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Evaluation of Nutritional and Inflammatory Status Using Naples Prognostic Score Measurements in Patients with Erectile Dysfunction

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What's known on the subject? and What does the study add?

Previous studies have demonstrated that nutritional and inflammatory markers, particularly neutrophil-to-lymphocyte ratio, correlate with erectile dysfunction (ED). However, comprehensive prognostic scores like the Naples prognostic score (NPS), combining nutritional and inflammatory parameters, have not been extensively explored in ED patients. This study provides novel evidence that the NPS is significantly associated with both the presence and severity of ED. It highlights that higher NPS scores indicate worse nutritional and inflammatory status, correlating strongly with increased ED severity.

Abstract

Objective: To investigate the relationship between the presence and severity of erectile dysfunction (ED) and the Naples prognostic score (NPS).

Materials and Methods: Data from patients who presented to two urology outpatient clinics with complaints of ED between July 2024 and January 2025 were retrospectively analyzed. Patients older than 18 years of age engaged in regular sexual activities were included. A total of 163 patients with ED meeting the inclusion criteria and 160 healthy controls without ED were evaluated. Patients' age, weight, height, comorbidities, laboratory findings, and International Index of Erectile Function-5 scores were recorded at baseline.

Results: The mean ages of the patients with ED and controls were 58.7±12.4 and 56.9±12.8 years, respectively (p=0.197). In the multivariate analysis between the ED and control groups, the neutrophil-to-lymphocyte ratio (p=0.009) and the presence of NPS 3-4 (p<0.001) were identified as independent variables. Multivariate analysis comparing mild and mild-to-moderate ED groups with moderate and severe ED groups showed that the presence of NPS 3-4 was the only independent predictor of increased ED severity (NPS group 3-4 vs. NPS group 1-2, p=0.021; NPS group 3-4 vs. NPS group 0, p=0.007).

Conclusion: NPS was higher in patients with ED compared to healthy controls. In addition, NPS was significantly higher in patients with moderate and severe ED than in those with mild or mild-to-moderate ED.

Keywords: Naples prognostic score, erectile dysfunction, mild, moderate

Introduction

Erectile dysfunction (ED) is a common condition that significantly affects men's quality of life (1). It may be psychogenic (20%) or organic (80%) in origin, with organic causes often being vasculogenic or iatrogenic. ED is seen in 1-10% of men under 40 years of age and in 30-50% of those between 40 and 70 years. Metabolic syndrome, cardiovascular disease, and obesity are among the major risk factors (2).

According to the European Association of Urology guidelines, both inflammatory and nutritional disorders such as rheumatic diseases, Crohn's disease, ulcerative colitis, vitamin D deficiency, and folic acid deficiency are associated with an increased risk of ED (3). Furthermore, there is evidence linking inflammatory

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parameters with ED (4,5). The Naples prognostic score (NPS), which integrates markers of nutritional and inflammatory status, namely total cholesterol, serum albumin, lymphocyte-to-monocyte ratio (LMR), and neutrophil-to-lymphocyte ratio (NLR), has been established as a valuable prognostic tool, particularly in patients undergoing surgery for neoplastic diseases (6-8). The NPS is a composite index that reflects both inflammatory and nutritional status. It is calculated based on four parameters: NLR, LMR, serum albumin level, and total cholesterol level. Specifically, NPS is assigned as follows: NLR >2.96 (1 point), LMR ≤4.44 (1 point), serum albumin <4.0 g/dL (1 point), and total cholesterol ≤180 mg/dL (1 point), with a higher total score indicating a poorer nutritional and inflammatory profile (9). Recent studies have also reported associations between NPS and the prognosis of both acute and chronic diseases (10-12). However, there is a paucity of data in the literature on the nutritional status of patients with ED. We hypothesize that both nutritional and inflammatory statuses may be impaired in this patient population. This study aimed to investigate the relationship between the presence and severity of ED and NPS.

Materials and Methods

Patient Selection

The ethical approval for the study was obtained from the University of Health Sciences Turkiye, Gülhane Scientific Research Ethics Committee in June 2024 (approval number: 2024-354, date: 28.06.2024). Data from patients who presented to two urology outpatient clinics with complaints of ED between July 2024 and January 2025 were retrospectively analyzed. Patients over 18 years of age with a regular sexual life were included. Patients with malignancy, autoimmune disease, or immunodeficiency; those under follow-up for diabetes mellitus, heart failure, or chronic kidney disease (glomerular filtration rate <60 mL/min); individuals with benign prostatic hyperplasia or psychogenic ED, those with a history of prostate surgery; and patients who had used selective phosphodiesterase type 5 inhibitors within the last three months were excluded from the study. After applying these criteria, a total of 163 patients with ED and 160 healthy controls without ED were evaluated.

Data Collection

At baseline, patients' age, weight, height, comorbidities, and physical examination findings were recorded. Laboratory tests, including absolute neutrophil, lymphocyte, and monocyte counts, as well as serum albumin and total cholesterol levels, were recorded within seven days of the initial examination.

All participants completed the validated Turkish version of the five-item International Index of Erectile Function (IIEF-5) questionnaire (13). The healthy control group consisted of volunteers with an IIEF-5 score of greater than or equal to 22. The patients with ED were also categorized into subgroups based on disease severity.

Statistical Analysis

SPSS version 24.0 was used for statistical analysis (version 24.0, IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was used to assess the normality of the numerical data distribution. Numerical parameters were compared using Student's t-test. The Cochran-Armitage and chi-square tests were used to compare categorical parameters. Independent parameters were determined using logistic regression analysis. A p-value of <0.05 was considered statistically significant.

The Cochran-Armitage trend test was used to compare variables with more than two ordered categories. This test was applied to assess whether there was a significant linear trend across ordered groups (14).

Ordinal logistic regression analysis was performed for the Naples score groups (more than two groups and ordinal scales) (15).

Results

The mean ages of the patients with ED and the control group were 58.7±12.4 and 56.9±12.8 years, respectively (p=0.197). The mean IIEF-5 scores of the ED and control groups were 13±4.7 and 23.6±1.3, respectively (p<0.001). There were no statistically significant differences between the groups in terms of body mass index, blood lymphocyte count, or monocyte count (p=0.148, p=0.059, and p=0.066). However, significant differences were observed in NPS group distribution (p=0.001), mean NPS score (1.5±1.1 vs. 1.0±0.9; p<0.001), smoking status (p=0.036), serum albumin level (p=0.019), total cholesterol level (p=0.043), and neutrophil count (p<0.001). The mean NLR values were 2.26±1.10 in the ED group and 1.74±0.58 in the control group (p<0.001), while the mean LMR values were 4.46±1.54 and 5.18±1.56, respectively (p<0.001). In a multivariate logistic regression analysis that compared patients with ED to healthy controls, NLR (p=0.020), mean NPS score (p=0.003), and the presence of NPS group 3-4 (p<0.001) were identified as independent predictors of ED. Table 1 provides a detailed comparison of the parameters between the two groups.

When patients with mild and mild-to-moderate ED (group 1) were compared to those with moderate and severe ED (group 2), their mean IIEF-5 scores were 16.2±2.4 and 7.6±1.9, respectively (p<0.001). No significant differences were found between the groups in terms of body mass index, total cholesterol level, albumin level, or monocyte count (p=0.212, p=0.067, p=0.498, and p=0.324). However, significant differences were observed in age (p=0.007), smoking status (p=0.001), neutrophil count (p=0.007), lymphocyte count (p<0.001), NLR (p<0.001), LMR (p<0.001), and mean NPS score (2.4±1.1 vs. 1.1±0.7; p<0.001).

NPS group distribution also differed significantly between these ED severity groups (p<0.001). Table 2 presents a detailed comparison of the parameters by ED severity. In the multivariate analysis, mean NPS score (p<0.001) and the presence of NPS group 3-4 (p=0.014 and p=0.042, respectively) remained independent predictors of increased ED severity.

In addition to group-wise comparisons, the mean NPS score was significantly higher in patients with ED than in healthy controls (1.5±1.1 vs. 1.0±0.9, p<0.001). Furthermore, in subgroup analysis according to ED severity, patients with moderate and severe ED had significantly higher mean NPS scores compared to those with mild or mild-to-moderate ED (2.4±1.1 vs. 1.1±0.7, p<0.001). These findings further support the association between elevated NPS and increased ED severity.

Additionally, a significant negative correlation was observed between NPS and IIEF-5 scores in patients with ED (r=-0.695, p<0.001). Mean IIEF-5 scores progressively decreased with increasing NPS values (NPS 0: 16.8±3.9; NPS 1: 15±3.2; NPS 2: 11.3±3.1; NPS 3: 8.7±4.6; NPS 4: 5.8±2.7; p<0.001, Welch's test). When grouped as NPS 0, NPS 1-2, and NPS 3-4, the corresponding mean IIEF-5 scores were 16.8±3.9, 13.8±3.6, and 7.6±4.2, respectively (p<0.001). Post-hoc analysis using the Games-Howell test revealed significant differences between NPS 0 and NPS 2, 3, and 4 (p<0.001); between NPS 1 and NPS 2, 3, and 4 (p<0.001); between NPS 2 and NPS 4 (p<0.001); and between NPS 3 and NPS 4 (p=0.008). In grouped comparisons, patients in the NPS 3-4 category had significantly lower IIEF-5 scores than those in NPS 0 and NPS 1-2 categories (p<0.001) (Table 3).

Table 1. Features of patients with ED and healthy controls

	Univariate analysis			Multivariate analysis
(n)	**ED group (n=163)**	**Control group (n=160)**	**p**	**p**
Age (year) mean ± SD	58.7±12.4	56.9±12.8	0.197[a]	
Smoking status				
Never	56 (34.4)	79 (49.4)	0.036[b]	0.217
Former	50 (30.7)	39 (24.4)		
Current	57 (34.9)	42 (26.2)		
BMI, mean ± SD	28.2±4.1	27.6±4.2	0.148[a]	
Albumin (g/dL), mean ± SD	4.2±0.4.4	4.5±0.2	0.019[a]	0.362
Total cholesterol (mg/dL), mean ± SD	201.7±41.5	193.6±26.9	0.043[a]	0.541
Neutrophil count (cell/mL), mean ± SD	4.510±1.770	3.760±0.980	<0.001[a]	0.275
Lymphocyte count (cell/mL), mean ± SD	2.130±0.630	2.310±0.790	0.059[a]	
Monocyte count (cell/mL), mean ± SD	510±150	470±190	0.066[a]	
NLR, mean ± SD	2.26±1.10	1.74±0.58	<0.001[a]	0.020
LMR, mean ± SD	4.46±1.54	5.18±1.56	<0.001[a]	0.060
NPS group			0.001[c]	
0	23 (14.1)	41 (25.6)		<0.001 <0.001 Reference
1-2	108 (66.3)	104 (65)		
3-4	32 (19.6)	15 (9.4)		
NPS, mean ± SD	1.5±1.1	1±0.9	<0.001[a]	0.003

Univariate analysis: [a]: Independent samples t-test, [b]: Chi-square test, [c]: Cochran-Armitage test multivariate analysis: ordinal logistic regression analysis, SD: Standard deviation, BMI: Body mass index, NLR: Neutrophil-to-lymphocyte ratio, LMR: Lymphocyte-to-monocyte ratio, NPS: Naples prognostic score, ED: Erectile dysfunction

Table 2. Features of patients with ED according to disease severity

	Univariate analysis			Multivariate analysis
	Mild and mild-to-moderate ED (n=102)	**Moderate and severe ED (n=61)**	**p**	**p**
Age (year), mean ± SD	57.8±11.6	63.1±12.8	0.007[a]	0.526
Smoking status				
Never	40 (39.2)	16 (26.2)	0.001[b]	0.463
Former	34 (33.3)	16 (21.3)		
Current	28 (27.5)	29 (52.5)		

Table 2. Continued				
	Univariate analysis			Multivariate analysis
	Mild and mild-to-moderate ED (n=102)	Moderate and severe ED (n=61)	p	p
BMI, mean ± SD	28.9±3.8	29.9±4.3	0.212[a]	
Albumin, (g/dL), mean ± SD	4.3±0.3	4.2±0.5	0.498[a]	
Total cholesterol, (mg/dL), mean ± SD	204.8±46.8	196.1±48.9	0.067[a]	
Neutrophil count, (cell/mL), mean ± SD	4.15±1.34	5.10±2.20	0.007[a]	0.907
Lymphocyte count, (cell/mL), mean ± SD	2.31±0.63	1.82±0.52	<0.001[a]	0.587
Monocyte count, (cell/mL), mean ± SD	0.49±0.14	0.52±0.17	0.324[a]	
NLR, mean ± SD	1.86±0.70	2.91±1.1	<0.001[a]	0.759
LMR, mean ± SD	4.97±1.56	3.59±1.01	<0.001[a]	0.426
NPS group				
0	20 (19.6)	3 (4.9)	<0.001[c]	0.014
1–2	78 (76.5)	30 (49.2)		0.042
3–4	4 (3.9)	28 (45.9)		Reference
NPS, mean ± SD	1.1±0.7	2.4±1.1	<0.001[a]	<0.001

Univariate analysis: [a]: Independent samples t-test, [b]: Chi-square test, [c]: Cochran-Armitage test multivariate analysis: ordinal logistic regression analysis, SD: Standard deviation, BMI: Body mass index, NLR: Neutrophil-to-lymphocyte ratio, LMR: Lymphocyte-to-monocyte ratio NPS: Naples prognostic score, ED: Erectile dysfunction

Table 3. IIEF-5 score of patients with ED according to NPS						
NPS	**0**	**1**	**2**	**3**	**4**	**p**
IIEF-5 score, mean ± SD	16.8±3.9	15±3.2	11.3±3.1	8.7±4.6	5.8±2.7	<0.001[a]
NPS group	**0**	**1-2**		**3-4**		
IIEF-5 score, mean ± SD	16.8±3.9	13.8±3.6		7.6±4.2		<0.001[a]

[a]: Welch's test, NPS: Naples prognostic score, ED: Erectile dysfunction, IIEF-5: Five-item version of the International Index of Erectile Function, Multivariate post-hoc analysis (Games-Howell test): NPS 0 vs. NPS 2, 3 and 4 (p<0.001), NPS 1 vs. NPS 2, 3 and 4 (p<0.001), NPS 2 vs. NPS 4 (p<0.001), NPS 3 vs. NPS 4 (p=0.008). NPS 0 vs. NPS 1-2 (p=0.005), NPS 3-4 vs. NPS 0 and NPS 1-2 (p<0.001)

Discussion

In this study, we evaluated the relationship between inflammatory and nutritional factors and the presence and severity of ED. NPS was significantly higher in patients with ED than in healthy controls. NPS was also higher in patients with moderate or severe ED than in those with mild or mild-to-moderate ED. Our results clearly indicate that nutritional and inflammatory parameters are impaired in patients with ED and that this impairment significantly correlates with disease severity. To the best of our knowledge, this is the first study to assess the association between NPS and ED (Figure 1).

Nutritional status is considered to play a critical role in disease progression and severity (16). Parameters such as serum albumin and cholesterol provide important prognostic information in various diseases (17). Given that NPS incorporates both nutritional and inflammatory components, it offers a comprehensive assessment tool. For example, Zhu et al. (18) reported that NPS was higher in patients with asthma and was associated with mortality. Similarly, Liu et al. (19) demonstrated that a high NPS was predictive of worse short-term (six-month) outcomes in patients with intracranial hemorrhage. Supporting this, a high NPS in our study was associated with more severe ED symptoms.

It has been suggested that dietary habits may also affect sexual function. Deng et al. (20) found that higher dietary intake of calcium, phosphorus, and potassium was associated with a lower risk of developing ED. Farag et al. (21) reported that ED was more prevalent among individuals with vitamin D deficiency, while Karabakan et al. (22) showed that folic acid levels were lower in patients with ED compared to healthy controls. These findings underscore the significant role of nutritional status, which is influenced by multiple factors, on sexual function.

Previous studies have also established a link between ED and systemic inflammation (23). It has been reported that NLR, a marker of systemic inflammation, is elevated in patients with ED. Sambel et al. (24) found that the median NLR was 1.93 in patients with ED, compared to 1.63 in controls, and Feng et al. (25) reported median NLR values of 2.36 in the ED group and 2.13 in the control group. Consistent with the literature, in our study, the mean NLR was 2.26 in patients with ED and 1.74 in controls.

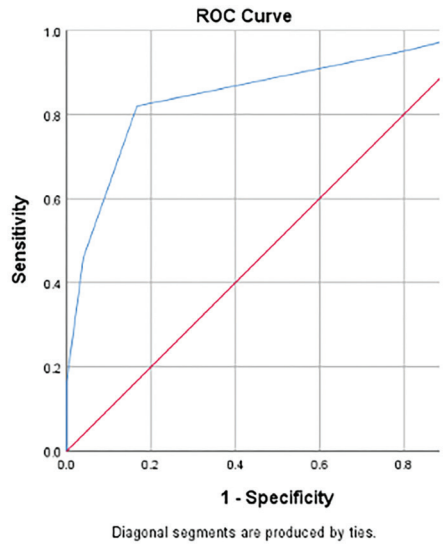

Figure 1. Receiver operating characteristic of NPS for predicting ED severity

In the ROC curve analysis, the optimal threshold value for NPS was determined as 2. The sensitivity of this threshold (NPS ≥2) for ED severity (moderate and severe ED versus mild and mild-to-moderate ED) was 82%, specificity was 83.3%, (area under the curve=0.849 and p<0.001)

ROC: Receiver operating characteristic, NPS: Naples prognostic score, ED: Erectile dysfunction

Sexual dysfunction is a well-documented clinical manifestation of chronic inflammatory diseases. Gaber et al. (26) found that ED was more prevalent among patients with rheumatoid arthritis compared to healthy volunteers and that it correlated with disease activity. Yıldız et al. (27) reported lower IIEF-5 scores in individuals with Behçet's disease compared to healthy controls and attributed this difference to impaired psychometric parameters and quality of life. Similarly, Zhang et al. (28) observed a higher prevalence of ED in patients with Crohn's disease and ulcerative colitis compared to the control group. The authors reported that impaired psychometric parameters and active perianal disease increased the presence of ED.

NPS has been widely used to predict prognosis in many types of cancer among oncological surgery patients (29,30). In the field of urology, Wang et al. (31) evaluated NPS in patients with renal cell carcinoma and found it to be a reliable preoperative prognostic marker. Additionally, Liang et al. (32) conducted a population-based study in China and reported that patients with cancer had higher NPS, and that those with high NPS had a worse prognosis..

Study Limitations

This study has several limitations. First, the retrospective design may constitute a limitation. Second, the relatively small number of patients could limit the generalizability of the results. However, we employed comprehensive exclusion criteria to create a highly selective cohort to minimize potential confounders. Nevertheless, considering the limited data published to date on this issue, our findings provide valuable insight, particularly as this study explores the relationship between NPS and ED while contributing to the existing body of literature.

Conclusion

In this study, NPS was found to be higher in patients with ED than in healthy volunteers. NPS was also higher in moderate or severe ED cases compared to mild or mild-to-moderate cases. To the best of our knowledge, this is the first study to evaluate the association between NPS and ED.

Ethics

Ethics Committee Approval: The ethical approval for the study was obtained from the University of Health Sciences Turkiye, Gülhane Scientific Research Ethics Committee in June 2024 (approval number: 2024-354, date: 28.06.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.B., E.A., Concept: E.B., E.A., Design: F.Y.İ., Y.K.T., S.B., Data Collection or Processing: Y.K.T., B.Ü., Analysis or Interpretation: F.Y.İ., S.B., Literature Search: F.Y.İ., Writing: F.Y.İ.

Conflict of Interest: No conflict of interest was declared by the authors.

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