

# Polycystic Ovary Syndrome and Pelvic Floor Dysfunction: A Narrative Review

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Marzieh Saei Ghare Naz<sup>1</sup>  
Fahimeh Ramezani Tehrani<sup>2</sup>  
Tahereh Behrooz-Lak<sup>3</sup>  
Farnaz Mohammadzadeh<sup>4</sup>  
Farhnaz Kholosi Badr<sup>4</sup>  
Giti Ozgoli<sup>5</sup>

<sup>1</sup>Student Research Committee, Reproductive Endocrinology Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran;

<sup>2</sup>Reproductive Endocrinology Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran;

<sup>3</sup>Reproductive Health Research Center, Department of Infertility, Urmia University of Medical Sciences, Urmia, Iran; <sup>4</sup>Department of Reproductive Health, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran; <sup>5</sup>Department of Midwifery and Reproductive Health, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran

**Abstract:** Pelvic floor dysfunction is one of the most common disorders in women that is associated with social and economic consequences. In general, this disorder imposes direct and indirect costs on the economy of various societies. This review aimed to investigate pelvic floor dysfunction in women with polycystic ovary syndrome (PCOS). In this narrative review, the published articles on pelvic floor dysfunction were examined in PubMed, Scopus, Web of Sciences and Google Scholar. We searched for terms related to polycystic ovary syndrome and pelvic floor dysfunction. Inclusion criteria of this research were observational, experimental, and review studies. In this investigation, the complications associated with polycystic ovary syndrome were examined as risk factors for pelvic floor dysfunction. In this narrative review, we discuss about changes in hormone levels, obesity and overweight, hormonal medications and complications such as diabetes and metabolic disorders and obstetric complications of PCOS can be involved in the pathophysiology of pelvic floor dysfunctions, including stress urinary incontinence and pelvic organ prolapse in women with PCOS. This review highlights knowledge gaps about protective effect of hyperandrogenism on pelvic floor dysfunction as well as destructive effect of metabolic changes on pelvic floor dysfunction in women with PCOS. Further cohort and prospective studies are recommended in women with PCOS to investigate the concept of pelvic organ dysfunction in these women.

**Keywords:** pelvic floor, muscles, urinary stress incontinence, polycystic ovary syndrome

## Introduction

Millions of women around the world suffer from symptoms of pelvic floor dysfunction.<sup>1,2</sup> Pelvic organ prolapse is a function of the weakness or injury of supporting tissues of pelvic floor, which is associated with the pressure of organs on different parts of the vagina (anterior, posterior, apex). The female pelvic floor provides support for the organs that lie on it and plays an important role in sexual function and parturition, as well as controlling the release of urine and feces.<sup>3</sup> The dysfunction of pelvic floor muscle affects contraction and fiber length of pelvic floor muscles.<sup>4</sup>

Several sexual, urinary and digestive symptoms are present in pelvic floor dysfunction and prolapse of pelvic organs.<sup>5,6</sup> A study on Korean women showed that the prolapse rate of pelvic organs in women over 50 years of age was 180 per 100,000.<sup>7</sup> Urinary incontinence is a complication of pelvic floor disorders with prevalence rates of 5–70% in different countries as well as 25–40% incidence in the majority of studies.<sup>8</sup> Pelvic floor disorders are frequently observed in women and can be influenced by factors such as age, type and number of childbirths, multiple birth, high BMI, and

Correspondence: Giti Ozgoli  
Department of Midwifery and Reproductive Health, Midwifery and Reproductive Health Research Center, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran  
Tel/Fax +98 21 88202512  
Email gozoli@gmail.com

family history.<sup>9,10</sup> The pathophysiology of pelvic floor disorders involves factors such as genetics, hormonal imbalance, and neuromuscular damage.<sup>11–14</sup>

Prevailing scientific literature has indicated the presence of androgen receptors in the levator ani muscle and pelvic fascia.<sup>15</sup> The existence of androgen receptors in the vaginal wall can play an essential role in the development of pelvic floor disorders in women.<sup>16</sup> Thus, androgen-related disorders may interfere with the function of pelvic floor muscles. In this regard, polycystic ovary syndrome (PCOS) is one of the most heterogeneous disorders in women of reproductive age, which is associated with the increase in androgen levels.<sup>17</sup> The prevalence of PCOS has been reported at 3–10%, which is different across geographical locations as well as races and ethnicities.<sup>18</sup> The clinical characteristics of PCOS include oligomenorrhea, hirsutism, baldness and acne.<sup>19</sup> Based on the Rotterdam criteria, there are four phenotypes of PCOS as follows: (A) hyperandrogenism (HA), chronic anovulation (AO) and polycystic ovaries (PCOM); (B) (AO + PCOM); (C) (HA + AO); (D) (HA + PCOM).<sup>20</sup> The long-term complications of PCOS include impaired glucose tolerance and diabetes, cardiovascular disease and hypertension, dyslipidemia, endometrial cancer, ovarian cancer, and breast cancer.<sup>21,22</sup> The results of some studies on women with PCOS indicated a higher frequency of pelvic organ prolapse in them.<sup>23</sup> Another research showed that the strength of pelvic floor muscle of women with PCOS is similar to women without PCOS.<sup>24</sup> According to the evidence, women with polycystic ovaries may have abnormal electromyography activity the urethral sphincter.<sup>25</sup>

Disorders of pelvic floor muscles have negative effects on women's emotions and sentiments and are associated with psychological problems such as depression, anger, anxiety, sadness,<sup>26</sup> as well as social burdens at individual and community levels.<sup>27</sup> In general, pelvic floor dysfunctions inflict direct and indirect costs on the economy of societies.<sup>28–31</sup> Given the increasing frequency of PCOS and pelvic floor dysfunctions and the lack of a study investigating the relationship between pelvic floor dysfunction in women with PCOS, this review examines pelvic floor dysfunction in such women.

## Method

This narrative review is based on SANRA (scale for the quality assessment of narrative review articles), which is a feasible and valid scale for assessment of narrative reviews to improve the standard of nonsystematic reviews.<sup>32</sup>

This study was approved by ethical committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran with ethic code number [IR.SBMU.RETECH.REC.1397.970].

In this study, a review of articles published on pelvic floor disorders in PubMed, Scopus, Web of Sciences and Google Scholar was performed and the following Medical Subject Headings [MeSH] terms were searched: stress incontinence, urinary incontinence, urine incontinence, pelvic organ prolapse, androgens, testosterone, hormones, POP, muscle, pelvic floor dysfunction, menstrual cycle, polycystic ovary syndrome, PCOS, obesity, overweight, metabolic syndrome, diabetes, body mass index, waist circumference, insulin resistance, hypertension. We combined search terms and fields using AND, OR. The search was performed by two researchers without time limitation until December 2019. The manual search of the reference lists of articles was carried out by researchers. The search strategy was developed with English language restriction.

Inclusion criteria of this study were observational, experimental, and review studies. After searching the mentioned databases, the titles and abstracts of the articles were studied and then the full text of related research was reviewed. In this research, the symptoms and complications associated with PCOS were investigated, which were risk factors for pelvic floor disorders, and played a role in its pathophysiology. Therefore, the findings were presented in the form of clinical and biochemical symptoms related with PCOS and pelvic floor dysfunction. The population in this research included women with PCOS or women without it and the indicator of this study was pelvic organ dysfunction. A total of 78 references were used in this narrative review.

## Results and Discussion

### Hormonal Changes

Hormonal imbalance has been claimed to be involved in the pathophysiology of pelvic floor dysfunction. Hormones play a crucial role in pelvic floor function and hormonal changes throughout the life of women and are implicated in several aspects of pelvic floor physiology.<sup>33</sup> Testosterone is a male hormone with an essential role in the function of pelvic floor muscles and lower urinary tract by increasing muscle mass and decreasing adipose tissue of skeletal structure, inducing protein synthesis and modulating the physiological function of lower urinary tract through nitric oxide.<sup>34</sup> There are high levels of testosterone in the third

decade of life in women, which are gradually reduced afterwards.<sup>35</sup>

The question is whether women with PCOS who have high levels of androgen show disrupted pelvic floor function? Evidence in this respect remains insufficient, although a number of studies have noted the positive effect of testosterone. A case–control study performed on 103 women with PCOS and 99 women as the control group used a pelvic floor distress questionnaire. The results showed that pelvic organ prolapse was higher in women with PCOS, especially in those with hyperandrogenic phenotype, menstrual cycle disorder, and polycystic ovary ultrasound and that there was a significant correlation between luteinizing hormone levels and pelvic organ prolapse symptoms in this study.<sup>23</sup> The result of the Douchi et al study showed that serum testosterone levels of PCOS women with a mean age of 28.8 years was related to the distribution of peripheral muscle mass.<sup>36</sup> Evidence has shown that testosterone may induce muscle hypertrophy.<sup>37</sup> The pelvic muscle strength plays an important role in effective function of this muscle.<sup>4</sup> Kogure et al reported that progressive resistance training three times per week for four months among 45 PCOS and 52 nonPCOS women leads to increased muscle strength in women with PCOS because of hyperandrogenism.<sup>38</sup> In a case–control study (PCOS=36 and control=43), Antônio et al reported that the pelvic floor muscle strength was not significantly different between PCOS and the control group and that the prevalence of urinary incontinence in the PCOS group was 0% and control group was 18%.<sup>24</sup>

Some studies have attempted to identify the androgens role in pelvic organ function. Kim et al conducted a study on 2321 women aged over 20 years to examine the relationship between testosterone levels and urinary incontinence. The findings of this study showed that the probability of stress urinary incontinence (SUI) and mixed incontinence were increased by 1.45- and 1.68-fold among women with low testosterone levels, respectively, but there was no association between testosterone level with urgent incontinence.<sup>35</sup> Teleman et al examined 6917 Swedish women aged 50–59 years and found that high levels of estradiol (and not testosterone) were associated with female urinary incontinence.<sup>39</sup>

Medications used by women with PCOS may have a role in pelvic organ function because of the hormonal component of some of them. Oral contraceptives are a treatment option for women with PCOS.<sup>40</sup> Nurses' Health Study results in Boston on 21,864 premenopausal nurses indicated that women who used oral contraceptives were on average 27%

more likely to develop urinary incontinence.<sup>41</sup> According to the results of a cohort study on Swiss women, those taking oral contraceptives had a reduced risk of developing symptoms related to stress, urgent, and mixed incontinence.<sup>42</sup> There is no evidence about the medical management of PCOS and risk of pelvic organ dysfunction.

Estrogen and progesterone may play a role in the function of the lower urinary tract via central mechanisms on neural receptors; estrogen can also alter the function of the bladder and urethra by changing cell cycle activity, blood flow, collagen synthesis and sensitivity of alpha-adrenergic receptors.<sup>43,44</sup> Women with PCOS may experience hyperestrogenism.<sup>45,46</sup> Micussi et al in their study of 30 women having menstrual cycles with ovulation showed that estradiol levels on the seventh day of the menstrual cycle as well as testosterone levels on twenty-first day were associated with pelvic floor muscle tone.<sup>47</sup> However, the following question is raised: are women with PCOS who experience hormone imbalance at a higher risk of pelvic floor dysfunction? Although it has been suggested that high androgen levels in women with PCOS and the presence of androgen receptors in the urinary tract may have a protective role on pelvic floor muscle function, there is still insufficient evidence to support the protective role of PCOS in pelvic floor muscle dysfunction.<sup>48</sup> In a cross-sectional study of 42 PCOS patients and 13 premenopausal women, Micussi and colleagues reported that the serum levels of estradiol and testosterone correlated with pelvic floor muscle tone and that maximum voluntary contraction (MVC) and PCOS patients had higher electromyographic value; in other words, the hyperandrogenism in these patients had a protective effect on pelvic floor muscles.<sup>49</sup> Future studies are needed to investigate the potential effect of hormonal imbalance and pelvic organ function in women with PCOS.

## Obesity

Obesity, being overweight and central obesity are common disorders of women with PCOS.<sup>50,51</sup> Obesity may be a risk factor for SUI and lower urinary tract symptoms (LUTS).<sup>52</sup> Evidence has shown that intra-abdominal pressure increases in obese women, leading to pelvic floor injury and increased likelihood of stress incontinence in addition to affecting the neuromuscular function of the urinary tract.<sup>53</sup> A meta-analysis showed that overweight and obese women were 1.36 and 1.47 times more likely to develop pelvic organ prolapse, respectively.<sup>54</sup> Every five-unit increase in BMI is associated with 20–70% increase

in the likelihood of stress incontinence in women.<sup>55</sup> Although weight loss is not usually associated with anatomical improvement, it reduces symptoms of pelvic organ prolapse.<sup>56</sup>

While the role of obesity in the development of pelvic organ prolapse symptoms is generally unknown, it has been suggested that weight loss in obese people plays an important role in reducing pelvic organ prolapse symptoms.<sup>52</sup> Montezuma et al who studied symptoms of urinary incontinence among women with PCOS examined four groups of women aged 18–40 years as follows: 18 women with PCOS having normal BMI, 32 patients with polycystic ovary syndrome with BMI >25 kg/m<sup>2</sup>, 29 controls with normal BMI, and 34 controls with BMI <25 kg/m<sup>2</sup>. Their findings indicated that the control group with BMI >25 kg/m<sup>2</sup> had a higher level of stress incontinence.<sup>48</sup> Furthermore, Taghavi et al, in a study on 103 PCOS women and 99 controls, found that the BMI had no significant effect on the pelvic organ prolapse distress.<sup>23</sup> Melo et al found that pelvic floor muscle thickness of PCOS patients was not different from the control group; however, the mean BMI of control group and PCOS was 22.5 kg/m<sup>2</sup> and 27.8 kg/m<sup>2</sup>,<sup>57</sup> respectively. In Micussi et al, a study of 42 PCOS and 13 premenopausal women, there was no correlation between BMI and muscle tone and MVC.<sup>49</sup>

Given these statements, it is important to understand the effect of obesity and its neurophysiological mechanism on pelvic floor dysfunction of PCOS patients.

## Metabolic Disorders

Available scientific evidence has shown the association between metabolic syndrome (MetS) and urological disorders. The outcomes of MetS (ie obesity, hypertension, diabetes) may lead to pelvic floor dysfunction such as urinary incontinence (UI).<sup>58</sup> MetS is a disorder to which women with polycystic ovary syndrome are exposed.<sup>58</sup> The results of a meta-analysis showed that women with PCOS are 3.35 times more likely to develop MetS.<sup>59</sup> The association between metabolic disorders as a complication of PCOS with pelvic floor dysfunction has been dealt with in a number of studies. Research on 100 Polish women showed that MetS and high triglyceride levels were correlated with the severity of organ prolapse.<sup>60</sup> Women with PCOS are at increased risk of hypertension.<sup>61</sup> Yoon et al, in a study of 5318 Korean women (19 years and older), reported that 9.18% of women had UI. They also revealed that UI had a significant relationship with insulin resistance in nondiabetic postmenopausal women.<sup>62</sup> Women

with diabetes are exposed to a higher risk of UI,<sup>63</sup> while PCOS is a risk factor for diabetes.<sup>64</sup> A study on Italian women showed that those suffering from pelvic organ prolapse were more prone to develop metabolic disorders.<sup>65</sup> An investigation of 586 Turkish women indicated that from 186 patients with pelvic organ prolapse, coexistence of diabetes and hypertension increased the risk of pelvic organ prolapse by 1.9-fold.<sup>66</sup>

Therefore there are different types of PCOS. Hosseiniapanah et al reported that there is no difference in metabolic features of different phenotypes of PCOS.<sup>67</sup> Ramezani Tehrani et al found that in 85 women with PCOS, the phenotype B of PCOS (oligo/anovulation + hyperandrogenism), MetS was more prevalent than other phenotypes, but phenotype A had a higher serum level of insulin, glucose, cholesterol, and triglycerides.<sup>68</sup> Evidence showed that insulin resistance may aggravate the electromyographic activity.<sup>69</sup> In a study on 5318 nondiabetic Korean women Yoon et al reported that insulin resistance was a risk factor for UI.<sup>62</sup> Sachdeva et al and Stopinska-Gluszak et al found that the phenotype A of PCOS was a high risk for adverse metabolic outcomes.<sup>70,71</sup> In line with this finding, Taghavi et al reported that PCOS patients with menstrual dysfunction (M), and hyperandrogenism (HA) phenotype experience POP symptoms more frequently than the other phenotypes.<sup>23</sup> As a result, it seems women with phenotype A may experience higher adverse metabolic outcomes and pelvic floor dysfunction, but much more research is needed to deeply understand the role of metabolic disorder in pelvic floor function in women with PCOS.

## Obstetric Complications

The obstetric factor association with pelvic floor disorders is well documented.<sup>72</sup> The results of a meta-analysis showed that women with PCOS have increased risk of cesarean section, pregnancy-induced hypertension (PIH), gestational diabetes mellitus (GDM).<sup>73</sup> Women with history of cesarean delivery have higher pelvic floor muscle (PFM) strengths than vaginal delivery group.<sup>74</sup> There is a multifactorial mechanism about the damage of pelvic floor during vaginal delivery.<sup>72,75</sup> However the cesarean section may reduce the risk of pelvic floor dysfunction but according to the above-mentioned evidence comorbidities such as hypertension and diabetes may increase the risk of pelvic floor dysfunction.

## Conclusion

Overall, studies suggest that cardiovascular diseases, chronic obstructive pulmonary disease, MetS, constipation,



autoimmune and renal diseases and obstetric complications can all impair pelvic floor function.<sup>72,76</sup> Nonetheless, PCOS (endocrine-metabolic disorder) is associated with increasing risk of cardiovascular disease<sup>77</sup> and MetS.<sup>78</sup> Moreover, this review highlights knowledge gaps about protective effect of hyperandrogenism on pelvic floor dysfunction as well as destructive effect of metabolic changes on pelvic floor dysfunction in women with PCOS. Further cohort and prospective studies are recommended in women with PCOS. Since PCOS and the pelvic floor dysfunction, are both prevalent health problems, it seems that the diagnosis of women with PCOS who are at higher risks for development of pelvic floor dysfunction as well as adopting preventive strategies for them are cost effective in health problem management.

## Abbreviations

PCOS, polycystic ovary syndrome; MVC, maximum voluntary contraction; MetS, metabolic syndrome; SANRA, scale for the quality assessment of narrative review articles; PIH, pregnancy-induced hypertension; GDM, gestational diabetes mellitus; pelvic floor muscle (PFM); stress urinary incontinence (SUI).

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## Disclosure

The authors report no conflicts of interest in this study.

## References

1. Dheresa M, Worku A, Oljira L, Mengiste B, Assefa N, Berhane Y. One in five women suffer from pelvic floor disorders in Kersa district Eastern Ethiopia: a community-based study. *BMC Womens Health*. 2018;18(1):95. doi:10.1186/s12905-018-0585-1
2. Tehrani FR, Simbar M, Abedini M. Reproductive morbidity among Iranian women; issues often inappropriately addressed in health seeking behaviors. *BMC Public Health*. 2011;11(1):863. doi:10.1186/1471-2458-11-863
3. Jundt K, Peschers U, Kantenich H. The investigation and treatment of female pelvic floor dysfunction. *Dtsch Arztebl Int*. 2015;112(33–34):564. doi:10.3238/arztebl.2015.0564
4. Marques A, Stothers L, Macnab A. The status of pelvic floor muscle training for women. *Can Urol Assoc J*. 2010;4(6):419. doi:10.5489/cuaj.10026
5. Bureau M, Carlson KV. Pelvic organ prolapse: a primer for urologists. *Can Urol Assoc J*. 2017;11(6Suppl2):S125. doi:10.5489/cuaj.4634
6. Fünfgeld C, Stehle M, Henne B, et al. Quality of life and pelvic organ prolapse-related symptoms after pelvic floor reconstruction with a titanized polypropylene mesh for cystocele: long-term results in a 36 month follow-up. *Pelviperrineology*. 2018;105.
7. Yuk J-S, Lee JH, Hur J-Y, Shin J-H. The prevalence and treatment pattern of clinically diagnosed pelvic organ prolapse: a Korean national health insurance database-based cross-sectional study 2009–2015. *Sci Rep*. 2018;8(1):1–6. doi:10.1038/s41598-018-19692-5
8. Milsom I, Gyhagen M. The prevalence of urinary incontinence. *Climacteric*. 2019;22(3):217–222. doi:10.1080/13697137.2018.1543263
9. Kepenekci I, Keskinilic B, Akinsu F, et al. Prevalence of pelvic floor disorders in the female population and the impact of age, mode of delivery, and parity. *Dis Colon Rectum*. 2011;54(1):85–94. doi:10.1007/DCR.0b013e3181fd2356
10. Bodner-Adler B, Kimberger O, Laml T, et al. Prevalence and risk factors for pelvic floor disorders during early and late pregnancy in a cohort of Austrian women. *Arch Gynecol Obstet*. 2019;300(5):1325–1330. doi:10.1007/s00404-019-05311-9
11. Mushkat Y, Bukovsky I, Langer R. Female urinary stress incontinence—does it have familial prevalence? *Am J Obstet Gynecol*. 1996;174(2):617–619. doi:10.1016/S0002-9378(96)70437-4
12. Rohr G, Kragstrup J, Gaist D, Christensen K. Genetic and environmental influences on urinary incontinence: a Danish population-based twin study of middle-aged and elderly women. *Acta Obstet Gynecol Scand*. 2004;83(10):978. doi:10.1111/j.0001-6349.2004.00635.x
13. Cundiff GW, Harris RL, Coates KW, Bump RC. Clinical predictors of urinary incontinence in women. *Am J Obstet Gynecol*. 1997;177(2):262–267. doi:10.1016/S0002-9378(97)70185-6
14. Lin AS, Carrier S, Morgan DM, Lue TF. Effect of simulated birth trauma on the urinary continence mechanism in the rat. *Urology*. 1998;52(1):143–151. doi:10.1152/ajprenal.00230.2017
15. Copas P, Bukovsky A, Asbury B, Elder RF, Caudle MR. Estrogen, progesterone, and androgen receptor expression in levator ani muscle and fascia. *J Wom Health Gend Base Med*. 2001;10(8):785–795. doi:10.1089/15246090152636541
16. Chen Y, Hua K. Expression of androgen receptor in the vaginal wall and cardinal ligament of patients with pelvic organ prolapse. *Zhonghua Yi Xue Za Zhi*. 2008;88(41):2920–2923.
17. Sirmans SM, Pate KA. Epidemiology, diagnosis, and management of polycystic ovary syndrome. *Clin Epidemiol*. 2014;6:1. doi:10.2147/CLEP.S37559
18. Wolf WM, Wattick RA, Kinkade ON, Olfert MD. Geographical prevalence of polycystic ovary syndrome as determined by region and race/ethnicity. *Int J Environ Res Public Health*. 2018;15(11):2589. doi:10.3390/ijerph15112589
19. Ramanand SJ, Ghongane BB, Ramanand JB, Patwardhan MH, Ghanghas RR, Jain SS. Clinical characteristics of polycystic ovary syndrome in Indian women. *Indian J Endocrinol Metab*. 2013;17(1):138. doi:10.4103/2230-8210.107858
20. Eshre TR, Group A-Spcw. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril*. 2004;81(1):19–25.
21. Daniilidis A, Dinas K. Long term health consequences of polycystic ovarian syndrome: a review analysis. *Hippokratia*. 2009;13(2):90.
22. Teede H, Deeks A, Moran L. Polycystic ovary syndrome: a complex condition with psychological, reproductive and metabolic manifestations that impacts on health across the lifespan. *BMC Med*. 2010;8(1):41. doi:10.1186/1741-7015-8-41
23. Taghavi SA, Bazarganipour F, Allan H, et al. Pelvic floor dysfunction and polycystic ovary syndrome. *Hum Fertil*. 2017;20(4):262–267. doi:10.1080/14647273.2017.1292003
24. Antônio FI, Bo K, Ferriani RA, de Sá MFS, de Sá Rosa ACJ, Ferreira CHJ. Pelvic floor muscle strength and urinary incontinence in hyperandrogenic women with polycystic ovary syndrome. *Int Urogynecol J*. 2013;24(10):1709–1714. doi:10.1007/s00192-013-2095-x

25. Fowler CJ, Christmas TJ, Chapple CR, Parkhouse HF, Kirby RS, Jacobs HS. Abnormal electromyographic activity of the urethral sphincter, voiding dysfunction, and polycystic ovaries: a new syndrome? *BMJ*. 1988;297(6661):1436–1438. doi:10.1136/bmj.297.6661.1436
26. Ghatti C, Skoczylas LC, Oliphant SS, Nikolajski C, Lowder JL. The emotional burden of pelvic organ prolapse in women seeking treatment: a qualitative study. *Female Pelvic Med Reconstr Surg*. 2015;21(6):332. doi:10.1097/SPV.0000000000000190
27. Twiss C, Triaca V, Bergman J, Rodríguez LV. The epidemiology, social burden, and genetics of pelvic organ prolapse. *Curr Bladder Dysfunct Rep*. 2008;3(2):90–94. doi:10.1007/s11884-008-0014-7
28. Aoki Y, Brown HW, Brubaker L, Cornu JN, Daly JO, Cartwright R. Urinary incontinence in women. *Nat Rev Dis Primers*. 2017;3(1):1–20. doi:10.1038/nrdp.2017.42
29. Subramanian D, Szwarcensztein K, Mauskopf JA, Slack MC. Rate, type, and cost of pelvic organ prolapse surgery in Germany, France, and England. *Eur J Obstet Gynecol Reprod Biol*. 2009;144(2):177–181. doi:10.1016/j.ejogrb.2009.03.004
30. Subak LL, Waetjen LE, Van Den Eeden S, Thom DH, Vittinghoff E, Brown JS. Cost of pelvic organ prolapse surgery in the United States. *Obstet Gynecol*. 2001;98(4):646–651. doi:10.1016/S0029-7844(01)01472-7
31. Hakimi S, Simbar M, Tehrani FR. Perceived concerns of Azeri menopausal women in Iran. *Iran Red Crescent Med J*. 2014;16:5. doi:10.5812/ircmj.11771
32. Baethge C, Goldbeck-Wood S, Mertens S. SANRA—a scale for the quality assessment of narrative review articles. *Res Integr Peer Rev*. 2019;4(1):5. doi:10.1186/s41073-019-0064-8
33. Davila GW. Hormonal influences on the pelvic floor. In: Davila GW, Ghoniem GM, Wexner SD, editors. *Pelvic Floor Dysfunction*. London: Springer; 2008:295–299. doi:10.1007/978-1-84800-348-4\_50
34. Ho MH, Bhatia NN, Bhasin S. Anabolic effects of androgens on muscles of female pelvic floor and lower urinary tract. *Curr Opin Obstet Gynecol*. 2004;16(5):405–409. doi:10.1097/00001703-200410000-00009
35. Kim MM, Kreydin EI. The association of serum testosterone levels and urinary incontinence in women. *J Urol*. 2018;199(2):522–527. doi:10.1016/j.juro.2017.08.093
36. Douchi T, Oki T, Yamasaki H, Kuwahata R, Nakae M, Nagata Y. Relationship of androgens to muscle size and bone mineral density in women with polycystic ovary syndrome. *Obstet Gynecol*. 2001;98(3):445–449. doi:10.1016/s0029-7844(01)01450-8
37. Sinha-Hikim I, Roth SM, Lee MI, Bhasin S. Testosterone-induced muscle hypertrophy is associated with an increase in satellite cell number in healthy, young men. *Am J Physiol*. 2003;285(1):E197–E205. doi:10.1152/ajpendo.00370.2002
38. Kogure GS, Silva RC, Miranda-Furtado CL, et al. Hyperandrogenism Enhances muscle strength after progressive resistance training, independent of body composition, in women with polycystic ovary syndrome. *J Strength Cond Res*. 2018;32(9):2642–2651. doi:10.1519/JSC.00000000000002714
39. Teleman PM, Persson J, Mattiasson A, Samsioe G. The relation between urinary incontinence and steroid hormone levels in perimenopausal women. A report from the Women's Health in the Lund Area (WHILA) study. *Acta Obstet Gynecol Scand*. 2009;88(8):927–932. doi:10.1080/00016340903117986
40. Nader S, Diamanti-Kandarakis E. Polycystic ovary syndrome, oral contraceptives and metabolic issues: new perspectives and a unifying hypothesis. *Hum Reprod*. 2007;22:317. doi:10.1093/humrep/del407
41. Townsend MK, Curhan GC, Resnick NM, Grodstein F. Oral contraceptive use and incident urinary incontinence in premenopausal women. *J Urol*. 2009;181(5):2170–2175. doi:10.1016/j.juro.2009.01.040
42. Iliadou A, Milsom I, Pedersen NL, Altman D. Risk of urinary incontinence symptoms in oral contraceptive users: a national cohort study from the Swedish Twin Register. *Fertil Steril*. 2009;92(2):428–433. doi:10.1016/j.fertnstert.2008.07.002
43. Hextall A, Bidmead J, Cardozo L, Hooper R. The impact of the menstrual cycle on urinary symptoms and the results of urodynamic investigation. *BJOG*. 2001;108(11):1193–1196. doi:10.1111/j.1471-0528.2003.00280.x
44. Edwall L, Carlström K, Jonasson AF. Endocrine status and markers of collagen synthesis and degradation in serum and urogenital tissue from women with and without stress urinary incontinence. *Neurourol Urodyn*. 2007;26(3):410–415. doi:10.1002/nau.20335
45. Rosenfield RL, Ehrmann DA. The pathogenesis of polycystic ovary syndrome (PCOS): the hypothesis of PCOS as functional ovarian hyperandrogenism revisited. *Endocr Rev*. 2016;37(5):467–520. doi:10.1210/er.2015-1104
46. Barnes RB. The pathogenesis of polycystic ovary syndrome: lessons from ovarian stimulation studies. *J Endocrinol Invest*. 1998;21(9):567–579. doi:10.1007/bf03350782
47. Micussi MT, Freitas RP, Angelo PH, Soares EM, Lemos TM, Maranhão TM. Is there a difference in the electromyographic activity of the pelvic floor muscles across the phases of the menstrual cycle? *J Phys Ther Sci*. 2015;27(7):2233–2237. doi:10.1589/jpts.27.2233
48. Montezuma T, Antônio FI, Silva A, Sá M, Ferriani RA, Ferreira CHJ. Assessment of symptoms of urinary incontinence in women with polycystic ovary syndrome. *Clinics*. 2011;66(11):1911–1915. doi:10.1590/S1807-59322011001100010
49. Micussi MT, Freitas RP, Varella L, Soares EM, Lemos TM, Maranhão TM. Relationship between pelvic floor muscle and hormone levels in polycystic ovary syndrome. *Neurourol Urodyn*. 2016;35(7):780–785. doi:10.1002/nau.22817
50. Lim SS, Davies M, Norman RJ, Moran L. Overweight, obesity and central obesity in women with polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod Update*. 2012;18(6):618–637. doi:10.1093/humupd/dms030
51. Legro RS. Obesity and PCOS: implications for diagnosis and treatment. Paper presented at: Seminars in reproductive medicine; 2012. doi:10.1055/s-0032-1328878
52. Pomian A, Lisik W, Kosieradzki M, Barcz E. Obesity and pelvic floor disorders: a review of the literature. *Med Sci Monit*. 2016;22:1880. doi:10.12659/MSM.896331
53. Cummings J, Rodning C. Urinary stress incontinence among obese women: review of pathophysiology therapy. *Int Urogynecol J*. 2000;11(1):41–44. doi:10.1007/s001920050008
54. Giri A, Hartmann KE, Hellwege JN, Edwards DRV, Edwards TL. Obesity and pelvic organ prolapse: a systematic review and meta-analysis of observational studies. *Am J Obstet Gynecol*. 2017;217(1):11–26. e13. doi:10.1016/j.ajog.2017.01.039
55. Subak LL, Richter HE, Hunskaar S. Obesity and urinary incontinence: epidemiology and clinical research update. *J Urol*. 2009;182(6S):S2–S7. doi:10.1016/j.juro.2009.08.071
56. Lee UJ, Kerkhof MH, Van Leijssen SA, Heesakkers JP. Obesity and pelvic organ prolapse. *Curr Opin Urol*. 2017;27(5):428–434. doi:10.1097/MOU.0000000000000428
57. de Melo MV, Micussi MABC, de Medeiros RD, Cobucci RN, de Oliveira Maranhão T, Gonçalves A. Pelvic floor muscle thickness in women with polycystic ovary syndrome. *Clin Exp Obstet Gynecol*. 2018;45(6):2018. doi:10.12891/ceog4113.2018
58. Gorbachinsky I, Akpinar H, Assimios DG. Metabolic syndrome and urologic diseases. *Rev Urol*. 2010;12(4):e157.
59. Lim S, Kakoly N, Tan J, et al. Metabolic syndrome in polycystic ovary syndrome: a systematic review, meta-analysis and meta-regression. *Obes Rev*. 2019;20(2):339–352. doi:10.1111/obr.12762
60. Rogowski A, Bienkowski P, Tarwacki D, et al. Association between metabolic syndrome and pelvic organ prolapse severity. *Int Urogynecol J*. 2015;26(4):563–568. doi:10.1007/s00192-014-2468-9
61. Joham AE, Boyle JA, Zoungas S, Teede HJ. Hypertension in reproductive-aged women with polycystic ovary syndrome and association with obesity. *Am J Hypertens*. 2015;28(7):847–851. doi:10.1093/ajh/hpu251

62. Yoon BI, Han K-D, Lee KW, et al. Insulin resistance is associated with prevalence of physician-diagnosed urinary incontinence in post-menopausal non-diabetic adult women: data from the Fourth Korea National Health and Nutrition Examination Survey. *PLoS One*. 2015;11:10. doi:10.1371/journal.pone.0141720
63. Phelan S, Grodstein F, Brown JS. Clinical research in diabetes and urinary incontinence: what we know and need to know. *J Urol*. 2009;182(6):S14–S17. doi:10.1016/j.juro.2009.07.087
64. Legro RS. Type 2 diabetes and polycystic ovary syndrome. *Fertil Steril*. 2006;86:S16–S17. doi:10.1016/j.fertnstert.2006.04.010
65. Gava G, Alvisi S, Mancini I, Seracchioli R, Meriggiola MC. Prevalence of metabolic syndrome and its components in women with and without pelvic organ prolapse and its association with prolapse severity according to the pelvic organ prolapse quantification system. *Int Urogynecol J*. 2019;30(11):1911–1917. doi:10.1007/s00192-018-3840-y
66. Isik H, Aynioglu O, Sahbaz A, Selimoglu R, Timur H, Harma M. Are hypertension and diabetes mellitus risk factors for pelvic organ prolapse? *Eur J Obstet Gynecol Reprod Biol*. 2016;197:59–62. doi:10.1016/j.ejogrb.2015.11.035
67. Hosseiniapanah F, Barzin M, Keihani S, Ramezani Tehrani F, Azizi F. Metabolic aspects of different phenotypes of polycystic ovary syndrome: Iranian PCOS prevalence study. *Clin Endocrinol (Oxf)*. 2014;81(1):93–99. doi:10.1111/cen.12406
68. Tehrani FR, Rashidi H, Khomami MB, Tohidi M, Azizi F. The prevalence of metabolic disorders in various phenotypes of polycystic ovary syndrome: a community based study in Southwest of Iran. *Reprod Biol Endocrinol*. 2014;12(1):89. doi:10.1186/1477-7827-12-89
69. Micussi MT, Freitas RP, Angelo PH, Soares EM, Lemos TM, Maranhão TM. Evaluation of the relationship between the pelvic floor muscles and insulin resistance. *Diabetes Metab Syndr Obes*. 2015;8:409. doi:10.2147/DMSO.S85816
70. Sachdeva G, Gainer S, Suri V, Sachdeva N, Chopra S. Comparison of the different PCOS phenotypes based on clinical metabolic, and hormonal profile, and their response to clomiphene. *Indian J Endocrinol Metab*. 2019;23(3):326. doi:10.4103/ijem.IJEM\_30\_19
71. Gluszk O, Stopińska-Gluszk U, Glinicki P, et al. Phenotype and metabolic disorders in polycystic ovary syndrome. *ISRN Endocrinol*. 2012;2012:1–7. doi:10.5402/2012/569862
72. Weintraub AY, Gliner H, Marcus-Braun N. Narrative review of the epidemiology, diagnosis and pathophysiology of pelvic organ prolapse. *Int Braz J Urol*. 2020;46(1):5–14. doi:10.1590/S1677-5538.IBJU.2018.0581
73. Qin JZ, Pang LH, Li MJ, Fan XJ, Huang RD, Chen HY. Obstetric complications in women with polycystic ovary syndrome: a systematic review and meta-analysis. *Reprod Biol Endocrinol*. 2013;11(1):56. doi:10.1186/1477-7827-11-56
74. Zhao Y, Zou L, Xiao M, Tang W, Niu H-Y, Qiao F-Y. Effect of different delivery modes on the short-term strength of the pelvic floor muscle in Chinese primipara. *BMC Pregnancy Childbirth*. 2018;18(1):275. doi:10.1186/s12884-018-1918-7
75. Memon HU, Handa VL. Vaginal childbirth and pelvic floor disorders. *Womens Health*. 2013;9(3):265–277. doi:10.2217/whe.13.17
76. Yu C-J, Hsu -C-C, Lee W-C, Chiang P-H, Chuang Y-C. Medical diseases affecting lower urinary tract function. *Urol Sci*. 2013;24(2):41–45. doi:10.1016/j.urols.2013.04.004
77. Zhao L, Zhu Z, Lou H, et al. Polycystic ovary syndrome (PCOS) and the risk of coronary heart disease (CHD): a meta-analysis. *Oncotarget*. 2016;7(23):33715. doi:10.18632/oncotarget.9553
78. Yao K, Bian C, Zhao X. Association of polycystic ovary syndrome with metabolic syndrome and gestational diabetes: aggravated complication of pregnancy. *Exp Ther Med*. 2017;14(2):1271–1276. doi:10.3892/etm.2017.4642

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