Human Reproduction, Vol.28, No.9 pp. 2562–2569, 2013
Advanced Access publication on June 27, 2013 doi:10.1093/humrep/det262

human reproduction

ORIGINAL ARTICLE *Reproductive epidemiology*

Prevalence of polycystic ovary syndrome in women in China: a large community-based study

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Submitted on February 14, 2013; resubmitted on May 15, 2013; accepted on May 28, 2013

STUDY QUESTION: What is the prevalence of polycystic ovary syndrome (PCOS) in Han Chinese women from different communities?

SUMMARY ANSWER: The prevalence of PCOS in Chinese women aged 19–45 years is 5.6%.

WHAT IS KNOWN ALREADY: The prevalence of PCOS is reported to range from 5 to 10% but to the best of our knowledge the Han Chinese population has not been studied.

STUDY DESIGN, SIZE, DURATION: A large-scale epidemiological study was carried out between October 2007 and September 2011 in 15 924 Han Chinese women of reproductive age (19–45 years) from the 10 provinces and municipalities in China.

PARTICIPANTS/MATERIALS, SETTING, METHODS: A total of 16 886 women from 152 cities and 112 villages were involved in the study. All study participants received a questionnaire and underwent a physical and transvaginal ultrasound examination. Blood samples were collected from a subsample of women ($n = 3565$) for analysis of metabolic markers and hormones. Based on the Rotterdam PCOS criteria, we assessed hyperandrogenism (H), chronic anovulation (O) and polycystic ovaries (P). Following diagnosis, women with PCOS were assigned to one of four different phenotypes. Finally, the prevalence and related risks of PCOS among Chinese women were estimated based on all the data sources.

MAIN RESULTS AND THE ROLE OF CHANCE: A total of 16 886 women were initially involved in the study and 15 924 eligible participants then completed the study; the overall response rate was 94.3% (15 924/16 886). The prevalence of PCOS in the Chinese community population was 5.6% (894/15 924). Blood samples were analyzed from 833 of these women who were assigned to the four PCOS phenotypes as follows: 19% H + O, 37% H + P, 15% O + P and 29% H + O + P. Comparing the 833 women with PCOS to 2732 women without PCOS indicated that PCOS occurs in younger women ($P < 0.05$) and these women were prone not only to menstrual problems, hyperandrogenism, PCO and infertility but also metabolic syndrome (MS) and insulin resistance (IR). However, there was no significant difference in the rate of hypertension or hyperlipemia between the two groups. Obese patients with PCOS had a higher rate of MS (16 versus 48%), IR (7 versus 28%), hypertension (8 versus 30%) and hyperlipemia (48 versus 73%) compared with non-obese patients (all $P < 0.05$), respectively. The rates of metabolic complications in patients with PCOS increased with age.

LIMITATIONS, REASONS FOR CAUTION: Age and ethnic origin contribute to the differing manifestations of PCOS; therefore, sampling is one of the most important issues in epidemiological research into PCOS. Owing to the mobility of the Chinese population, the survey among resident populations caused a certain deviation in the age distribution.

WIDER IMPLICATIONS OF THE FINDINGS: The prevention and treatment of PCOS, particularly in those who are obese, are essential in Chinese women of reproductive age.

STUDY FUNDING/COMPETING INTEREST(S): This study was supported by National Science Fund for Distinguished Young Scholars, Capital Medical Development Scientific Research Fund and National Key Technology R&D Program. Ten participant university hospitals and the National Center for Chronic and Noncomunicable Disease Control and Prevention participated. All authors have nothing to disclose.

Key words: polycystic ovary syndrome / epidemiology / community / obesity

Introduction

Polycystic ovary syndrome (PCOS) is a common metabolic dysfunction and heterogeneous endocrine disorder in women of reproductive age (Wood *et al.*, 2007; Toulis *et al.*, 2009; Franks, 2011). PCOS is characterized by a clustering of hyperandrogenism, hyperinsulinemia, hypersecretion of LH, menstrual dysfunction, hirsutism, infertility and pregnancy and neonatal complications (Toulis *et al.*, 2009; Franks, 2011; Qiao and Feng, 2011). PCOS also contributes to other long-term health risks, metabolic complications and psychological problems, such as type II diabetes mellitus (DM2), cardiovascular disease (CVD), poor self-esteem, venous thromboembolism and anxiety (Legro *et al.*, 1999; Solomon, 1999; Paradisi *et al.*, 2001; Hart *et al.*, 2004; Apridonidze *et al.*, 2005; Meyer *et al.*, 2005; Boomsma *et al.*, 2006; Jones *et al.*, 2008; Okoroh *et al.*, 2012; Bird *et al.*, 2013). In addition, a wide range in the incidence of PCOS has been reported in small samples from different countries (Asuncion *et al.*, 2000; March *et al.*, 2010). As a result, most studies quoted a prevalence of PCOS ranging from 5 to 10% (Asuncion *et al.*, 2000; Teimuraz *et al.*, 2005; March *et al.*, 2010; Franks, 2011).

Diagnosis of PCOS is usually based on the Rotterdam PCOS criteria (Rotterdam EHSRE/ASRM-Sponsored PCOS Consensus Workshop Group, 2004) and National Institutes of Health (NIH) final report (http://prevention.nih.gov/workshops/2012/pcos/docs/PCOS_Final_Statement.pdf). These criteria include oligo-ovulation or anovulation, clinical or biochemical hyperandrogenism and the presence of polycystic ovaries on ultrasound; these heterogeneous symptoms create a variety of clinical manifestations. According to the Rotterdam PCOS criteria, the diagnosis of PCOS may present in patients with four different phenotypes: (i) hyperandrogenism (H) and chronic anovulation (O), but normal ovaries (H + O); (ii) hyperandrogenism and polycystic ovaries (PCO), but ovulatory cycles (H + P); (iii) chronic anovulation and polycystic ovaries, but no clinical or biochemical hyperandrogenism (O + P) and (iv) hyperandrogenism, chronic anovulation and polycystic ovaries (H + O + P).

This variability in the PCOS phenotype is due to several factors, such as logistically difficult diagnoses with the necessity to carry out blood or ultrasound tests and different diagnostic criteria based on prior NIH criteria or the Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group criteria. For the above reasons, there are currently less than 1000 participants in epidemiological reports about the prevalence of PCOS in community settings in the USA and Italy (Apridonidze *et al.*, 2005; Carmina *et al.*, 2006). On this point, because of the rapid change in lifestyles in China, for example the dietary structure, there is concern that PCOS may become epidemic. The Chinese intake of a cereal diet has decreased by 15%, while the meat consumption increased by 40%. (http://wenwen.soso.com/z/q131012449.htm). However, no cross-community population-based studies have been conducted yet in China, particularly detailed studies on the prevalence of PCOS among Chinese women. Therefore, it is very important to evaluate the current PCOS status in the community and understand PCOS-related risks in order to effectively prevent and treat women with PCOS in the Chinese community.

Materials and Methods

Study participants

From October 2007 to September 2011, a large-scale national epidemiological investigation was conducted in women of reproductive age (19–45 years) from the top 10 provinces and municipalities in China (Fig. 1). First, the 10 provinces/municipalities contain the major residential population from 30 provinces of the whole China, geographically distributed in northeast, north, east, central south, northwest and southwest regions. The provinces/municipalities include: Heilongjiang, Liaoning, Beijing, Tianjin, Shanxi, Henan, Anhui, Hunan, Sichuan and Guangdong. A multi-layer, stratified sampling method was performed from each province or municipality by city or district, town/township and village/street order and ultimately selected communities. The townships were categorized into three strata with almost the same number of townships in each stratum, and then one township was randomly selected from each stratum. Secondly, in each selected township, all the villages were ranked according to the distances from the villages to the town and divided into three strata with each having almost the same numbers of villages, and then one village was randomly selected from each stratum. Finally, in the selected villages, participants aged 19–45 years were identified. China is a multi-ethnic country with 56 ethnic groups and Han is the main ethnic group comprising 92% of the total population. Therefore, this study was designed to investigate the Chinese Han population only. All selected involvers were asked to choose Han ethnicity participants from both rural and urban communities; a rural:urban ratio of 1:1 was applied, and 80–120 residential women per community were recruited. A total of 16 886 women from 152 cities and 112 villages were involved in the study. Of these, 15 924 eligible participants completed the study; the overall response rate was 94.3% (15 924/16 886) (Fig. 2).

This study was approved by the Ethics Committee of Peking University Third Hospital and the National Center for Chronic and Noncomunicable Disease Control and Prevention (NCNCD). All participants signed the informed consent.

Figure 1 The 10 regions that were selected to determine the prevalence of PCOS in China. According to the geographic region (northeast, north, east, south central, northwest and southwest China), we included Heilongjiang, Liaoning, Beijing, Tianjin, Shanxi, Henan, Anhui, Hunan, Sichuan and Guangdong provinces.

Screening protocol and assessment criteria

All the participants underwent a free medical evaluation, including a questionnaire associated with personal information, menstrual history, obstetric history, skin problems associated with hyperandrogenism and endocrine and metabolic diseases. Participants also underwent physical, pelvic and transvaginal ultrasound examinations.

Questionnaire

The questionnaire requested details regarding birth, age of menarche, menstrual cycle history, related family history, skin problems (hirsutism, acne and premature alopecia), metabolic diseases and any possible gynecologic diseases. A portion of the community participants and all outpatients had a blood sample drawn for biochemical testing. Women experiencing menopause or an ongoing pregnancy at the time of the investigation were excluded. The questionnaire was designed by experts in reproductive medicine and epidemiologists. Twenty interviewers (one senior and one junior gynecologist or postgraduate student from each participating university hospital) were well trained to manage the standardized questionnaire and physical examination. All investigators were fully trained in their respective regions, including pilot interviews in non-sampled communities that were monitored by the principal investigators and on-site supervisors.

Oligomenorrhea was defined as having fewer than eight menstrual cycles per year, or when the duration of a cycle exceeds 35 days. Amenorrhea was diagnosed by the absence of three to six consecutive menstrual cycles, or four or fewer menstrual periods per year (Rumball and Lebrun, 2005).

Physical and pelvic examination

Every participant was assessed for blood pressure, body mass index (BMI), breast, thyroid, modified Ferriman–Gallwey (mF-G) score, acne, premature alopecia and any possible uterine and/or ovarian issues by physical and pelvic examination.

The mF-G scoring system is used to classify the severity of hirsutism, quantified by the presence of terminal hair over nine body areas (Ferriman and Gallwey, 1961; Hatch *et al.*, 1981). The scale ranges from 0 (absence of terminal hair) to 4 (extensive terminal hair growth), with the numbers added together to reach a maximal score of 36. Within each body area, a score of 0–4 represented the absence of terminal hair to a typically male hair pattern. Clinically, terminal hairs are distinguished from vellus hairs primarily by their length (i.e. longer than 0.5 cm) and they are usually pigmented.

Hirsutism was diagnosed as an mF-G score >6 (Ichikawa *et al.*, 1988). Acne grading is based on the evaluations of the papules, pustules and nodules of acne on the cheeks, neck, chest and upper back. The severity of acne was graded according to the Consensus Conference on Acne Classification (Reingold and Rosenfield, 1987).

Transvaginal ultrasound examination

A transvaginal ultrasound scan was performed on every participant during a clinical examination to determine the number of follicles and ovarian volume. Polycystic ovary (PCO) is defined as ≥ 12 follicles in either ovary, measuring 2–9 mm in diameter and/or increased ovarian volume of each ovary >10 ml.

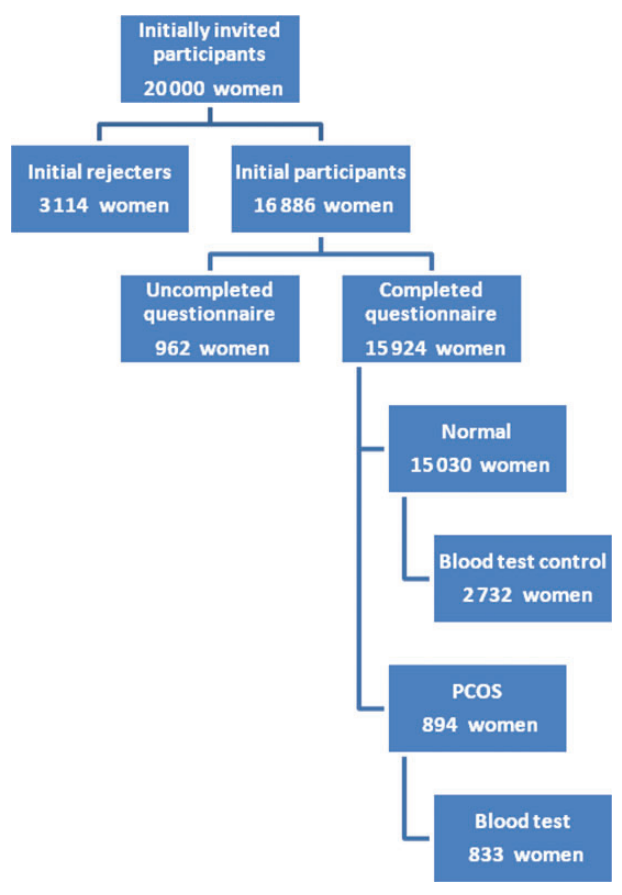

Figure 2 Flowchart of participants for a study of the prevalence of PCOS in China.

Metabolic and other assessments

The diagnosis of MS was made according to the modified National Cholesterol Education Program (NCEP) ATP III guidelines of 2005; the criteria were considered to be met when at least three of following five measures were present: (i) waist circumference ≥80 cm, (ii) serum triglyceride (TG) ≥1.7 mmol/l, (iii) serum high-density lipoprotein (HDL) cholesterol <1.3 mmol/l or the use of lipid lowering medication, (iv) blood pressure ≥130/85 mmHg or the use of anti-hypertensive medication and (v) fasting plasma glucose ≥5.6 mmol/l (Alberti *et al*., 2006).

Other diagnoses included obese: BMI ≥23 kg/m^2 in Asian women (Pan and Yeh, 2008); hyperlipemia: TG ≥1.7 mmol/l or HDL cholesterol <1.29 mmol/l; IR: the homeostatic model assessment [HOMA-IR: (fasting insulin × fasting glucose)/22.5] and 2.69 was selected as the cut-off point (Xing *et al*., 2004) and hypertension: when BP recorded was ≥140/90 mmHg on two separate occasions (Koh-Banerjee *et al*., 2004).

Diagnosis of PCOS

Diagnosis of PCOS was made according to the Rotterdam diagnostic criteria, i.e. presence of two or more of the following three criteria: oligo/amenorrhea, clinical and/or biochemical hyperandrogenism and polycystic ovaries (PCO). Oligo/amenorrhea (O) is defined as the absence of menstruation for 35 days or more. Hyperandrogenism (H) included clinical and biochemical hyperandrogenism: The former is defined as an mF-G score of ≥6 with/without acne, and/or androgenic alopecia; the latter as an androstenedione level of >10.8 nmol/l or total testosterone level of >2.81 nmol/l.

Eight hundred and ninety-four participants were diagnosed as having PCOS, which divided into four phenotypes: oligo/amenorrhea + H (O + H); PCO + H (P + H); oligo/amenorrhea + PCO (O + P) and oligo/amenorrhea + PCO+H (O + P + H).

The exclusion criteria included those individuals diagnosed with: hyperprolactinemia, hypogonadotropic hypogonadism, premature ovarian failure, congenital adrenal hyperplasia, an androgen-secreting tumor, Cushing's syndrome, uterine disorders, chromosomal anomalies and ovarian cysts or tumors.

Hormonal assays

Eight hundred and ninety-four women were diagnosed with PCOS according to the Rotterdam criteria, and 2732 women were selected as normal controls. Normal controls were women who had no clinical evidence of hyperandrogenism or menstrual disturbances, and were not taking any hormonal medication. All the women with PCOS and normal controls completed all clinical examinations, ultrasound examinations and hormone tests. During the survey, two non-PCOS respondents (within ±5 years of age) was selected as a control on the same day to run laboratory hormone tests if one case of PCOS or a suspected patient (PCO or menstrual abnormalities) was found. This project was conducted on the 1:2 principle for drawing blood, i.e. in order to reduce the cost of the study, not all of the survey participants had blood taken.

All blood samples were collected in the morning after fasting for at least 8 h. Sex hormone-binding globulin (SHBG), total testosterone (TT) and androstenedione (A) were assessed by chemiluminescence using the Immulite 1000 (DPC, USA). Anti-Mullerian hormone and inhibin B were assessed by enzyme-linked immunosorbent assay (ELISA) (DSL, USA). Manufacturer's instructions were followed for preparation, set-up, dilutions, adjustments, assay and quality control procedures. For all measurements, the inter-assay coefficient of variation was less than 10% and the intra-assay variation was less than 15%. The free androgen index was calculated using the formula [TT (nmol/l) × 100/SHBG (nmol/l)]. Fasting glucose, insulin, cholesterol, TG, low-density lipoprotein and HDL were also measured.

Statistical analysis

Statistical analysis was performed using the SPSS15.0 for Windows (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were generated to enable comparisons between groups. Continuous variables were checked for normality and means were presented with SD, or medians and ranges, as appropriate. Distributions were compared using Student's *t*-test or Mann–Whitney *U*-test or ANOVA, as appropriate. Categorical variables were compared using Pearson's chi-square (χ^2) test. Hormonal test results were expressed as a median and range because some of the hormonal variables were not normally distributed. The other results are presented as the mean ± SD. The 95th percentile was calculated for the hormonal values in the population to determine the upper-normal limits. Correlations between variables were evaluated with Pearson correlation coefficients, the two-tailed method and 95% confidence intervals (95% CIs). The odds ratios (ORs) was modeled to analyze risk factors of PCOS. Logistic regression was used to examine independent predictors. $P < 0.05$ was considered statistically significant.

Results

Prevalence of PCOS in the Chinese community population

A total of 15 924 participants were selected and invited to participate in this the study, of which 894 women were diagnosed as having PCOS according to the Rotterdam criteria, and 4750 women were suspected

as PCOS, as they had oligo/amenorrhea and/or hirsutism/acne and/or PCO. Overall, from this large sample group, the incidence of women with PCOS among the Chinese Han population is 5.6% (894/15 924).

Subtypes of PCOS

Eight hundred and thirty-three PCOS women responded to the questionnaire and underwent physical examination, transvaginal ultrasound and blood tests. The breakdown into PCOS subtypes for the 833 women was as follows: 158 H + O (Type I, 19.0%), 311 H + P (Type II, 37.3%), 125 O + P (Type III, 15.0%) and 239 H + O + P (Type IV, 28.7%). The prevalence of different PCOS subtypes in the 15 924 eligible participants was: 1.0% H + O (Type I, $n = 158$), 2.0% H + P (Type II, $n = 311$), 0.8% O + P (Type III, $n = 125$) and 1.5% H + O + P (Type IV, $n = 239$).

The characteristics of Chinese women with and without PCOS

Some women were unable to complete the full panel of tests; 833 women with PCOS and 2732 women without PCOS were finally involved in completing the questionnaire and undergoing the physical examination, transvaginal ultrasound and blood tests. The results show that, compared with unaffected women, the women with PCOS were younger ($P < 0.05$) and more prone to not only menstrual problems, hyperandrogenism and PCO but also to MS and IR (all $P < 0.05$). However, there was no difference in the hypertension and hyperlipemia rate between the two groups. All these predictors also had OR > 1, but only IR had an OR of 1.792, 95% CI 1.061–3.027, after logistic regression (Table I).

The complications in women with different subtypes of PCOS

In the 833 women with PCOS, the rates of metabolic complications, such as MS, IR, hypertension and hyperlipemia, did not differ among the four subtypes. Significant differences in the irregular menstrual rate and infertility rate were observed (Table II).

Complication rates in women with PCOS according to age

Among the 833 PCOS women, the rates of obesity, PCO, hyperandrogenism, MS, hypertension and hyperlipemia, all increased with age (Table III).

The complications between obese and non-obese women with PCOS

For the obese ($n = 284$) and non-obese ($n = 549$) subgroups, the obese women with PCOS had higher metabolic complication rates. However, there were no significant differences in the menstrual and fertility problems between the two subgroups (Table IV).

Discussion

PCOS affects 5–10% of reproductive-age women (Jones *et al*., 2008), therefore it is a common endocrine disorder (Franks, 2011). However, previous reports from a variety of different countries demonstrate the diversity in the incidence of PCOS, and the prevalence of PCOS also depends on the criteria used to evaluate this syndrome (Asuncion *et al*., 2000; Teimuraz *et al*., 2005; March *et al*., 2010). Different PCOS prevalence surveys have been carried out in specific populations using special diagnostic criteria. However, data on the long-term complications from PCOS came from a hospital population, not women in the community. Some have suggested that PCOS-afflicted individuals have higher risk for CVD, while others thought that only MS, not CVD, were common in PCOS (March *et al*., 2010). Therefore, gynecologists now are paying more attention to necessary medical treatment and potential health implications of PCOS. There are two trends based on the current understanding of PCOS; one is an over-treatment of all PCOS-afflicted women, by loss of weight and prescribing metformin, with the other approach being no treatment at all. The heterogeneity of symptoms of the syndrome makes diagnosis difficult and creates this variability. In this large epidemiological study, the incidence of women with PCOS in the Chinese Han population is 5.6% (894/15 924), according to the Rotterdam PCOS criteria. To the best of our knowledge, this is the first report on the incidence of PCOS in Chinese communities. These results indicate that PCOS has reached epidemic proportions in women of reproductive age in China. Overall, ~20–30% of participants had varying degrees of MS, IR and other complications, but only 9.6% (86/894) of PCOS patients were aware of endocrine or gynecologic diseases, and ~5.9% (53/894) received medical treatment, such as oral contraception pills and metformin. Our previous study showed that women with oligomenorrhea required treatment, such as using progesterone and oral contraception pills, in order to prevent hyperplasic endometrium and endometrial carcinoma (Ma *et al*., 2010).

Diagnostic features of PCOS include clinical or biochemical hyperandrogenism, and/or oligo-ovulation or anovulation, and/or presence of polycystic ovaries on ultrasound. It is difficult to analyze the relationship between different PCOS phenotypes and complications associated with PCOS. The recent PCOS prevalence study in 2010 created a representative estimate of PCOS in the community under the NIH criteria and the more recent Rotterdam consensus criteria and Androgen Excess Society (AES) criteria, which has drawn attention to the fact that many women with PCOS in the community in Australia remain undiagnosed (March *et al*., 2010). It was clear that their proportion in PCOS in the population was higher using the Rotterdam PCOS criteria than those of the NIH and AES. In the present study, the different phenotypes of PCOS in community women were evaluated according to the Rotterdam PCOS criteria. The breakdown of PCOS in women in the community in our study was as follows: H + O subtypes (Type I, 19.0%), H + P subtypes (Type II, 37.3%), O + P subtypes (Type III, 15.0%) and H + O + P subtypes (Type IV, 28.7%), respectively. Comparing the different subtypes of PCOS, we found that the metabolic complications of PCOS, such as MS, IR, hypertension and hyperlipemia, did not differ, but menstrual and fertility problems were significantly different, which indicated that PCOS is associated with fertility problems in Chinese communities. Therefore, most clinical trials have paid more attention to infertility treatments for PCOS patients (The Thessaloniki ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group, 2008).

PCOS is also associated with a significantly increased risk of metabolic dysfunction, including IR with consequent compensatory hyperinsulinemia and dyslipidemia (DeUgarte *et al*., 2005; Escobar-Morreale *et al*., 2011). Furthermore, PCOS could also cause many serious complications and psychological problems, including MS, DM2, CVD and low self-esteem (Legro *et al*., 1999; Solomon, 1999; Paradisi *et al*., 2001; Hart

Table I Comparison of the general characteristics and complications between Chinese women with and without PCOS in the community.

Community women	Community PCOS ($n = 833$)	Community non-PCOS ($n = 2732$)	OR (95%CI)
Age (years)	29.1 ± 5.4	32.3 ± 6.1*	
BMI (kg/m^2)	22.2 ± 4.2	22.1 ± 3.4	
mF-G score	2.7 ± 3.7	1.1 ± 2.0*	
Testosterone (nmol/l)	2.1 ± 1.1	1.4 ± 0.8*	
Androstenedione (nmol/l)	13.0 ± 5.0	8.9 ± 4.3*	
SHBG (nmol/l)	57.4 ± 33.1	66.0 ± 34.3*	
FAI	5.0 ± 4.6	2.8 ± 2.7*	
HOMA-IR	1.5 ± 2.3	1.4 ± 2.2	
AMH (ng/ml)	9.5 ± 5.5 (319)	4.4 ± 4.2(83)*	
INH B (pg/ml)	98.8 ± 92.5($n = 319$[b])	81.6 ± 76.4($n = 83$)	
Irregular menstrual cycles	47.2% (393/833)	13.0% (355/2732)*	6.0 (5.0–7.1)
Obesity	34.1% (284/833)	35.0% (957/2732)	1.0 (0.8–1.1)
Infertility	6.4% (53/833)	2.8% (75/2732)*	2.4 (1.7–3.5)
Hyperandrogenism	85.0% (708/833)	26.7% (729/2732)*	15.6 (12.6–19.2)
PCO	81.0% (675/833)	12.4% (339/2732)*	30.2 (24.5–37.1)
MS	26.8% (223/833)	23.2% (635/2732)*	1.2 (1.0–1.4)
Insulin resistance	14.2% (118/833)	9.3% (254/2732)*	1.6 (1.3–2.0)[a]
Hypertension	15.3% (127/833)	15.2% (415/2732)	1.0 (0.8–1.2)
Hyperlipemia	56.4% (470/833)	53.7% (1467/2732)	1.1 (1.0–1.3)

Distributions were compared using Student's *t*-test or Mann–Whitney *U*-test, as appropriate. Categorical variables were compared using Pearson's chi-square (χ^2) test.
mF-G score, modified Ferriman–Gallwey score; MS, metabolic syndrome; SHBG, sex hormone-binding globulin; AMH, anti-Mullerian hormone; INH B, inhibin B; FAI, free androgen index; HOMA-IR, homeostatic model assessment of insulin resistance; PCO, polycystic ovaries (defined by ultrasound).
[a]Logistic regression: insulin resistance OR 1.8; 95% CI 1.1–3.0.
[b]Based on 402 blood samples from 319 women with PCOS and 83 without PCOS.
*$P < 0.05$.

Table II The complications in different subtypes of PCOS.

	Type I ($n = 158$)	Type II ($n = 311$)	Type III ($n = 125$)	Type IV ($n = 239$)	*P*
Irregular menstrual cycles	65.8% (104)	10.6% (33)	70.4% (88)	70.3% (168)	0.000*
Infertility	6.3% (10)	4.2% (13)	4.8% (6)	10.0% (24)	0.033*
Hyperandrogenism	100% (158)	100% (311)	0% (0)	100% (239)	0.000*
Obesity	34.8% (55)	31.8% (99)	36.8% (46)	35.2% (84)	0.737
PCO	0% (0)	100% (311)	100% (125)	100% (239)	0.000*
MS	27.2% (43)	24.8% (77)	24.0% (30)	30.5% (73)	0.410
Insulin resistance	13.9% (22)	12.9% (40)	12.8% (16)	16.7% (40)	0.586
Hypertension	16.5% (26)	15.1% (47)	14.4% (18)	15.1% (36)	0.968
Hyperlipemia	55.7% (88)	53.4% (166)	55.2% (69)	61.5% (147)	0.284

Distributions were compared using analysis of variance (ANOVA). Categorical variables were compared using Pearson's chi-square (χ^2) test.
PCO, polycystic ovary; MS, metabolic syndrome.
*$P < 0.05$.

et al., 2004; Apridonidze et al., 2005; Meyer et al., 2005; Boomsma et al., 2006; Jones et al., 2008; Okoroh et al., 2012). Based on the Adult Treatment Panel III criteria, the prevalence of MS was reported to be 8.2% (Carmina et al., 2006) and 43% (Apridonidze et al., 2005) in Italian and US women with PCOS, respectively. Since the rapid change in dietary structure in China, our previous study suggested that women in the community with PCOS had higher MS and IR rates than those without PCOS. However, the metabolic complication rates were significantly different between and obese and non-obese women with PCOS. There were no significant differences in the menstrual and fertility functions.

Table III The complications according to age in women with PCOS.

Age (years)	≤25 (*n* = 226)	26–35 (*n* = 493)	36–40 (*n* = 93)	≥41 (*n* = 21)	*P*
Irregular menstrual cycle	46.5% (105)	47.1% (232)	51.6% (48)	38.1% (8)	0.688
Infertility	4.9% (11)	7.5% (37)	5.4% (5)	0% (0)	0.128
Hyperandrogenism	89.4% (202)	83.4% (411)	81.7% (76)	90.5% (19)	0.000*
Obesity	15.9% (36)	37.3% (184)	55.9% (52)	57.1% (12)	0.000*
PCO	81.0% (183)	83.2% (410)	74.2% (69)	61.9% (13)	0.026*
MS	18.1% (41)	28.6% (141)	32.3% (30)	52.4% (11)	0.000*
Insulin resistance	11.1% (25)	15.2% (75)	15.1% (14)	19.1% (4)	0.435
Hypertension	8.0% (18)	16.4% (81)	21.5% (20)	38.1% (8)	0.000*
Hyperlipemia	47.8% (108)	58.4% (288)	61.3% (57)	81.0% (17)	0.003*

Distributions were compared using ANOVA. Categorical variables were compared using Pearson's chi-square (χ^2) test.
PCO, polycystic ovary; MS, metabolic syndrome.
*$P < 0.05$.

Table IV The complications in obese and non-obese women with PCOS.

	Non-obese PCOS (*n* = 549)	Obese PCOS (*n* = 284)	*P*
BMI (kg/m^2)	19.9 ± 2.51	26.6 ± 3.3	0.000*
Irregular menstrual cycle	45.7% (251)	50.0% (142)	0.243
Infertility	5.1% (28)	8.8% (25)	0.259
Hyperandrogenism	85.6% (470)	83.8% (238)	0.539
PCO	81.2% (446)	80.6% (229)	0.852
MS	15.9% (87)	47.9% (136)	0.000*
Insulin resistance	7.1% (39)	27.8% (79)	0.000*
Hypertension	7.7% (42)	29.9% (85)	0.000*
Hyperlipemia	47.7% (262)	73.2% (208)	0.000*

Distributions were compared using Student's *t*-test or Mann–Whitney *U*-test, as appropriate. Categorical variables were compared using Pearson's chi-square (χ^2) test.
PCO, polycystic ovary; MS, metabolic syndrome.
*$P < 0.05$.

Obesity was a very important factor to the metabolic complications of PCOS. Since this survey did not involve data on structure of the diet, we could not assess the relationship diet, obesity and PCOS.

In the current study, the general characteristics and complications of PCOS were compared among women in the community with and without PCOS. Women with PCOS were younger, and more were suffering from menstrual problems, obesity and hyperandrogenism, but had a similar HOMA-IR compared with women without PCOS. Most women with PCOS in the community did not have infertility problems; the infertility rate was only 6.36%, but they exhibited the long-term complications of PCOS, including IR and MS. The results suggest that the women with PCOS had not only more menstrual problems, hyperandrogenism and PCO, but also MS and IR. However, only IR had an OR 1.792, 95% CI 1.061–3.027, after logistic regression. It has been suggested that women with PCOS have elevated potential risks for some systemic diseases, which was the long-term focus of prevention by health-care clinicians: by reducing intake of fats and sugar and keeping up a daily exercise routine. It is also extremely important to have blood pressure and cholesterol checked routinely.

In summary, this is first large-scale study on the prevalence of PCOS based on reproductive-age women in the community from 10 provinces of China. The prevalence of PCOS in Chinese women aged 19–45 years is 5.6% according to the Rotterdam diagnostic criteria, and while this is not an emergency public health problem yet, the data suggest that strategies aimed at health education and the prevention and treatment of PCOS in women in the community, particularly those who are obese, are needed. Further research should examine the long-term health risks of the metabolic complications and psychological problems associated with PCOS, such as DM2, CVD, low self-esteem and anxiety, in Chinese women.

Acknowledgements

Thanks to Dr Karla Saner for her critical review and comments during the preparation of this manuscript.

Authors' roles

R.L. contributed to the acquisition of Beijing and Henan provinces' data, drafting the article and revising it critically for important intellectual content. Q.Z. was mainly in charge of the data analysis. D.Y., S.L., S.L., X.W., Z.W., X.S., X.W. and S.F. did the specific data interpretation of Guangdong, Sichuan, Shanxi, Heilongjiang, Anhui, Tianjin and Hunan provinces, respectively. J.L., Y.Z., Y.J. and H.F. took part in the design and article revises. J.Q. contributed to conception and design, final approval of the version to be published as corresponding author.

Funding

This study was supported by National Science Fund for Distinguished Young Scholars, Capital Medical Development Scientific Research Fund and National Key Technology R&D Program. Ten participant

university hospitals and the National Center for Chronic and Noncomunicable Disease Control and Prevention (NCNCD) participated.

Conflict of interest

All authors have nothing to disclose.

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