utilization of eye-care services

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PURPOSE: To assess the number of recruits for military service in the Israeli Defense Force (IDF) who underwent refractive surgery prior to enlistment and examine whether the procedure affected their ability to accomplish combat training.

SETTING: Medical records of IDF recruits.

DESIGN: Retrospective analysis of medical records of recruits with ametropia who underwent or did not undergo refractive surgery prior to enlistment.

METHODS: Recruits were categorized into ametropes and recruits who underwent refractive surgery. Fitness and assignment to combat units and completion status of combat training were compared between the two groups.

RESULTS: The study included 334,688 (182,969 males, 151,719 females) ametropes of which 5231 (4753 males, 478 females) underwent refractive surgery prior to recruitment. Refractive surgery prevalence increased from 9/1000 ametropes in 2005 to 18.5/1000 ametropes in 2018 ($r = 0.912$, $p < 0.001$); 2643 of the operated recruits (50.5%) had their surgery at the age of 17–18. Dropout rates from combat training were significantly lower in the refractive surgery group during the study period (1.68% vs. 6.14%, respectively, $p < 0.001$). Soldiers in the operated group were more frequently referred to ophthalmologists than those in the ametropes group and less frequently referred to optometrists.

CONCLUSIONS: The prevalence of refractive surgery in IDF recruits has increased substantially during the last decade with more of them applying to combat units. Refractive surgery opened new possibilities for recruits who were unfit for combat duty prior to surgery and did not appear to impair the chances of successfully completing combat training.

Eye (2023) 37:1484–1488; <https://doi.org/10.1038/s41433-022-02164-6>

INTRODUCTION

Refractive error is the leading cause of reversible visual impairment worldwide [1], and over the last 30 years, its prevalence has dramatically increased [2, 3]. Previous reports estimate that by 2050 nearly 50% of the world's population will have myopia [2]. In the United States Army, approximately one-third of service men and women required corrective lenses in 2000–2003 [4]. In Israel, the rate of myopia in candidates for military service rose from 20.4% in 1990 to 26.2% in 2012 [5].

For soldiers serving in combat units, wearable glasses or contact lenses are more than an inconvenience or simple cosmetic issue. Corrective eyewear is often incompatible with special equipment such as night vision goggles and helmet-mounted gear [6, 7]. Glasses can fall off, fog up, or break, compromising readiness for combat duties and risking soldiers' welfare in battle. Moreover, contact lenses pose a significant threat of infection due to poor hygiene in combat conditions and during outdoor activities which often involve dust and sand [8]. For all these reasons, myopia is considered a contraindication for serving in Israel Defense Force

(IDF) Special Forces and myopes over 6 diopters cannot serve in combat units at all.

For ametropic soldiers, refractive surgery is the most effective solution to circumvent the difficulties posed by spectacles and contact lenses. Since the FDA approved the use of the excimer laser in 1995 [9], there has been a steady increase in the number of patients undergoing refractive procedures. These procedures are known to have a good safety profile and satisfaction rates [10–12], and currently are one of the most frequent ocular surgeries performed globally [13, 14].

The reported rates of postoperative complications are low but may include increased glare, halos, haze, and higher order aberrations, which might impair visual performance in low light environments [15–17]. As the PROWL study shows, about 28% of participants with normal Ocular Surface Disease Index scores preoperatively, developed mild, moderate, or severe dry eye symptoms at 3 months [10]. Other adverse events, including flap-related complications, are a possible concern, although many recent publications showed a strong safety track record [18–20].

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Received: 20 June 2021 Revised: 26 May 2022 Accepted: 20 June 2022

Published online: 14 July 2022

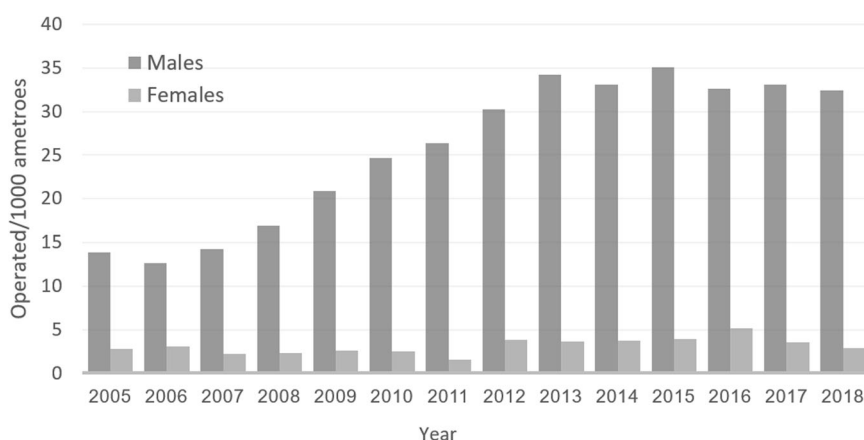


Fig. 1 Prevalence of ametropic soldiers who had refractive surgery prior to recruitment.

Since 2001, IDF recruitment policy in regard to post-refractive surgery recruits has gradually changed, allowing operated candidates to enlist in more elite combat units. In 2009, the Israeli Air Force accepted the first operated cadet to its prestigious flight course. Currently, post-refractive surgery recruits can enlist to all combat units in the IDF, as long as their unocular uncorrected distance visual acuity (UDVA) in both eyes is equal to or better than 20/40, and they do not have other ocular comorbidities (e.g., retinal tears, high myopia over 5.5D preoperatively, phakic-IOL, etc.).

In 2008, Horowitz et al. showed an increase in the number of refractive surgeries among IDF recruits between 1998–2005, with no deleterious effect on the recruits' fitness for service [21]. The purpose of our study is to use a similar methodology to determine the prevalence of refractive surgery in recruits for military service in the IDF over the past decade, and evaluate the effect of surgery on recruits' ability to achieve combat training and serve in combat units.

METHODS

The study protocol was approved by the IDF Medical Institutional Ethics Committee and conducted according to the ethics standards of the Declaration of Helsinki. The IRB/Ethics Committee ruled that approval was not required for this study.

Study population and outcome measures

The study population included all recruits for military service in the IDF between 2005 and 2018, who were categorized as having a refractive error (myopia, hyperopia, and/or astigmatism). The study group included recruits who underwent refractive surgery prior to their recruitment. As the IDF does not regularly allow recruits to undergo refractive surgery during mandatory service, soldiers who had refractive surgery during their military service were excluded. The control group included ametropic recruits who had not undergone refractive surgery.

Before recruitment, candidates underwent draft board assessment to check their suitability for active military service. This assessment includes visual acuity measurements, amongst other examinations (e.g., physical examination, psychological assessment). The candidate's UDVA was evaluated using a standard Snellen chart at 6 m. Candidates with UDVA <20/20 in either eye underwent non-cycloplegic refraction using an automated refractometer (Speedy K; Nikon Corp; KR-8000, KR7000S, and earlier models; Topcon), and a complementary subjective refraction was performed for validation using a Snellen chart. As stated above, recruits were then defined as ametropes if UDVA was <20/20, with improvement upon correction.

Recruits were also categorized as having undergone refractive surgery prior to their recruitment, or not. If refractive surgery was performed within 3 months prior to recruitment, recruitment was postponed until a minimum of 3 months had passed since the surgery. Data regarding

procedure type (photorefractive keratectomy (PRK), laser-assisted in situ keratomileusis (LASIK) or laser-assisted sub-epithelial keratectomy (LASEK) was documented.

Besides reviewing the prevalence of surgery during the study period, we aimed to assess the implications of refractive surgery on assignment to combat units, dropout rates from combat training, and utilization of eye-care providers' services. In order to achieve this, we compared the percentage of recruits assigned to combat units among post-refractive surgery recruits, compared to that of non-operated ametropes. Out of those assigned to combat units, we compared the dropout rates from combat training between the two groups. As all military training milestones are documented in the military personnel digital files, these were accessed for the purpose of retrieving the data for this study. As all referrals to specialists are given using the same digital military medical records system, annual referral rates to ophthalmologists and optometrists were also accessed and compared between the groups. Data regarding referrals to ophthalmologists and optometrists were available from 2011.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, N.Y., USA). Continuous variables were compared between the two study groups using the independent-sample *t*-test. The univariate Pearson correlation test was used to analyze annual increases. *p* values were two-sided and considered statistically significant when values were lower than 0.05.

RESULTS

The study included 334,688 (182,969 males, 151,719 females) ametropes and 5231 recruits (4753 males, 478 females) who underwent refractive surgery prior to recruitment, between 2005 and 2018 (5231/334,688, 1.56%).

During the study period, the rate of recruits who underwent refractive surgery doubled, from 9/1000 ametropes in 2005 to 18/1000 ametropes in 2018 ($r = 0.912$, $p < 0.001$). Rate of refractive surgery in male recruits showed an increase throughout the study period, rising from 13/1000 in 2005 to 32/1000 in 2018 ($r = 0.913$, $p < 0.001$). A mild increase was also observed among female recruits (2.7/1000 in 2005 to 2.9/1000 in 2018, $r = 0.582$, $p = 0.037$) (Fig. 1).

Of all operated recruits, 2643 (50.5%) had their surgery between the ages of 17 and 18. Between 2005 and 2018, the rate of soldiers who had surgery at the ages of 17–18 increased from 9/1000 ametropes in 2005, to 18.45/1000 ametropes in 2018 ($r = 0.929$, $p < 0.001$) (Fig. 2).

Information regarding the type of surgery performed was available for 19.2% of operated soldiers ($n = 1008/5238$); 727 (72%) underwent PRK, 49 (5%) had LASEK while 232 (23%) had LASIK surgery.

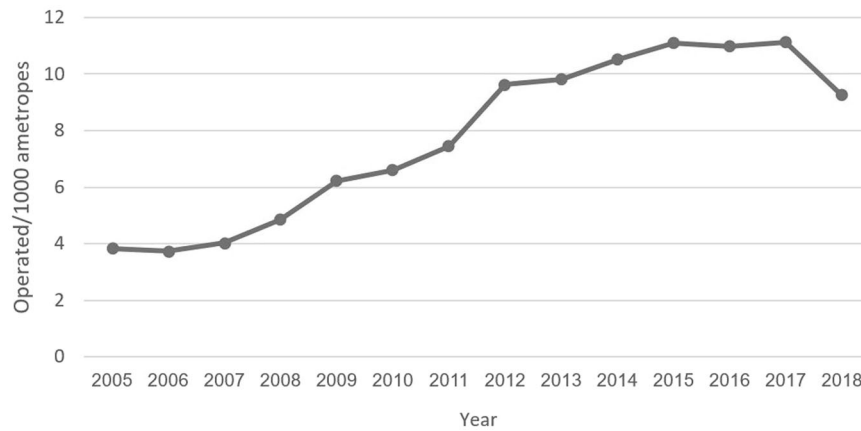


Fig. 2 Incidence of soldiers who had refractive surgery at the age of 18 or younger.

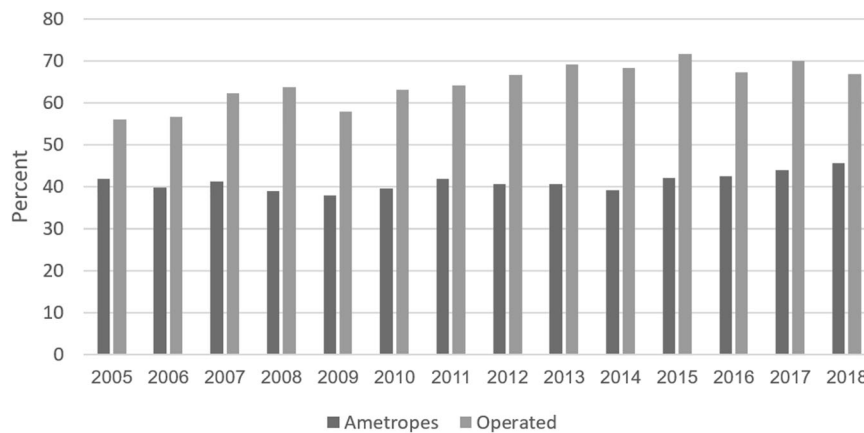


Fig. 3 Proportion of assignment to combat units amongst ametropes and operated recruits.

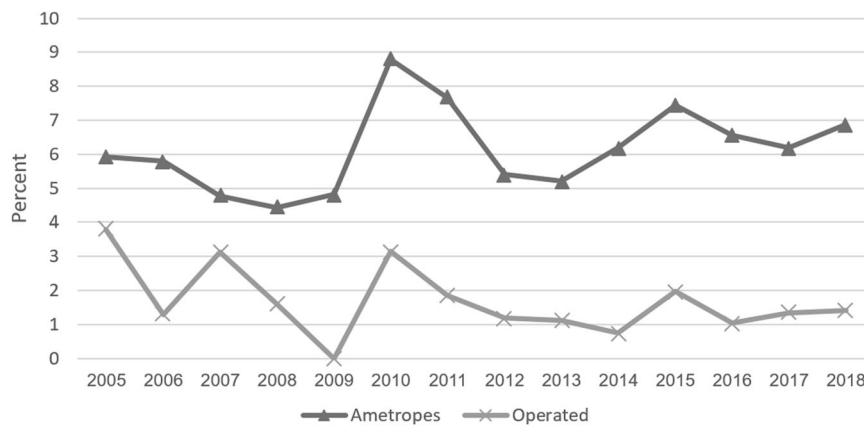


Fig. 4 Dropout rates from combat training.

Combat fitness and dropout rates

Eighty-three percent (4361/5231) of soldiers who had refractive surgery were fit for combat service according to their overall medical records, compared with 43% (145,069/334,688) of ametropes ($p < 0.001$). Out of those fit for combat service, 64.5% of operated soldiers and 41.1% of ametropes were subsequently assigned to a combat unit ($p < 0.001$) (Fig. 3).

Dropout rate from combat training was also significantly lower in the operated group compared with the ametropes study group (1.68% vs. 6.15%, $p < 0.001$) (Fig. 4). Dropout rate was derived only

from male recruits because of female recruits' low rate of enlistment to combat units after refractive surgery (24 females, 5% of all post-refractive females).

Eye-care provider utilization

Soldiers in the operated group were more frequently referred to ophthalmologists than ametropes (0.26 vs. 0.16 mean annual referrals, respectively, $p < 0.001$) and less frequently referred to optometrists (0.032 vs. 0.078 mean annual referrals, respectively, $p < 0.001$) (Fig. 5).

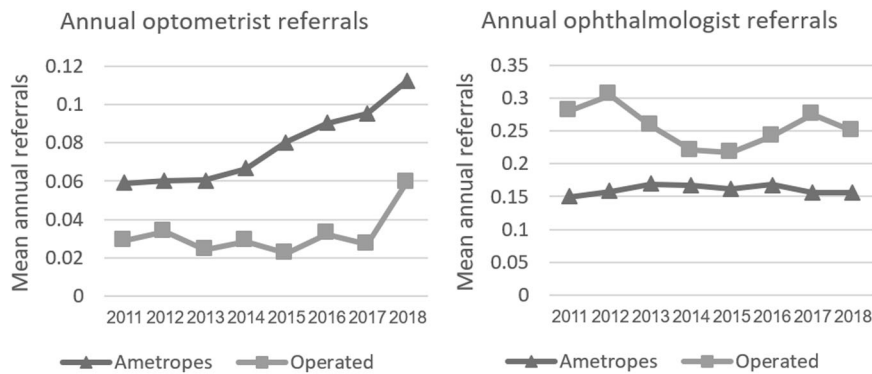


Fig. 5 Annual referrals to eye-care providers during mandatory service.

DISCUSSION

The study results show a significant increase in the proportion of operated ametropes among IDF recruits. We believe that the change in IDF recruitment policy and worldwide rising popularity of refractive surgery contributed to this change.

As previously mentioned, Horowitz et al. showed a rise in the number of refractive surgeries performed in IDF recruits from 0.8/1000 operated ametropes in 1998 to 4.9/1000 operated ametropes in 2005 [21]. Recruits in their study group were more likely to be assigned to combat units, and dropout rates were lower than among recruits who wore corrective eyewear. Our findings show a persistence of this trend, with refractive surgeries reaching a peak among recruits in recent years. Dropout rates continued to decrease in both groups, but were lower amongst operated individuals, staying below 2% since 2011.

As many studies show that the progression of refractive errors continues into early adulthood, refractive surgery at ≤ 18 years is less common than in later stages in life [22–24]. For these reasons, the Food and Drug Administration approved LASIK only for patients >18 years [25]. Horowitz et al. reported that only 14% ($n = 84/597$) of recruits who underwent surgery between 1998 and 2005 were 18 years or younger at the time of surgery [21], whereas in our study more than half of all recruits who underwent surgery were 18 years or younger. As surgical technology becomes safer and more efficacious and predictable, surgeons may feel more confident operating on patients ≤ 18 years, provided refraction was stable in the year preceding the surgery [26]. We believe young recruits are seeking to improve their chances of getting accepted into elite units, some of which require uncorrected visual acuity of 20/40 or better. As mandatory service is at the age of 18, these young enthusiastic recruits may undergo the surgery before enlisting to the army in order to allow sufficient recovery from surgery.

Although the safety and efficacy of refractive surgery was demonstrated in many studies, potential side effects may impair the visual performance of combat soldiers. IDF combat duty service often requires operating in sandy, blustery, and warm environments on a daily basis. These conditions can aggravate some known side effects of refractive surgery, such as dry eye. The alternative for ametropes is wearing glasses or contact lenses, which have their own risk in the military setting; Glasses being broken or fogging of gas mask inserts are life threatening in combat. Contact lenses have the inherent risk of keratitis, especially in low hygiene settings such as in military training or combat [8, 27]. In our study population, recruits after refractive surgery were 3.6 times less likely to drop out from their training compared to ametropes who had not undergone surgery. Our findings are in accordance with Rose et al. who reported a subjective improvement in the capability and readiness of active military members after refractive surgery [28].

In the IDF, combat roles are among the most esteemed positions, and this prestige is transferable to civilian life [29]. That being said, military service in Israel is mandatory, and so is assignment to a combat or other unit. As mentioned earlier, some combat units and especially special forces do not recruit individuals with a refractive error requiring correction. It is our experience that enlisting to a combat unit is the leading factor influencing recruit candidates to undergo refractive surgery. Therefore, we believe that recruits performing surgery to get accepted to combat units had more motivation to complete combat unit training than their non-operated peers, hence the lower dropout rate in this group. This can also be reflected by the fact that most recruits who underwent refractive surgery were men (male:female ratio of 10:1, Fig. 1). A possible explanation for this difference is the lower enlistment rate to combat units within the female group over the study period. Although many combat units enlist female soldiers, our data might suggest a lower motivation to improve their readiness for combat duties. Our findings are limited by the retrospective nature of our study, and by possible confounders such as the above-mentioned motivation. Also, our findings were not normalized for type of combat unit, or existence of other comorbidities such as orthopedic problems affecting fitness to combat service.

As expected, we found lower rates of referrals to optometrists among operated recruits compared to non-operated ametropes. We also found higher rates of referral to ophthalmologists among this population. As adults are commonly recruited in Israel at the age of 18, and because refractive surgeons usually do not operate on patients much younger than 18, many candidates undergo refractive surgery close to their recruitment date, as the IDF allows recruitment as soon as 3 months post-surgery. Hence, regular post-op follow-ups can be the possible cause of this finding. It would have been interesting to know at what stage in their military service these referrals occurred, but this information was not available to us. Despite this increase, the absolute referral rate was small and probably did not pose a burden on the soldier's combat training or medical facilities. Unfortunately, no data regarding the diagnoses and treatments done in the IDF clinics was available in our study.

Although definite data regarding type of surgery was only available for 19% of the study cohort, most of them underwent PRK rather than LASIK. This observation, typical among young patients, is in accordance with a recent study that reported a higher rate of PRK surgery in patients ≤ 18 years operated on in Israel [30]. These findings may be due to the reluctance of surgeons to use flaps in candidates for combat unit who are at higher risk of eye trauma, although LASIK flap-related complications are considered rare even in the event of significant trauma [18].

In conclusion, our study demonstrates that the prevalence of refractive surgery in IDF recruits has increased substantially over the past decade, opening new possibilities for recruits previously deemed unfit for combat duty prior to surgery. Operated

individuals were not less likely to be assigned to combat units and successfully completing combat training.

SUMMARY

What was known before

- Refractive surgery is known to have a good safety profile, and currently are one of the most frequent ocular surgeries performed globally.
- Subjective improvement in the capability and readiness of active military members after refractive surgery.

What this study adds

- Rising prevalence of refractive surgery in IDF recruits.
- Reinforces the beneficial effect of refractive surgery on young recruits in their assignment and training for combat unit and the completion of service, on a model of national mandatory military service.

DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

EG was responsible for the data collection, analysis, writing the manuscript and drafting the manuscript. EB was responsible for data collection, analysis, writing the manuscript. SS was responsible for data collection and analysis and critical review. DH, YN, EL, AG, and IB were also responsible for parts of data collection and critical review of the manuscript. All authors contributed to conceptualization and approved the final version of the manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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