ORIGINAL ARTICLE

Physical load, Doppler haemodynamics and semen quality in conscripts with varicocele: an early detection algorithm

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Abstract

Aim. To assess the frequency and clinical-instrumental features of varicocele in young military conscripts with different physical load profiles, to relate Doppler haemodynamics to semen quality, and to develop a risk-stratified algorithm for early detection and follow-up.

Methods. A retrospective cohort of 98 conscripts aged 18–22 years with varicocele and a prospective cohort of 130 conscripts examined with a standardised protocol (clinical examination with the Valsalva manoeuvre, scrotal Doppler ultrasound and extended semen analysis) were studied at a military hospital in Tashkent, Uzbekistan, in 2023–2025. Logistic regression and receiver operating characteristic (ROC) analysis were used.

Results. In the prospective cohort, varicocele was detected in 36 of 130 conscripts (27.7%): 47.1% with high physical load vs. 17.6% with low load ($p = 0.010$). High load (adjusted OR 4.10; 95% CI 1.40–12.10), service of 8 months or longer (2.70; 1.20–6.20) and regular lifting of loads above 20 kg (3.60; 1.40–9.10) were independent predictors. Progressive motility below 40% occurred in 20.0%, 50.0% and 100% of men with grade I, II and III varicocele vs. 6.4% of controls. Venous reflux of 1.5 s or longer was associated with progressive motility below 40% (OR 21.0; 95% CI 6.0–73.6). A composite criterion (at least two of: reflux ≥1.5 s, Valsalva vein diameter ≥3.5 mm, diameter increment ≥0.6 mm) had an AUC of 0.86, specificity 92.7% and negative predictive value 92.7%. A 0–10-point load-based score had an AUC of 0.82; detection rose from 5.0% at 0–2 points to 64.3% at 7–10 points.

Conclusion. Varicocele is common in conscripts exposed to heavy physical load. Combining load-based triage with quantitative Doppler criteria identifies functionally significant cases early and supports targeted load modification and urological referral during military service.

Keywords: *Military Personnel; Physical Exertion; Semen Analysis; Sperm Motility; Ultrasonography, Doppler; Varicocele.*

MAIN TEXT

Introduction

Varicocele, an abnormal dilatation and tortuosity of the pampiniform plexus veins, is found in about 15% of the general male population, in 35–44% of men with primary infertility and in up to 81% of men with secondary infertility [1]. It is the most common correctable cause of impaired spermatogenesis [2]. In a study of 7035 young men from six European countries, varicocele was associated with lower semen quality and altered reproductive hormone levels, particularly in higher grades [3], and a meta-analysis confirmed reductions in sperm count, motility and morphology when the 2010 WHO criteria were applied [4]. Venous stasis, raised testicular temperature, hypoxia and oxidative stress leading to sperm DNA damage are the main proposed mechanisms [5–7].

The European Association of Urology (EAU) and AUA/ASRM guidelines recommend treatment of clinically palpable varicocele in men with abnormal semen parameters, and close follow-up of young men with progressive testicular dysfunction [8, 9]. Identifying which young men need such follow-up remains difficult, because most varicoceles are asymptomatic and grade I disease is easily missed on routine examination [10].

Conscript soldiers aged 18–22 years are a large, accessible and homogeneous population for early detection. Their service involves repeated lifting, carrying of equipment, long marches and prolonged standing, all of which raise intra-abdominal and venous pressure. Certain sports with similar loading have been associated with a higher prevalence and severity of varicocele [11], but data on military physical load are scarce. Doppler ultrasound measures vein diameter and venous reflux objectively [12], yet the thresholds that identify functionally significant varicocele in young men, and how they should be combined with organisational risk factors in military medical practice, have not been defined [13].

This study aimed (1) to describe the clinical and Doppler features of varicocele in conscripts; (2) to assess the association of physical load profile and service factors with varicocele detection; (3) to relate Doppler parameters to semen quality and to define a minimal set of quantitative criteria for functionally significant varicocele; and (4) to develop a risk-stratified algorithm for early detection, load modification and referral.

Material and Methods

Study design, setting and participants

The study was conducted in 2023–2025 at the urology department of the Central Military Clinical Hospital of the Ministry of Defence of the Republic of Uzbekistan, Tashkent, and is reported according to the STROBE statement [14]. It comprised two cohorts. The retrospective cohort included all 98 conscripts (18–22 years) with a documented diagnosis of varicocele who were referred to the specialised department in 2023–2024; data were extracted from case histories

and outpatient records. The prospective cohort included 130 conscripts (18–22 years) examined in 2023–2024 according to a standardised protocol without prior selection by diagnosis; after examination, 36 had confirmed varicocele (grade I, n = 20; grade II, n = 12; grade III, n = 4) and 94 without varicocele formed the internal control subgroup.

Inclusion criteria were male sex, age 18–22 years, current conscript service and either sufficient medical documentation (retrospective cohort) or a completed standardised protocol (prospective cohort). Exclusion criteria were previous scrotal or inguinal surgery capable of altering venous haemodynamics, acute inflammatory scrotal disease at examination, severe concomitant disease precluding standard diagnostics, and missing key variables. The two cohorts did not differ in age (19.9 ± 1.2 vs. 19.8 ± 1.2 years; p = 0.58), length of service (7.1 ± 2.4 vs. 6.7 ± 2.4 months; p = 0.19), proportion serving 8 months or longer (43.9% vs. 40.0%; p = 0.651) or physical load profile (p = 0.879).

Physical load profile and service factors

Before statistical analysis, each conscript was assigned to one of three load profiles according to unit affiliation and typical duties: high (systematic high-intensity training, march-runs, carrying equipment and regular strength loads), moderate (mixed regimen of moderate intensity) or low, predominantly static (prolonged static postures, limited mobility, intermittent loads and vibration). A structured questionnaire recorded regular lifting or carrying of loads above 20 kg, regular marches of 10 km or more at least once a week, prolonged static load (at least 4 h a day) and episodes of severe straining.

Clinical examination and Doppler ultrasound

Complaints (pain, discomfort, heaviness, worsening after exertion) were recorded and pain was rated on a 10-point visual analogue scale (VAS). Examination was performed in a warm room after at least 5 min of rest, standing and supine, with the Valsalva manoeuvre; varicocele was graded clinically as I–III according to Dubin and Amelar [15]. Scrotal grey-scale and colour Doppler ultrasound measured the maximal diameter of the pampiniform plexus veins at rest and during the Valsalva manoeuvre (each at least twice, with the largest value recorded), the increment between them (Δ diameter) and the duration of retrograde flow (reflux) during the Valsalva manoeuvre. Reflux of 1.0 s or longer was taken as pathological and reflux of 1.5 s or longer as haemodynamically significant. In the retrospective cohort, Doppler data were available for 86 of 98 men (87.8%).

Semen analysis

Extended semen analysis was performed in the prospective cohort (n = 130) according to the WHO laboratory manual, after 2–7 days of abstinence and exclusion of fever or intercurrent illness,

using an SQA-Vision automated analyser (Medical Electronic Systems, Israel) with a Makler chamber for verification and an Olympus CX23 microscope. Volume, pH, liquefaction time, viscosity, agglutination, concentration, total sperm count, progressive (PR) and non-progressive motility, vitality (eosin–nigrosin), normal morphology (strict criteria), leukocytes (peroxidase test; >1.0 × 10 [8]/mL) and the mixed antiglobulin reaction (MAR; ≥50% considered significant) were recorded. The total motile sperm count (TMSC) was calculated as volume × concentration × PR. Progressive motility below 40% (PR <40%) was used as the clinically relevant functional outcome. The first available measurement was used in the analysis. Semen data were not analysed in the retrospective cohort because of non-standardised recording.

Statistical analysis

Analyses were performed with IBM SPSS Statistics 26.0. Continuous variables are presented as mean ± standard deviation (SD) or median (Q1; Q3) after testing normality with the Shapiro–Wilk test. Groups were compared with Student's t test or the Mann–Whitney U test, and three or more groups with ANOVA or the Kruskal–Wallis test with post hoc procedures. Categorical variables were compared with Pearson's χ^2 or Fisher's exact test, and trends across ordered grades with the Cochran–Armitage test. Correlations were assessed with Spearman's coefficient. Logistic regression was used for two outcomes: varicocele detection and PR <40%. Variables with $p < 0.10$ or clinical relevance in univariable analysis were entered into multivariable models; collinearity was checked with variance inflation factors, and model fit with the omnibus test, Nagelkerke R^2 and the Hosmer–Lemeshow test. Discrimination was assessed by the area under the ROC curve (AUC). For the bedside score, regression coefficients were converted to integer points (β 0.7–1.0 = 2 points; β 1.2–1.4 = 3 points). $p < 0.05$ was considered significant.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki [16]. Personal data were coded before statistical analysis. Informed consent to examination and to processing of de-identified data was documented for all participants of the prospective cohort; retrospective data were analysed from archive records without identifiers. Only men were studied because the condition is sex-specific.

Results

Clinical and Doppler profile of hospital-referred varicocele

In the retrospective cohort (n = 98), grade I varicocele was found in 50 men, grade II in 39 and grade III in 9; grades II–III together accounted for 49.0%. Symptoms, VAS scores and all Doppler parameters increased monotonically with grade (Table 1). Asymptomatic disease predominated in grade I (62.0%), whereas all men with grade III had pain or discomfort.

Haemodynamically significant reflux (≥1.5 s) was present in 6.8% of men with grade I, 50.0% with grade II and 100% with grade III ($p < 0.001$). Left-sided varicocele predominated regardless of load profile.

Table 1. Clinical and Doppler characteristics by varicocele grade in the retrospective cohort.

Characteristic	Grade I	Grade II	Grade III	p
Clinical (n = 98)	n = 50	n = 39	n = 9	
Pain or discomfort, n (%)	13 (26.0)	27 (69.2)	9 (100)	<0.001
Sensation of heaviness, n (%)	16 (32.0)	26 (66.7)	9 (100)	<0.001
Asymptomatic, n (%)	31 (62.0)	9 (23.1)	0 (0.0)	<0.001
VAS score, mean ± SD	1.5 ± 1.3	4.2 ± 1.6	6.9 ± 0.9	<0.001
Doppler ultrasound (n = 86)	n = 44	n = 34	n = 8	
Vein diameter at rest, mm	2.5 ± 0.3	2.8 ± 0.4	3.1 ± 0.4	<0.001
Vein diameter, Valsalva, mm	3.1 ± 0.3	3.6 ± 0.4	4.2 ± 0.5	<0.001
Δ diameter, mm	0.6 ± 0.2	0.8 ± 0.2	1.1 ± 0.2	<0.001
Reflux duration, s	1.0 ± 0.2	1.5 ± 0.3	2.1 ± 0.4	<0.001
Reflux ≥1.5 s, n (%)	3 (6.8)	17 (50.0)	8 (100)	<0.001

Continuous variables are mean ± SD. Proportions compared by χ^2 or Fisher's exact test; continuous variables by ANOVA or Kruskal–Wallis test. VAS = visual analogue scale; Δ diameter = Valsalva minus rest.

Frequency of varicocele and physical load in the prospective cohort

On standardised screening, varicocele was detected in 36 of 130 conscripts (27.7%): 55.6% grade I, 33.3% grade II and 11.1% grade III. Detection depended on load profile: 47.1% (16/34) with high load, 22.6% (14/62) with moderate load and 17.6% (6/34) with low static load ($\chi^2 = 9.17$; $p = 0.010$) (Figure 1). Pain or discomfort was reported by 30.0%, 66.7% and 100% of men with grades I, II and III ($p = 0.005$); left-sided disease predominated (75.0–85.0%) and bilateral disease was found in 11.1%.

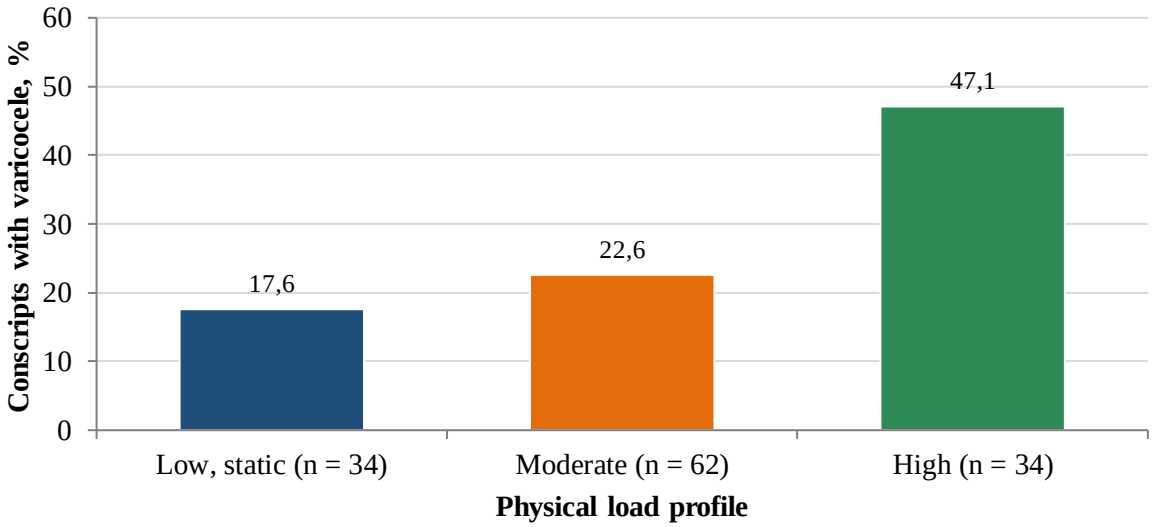


Figure 1. Frequency of varicocele detected on standardised screening according to physical load profile in the prospective cohort (n = 130); $\chi^2 = 9.17$, p = 0.010.

Doppler haemodynamics and semen quality

All Doppler parameters increased stepwise from controls through grades I–III (p for trend < 0.001), and reflux ≥1.5 s was found in 2.1% of controls, 10.0% of men with grade I, 58.3% with grade II and 100% with grade III (Table 2). Compared with controls, men with varicocele had a lower ejaculate volume (2.8 ± 0.7 vs. 3.2 ± 0.8 mL; p = 0.008), longer liquefaction (33 ± 9 vs. 26 ± 7 min; p < 0.001), more frequent increased viscosity (27.8% vs. 8.5%; p = 0.004) and agglutination ≥1+ (16.7% vs. 5.3%; p = 0.031). Sperm concentration, total count, TMSC, progressive and total motility, vitality and normal morphology declined with increasing grade, while leukocytospermia and MAR positivity increased (Table 2, Figure 2, Figure 3). Overall, PR <40% was found in 14 of 36 men with varicocele (38.9%) and 6 of 94 controls (6.4%).

Table 2. Doppler and semen parameters in controls and by varicocele grade in the prospective cohort.

Parameter	Control (n = 94)	Grade I (n = 20)	Grade II (n = 12)	Grade III (n = 4)	p (trend)
Doppler ultrasound					
Vein diameter at rest, mm	2.1 ± 0.3	2.6 ± 0.3	2.9 ± 0.4	3.2 ± 0.4	<0.001
Vein diameter, Valsalva, mm	2.3 ± 0.3	3.1 ± 0.3	3.6 ± 0.4	4.2 ± 0.5	<0.001
Δ diameter, mm	0.2 ± 0.1	0.5 ± 0.2	0.7 ± 0.2	1.0 ± 0.2	<0.001
Reflux duration, s	0.3 ± 0.2	1.0 ± 0.2	1.5 ± 0.3	2.1 ± 0.4	<0.001
Reflux ≥1.5 s, n (%)	2 (2.1)	2 (10.0)	7 (58.3)	4 (100)	<0.001
Semen analysis					
Concentration, $\times 10^6$/mL	55 ± 13	44 ± 14	36 ± 15	28 ± 12	<0.001
Total sperm count, $\times 10^6$	176 ± 46	124 ± 48	98 ± 50	67 ± 34	<0.001
TMSC, $\times 10^6$	92 ± 34	63 ± 28	44 ± 24	26 ± 16	<0.001

Parameter	Control (n = 94)	Grade I (n = 20)	Grade II (n = 12)	Grade III (n = 4)	p (trend)
Progressive motility, %	49 ± 9	41 ± 10	34 ± 9	26 ± 8	<0.001
Non-progressive motility, %	10 ± 4	11 ± 4	12 ± 5	14 ± 5	0.08
Total motility, %	59 ± 10	52 ± 11	46 ± 10	40 ± 9	<0.001
PR <40%, n (%)	6 (6.4)	4 (20.0)	6 (50.0)	4 (100)	<0.001
Normal forms, %	5.2 ± 1.4	4.3 ± 1.2	3.7 ± 1.1	3.0 ± 1.0	0.002
Vitality, %	75 ± 8	68 ± 9	64 ± 10	58 ± 9	<0.001
Leukocytes >1.0 ×10^6/mL, n (%)	6 (6.4)	3 (15.0)	3 (25.0)	2 (50.0)	0.006
MAR test ≥50%, n (%)	4 (4.3)	1 (5.0)	1 (8.3)	2 (50.0)	0.004

Mean ± SD unless stated otherwise. Δ diameter = Valsalva minus rest; TMSC = total motile sperm count (volume × concentration × progressive motility); PR = progressive motility; MAR = mixed antiglobulin reaction.

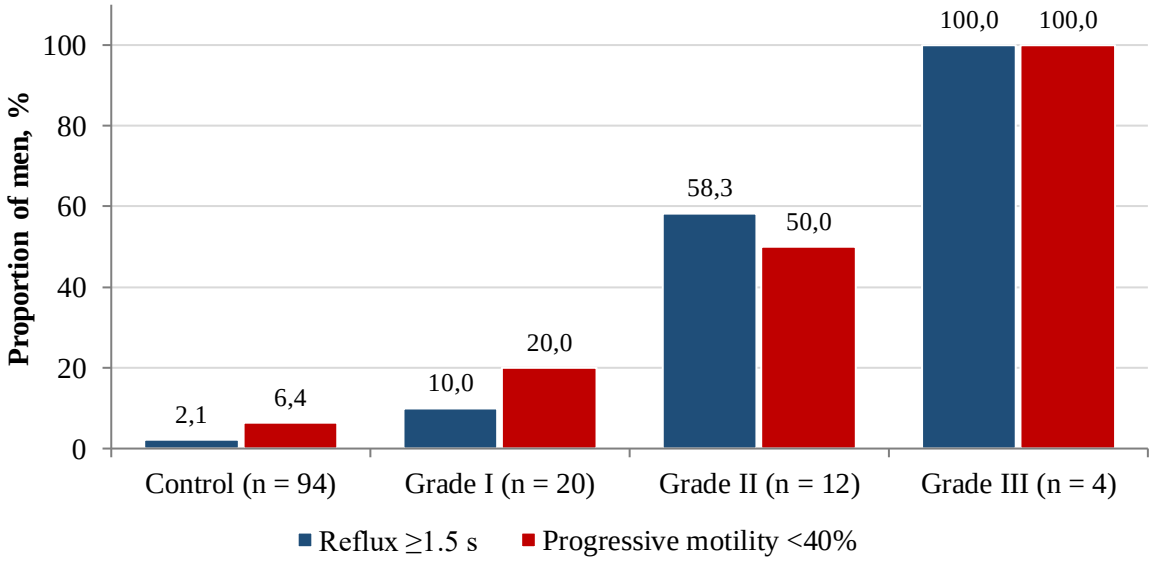


Figure 2. Proportion of men with haemodynamically significant reflux (≥1.5 s) and with progressive motility below 40% in controls and by varicocele grade (prospective cohort; p for trend < 0.001 for both).

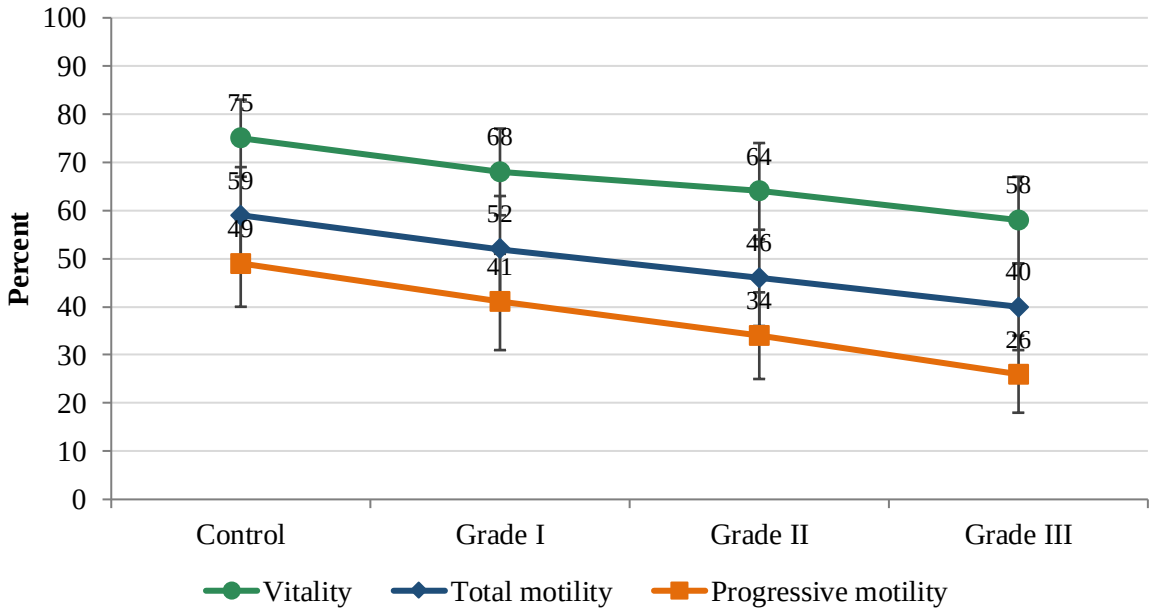


Figure 3. Progressive motility, total motility and vitality (mean ± SD) in controls and by varicocele grade (prospective cohort; p for trend < 0.001 for all three).

Quantitative Doppler criteria for functionally significant varicocele

Within the varicocele subgroup, grade correlated with Valsalva vein diameter (r = 0.66) and reflux duration (r = 0.71; both p < 0.001); reflux correlated inversely with progressive motility (r = −0.46; p = 0.005) and TMSC (r = −0.43; p = 0.009), and Valsalva diameter with normal morphology (r = −0.33; p = 0.049). In the whole prospective cohort, PR <40% was present in 20 men (15.4%). Each Doppler threshold raised the proportion with PR <40% from 8–9% to 48–67% (Table 3). In multivariable analysis, reflux ≥1.5 s, Valsalva diameter ≥3.5 mm and grade II–III remained independent predictors of PR <40%, whereas high load and service length did not. The composite criterion (at least two of three thresholds) was positive in 20 men and correctly classified 12 of 20 with PR <40% and 102 of 110 without it (sensitivity 0.60; specificity 0.927; positive predictive value 0.60; negative predictive value 0.927). Among men with varicocele, referring only those with reflux ≥1.5 s to extended semen analysis (13 of 36) raised the yield of PR <40% from 38.9% to 76.9% while capturing 10 of the 14 affected men (71.4%).

Table 3. Doppler thresholds as predictors of progressive motility below 40% in the prospective cohort (n = 130).

Criterion	PR <40% if present, n (%)	PR <40% if absent, n (%)	OR (95% CI)	aOR (95% CI)	AUC (95% CI)	Se / Sp
Reflux ≥1.5 s	10/15 (66.7)	10/115 (8.7)	21.0 (6.0–73.6)	6.8 (2.1–22.1)	0.82 (0.72–0.92)	0.50 / 0.95
Valsalva diameter ≥3.5 mm	11/22 (50.0)	9/108 (8.3)	11.0 (3.7–32.4)	3.9 (1.3–11.9)	0.79 (0.68–0.90)	0.55 / 0.90

Criterion	PR <40% if present, n (%)	PR <40% if absent, n (%)	OR (95% CI)	aOR (95% CI)	AUC (95% CI)	Se / Sp
Δ diameter ≥0.6 mm	10/21 (47.6)	10/109 (9.2)	9.0 (3.1–26.4)	—	0.78 (0.67–0.89)	0.50 / 0.90
Grade II–III	—	—	—	3.2 (1.1–9.3)	—	—
High physical load	—	—	—	2.0 (0.8–5.3)	—	—
Composite ≥2 of 3	12/20 (60.0)	8/110 (7.3)	—	—	0.86 (0.77–0.95)	0.60 / 0.93

$p < 0.001$ for all univariable ORs (Fisher's exact test). aOR from multivariable logistic regression; $p = 0.002$ (reflux), 0.016 (diameter), 0.036 (grade II–III vs. control or grade I) and 0.14 (high vs. low load); service ≥8 months aOR 1.5 (CI not reported). AUC for continuous parameters; Se/Sp at the stated cut-off. PR = progressive motility; Se = sensitivity; Sp = specificity.

Load-based risk score for varicocele detection

In univariable analysis, high load (OR 4.15; 95% CI 1.37–12.58; p = 0.010), service of 8 months or longer (38.5% vs. 20.5%; OR 2.42; 1.11–5.30; p = 0.025) and regular lifting of loads above 20 kg (44.4% vs. 15.8%; OR 4.27; 1.88–9.66; p < 0.001) were associated with varicocele detection, while weekly marches of 10 km or more showed a trend (36.0% vs. 22.5%; p = 0.094). Three predictors remained independent in the multivariable model (Table 4), which fitted well (likelihood ratio $\chi^2 = 29.8$, df = 5, p < 0.001; Nagelkerke $R^2 = 0.33$; Hosmer–Lemeshow p = 0.71). The derived 0–10-point score had an AUC of 0.82 (95% CI 0.74–0.90). Detection rose from 0% at 0 points to 75.0% at 8 and 10 points (Figure 4) and was 5.0% (2/40) for low risk (0–2 points), 25.8% (16/62; OR 6.61; 1.43–30.57) for moderate risk (3–6 points) and 64.3% (18/28; OR 34.2; 6.78–172.6) for high risk (7–10 points). The high-risk fifth of conscripts (28 of 130) contained half of all cases (18 of 36). At a cut-off of ≥3, ≥5 and ≥7 points, sensitivity was 0.944, 0.778 and 0.500, specificity 0.404, 0.702 and 0.894, and the proportion referred 69.2%, 43.1% and 21.5%, respectively.

Table 4. Predictors of varicocele detection and the derived load-based risk score (prospective cohort, n = 130).

Predictor	Varicocele, n/N (%)	aOR (95% CI)	p	Score points
Load profile: low/static (reference)	6/34 (17.6)	1.00	—	0
Load profile: moderate	14/62 (22.6)	1.30 (0.46–3.90)	0.62	1
Load profile: high	16/34 (47.1)	4.10 (1.40–12.10)	0.010	3
Service ≥8 months	20/52 (38.5)	2.70 (1.20–6.20)	0.016	2
Regular lifting >20 kg	24/54 (44.4)	3.60 (1.40–9.10)	0.007	3

Predictor	Varicocele, n/N (%)	aOR (95% CI)	p	Score points
Weekly marches ≥10 km	18/50 (36.0)	2.10 (0.90–4.80)	0.08	2
Total score				*0–10*

aOR = adjusted odds ratio from multivariable logistic regression including all listed predictors. Risk categories: low 0–2, moderate 3–6, high 7–10 points. Moderate load was retained as a transitional category (1 point) for organisational reasons despite lack of significance.

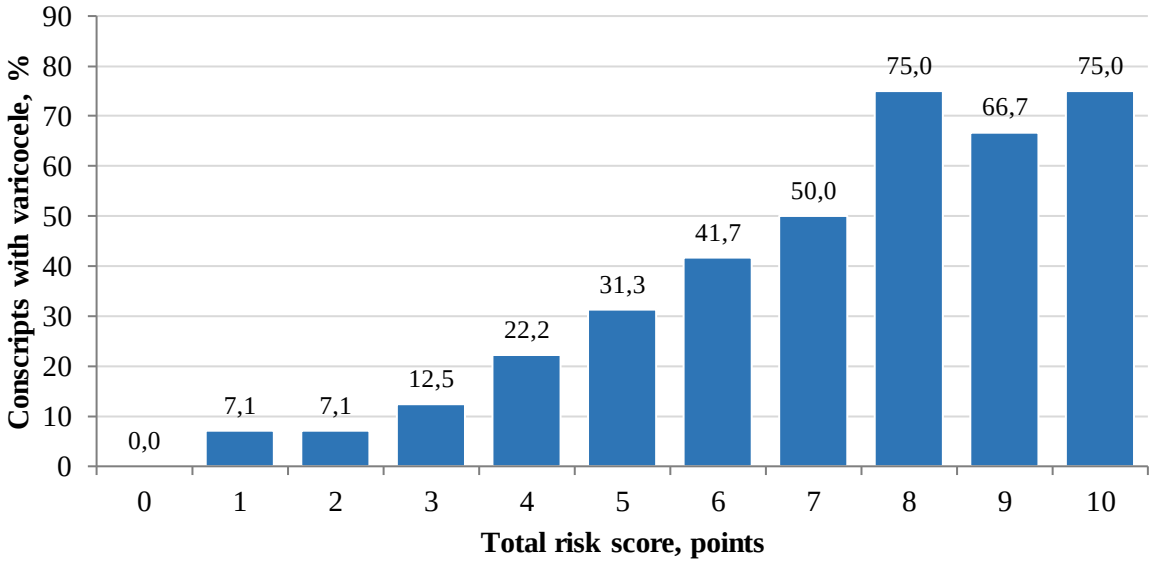


Figure 4. Frequency of varicocele detection according to the total load-based risk score (prospective cohort, n = 130; number of conscripts per score: 12, 14, 14, 16, 18, 16, 12, 10, 8, 6 and 4). AUC = 0.82 (95% CI 0.74–0.90).

Early detection and follow-up algorithm

The results were combined into a stepwise algorithm. Step 1 (unit medical service): the score is calculated for every conscript; low risk (0–2 points, no complaints) leads to routine examination, moderate risk (3–6 points or complaints) to a targeted scrotal examination with the Valsalva manoeuvre at the first opportunity, and high risk (≥7 points) to priority examination and Doppler ultrasound regardless of complaints; VAS ≥3 or pain after exertion prompts examination without delay. Step 2 (Doppler): varicocele is confirmed by Valsalva diameter ≥3.5 mm or reflux ≥1.0 s, and judged haemodynamically significant by reflux ≥1.5 s or the composite criterion. Step 3 (clinical significance): grade II–III, reflux ≥1.5 s, the composite criterion or VAS ≥4 indicate extended semen analysis, priority urological consultation and restriction of lifting above 20 kg and straining; right-sided or bilateral varicocele requires mandatory urological assessment. Clinical control is scheduled every 6 months for clinically insignificant grade I disease, every 3 months for borderline cases and every 1–3 months for clinically significant disease.

Discussion

In this study, standardised screening found varicocele in more than a quarter of young conscripts, and its frequency was 2.7 times higher in units with high physical load than in units with predominantly static duties. Organisational exposures—high load, regular heavy lifting and service of 8 months or longer—were independent predictors of varicocele. In turn, quantitative Doppler parameters, rather than clinical grade alone, identified the men whose semen quality was impaired.

The 27.7% detection rate is higher than the roughly 15% reported in general male populations [1] and the prevalence in the large European study of young men [3]. Two factors may contribute: systematic examination with the Valsalva manoeuvre and Doppler confirmation detects subclinical and grade I disease, and conscripts are exposed to repeated increases in intra-abdominal pressure. The gradient across load profiles and the independent effect of heavy lifting support a role of mechanical venous loading, consistent with reports that sports involving jumping, sprinting and straining are associated with more frequent and more severe varicocele [11]. Because the study was cross-sectional at the time of screening, we cannot exclude that men with pre-existing varicocele were allocated to demanding units; prospective follow-up from enlistment is needed to establish whether load causes onset or progression [17].

Semen quality deteriorated with grade, with stepwise falls in concentration, TMSC, progressive motility, vitality and normal morphology, in line with meta-analytic evidence [4]. The higher frequency of increased viscosity, agglutination, leukocytospermia and MAR positivity in higher grades is compatible with the oxidative, inflammatory and immunological mechanisms proposed for varicocele-related testicular damage [5]. Clinically, it is important that 20% of men with grade I varicocele already had PR <40%. Grade I disease is often regarded as insignificant; our data show that it is functionally heterogeneous and that men with grade I and reflux ≥1.5 s resemble those with grade II [18].

Reflux duration was the most informative single Doppler parameter: it correlated with motility and TMSC, remained an independent predictor of PR <40% (aOR 6.8) and, at 1.5 s, gave a specificity of 0.95. International ultrasound recommendations combine vein diameter measured standing and during the Valsalva manoeuvre with the presence and duration of reflux, but the recommended cut-offs vary [12, 19]. Our thresholds (Valsalva diameter ≥3.5 mm, Δ ≥0.6 mm, reflux ≥1.5 s) are within the range used in these recommendations and were chosen for specificity, because in a mass-screening setting false positives generate unnecessary laboratory tests and restrictions. The composite criterion improved discrimination (AUC 0.86) while keeping specificity at 0.93, so it is suitable as a filter for extended semen analysis. Conversely, the presence of isolated reflux ≥1.5 s in 2.1% of controls argues against relying on a single Doppler sign [20].

The load-based score addresses a practical problem of military medicine: Doppler ultrasound and semen analysis are not available in every unit, and most varicoceles in young men are silent, so selection by complaints misses many cases. The score uses information that unit medical staff already have and ranks conscripts by pre-test probability (5.0% vs. 64.3% between the lowest and highest categories). Its threshold can be adapted to resources: ≥3 points for a high-sensitivity strategy, ≥5 points for a balanced strategy and ≥7 points when ultrasound capacity is limited. The resulting algorithm does not replace clinical judgement; it orders examination, defines objective criteria for referral and links load modification to documented haemodynamic and functional findings.

For the individual conscript, early identification matters because varicocele repair improves semen parameters and spontaneous pregnancy rates in selected infertile men [21], and guidelines recommend monitoring testicular growth and semen quality in young men with varicocele [8, 9, 22]. Service is a window in which a large, otherwise hard-to-reach population can be examined systematically and counselled before attempting conception [23–25].

Strengths and limitations

Strengths include the combination of a hospital-based retrospective cohort, which described the full clinical spectrum, with a prospective cohort examined without prior selection by diagnosis using a uniform clinical, Doppler and laboratory protocol; pre-specified load categories; and assessment of both statistical association and practical yield. Limitations include the single-centre design; the small number of grade III cases (n = 4), which makes grade-specific estimates imprecise; a single semen sample per man, whereas guidelines recommend two analyses [22]; the absence of testicular volume and reproductive hormone data; derivation and evaluation of the score and thresholds in the same sample without internal or external validation, which may overestimate performance; the lack of inter-observer reliability data for Doppler measurements; and the cross-sectional assessment of physical load, which does not establish causality.

Conclusion

Varicocele is detected in more than a quarter of conscripts on standardised screening, and high physical load, regular lifting of loads above 20 kg and service of 8 months or longer independently increase the probability of detection. Reflux of 1.5 s or longer and a Valsalva vein diameter of 3.5 mm or more identify functionally significant varicocele, including a subset of grade I cases. A two-step approach—load-based triage followed by quantitative Doppler criteria—allows military medical services to detect varicocele early, target semen analysis and urological referral, and adjust physical load during service. External validation is required before routine implementation.

Additional information

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