OPEN ACCESS

LETTER

The Innovation Medicine

Male reproductive metabolic syndrome: Redefining the "male PCOS equivalent" and its link to erectile dysfunction

Haocheng Lin,[1,2,5] Zhongjie Zheng,[1,2,5] Qianxi Chen,[1,2,5] Eric Chung,[3,4,*] Huiyu Xu,[2,*] and Kai Hong[1,2,*]

[1]Department of Urology, Peking University Third Hospital, Beijing 100191, China

[2]Center for Reproductive Medicine, Department of Obstetrics and Gynecology, Peking University Third Hospital, Beijing 100191, China

[3]Department of Urology, Princess Alexandra Hospital and University of Queensland, Brisbane, QLD 4000, Australia

[4]AndroUrology Centre, St. Andrew's War Memorial Hospital, Brisbane, QLD 4000, Australia

[5]These authors contributed equally

*Correspondence: kenhong99@hotmail.com (K.H.); huiyu56@bjmu.edu.cn (H.X.); ericchg@hotmail.com (E.C.)

Received: April 7, 2025; Accepted: July 16, 2025; Published Online: July 17, 2025; https://doi.org/10.59717/j.xinn-med.2025.100144

Citation: Lin H., Zheng Z., Chen Q., et al. (2025). Male reproductive metabolic syndrome: Redefining the "male PCOS equivalent" and its link to erectile dysfunction. *The Innovation Medicine* **3**:100144.

Dear Editor,

This manuscript challenges the traditional understanding of Polycystic Ovary Syndrome (PCOS) as a condition predominantly affecting female, highlighting the existence of PCOS-like symptoms in males and proposing its definition as the term "Male Reproductive Metabolic Syndrome (MRMS)". Scholars have previously proposed the concept of the "male PCOS equivalent", which is a clinical presentation with symptoms similar to those seen in females with PCOS, including metabolic syndrome, insulin resistance, and reproductive issues.[1-3] However, the male PCOS equivalent is not currently recognized as any specific known disease. Although individuals in this population suffer significantly from its effects, they face difficulties in obtaining diagnosis and treatment. Although the male PCOS equivalent can describe this presentation and is being used by some scholars or physicians, the concept of the male PCOS equivalent is prone to ambiguity, as males do not have the ovarian organ. Therefore, we call for its redefinition and propose defining it as MRMS. In addition to the definition, diagnosing MRMS remains challenging because its diagnosis relies excessively on clinical symptoms, and there is a lack of uniform diagnostic criteria. Therefore, establishing diagnostic criteria for MRMS is of utmost importance, particularly the availability of quantifiable diagnostic indicators. Our initial research indicates a possible association between Anti-müllerian Hormone (AMH) and male erectile

A

Category	PCOS	MRMS
Core endocrine features		
	Hyperandrogenism	Hyperandrogenism
Reproductive manifestations		
	Female infertility	Male infertility
	Irregular menstruation	Erectile dysfunction
	Risk of endometrial cancer	Risk of prostate cancer
	Low libido	Low libido
Metabolic symptoms		
	Insulin resistance	Insulin resistance
	Obesity	Obesity
	Dyslipidemia	Dyslipidemia
	Diabetes mellitus	Diabetes mellitus
Secondary symptoms		
	Acne	Acne
	Hirsutism	Hirsutism
	Alopecia	Alopecia
	Sleep disordered breathing	Sleep disordered breathing
	Cardiovascular disease	Cardiovascular disease
Organ-specific pathology		
	Polycystic ovarian morphology	No ovarian equivalent

B

Items	Erectile dysfunction (n=210)	Male infertility (n=210)	*P*-value
Age (years), mean (SD)			
	31.04 (4.80)	31.28 (3.99)	0.29
AMH level (ng/mL), mean (SD)			
	12.40 (7.10)	8.81 (5.11)	<0.001
Cases in different AMH ranges, n (%)			
0-5	24 (33.33%)	48 (66.67%)	<0.001
5-10	68 (44.74%)	84 (55.26%)	
10-15	57 (50.44%)	56 (49.56%)	
>15	61 (73.49%)	22 (26.51%)	

C

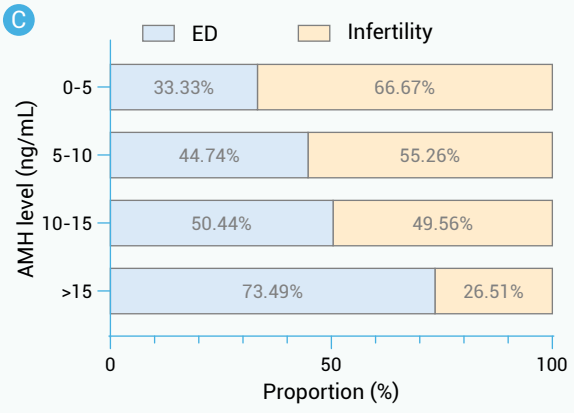

Figure 1. (A) Comparison of common PCOS and MRMS symptoms. (B) The comparison of age and AMH level between ED and infertility patients. (C) The proportion of ED and infertility in different AMH ranges. Data are represented as mean (SD).

dysfunction (ED), suggesting that AMH, known as a potential diagnostic marker for female PCOS, could be a significant indicator for further investigation into the MRMS.

CHALLENGING TRADITIONAL NOTIONS: REDEFINING MALE PCOS EQUIVALENT

PCOS has historically been recognized as a predominant endocrine disorder in women.[4] Since its initial description in 1935, the traditional definition of PCOS has centered on female clinical presentations, including irregular menstruation, hyperandrogenism, and polycystic ovarian morphology observed via ultrasound.[4] This framework was standardized at the 2003 Rotterdam conference, establishing diagnostic criteria and treatment approaches for female PCOS. However, advancing medical research has revealed that PCOS's pathophysiology is more complex than previously understood and extends beyond sex-specific boundaries.[2-6]

Recent attention has shifted to male manifestations of a condition resembling female PCOS, termed "male PCOS equivalent" or "male PCOS phenotype".[1,2] This discovery challenges traditional notions of PCOS and provides new insights into its impact on males. Males with PCOS-like symptoms often exhibit one or more of the following: metabolic syndrome, insulin resistance, hyperandrogenism, and reproductive dysfunction, the prevalence and impact of which may be severely underestimated.[2,3,6] Additionally, male relatives of women with PCOS also frequently exhibit metabolic abnormalities.[3]

However, research into the male PCOS equivalent faces multiple challenges. Firstly, the absence of uniform diagnostic criteria complicates the identification and study of the male PCOS equivalent.[2] Secondly, societal under prioritization of male reproductive health often delays diagnosis and treatment for affected individuals. Moreover, the pathophysiological mechanisms of the male PCOS equivalent remain incompletely understood, necessitating the accumulation of more clinical cases and further basic and clinical research to elucidate its endocrine and metabolic molecular mechanisms.[3] More importantly, it is widely believed that the name "male PCOS equivalent" is misleading because it implies a physiological function that does not exist in males. As recently proposed by Myers et al., to avoid mistakenly attributing ovarian-specific pathologies to males, the term "Endocrine Metabolic Syndrome" may better describe the male PCOS equivalent.[6] However, our emphasis lies in the recognition that the prominent abnormal reproductive manifestations of this condition are of greater significance, thus we recommend defining it as MRMS.

SYMPTOMS OF MRMS

The diagnosis of female PCOS largely relies on clinical symptoms and ovarian imaging, but males lack ovaries, making clinical symptoms particularly crucial for identifying MRMS. Figure 1A shows common symptoms of female PCOS and their male counterparts, aiding in the diagnosis of MRMS.

The absence of diagnostic criteria for MRMS[2,3] leads to inconsistent diagnoses and non-standardized treatments. Diagnostic methods of MRMS often focus on male PCOS equivalent, which depending clinical symptoms, such as reproductive dysfunction, increased body hair, or weight gain. However, these symptoms vary significantly among different patients and overlap with other endocrine disorders, making diagnosis highly uncertain. Moreover, PCOS can be diagnosed by observing ovarian morphology via ultrasound and measuring hormone levels, while MRMS currently lacks of accurate quantifiable diagnostic indicators, ultimately making the establishment of precise diagnostic criteria for MRMS a significant challenge.

To address these limitations, researchers are exploring the application of biomarkers in the diagnosis of the male PCOS equivalent.[3,5] Potential biomarkers include changes in hormone levels (such as testosterone, sex hormone-binding globulin, luteinizing hormone), metabolic parameters (such as blood sugar, blood lipids, insulin resistance index), and inflammatory markers (such as C-reactive protein[5]). Accurate measurement and analysis of these biomarkers provide the possibility for early diagnosis and precise typing of the MRMS.[7]

AMH AND PCOS

AMH has emerged as a significant biomarker in reproductive health research.[4,5] Traditionally, AMH has been primarily used to assess ovarian reserve function in females, but recent evidence suggests that AMH also plays an important role in male reproductive health.[5,7,8] AMH is a hormone secreted by testicular Sertoli cells, and its levels can reflect testicular reproductive function.[8] In males with PCOS-like symptoms, abnormally elevated AMH levels may be associated with insulin resistance, hyperandrogenism, and metabolic syndrome.[3,5] These pathological changes not only affect reproductive health but may also indirectly lead to erectile dysfunction by affecting vascular health and nerve function.

Researchers are exploring the use of AMH as a new diagnostic marker for male PCOS equivalent.[3,5,8] By combining AMH measurements with other hormonal and metabolic parameters, a more comprehensive assessment of the patient's reproductive health can be made.[8,9] Moreover, using machine learning algorithms to analyze the combination of these biomarkers can improve diagnostic accuracy and predict disease progression.[7]

For treatment, personalized treatment methods for male PCOS-like symptoms patients with abnormal AMH levels are being developed. Improving insulin sensitivity may help reduce AMH levels and potentially enhance erectile function. In addition, lifestyle adjustments, such as a balanced diet and regular exercise, have shown positive effects on metabolic health and sexual function. As an emerging biomarker, AMH holds promise in the diagnosis and treatment of the MRMS and its related complications.

AMH AND ED

ED is one of the typical symptoms of MRMS. To investigate the relationship between AMH and ED, we retrospectively included male outpatients aged 18-40 who visited the Reproductive Medicine Center of Peking University Third Hospital from December 3, 2023, to May 30, 2024, and underwent AMH testing. The exclusion criteria for this study were: 1) patients with concurrent diagnoses of erectile dysfunction (ED) and male infertility; 2) individuals with a history of testicular/penile trauma or surgical interventions involving the reproductive system; 3) those with hormone-related disorders (e.g., hypogonadism, cryptorchidism, testicular tumors); and 4) patients diagnosed with type 1 or type 2 diabetes mellitus. Serum AMH levels were measured using an ultrasensitive two-site enzyme-linked immunosorbent assay (ELISA) (Ansh Labs). The sensitivity and quality control of each assay were assessed by Xu et al.[9] 420 cases in total were included.

Based on whether the patients were diagnosed solely with erectile dysfunction or male infertility, they were divided into the ED group (n = 210) and the male infertility group (n = 210). Considering the absence of standardized male AMH reference ranges, we stratified AMH levels into four ranges: 0-5 ng/mL, 5-10 ng/mL, 10-15 ng/mL, and >15 ng/mL, following the same criteria used in a prior study to compare disease distribution across different AMH tiers.[10]

Data processing and analysis were carried out using SPSS 29.0 software. Normally distributed variables like age and AMH levels are presented as mean ± standard deviation. The independent - samples t-test was applied for comparisons between groups. Categorical variables were analyzed using the chi-square test with continuity correction. All tests were two-tailed with a significance level of $P < 0.05$.

There was no significant difference in age between the ED group (31.04 ± 4.80 years) and the male infertility group (31.28 ± 3.99 years, P=0.29). However, the AMH level in patients with only ED was significantly higher than that in infertile patients (12.40 ± 7.10 ng/mL vs. 8.81 ± 5.11 ng/mL, P<0.001), suggesting differences in AMH values between male infertility and erectile dysfunction (Figure 1B).

Further stratified analysis showed distinct disease distribution patterns between groups. In the 0-5 ng/mL range, the male infertility group accounted for 66.67% of cases compared to 33.33% in the ED group. This trend reversed in higher AMH ranges, with the ED group dominating in the >15 ng/mL category (73.49% vs. 26.51%, P<0.001). Intermediate ranges (5-10 ng/mL and 10-15 ng/mL) showed a gradual shift in proportions (ED group: 44.74% and 50.44%, respectively), indicating an AMH-level-dependent association with disease status (Figures 1B-C).

DISCUSSION AND CONCLUSION

While AMH is traditionally utilized to assess female reproductive function, this study innovatively applies it to the investigation of male ED, shedding

light on its potential role in male reproductive health. The significant difference in AMH mean values may reflect alterations in certain endocrine or physiological mechanisms in ED patients. Notably, the ED group dominated in the >15 ng/mL category, while the male infertility group showed a higher proportion in the 0-5 ng/mL range. This polarized distribution suggests that elevated AMH levels (>15 ng/mL) may serve as a risk indicator for ED, whereas lower AMH levels (0-5 ng/mL) may associate more strongly with infertility. The gradual shift in proportions across intermediate ranges (5-10 ng/mL and 10-15 ng/mL) further supports an AMH-level-dependent relationship with disease status. These findings warrant further clinical research to validate AMH's diagnostic or predictive value in male reproductive disorders.

In the male, AMH is secreted by Sertoli cells in the testes. During the embryonic development stage, it plays a crucial role in sex differentiation. Male embryos start to secrete AMH at around 8 weeks of gestation.[8] AMH binds to the receptors on the surface of Müllerian duct cells, inducing apoptosis of Müllerian duct cells, leading to the regression of the Müllerian duct, and thus preventing the development of female reproductive organs.[8] After puberty, AMH may exert an impact on reproductive function through the hypothalamic-pituitary-gonadal (HPG) axis. Although the specific mechanism remains incompletely understood, some studies have hypothesized that AMH may be involved in regulating the secretion of gonadotropin-releasing hormone (GnRH), thereby influencing the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH), and ultimately affecting spermatogenesis in the testes.[5,8]

Furthermore, in terms of sexual function, the potential association between AMH and ED has attracted significant attention. Some research indicates that AMH may affect erectile function by influencing the function of vascular endothelium and altering the blood supply to the corpus cavernosum of the penis. Meanwhile, AMH may also interfere with the synthesis and metabolism of androgens. Androgens play a vital role in maintaining penile erectile function, which indirectly affects male sexual function.

By conducting an in-depth analysis of clinical cases and integrating innovative diagnostic and therapeutic approaches, we can provide these patients with more effective health management strategies in the future. Future research should establish specific diagnostic criteria for MRMS, which should integrate clinical symptoms, biomarker panels, and exclusion of other endocrine disorders. In terms of treatment, current approaches may include lifestyle modifications and androgen regulation, with personalized strategies formulated based on biomarker profiles.[7]

Integrating the concept of MRMS into this discourse amplifies our understanding of the interplay between metabolic health and reproductive function. This syndrome, which encompasses both metabolic and reproductive aspects, offers a comprehensive framework for studying and treating the male PCOS equivalent. By recognizing the metabolic aberrations often present in ED patients and their potential to escalate into cardiovascular events, we can better appreciate the significance of early health markers such as male infertility. Defining the male PCOS equivalent as MRMS not only reflects the syndrome's metabolic and reproductive characteristics but also underscores the urgency of developing targeted diagnostic criteria and treatment plans to address this complex condition.

LIMITATIONS

This study still has its limitations. First, the single-center retrospective design may introduce selection bias, and the lack of dynamic follow-up and uncontrolled confounding factors result in insufficient clinical evidence. Besides, the absence of standardized male reference ranges for AMH may lead to an overestimation of its role as a potential biomarker.

REFERENCES

1. Kurzrock R. and Cohen P. R. (2007). Polycystic ovary syndrome in men: Stein-Leventhal syndrome revisited. *Med. Hypotheses* **68**:480–483. DOI:10.1016/j.mehy.2006.03.057
2. Cannarella R., Condorelli R. A., Mongioi L. M., et al. (2018). Does a male polycystic ovarian syndrome equivalent exist. *J. Endocrinol. Invest.* **41**:49–57. DOI:10.1007/s40618-017-0728-5
3. di Clemente N., Racine C. and Rey R. A. (2022). Anti-mullerian hormone and polycystic ovary syndrome in women and its male equivalent. *Biomedicines* **10**:2506. DOI:10.3390/biomedicines10102506
4. Stener-Victorin E., Teede H., Norman R. J., et al. (2024). Polycystic ovary syndrome. *Nat. Rev. Dis. Primers* **10**:27. DOI:10.1038/s41572-024-00511-3
5. Xu H., Zhang M., Zhang H., et al. (2021). Clinical applications of serum anti-mullerian hormone measurements in both males and females: An update. *The Innovation* **2**:100091. DOI:10.1016/j.xinn.2021.100091
6. Myers S. H., Soulage C. O. and Unfer V. (2025). Endocrine metabolic syndrome and metabolic syndrome: Distinct but interrelated pathologies. *Gynecol. Obstet. Invest.* **20**:1–11. DOI:10.1159/000545280
7. Feng G., Xu H., Wan S., et al. (2024). Twelve practical recommendations for developing and applying clinical predictive models. *Innov. Med.* **2**:100105. DOI:10.59717/j.xinn-med.2024.100105
8. Xu H. Y., Zhang H. X., Xiao Z., et al. (2019). Regulation of anti-Mullerian hormone (AMH) in males and the associations of serum AMH with the disorders of male fertility. *Asian J. Androl.* **21**:109–114. DOI:10.4103/aja.aja_83_18
9. Xu H., Zeng L., Yang R., et al. (2017). Retrospective cohort study: AMH is the best ovarian reserve markers in predicting ovarian response but has unfavorable value in predicting clinical pregnancy in GnRH antagonist protocol. *Arch. Gynecol. Obstet.* **295**:763–770. DOI:10.1007/s00404-016-4274-8
10. Tal R., Seifer D. B., Khanimov M., et al. (2014). Characterization of women with elevated antimullerian hormone levels (AMH): Correlation of AMH with polycystic ovarian syndrome phenotypes and assisted reproductive technology outcomes. *Am. J. Obstet. Gynecol.* **211**:59 e51–58. DOI:10.1016/j.ajog.2014.02.026

FUNDING AND ACKNOWLEDGMENTS

This research is financially supported by the National Key Research and Development Program (Grant No. 2024YFC2706900, 2023YFC2705500, 2023YFC2705501 and 2023YFC2705504), the National Science Foundation of China (Grant No. 82371633), Beijing Municipal Natural Science Foundation (Grant No. 7212134), the Fundamental Research Funds for the Central Universities: Peking University Clinical Scientist Program (Grant No. BMU2023PYJ H012) and the Clinical Cohort Construction Project C of Peking University Third Hospital (Grant No. BYSYDL2024011) . The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

AUTHOR CONTRIBUTIONS

All authors contributed significantly to the research. Lin H and Xu H were responsible for the conceptualization and study design. Zheng Z and Chen Q conducted data collection, performed data analysis, and interpreted the results. Lin H and Zheng Z were responsible for the drafting of the initial manuscript. Chung E, Hong K and Xu H contributed to the literature review, engaged in discussions, and revised the manuscript. All authors contributed to and approved the manuscript.

DECLARATION OF INTERESTS

The authors declare no competing interests.

ETHICAL STATEMENT AND PATIENT CONSENT

This study was conducted in accordance with the ethical standards of the Institutional Review Board of Peking University Third Hospital, and the protocol was approved by the same ethical committee (Approval Number: LM2025305). The study adhered to the Declaration of Helsinki and all applicable regulatory requirements for the protection of human subjects in medical research.

DATA AND CODE AVAILABILITY

Data are available from the corresponding author upon reasonable request.