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Original Research

Risk factors for decreased libido in men at high-altitudes: a cross-sectional study

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Abstract

Background: High-altitude regions' harsh conditions like low oxygen can affect male reproductive health, yet few studies focus on male libido decline in these areas.

Aim: To investigate the prevalence of decreased libido in men at high-altitudes and identify its risk factors.

Methods: In this cross-sectional study a total of 447 men living at high-altitudes in Ali, Tibet were recruited. Data on demographics, sleep quality, mental state, and sexual health were collected through face-to-face interviews and self-administered questionnaires. They were divided into a decreased libido group (n = 152) and a normal libido group (n = 295). Chi-square tests, t-tests, and multivariate logistic regression analysis were performed to analyze the differences between the two groups and find independent risk factors. Based on the results of the multivariable logistic regression analysis, the nomogram was constructed using the "rms" package in R software.

Outcomes: Determined the prevalence of decreased libido and key factors differentiating men with and without libido decrease.

Results: Significant differences were observed between the two groups in terms of age, cumulative high-altitude exposure, resting heart rate, daily oxygen inhalation time, exercise duration, type of exercise, companionship duration with the opposite sex, weight loss, self-rated sleep scale scores, and patient health questionnaire-9 scores. Multivariate analysis revealed that older age (OR = 1.15, 95% CI 1.11–1.20), longer high-altitude residence (OR = 1.08, 95% CI 1.05–1.11), reduced oxygen inhalation time (OR = 0.67, 95% CI 0.45–0.98), shorter exercise duration (OR = 0.75, 95% CI 0.55–1.01), decreased companionship time with the opposite sex (OR = 0.47, 95% CI 0.34–0.65), weight loss (OR = 2.05, 95% CI 1.19–3.54), poorer sleep quality (OR = 1.06, 95% CI 1.01–1.10), and higher levels of depression (OR = 1.10, 95% CI 1.04–1.16) are independent risk factors for decreased libido in men living at high-altitudes. A nomogram was developed and served as a reliable predictive tool for estimating the likelihood of decreased libido in men at high-altitudes, which provided a practical approach for risk assessment.

Clinical implications: Medical staff can use these findings to offer targeted health advice to high-altitude-dwelling men at risk, aiming to improve their sexual and overall health.

Strengths and limitations: Strengths include a relatively large sample size and rigorous statistical methods. Limitations encompass potential recall bias in self-reported data, restricted generalizability to low-altitude populations, and the absence of hormonal profiling due to logistical constraints.

Conclusion: Around 34% of men in high-altitude regions experience decreased libido. Understanding these risk factors is crucial for developing effective preventive and intervention strategies.

Keywords: high-altitude; libido; sexual health; hypoxia; sleep quality; depression; adaptation; physiological.

Background

High-altitude regions, characterized by low oxygen levels,[1] cold temperatures,[2] and intense ultraviolet radiation,[3] pose significant health challenges. Prolonged exposure to these conditions can lead to physiological and psychological adaptation issues.[4] The body responds to hypoxia by increasing heart rate to ensure adequate oxygen delivery,[5] resulting in elevated resting and exercise heart rates and additional strain on the cardiovascular system.[6] Hypoxia also disrupts sleep patterns, causing difficulties in falling asleep, increased nighttime awakenings, and prolonged light sleep phases, which impair rest and recovery.[7,8] Cognitive function is similarly affected, with reduced cerebral oxygenation leading to concentration difficulties, memory loss, slower reaction times, and diminished decision-making abilities.[9]

High-altitude hypoxia has been shown to adversely affect male reproductive health. Studies indicate that prolonged exposure to high-altitudes can lead to increased testicular oxidative stress and histological damage, resulting in reduced gonadal function and lower testosterone levels.[10] Research has demonstrated that individuals with lower testosterone levels tend to exhibit better acclimatization to high-altitude environments.[11,12] While this may facilitate adaptation, it can also negatively impact sexual desire, reproductive health, muscle mass, and emotional well-being.[13-16]

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Despite extensive research on general physiological adaptations to high-altitudes, studies specifically addressing the decline in male libido in these environments are scarce. This study aimed to address: Does prolonged high-altitude exposure increase the risk of decreased libido in men, and what are the key contributing factors? Investigating this issue is crucial to fill a research gap, improve quality of life, and inform health policies for populations in high-altitude areas.

Methods

Participants

This cross-sectional study adheres to the STROBE guidelines for observational studies. Prior to the study, we strictly adhered to ethical guidelines. We explained the study's purpose, procedures, potential risks, and benefits in detail to each participant and obtained their written informed consent.

This study incorporated males in the 18–60 age-range who had lived at altitudes of 3000 m or higher for a minimum of three straight months from 2023 to 2024. The recruitment of participants was centered around the allure of free comprehensive physical examinations, a strategy that not only encouraged participation but also facilitated the collection of in-depth health-related data. Participants were recruited voluntarily and provided informed consent. The age range was selected to focus on the working-age population while avoiding adolescent and elderly health issues. Participants needed adequate Chinese literacy to complete the questionnaires. Exclusion criteria included a history of mental health disorders, specifically diagnosed with schizophrenia, major depressive disorder, bipolar disorder, etc., which required professional psychiatric diagnosis and drug treatment within the past six months; severe chronic diseases, such as severe cardiovascular diseases (New York Heart Association functional class III or above); and use of medications affecting sexual function, including common antidepressants (eg, selective serotonin reuptake inhibitors), certain antihypertensive drugs (eg, thiazide diuretics). Missing data accounting for $<5\%$ were directly excluded. Of the 735 distributed questionnaires, 447 valid responses were collected, yielding an effective response rate of 60.8%. Given the challenges of recruitment in high-altitude regions, this study employed convenience sampling based on the maximum feasible sample size (735 participants), with 447 valid responses ultimately included. The sample size was determined primarily based on practical feasibility rather than statistical power calculations.

Data collection methods

Data were collected through face-to-face interviews and self-administered questionnaires, taking ~30–45 min per participant. The data collection tools included a general information questionnaire covering demographic characteristics, high-altitude adaptation, lifestyle, and work environment; the self-rated sleep scale (SRSS) for sleep quality assessment[17]; the patient health questionnaire-9 (PHQ-9) for depression screening; the generalized anxiety disorder-7 (GAD-7) for anxiety screening[18]; and the sexual desire inventory-2 (SDI-2) for sexual desire assessment.[19] Higher scores on the SRSS, GAD-7, and PHQ-9 indicate poorer sleep quality, more severe anxiety, and more severe depression, respectively. The SDI-2, a 14-item scale, measures sexual desire from a cognitive perspective, including four items evaluating frequency on an 8-point Likert scale and ten items assessing intensity on a 9-point Likert scale (0 = no sexual desire, 8 = extremely strong sexual desire). Participants with dyadic sexual desire (DSD) scores ≤ 24 and solitary sexual desire (SSD) scores ≤ 6 were classified as having decreased libido.[20] For the assessment of weight loss, it was defined as a reduction in body weight of $>5\%$. During data collection, participants were asked about any changes in their body weight, and this information was recorded accordingly to classify them into the "weight loss" or "no weight loss" category for subsequent analysis.

Data analysis

Data analysis was performed using IBM SPSS Statistics version 26.0 and R software version 4.3.1. Descriptive statistics were calculated for various variables to understand the study population's baseline. Univariate analysis with chi-square, t- and Mann-Whitney U tests was carried out, and *P*-values <0.05 were considered significant to screen factors related to decreased libido. Variables significant in univariate analysis ($P < 0.05$) were included in the multivariate logistic regression, which adjusted for confounders to identify independent risk factors, reported with *P*-values, Wald χ^2, OR, and 95% CI. The "rms" package in R was then used to construct a nomogram based on regression results. Regression coefficients were transformed into scores, total scores for participants were calculated and mapped to the probability scale of decreased libido. The nomogram's performance was evaluated by ROC curve (AUC) and calibration curve.

Result

Baseline characteristics of participants

In this study, 447 participants were categorized into a decreased libido group (152 individuals) and a normal group (295 individuals) based on their SDI-2 scores. The analysis revealed several significant differences between the two groups (Table 1): Participants in the decreased libido group were, on average, older and had lived in high-altitude environments for a longer duration compared to those in the normal group. They also exhibited higher resting heart rates, shorter daily oxygen inhalation times, and lower levels of physical activity, including less participation in chronic endurance training and fewer, shorter exercise sessions. Additionally, a lack of companionship with the opposite sex was more prevalent in the decreased libido group, and a greater proportion of these participants had experienced weight loss. Higher scores on the SRSS and the PHQ-9 were observed in the decreased libido group, indicating poorer sleep quality and higher levels of depressive symptoms. Notably, no statistically significant differences were found between the two groups regarding smoking status or scores on the GAD-7 scale.

Multivariate logistic regression analysis

The results of a multivariate logistic regression analysis (Table 2) indicate that increased age, long-term residence in high-altitude areas, weight loss, poor sleep quality, and symptoms of depression are primary independent risk factors for decreased libido. Conversely, daily oxygen inhalation time and the duration of companionship with the opposite sex serve as significant protective factors, contributing to a reduced risk of diminished libido.

Table 1. Baseline characteristics of participants.

Characteristics	Decreased libido		Total	X^2/t	*P*	95%CI [lower limit, upper limit]		
	Yes (n = 152)	No (n = 295)				Decreased libido	Normal libido	Total
Age(years)	35.86 ± 7.71	28.86 ± 6.21	31.24 ± 7.52	–9.68	<0.01	[34.63, 37.08]	[28.16, 29.57]	[30.54, 31.94]
Duration of high-altitude(months)	16.47 ± 12.90	7.29 ± 7.07	10.42 ± 10.41	–8.16	<0.01	[14.42, 18.52]	[6.49, 8.10]	[9.45, 11.38]
Resting heart rate				11.06	0.01			
<60	0(0.00)	6(2.03)	6(1.34)					
60–79	44(28.95)	123(41.69)	167(37.36)					
80–100	103(67.76)	159(53.90)	262(58.61)					
>100	5(3.29)	7(2.37)	12(2.68)					
Daily oxygen inhalation time				6.83	0.03			
0 h	34(22.37)	49(16.61)	83(18.57)					
<2 h	78(51.32)	133(45.08)	211(47.20)					
≥ 2 h	40(26.32)	113(38.31)	153(34.23)					
Smoking				0.09	0.76			
No	95(62.50)	180(61.02)	275(61.52)					
Yes	57(37.50)	115(38.98)	172(38.48)					
Daily exercise duration				15.91	<0.01			
0	79(51.97)	131(44.41)	210(46.98)					
<1 h	58(38.16)	89(30.17)	147(32.89)					
1–2 h	8(5.26)	29(9.83)	37(8.28)					
≥ 2 h	7(4.61)	46(15.59)	53(11.86)					
Daily exercise type				12.55	<0.01			
No exercise	16(10.53)	11(3.73)	27(6.04)					
Acute, resistance training	47(30.92)	70(23.73)	117(26.17)					
Chronic, endurance training	89(58.55)	214(72.54)	303(67.79)					
Daily duration of female companionship				42.72	<0.01			
0	121(79.61)	141(47.80)	262(58.61)					
<1 h	19(12.50)	79(26.78)	98(21.92)					
1–2 h	7(4.61)	36(12.20)	43(9.62)					
≥ 2 h	5(3.29)	39(13.22)	44(9.84)					
SRSS Score	20.20 ± 5.73	17.78 ± 7.10	18.60 ± 6.75	–3.63	<0.01	[19.29, 21.11]	[16.97, 18.59]	[17.98, 19.23]
PHQ-9 Score	6.61 ± 4.74	3.63 ± 4.76	4.64 ± 4.95	–6.26	<0.01	[5.85, 7.36]	[3.09, 4.18]	[4.19, 5.10]
GAD-7 Score	1.57 ± 3.02	1.33 ± 3.13	1.41 ± 3.10	–0.76	0.45	[1.08, 2.05]	[0.97, 1.69]	[1.12, 1.70]
Weight loss				18.01	<0.01			
No	58(38.16)	175(59.32)	233(52.13)					
Yes	94(61.84)	120(40.68)	214(47.87)					

Abbreviations: SRSS, self-rated sleep scale; PHQ-9, patient health questionnaire-9; GAD-7, generalized anxiety disorder-7. "Age (years)" and "Duration of high-altitude (months)" are in mean ± SD. Other categorical variables like "Resting heart rate" show counts and percentages. "SRSS Score", "PHQ-9 Score", and "GAD-7 Score" are mean ± SD for sleep, depression, and anxiety. "X2/t" gives test statistics and "*P*" is the *P*-value; $P < 0.05$ means significant group differences.

Establishment of a nomogram for the risk model

To predict the risk of decreased libido in males at high-altitudes, we developed a nomogram based on the results of a multivariate logistic regression analysis (Figure 1). This tool assigns a score to each identified risk factor and sums these scores to calculate an overall risk score, which estimates the likelihood of an individual experiencing reduced libido. The nomogram offers a visual and quantitative approach to assessing the cumulative impact of multiple factors on male sexual desire in high-altitude environments.

Figure 2a presents the Receiver Operating Characteristic (ROC) curve and calibration curve of the nomogram. The Area Under the Curve (AUC) of 0.89 indicates that the nomogram has excellent discriminatory power, effectively distinguishing individuals who are likely to experience decreased libido from those who are not. In clinical practice, such a model can assist physicians in identifying high-risk patients, enabling them to implement appropriate preventive measures or interventions. Figure 2b shows the calibration curve of the nomogram, which demonstrates its good calibration performance in predicting decreased libido. The close alignment between predicted probabilities and actual observations confirms that the nomogram is a reliable predictive tool, providing accurate estimates of the likelihood of decreased libido.[21]

Discussion

This study reveals that in men living in high-altitude regions, decreased libido is associated with multiple factors. Specifically, participants in the decreased libido group were found to be older on average, had a longer duration of residence in high-altitude environments, exhibited higher resting heart rates, spent less time on daily oxygen inhalation, participated less in physical activities, lacked companionship with the opposite sex more frequently, experienced poorer sleep quality, and showed more severe symptoms of depression compared to the normal control group. These findings suggest that prolonged exposure to high-altitude conditions and

Table 2. Multivariate logistic regression analysis.

Variable	b	SE	z	Wald χ2	*P*	OR	OR (95% CI)
Age	0.14	0.02	7.06	49.82	<0.01	1.15	1.11–1.20
Duration of high-altitude	0.08	0.02	5.02	25.19	<0.01	1.08	1.05–1.11
Resting heart rate	0.32	0.24	1.31	1.71	0.19	1.38	0.85–2.23
Daily oxygen inhalation time	–0.41	0.2	–2.08	4.34	0.04	0.67	0.45–0.98
Daily exercise duration	–0.29	0.15	–1.92	3.69	0.05	0.75	0.55–1.01
Daily exercise type	–0.3	0.23	–1.3	1.68	0.19	0.74	0.47–1.16
Daily duration of female companionship	–0.76	0.17	–4.5	20.21	<0.01	0.47	0.34–0.65
Weight loss	0.72	0.28	2.58	6.68	0.01	2.05	1.19–3.54
SRSS Score	0.05	0.02	2.42	5.85	0.02	1.06	1.01–1.10
PHQ-9 Score	0.1	0.03	3.52	12.37	<0.01	1.1	1.04–1.16

Abbreviations: SRSS, self-rated sleep scale; PHQ-9, patient health questionnaire-9. Rows represent independent variables. Columns: "B" is the regression coefficient (positive: higher outcome probability with increase; negative: lower), "SE" is its standard error (smaller = more precise), "Ward" is the Wald statistic for variable significance testing, "*P*" < 0.05 means statistical significance, "OR" (Odds Ratio) shows multiplicative change in outcome odds (OR > 1: risk factor; OR < 1: protective), and "95% CI" is the 95% confidence interval for OR (excluding 1 supports significance).

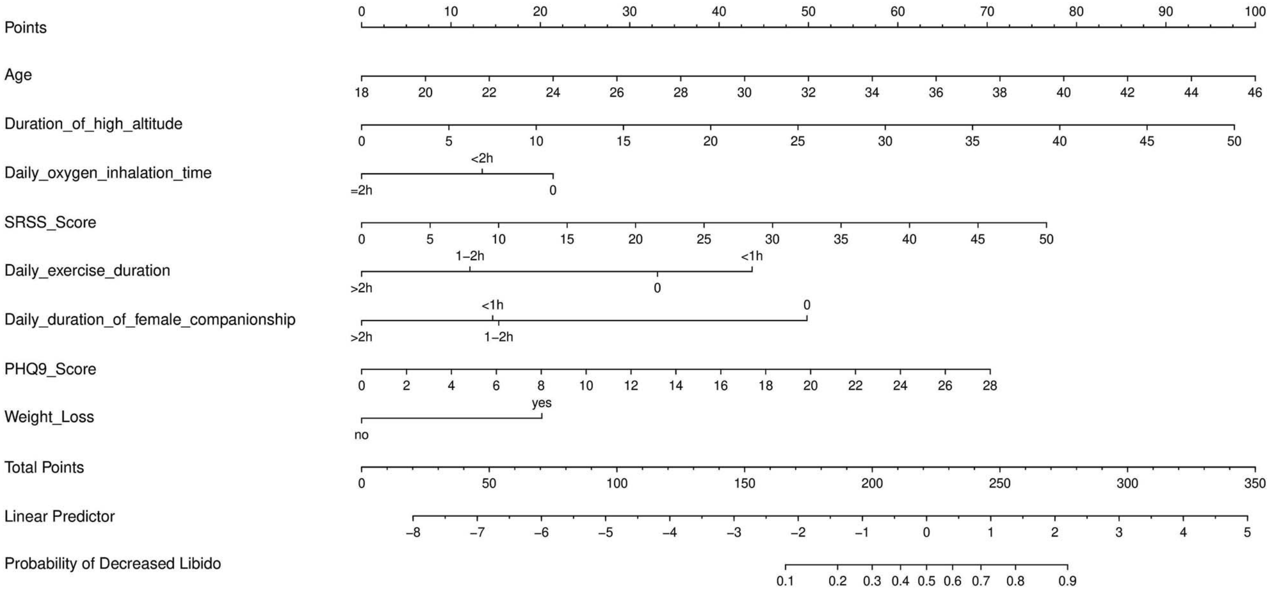

Figure 1. A nomogram of high-risk factors for reduced libido. The figure is a nomogram for high-risk factors of reduced libido. Axes represent individual risk factors, with a "points" scale above each to assign points based on regression coefficients. The "Total points" axis at the bottom sums these points. The right-hand "Probability of Reduced Libido" axis allows estimating an individual's risk by drawing a line from total points. It's a practical tool for quick, intuitive risk assessment, aiding early identification, and intervention.

accompanying lifestyle changes may have a detrimental impact on male sexual health.

According to the results of the multivariate logistic regression analysis, increased age, long-term residence in high-altitude areas, weight loss, higher stress levels, and depressive symptoms are significant independent risk factors for decreased libido. As individuals age, various bodily functions, including hormonal levels, naturally decline, which could contribute to reduced libido. The chronic hypoxic environment at high-altitudes can impose additional burdens on the cardiovascular and respiratory systems, leading to chronic hypoxia, which may indirectly affect sexual desire.[21] Weight loss, indicative of poor adaptation to high-altitudes, can lead to malnutrition, impacting hormonal balance and overall health, thereby lowering libido.[22] Research has shown that shorter and poorer sleep durations can reduce androgen levels, further affecting libido.[23] Beyond the emotional, psychomotor, and cognitive symptoms of this mood disorder, men with depression often report sexual dysfunction, including reduced libido, erectile dysfunction, and orgasmic disorders. Epidemiological studies have also documented lower testosterone concentrations in men with depression, suggesting that depression may be a potential cause of functional hypogonadism in men.[24]

Conversely, daily oxygen inhalation time and the duration of companionship with the opposite sex emerged as important protective factors, helping to mitigate the risk of decreased libido. In high-altitude regions, moderate supplemental oxygen can alleviate the negative effects of hypoxia, improving overall health and potentially maintaining normal libido levels.[25] Emotional support from a partner can provide psychological comfort and security, promoting mental and physical well-being, which positively influences libido.

Regarding smoking, although previous studies have shown its association with reduced testosterone and erectile dysfunction, in high-altitude environments, there may be special factors. The lifestyle and body metabolism of people in high-altitude areas are different from those in plain areas, which may affect the metabolism and effects of nicotine. As for the resting heart rate, although high-altitude affects

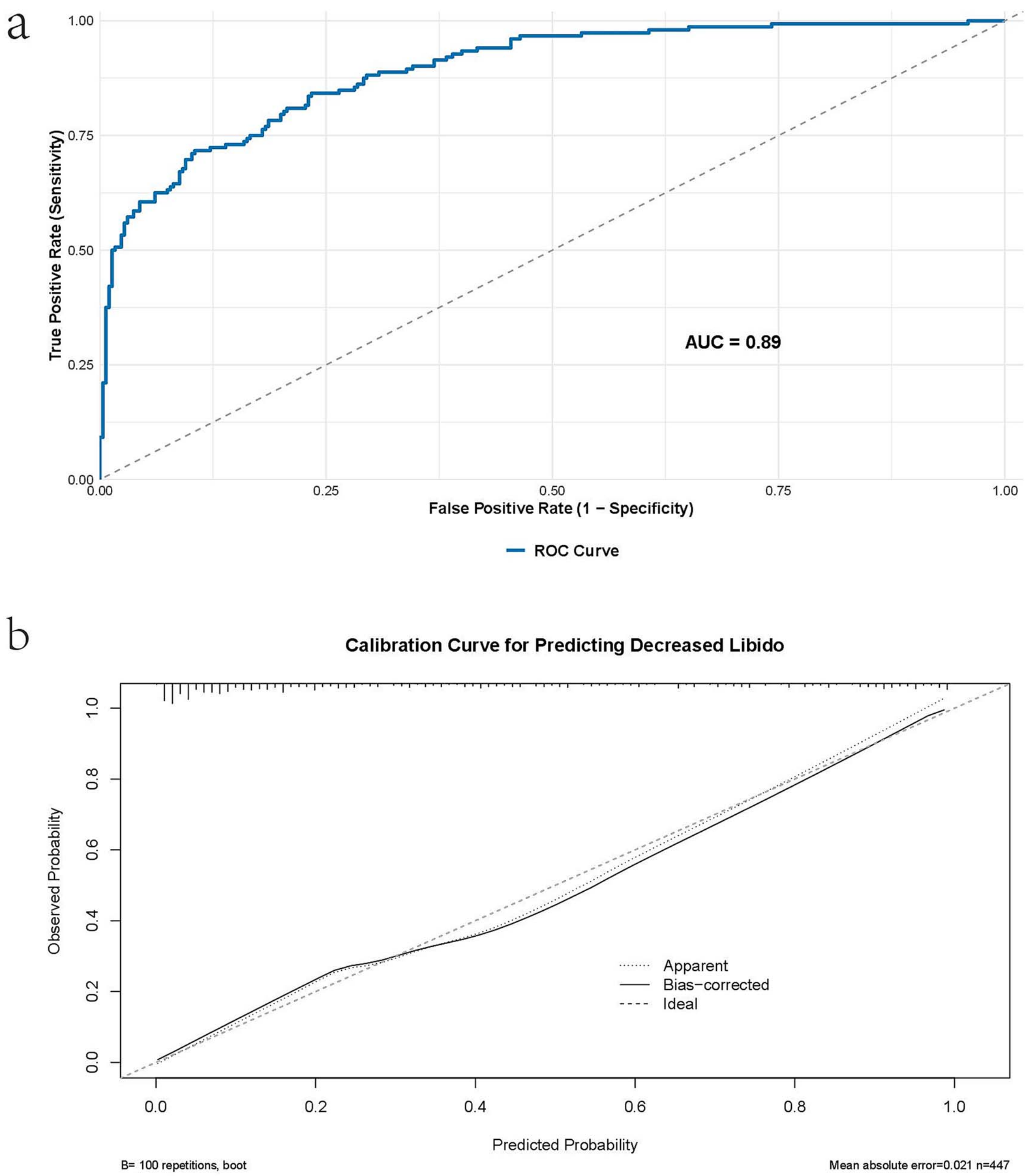

Figure 2. ROC curve and calibration curve of the prediction model.

cardiovascular function, it may not be a key factor directly affecting libido. The regulation of libido is a complex process involving multiple systems such as the nervous, endocrine, and psychological systems. The change in resting heart rate may just be an indicator of the adaptive changes of the cardiovascular system in high-altitude environments and does not directly participate in the core mechanism of libido regulation. We will further collect relevant data to explore the complex relationships among these factors in the future.

The nomogram developed based on the multivariate logistic regression analysis offers an intuitive and user-friendly method for predicting the risk of decreased libido. Healthcare professionals can quickly assess individual risk levels based on specific patient circumstances and develop appropriate intervention strategies. This tool not only aids clinical decision-making but can also be used for public health education, raising awareness about sexual health. The nomogram is designed for multiple applications. Clinically, doctors can use it to quickly assess the risk of decreased libido in male patients at high-altitudes,[26] providing a reference for personalized diagnosis and treatment. It also has potential applications in self-help and public health.

This study has several limitations that warrant consideration. First, the reliance on self-reported data introduces potential biases, including recall inaccuracies and social desirability effects.[27] Second, the sample was exclusively drawn from men residing in high-altitude regions, limiting the generalizability of findings to low-altitude populations or other demographic groups. The lack of a low-altitude control group limits direct comparisons; however, the observed prevalence of decreased libido (34%) substantially exceeds rates reported in comparable low-altitude cohorts (15%–25%),[28-30] highlighting the unique physiological stressors of high-altitude environments. Third, while hormonal assessments (eg, testosterone, LH, FSH) were initially planned, logistical constraints—including inadequate medical infrastructure and a lack of specialized personnel in remote high-altitude areas—precluded their inclusion. Future studies should prioritize endocrine profiling through collaborations with well-equipped institutions to clarify the mechanistic role of hormonal balance in altitude-related libido changes. Additionally, the developed nomogram, though validated for high-altitude populations, requires further testing before application to low-altitude settings. To address these limitations, longitudinal investigations are needed to validate current findings and explore understudied factors such as dietary patterns, cultural influences, and socioeconomic determinants, which may interact with altitude to shape sexual health outcomes.

In conclusion, this study underscores that decreased libido in men living in high-altitude regions is a multifaceted health issue involving both physiological and psychological factors. By identifying and understanding these factors, we can better prevent and manage this condition, thereby improving the quality of life for this population. Future research should continue to investigate the underlying mechanisms and develop more effective interventions.

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Author contributions

Dong-Dong Meng, Guo-Xiong Luo and Bing-Bing Niu contributed equally to this work.

DDM and CLZ: study conception and design; DDM and BBN: data collection; DDM and YDK: data analysis and interpretation; DDM: manuscript writing and reviewing; DHC: study supervision. All authors read and approved the final manuscript.

Dong-Dong Meng: Conceptualization, Data curation, Writing—original draft.

Guo-Xiong Luo and Bing-Bing Niu: Data curation, Formal analysis.

Chun-Lei Zhang: Methodology, Validation.

De-Hui Chang: Supervision, Writing—review & editing.

Yin-Dong Kang: Project administration, Resources.

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Conflicts of interest

They authors declare no potential conflicts of interests.

Data availability

The datasets generated during the current study are available from the corresponding author upon reasonable request.

Ethics statement

The study was approved by the Medical Ethics Committee of Joint Logistics Support Force 940 Hospital (No. 2022KYLL061). Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

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