Epidemiology of genital infections caused by *Mycoplasma hominis*, *M. genitalium* and *Ureaplasma urealyticum* in Iran; a systematic review and meta-analysis study (2000–2019)

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Abstract

Background: Although many species of mycoplasmas regard as normal flora, but some species causes serious genital disease. In Iran several epidemiological studies have documented the prevalence of *Mycoplasma hominis*, *M. genitalium* and *Ureaplasma urealyticum* in genital disorders. This meta-analysis is going to represent the prevalence of *M. hominis*, *M. genitalium* and *U. urealyticum* among Iranian couples and the correlation between mycoplasmas infection and infertility.

Methods: We search online databases from January 2000 to June 2019. We used following MeSH keywords (Prevalence, *M. hominis*, *M. genitalium*, *U. urealyticum*, male, female, fertility, Infertility, genitourinary tract infection and Iran) with all possible combinations with "OR" and "AND". Finally, forty-four articles from 2670 were chosen for data extraction and analysis by software using STATA version 14.0.

Results: This meta-analysis revealed that the prevalence of *U. urealyticum* was 17.53% in Iran and the prevalence of *M. genitalium* and *M. hominis* were 11.33 and 9.68% respectively. The rate of *M. genitalium*, *M. hominis* and *U. urealyticum* infection in women with symptoms of genitourinary tract infection was higher than men with genitourinary tract infection (6.46% vs 5.4, 7.67% vs 5.88 and 21.04% vs 12.13%, respectively). As expected, the prevalence of *M. genitalium*, *U. urealyticum* and *M. hominis* among infertile women (12.73, 19.58 and 10.81%) were higher than fertile women (3%, 10.85% and 4% respectively). Similarly, the prevalence of *M. hominis* and *U. urealyticum* among infertile men (14 and 21.18%) were higher than fertile men (4 and 3%). Based on this analysis, the rate of *U. urealyticum* was higher than *M. genitalium* and *M. hominis* among infertile men and women compared to the fertile group. The prevalence rate of *M. genitalium*, *M. hominis* and *U. urealyticum* in central provinces is higher than other parts of Iran.

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Background

Mycoplasma and Ureaplasma geniuses are the smallest self-replicating organism that belong to the Mollicutes class [1–4]. They live as external parasites of the human, animal, bird, insect and plant cells. Some species have a free-living existence in soil and water [5]. Since Dienes and Edsall isolated first mycoplasma from human in a Bartholin’s gland abscess in 1937, seventeen species of human mycoplasmas species have been identified [6, 7]. As a new derivative genus Ureaplasma is divided in to 14 known serotypes and two biovars: U. parvum and U. urealyticum. U. urealyticum can be transmitted in different ways, including directly by sexual transmission, vertically from mother to offspring, or through transplanted tissues [8–13]. Generally, genital mycoplasmas such as M. hominis, M. genitalium and U. urealyticum are important emerging sexually transmitted bacterial pathogens capable to cause asymptomatic, long-term and chronic infection in genitourinary tract which is considered to be a threat to community health [14, 15]. In a clinical study, about 40% of infants born from infected mothers with genital Mycoplasma infection had symptomatic infection such as neonatal conjunctivitis and meningitis by an ascending route or by crossing the placenta from the mother’s blood via delivery through a colonized birth canal [16].

Despite the worldwide incidence of genital mycoplasmas infections, there are no accurate reports of prevalence, common types, common routes of transmission and antibiotic resistance patterns of M. genitalium, M. hominis and U. urealyticum in Iran [17]. There are some studies about the presence of genital mycoplasmas among men, women, pregnant, newborns, infertile and etc in Iran. In this systematic review and meta-analysis, we are going to present an illustration of prevalence of M. hominis, M. genitalium, and U. urealyticum in Iran and the correlation between mycoplasmas infection and infertility in Iranian couples.

Methods

Search strategy

We search online databases including Pubmed, Scopus, Science Direct, IranMedex, SID (Scientific Information Database), and Google Scholar for the papers that were performed in Iran from January 2000 to June 2019. We used following MeSH keywords (Prevalence, M. hominis, M. genitalium, U. urealyticum, male, female, fertility, Infertility, genitourinary tract infection and Iran) with all possible combinations with “OR” and “AND”. Then the titles of the articles were entered into Mendeley software to find similar articles. Definition of terms were considered as WHO recommended. One of the limitations of this study is the lack of data in some part of Iran. Since different researchers worked on different samples and conditions, the data was categorized in six groups: 1. Fertile men 2. Infertile men 3. Men with urinary tract infection or prostatitis 4. Fertile women 5. Infertile women 6. Women with urogenital infection or abortion or pregnant.

Inclusion and exclusion criteria

Inclusion criteria of this study consisted of a reference to the prevalence of M. genitalium, M. hominis, and U. urealyticum in Iranian men and women by culture and PCR. Exclusion criteria were irrelevance or limited information, countries other than Iran, review articles, methods other than culture and PCR. At the end, 44 articles, which met our inclusion criteria, were conducted for meta-analysis.

Data extraction

The data were extraction by a pre-prepared checklist from all included articles. The checklist included the author’s name, year of the study, the location, sample volume, type of specimen and the prevalence of M. genitalium, M. hominis, and U. urealyticum. The studies on each Mycoplasma species were further categorized into subgroups, considering (1) study population according to gender (men and women) fertile, infertile and urogenital tract infection; (2) Analytical method (including PCR, and culture); (3) geographical region of sampling (including Eastern provinces: Kerman, North Khorasan, Razavi Khorasan, South Khorasan, Sistan and Baluchestan, and Yazd Provinces; Middle provinces (Northern, Central & Southern): Alborz, Golestan, Mazandaran, Qazvin, Qom, Semnan, Tehran, Bushehr, Chaharmahal and Bakhtiari, Fars, Hormozgan, Isfahan, Kohgiluyeh and Boyer-Ahmad Provinces; Western provinces: Ardabil, East Azerbaijan, Gilan, Kordestan, West Azerbaijan, Zanjan, Hamadan, Ilam, Kermanshah, Khuzestan, Lorestan and Markazi Provinces).
Analytic approach
The ratio of positive samples to total samples was defined as prevalence. Meta-analysis was conducted by STATA version 14 for prevalence of each bacterium on available data. Chi-squared (Q) and I-squared tests were used to assess heterogeneity among the studies. Since the heterogeneity was statistically significant ($p$-value of Q test < 0.1 and $I^2$ index > 75%), a random-effects model was used; The outcome was estimated as prevalence and 95% confidence intervals (CI).

Results
Description of included and excluded studies
Initially 11,345 articles were identified through database searching. About 2670 articles were remained after discarding duplicate papers based on title and abstract. From 2670 articles, we excluded further 1606 papers based on exclusion criteria (489 papers on M. genitalium, 595 papers on M. hominis, and 522 papers on U. urealyticum were excluded). Forty-four original articles (full texts) related to prevalence of M. genitalium, M. hominis, and U. urealyticum in Iranian men and women in our literature review remained for reviewing and assessing for eligibility criteria. The final 44 articles were included: M. genitalium [17], M. hominis [18], U. urealyticum [19] with some of them contains two [15] or three [2] of these bacteria (Fig. 1). Table 1 provides an overview of the eligible studies.

Prevalence of M. genitalium
The overall prevalence of M. genitalium was 16.60% (CI 95%; 12.01–21.18%) and 8.26% (CI 95%; 6.33–10.19%) in male and female respectively (Table 2).

Prevalence of M. hominis
The overall prevalence of M. hominis was 10.73% (CI 95%; 6.77–14.69%) and 8.83% (CI 95%; 6.67–10.98%), among male and female respectively (Table 3).

Prevalence of U. urealyticum
The prevalence of U. urealyticum was 13.92% (CI 95%; 7.58–20.26%) and 19.43% (CI 95%; 11.56–27.30%), in male and female respectively (Table 4).

The prevalence rates of genital mycoplasma infection are due to U. urealyticum, M. genitalium and M. hominis respectively, in Iran. This study shows that the rate of U. urealyticum, M. genitalium and M. hominis infection in women with symptoms of genitourinary tract infection was higher than men with genitourinary tract infection. The result indicated that the prevalence of U. urealyticum, M. genitalium and M. hominis in infertile women were higher than fertile women. However, the prevalence of U. urealyticum and M. hominis in infertile men were higher than fertile men.

Fig. 1 Flow chart of the literature search, systematic review and study selection
| No | Location  | Year | Author                  | Number & kind of sample | Method   | Prevalence (%) | Comment                                      | Ref  |
|----|-----------|------|-------------------------|-------------------------|----------|----------------|-----------------------------------------------|------|
| 1  | Tehran    | 2001 | Badami                 | n = 375 cervical swab   | Culture  | MH = 18(7.2) & UU = 48(19.2) Infertile women MH = 32(25.6) & UU = 41(32.8) | Fertile women = 250 Infertile women = 125 | [20] |
| 2  | Tehran    | 2003 | Salari                 | n = 125 swab urethral   | PCR      | MG = 9(72) UU = 24(19.2) MH = 3(24) | Men with NGU | [21] |
| 3  | Tehran    | 2005 | Aleyasin               | n = 312 cervical swab   | Culture   | MH = 20(6.4) &PCR MH = 50(16) Culture &PCR = 16(5) | Infertile women | [22] |
| 4  | Tehran    | 2005 | Najar Peerayeh         | n = 312 cervical swab   | Culture   | UU = 18(5.7) PCR: UU = 32(10.25) | Infertile women | [23] |
| 5  | Tehran    | 2006 | Najar Peerayeh         | n = 377 cervical swab   | PCR       | MH = 31(8.2) UU = 60(15.9) MH & UU = 25(6.6) | Infertile women | [18] |
| 6  | Tehran    | 2007 | Golshani               | n = 200 semen samples   | Multiplex PCR | MH = 22(11) UU = 6(3) MH&UU = 2(1) | Infertile men | [24] |
| 7  | Tehran    | 2007 | Zeighami               | n = 200 semen samples   | PCR       | Fertile men: UU = 3(3) Infertile men: UU = 12(12) | Fertile men = 100 Infertile men = 100 | [19] |
| 8  | Tehran    | 2007 | soleimani rahbar       | n = 100 semen samples   | PCR       | MH = 3(3) UU = 17(17) | Infertile men | [25] |
| 9  | Tehran    | 2007 | Najar Peerayeh         | n = 377 cervical swab   | PCR       | UU = 85(22.5) | Infertile women | [26] |
| 10 | Tehran    | 2008 | Najar Peerayeh         | n = 312 cervical swab   | Culture   | Culture: MH = 12(4) & UU = 39(12) PCR: MH = 28(9) & UU = 54(17) | Infertile women | [27] |
| 11 | Tehran    | 2008 | Ghazisaidi             | n = 75 urethral secretion samples after prostatic massage & First void urine | PCR       | urethral secretion: MH = 11(15) & UU = 19(25) First void urine: MH = 9 (12) & UU = 17(23) | Men suffering from nongonococcal urethritis and non-specific urethritis | [28] |
| 12 | Tehran    | 2008 | Najar Peerayeh         | n = 246 semen samples   | PCR       | Fertile men: UU = 3(3) Infertile men: UU = 23(15.7) | Fertile men = 100 Infertile men = 146 | [29] |
| 13 | Tehran    | 2009 | Amirmozafari           | n = 210 cervical swab   | Culture   | UU = 69(32.8) PCR: UU = 67(31.9) | Women with urogenital infection | [30] |
| 14 | Tehran    | 2010 | Ahmadi                 | n = 220 semen sample    | PCR       | MH = 34 (15) UU = 89(40) MH&UU = 25(11) | Infertile men | [31] |
| 15 | Tehran    | 2011 | Minejad                | n = 210 genital samples | PCR       | UU = 89(42.4) MG = 7(3.3) | Women with urogenital infection | [32] |
| 16 | Sabzevar  | 2011 | Haghighi Hasanabad     | n = 196 urine           | PCR       | MG = 2(11) | Pregnant women | [33] |
| 17 | Ahwaz     | 2011 | Moosavian              | n = 265                | Culture   | Culture: MH = 5 (18)& UU = 0 | Women with urogenital infection | [34] |
## Table 1

Prior studies concerning prevalence of *Mycoplasma hominis*, *Mycoplasma genitalium* and *Ureaplasma urealyticum* in Iran (Continued)

| No | Location       | Year | Author                    | Number & kind of sample | Method                  | Prevalence (%) | Comment                              | Ref   |
|----|----------------|------|---------------------------|-------------------------|-------------------------|----------------|--------------------------------------|-------|
| 18 | Kerman         | 2013 | Vosooghi                  | n = 58 semen sample     | PCR                     | MH = 13(22)    | Infertile men                        | [35]  |
| 19 | Tehran         | 2013 | irajian                   | n = 200 paraffin blocks | PCR                     | MG = 4(2)      | Men with prostatitis                 | [36]  |
| 20 | Ahvaz          | 2013 | Maleki                    | n = 265 urine = 110 cervical swab = 155 | Multiplex PCR Urine: MH = 11(10) & UU = 13(12) cervical swab: MH = 7 (4)& UU = 15(10) | Women with urogenital infection | [37]  |
| 21 | Tehran         | 2013 | Yeganeh                   | n = 200 urine           | PCR                     | MG = 14(7)     | Men refer to urology clinic           | [38]  |
| 22 | Tehran         | 2013 | Sadrpour                  | n = 120 semen samples   | PCR                     | MG = 12(10)    | Infertile men                        | [39]  |
| 23 | Mazandaran     | 2013 | mohseni                   | n = 44 genital samples  | PCR                     | MG = 10(22.7)  | Pregnant women                       | [40]  |
| 24 | Tehran         | 2014 | Seifoleslami              | n = 350 cervical swab   | PCR                     | Infertile women: MH = 8(5.3) & UU = 10(6.6) Fertile women: MH = 3(1.5) & UU = 5(2.5) MH&UU = 1 | Infertile women = 150 Fertile women = 200 | [17]  |
| 25 | Kurdistan      | 2014 | Ahmadi                    | n = 218 cervical swab   | PCR                     | Pregnant women: UU = 8(7.3) Spontaneous abortion: UU = 18(16.5) | Pregnant women = 109 Spontaneous abortion = 109 | [41]  |
| 26 | Sanandaj       | 2014 | Mousavi                   | n = 104 cervical swab   | Multiplex PCR MH = 3(3) MG = 3(3) UU = 39(37) MH&UU = 10(1) MH&MG = 1(1) MG&UU = 1(1) MG&UU&MH = 1(1) | Infertile women | [42]  |
| 27 | Kerman         | 2014 | JamalizadehBahaabadian    | n = 200 semen sample = 100 cervical swab = 100 | PCR                     | Semen sample: MH = 15(7) cervical swab: MH = 18(18) | Infertile men & Infertile women | [43]  |
| 28 | Kerman         | 2014 | Mohseni Moghadarn         | n = 200 semen samples = 100 cervical swab = 100 | PCR                     | Semen samples: MG = 13(13) cervical swab: MG = 10(1) | Infertile men Infertile women | [11]  |
| 29 | Tehran         | 2014 | Sobouti                   | n = 330 cervical swab their baby after delivery | Multiplex PCR           | Pregnant women: MH = 25(15.1) & UU = 25(15.1) their baby after delivery: MH = 15(9) & UU = 18(10.9) | Pregnant women = 165 their baby after delivery = 165 | [44]  |
| 30 | Tehran         | 2015 | Dadashi                   | n = 124 sample from ovarian cancer | PCR                     | MG = 9(72)     | Ovarian Cancer = 62 Benign Ovarian Cancer =62 | [45]  |
| 31 | Tehran         | 2015 | Eslami                    | n = 124 paraffin blocks | PCR                     | MG = 0 UU = 1(0.8) | From men who undergo prostatectomy | [46]  |
| no. | Location   | Year | Author                  | Number & kind of sample | Method       | Prevalence (%) | Comment                                      | Ref |
|-----|------------|------|-------------------------|-------------------------|--------------|----------------|-----------------------------------------------|-----|
| 32  | Tehran     | 2015 | Safavifar               | n = 45 semen samples   | PCR          | Infertile men: MG = 6(40) Fertile men: MG = 11(37) | Infertile men = 15 Fertile men = 30 | [47]|
| 33  | Kerman     | 2015 | Eftekhari Moghadam      | n = 50 urine            | PCR          | MH = 3(6)      | UTI patients                                   | [14]|
| 34  | Kashan     | 2015 | Safari                  | n = 864 urine           | PCR          | MH = 1(0.1)    | UTI patients                                   | [48]|
| 35  | Sanandaj   | 2016 | Ramazanzadeh            | n = 218 genital swab    | PCR          | Normal pregnant: MG = 4(3.6) Spontaneous abortion: MG = 2(18) | Normal pregnant = 109 Spontaneous abortion = 109 | [49]|
| 36  | Tehran     | 2016 | Ahmadi                  | n = 330 semen samples   | Real-time PCR | Infertile men = MH = 24(14) Fertile men: MH = 6(4) | Infertile men = 165 Fertile men = 165 | [50]|
| 37  | Qazvin     | 2016 | Bahrami                 | n = 232 cervical swab   | culture      | UU = 87(37.5)  | married females(20–50 years)                 | [51]|
| 38  | Qom        | 2016 | Asgari                  | n = 187 semen samples   | PCR          | MH = 71(39)    | Infertile men                                  | [52]|
| 39  | Tehran     | 2016 | Irajian                 | n = 200 prostatitis tissues with paraffin | PCR          | UU = 7(3.5)    | men suffering from prostatitis                | [53]|
| 40  | Tehran     | 2017 | sameni                  | n = 65 cervical swab    | PCR          | MG = 11(16.9)  | Infertile women                                | [54]|
| 41  | Tehran     | 2017 | Javadinia               | n = 194 urine           | PCR          | UU = 22(11.3) MG = 11(5.6) UU&MG = 5(2.6) | Pregnant women                              | [55]|
| 42  | Mashhad    | 2017 | Makari golkhmati        | n = 200 vaginal swab    | PCR-ELISA    | Infertile women: MG = 21(21) Fertile women: MG = 3(3) | Infertile women = 100 Fertile women = 100 | [56]|
| 43  | Hamedan    | 2018 | Moradi                  | n = 234 cervical swab   | Culture      | Culture: MH = 14(5.9) PCR: MH = 30(12.8) | married females(20–50 years)                 | [57]|
| 44  | Mashhad    | 2018 | Moridi                  | n = 100 semen samples   | Culture      | Culture: MH = 7(7) PCR: MH = 8(8) Culture: MG = 0(0) PCR: MG = 0(0) | Infertile men a                                      |     |

aThe data is under publication
Geographical distribution of *M. hominis, M. genitalium* and *U. urealyticum* in Iran

In Eastern provinces of Iran, the prevalence of *M. genitalium* and *M. hominis* were 9.60 and 9.73% respectively based of meta-analysis (CI 95%). There is no documented study on *U. urealyticum* respectively based of meta-analysis (CI 95%). There is no documented study on *U. urealyticum* in Iran based of meta-analysis (CI 95%). There is no documented study on *U. urealyticum* in Iran based of meta-analysis (CI 95%).

Analytical method

The forty-four selected articles which met our inclusion criteria were analyzed according to the culture and PCR methods. The prevalence rate of *M. hominis* and *M. genitalium* base on PCR (10.13% & 11.33%) was higher than culture method (8.27% & 0%), whereas that was contrary base on PCR (10.13% & 11.33%) was higher than culture method (8.27% & 0%), whereas that was contrary.

Table 2 The prevalence of *M. hominis* in Iran based of meta-analysis

| Study Population | studies | sample | prevalence, 95% CI | Model |
|------------------|---------|--------|--------------------|-------|
| Men              | 8       | 1114   | 16.60, 12.01–21.18 | Random|
| Fertile          | 1       | 30     | 37.00, 36.83–37.17 | Random|
| Infertile        | 4       | 435    | 21.00, 13.18–28.82 | Random|
| Symptomatic 1    | 4       | 649    | 5.40, 1.55–9.25  | Random|
| Women            | 11      | 1455   | 8.26, 6.33–10.19  | Random|
| Fertile          | 1       | 100    | 3.00, 2.97–3.03  | Random|
| Infertile        | 4       | 369    | 12.73, 4.44–21.01 | Random|
| Symptomatic 2    | 7       | 986    | 6.46, 4.62–8.29  | Random|
| Women and men    | 18      | 2569   | 11.33, 9.58–13.08 | Random|

Table 3 The prevalence of *M. hominis* in Iran based of meta-analysis

| Study Population | studies | sample | prevalence, 95% CI | Model |
|------------------|---------|--------|--------------------|-------|
| Men              | 12      | 2344   | 10.73, 6.77–14.69 | Random|
| Fertile          | 1       | 165    | 4.00, 3.97–4.03  | Random|
| Infertile        | 7       | 1130   | 14.00, 7.45–20.55 | Random|
| Symptomatic 1    | 4       | 1049   | 5.88, 2.18–9.57  | Random|
| Women            | 12      | 3670   | 8.83, 6.67–10.98 | Random|
| Fertile          | 2       | 450    | 4.35, −1.24–9.94 | Random|
| Infertile        | 7       | 1480   | 10.81, 7.18–14.45 | Random|
| Symptomatic 2    | 3       | 1740   | 7.67, 4.34–10.99 | Random|
| Women and men    | 22      | 6014   | 9.68, 7.75–11.61 | Random|

Table 4 The prevalence of *U. urealyticum* in Iran based of meta-analysis

| Study Population | studies | sample | prevalence, 95% CI | Model |
|------------------|---------|--------|--------------------|-------|
| Men              | 8       | 1290   | 13.92, 7.58–20.26 | Random|
| Fertile          | 2       | 200    | 3.00, 2.98–3.02  | Random|
| Infertile        | 4       | 766    | 21.18, 8.61–33.74 | Random|
| Symptomatic 1    | 4       | 342    | 12.13, 3.23–21.02 | Random|
| Women            | 14      | 4441   | 19.43, 11.56–27.30 | Random|
| Fertile          | 2       | 450    | 10.85, −5.52–27.22 | Random|
| Infertile        | 7       | 1757   | 19.58, 13.59–25.57 | Random|
| Symptomatic 2    | 5       | 2234   | 21.04, 8.95–33.13 | Random|
| Women and men    | 24      | 5731   | 17.53, 11.40–23.66 | Random|

Discussion

The epidemiology and role of *M. hominis, M. genitalium* and *U. urealyticum* in infertility has been less discussed in Iran [14]. The different reports documented in other countries around the world. *M. genitalium* has been identified as a causative agent of 10–35% nongonococcal-nonchlamydia urethritis [58–62]. According to the community-based prospective cohort study from Oakeshott (2010) *M. genitalium* is found in 0.7 to 3.3% of women in general populations, while the prevalence in high-risk groups such as sex workers and STD clinic attendees is 7–22% in London [5, 63]. However, *M. hominis* resides commensally on the mucosal surfaces of the cervix or vagina. It’s colonization values ranges between 20 and 30% around the world [48, 64]. *M. hominis* was detected in 21–53% of women without genital urinary tract infection and at a lower percentage in the urethra of male [1]. Several studies have proposed that *M. hominis* is potentially pathogenic and sometimes associated with a variety of disorders including bacterial vaginosis, pyelonephritis, pelvic inflammatory disease, chorioamnionitis, endometritis, preterm birth, low birth, spontaneous abortion, stillbirth, premature birth, postpartum fever, perinatal mortality and infertility overtime [65, 66]. The positive rates of *M. hominis, M. genitalium* and *U. urealyticum* are controversial and diverse in the world [67]. Recently, Ghadiri (2019) in Iran (Ahwaz) detected *U. urealyticum* (28%) and *M. hominis* (10%) in semen specimens of infertile men by PCR and isolated 22% of *U. urealyticum* and 2% of *M. hominis* in the same samples by culture. While, *U. urealyticum* and *M. hominis* were detected in 50% & 26% by PCR of endocervical swabs specimens of infertile women and 8% & 4% by culture [68]. Christian Leli (2018) was detected *U. urealyticum* in 4.7%, *M. hominis* in 3.4% and *M. genitalium* in 0% of 232 cervical swab specimens of infertile women by real-time PCR in Italy [69]. Xiaofei Zhu (2016) showed that the prevalence of *U. urealyticum* and *M. hominis* were 42.3 and 0.4% among 7374 infertile men by culture.

1. Men with urinary tract infection or prostatitis; 2. Women with urogenital infection or abortion or pregnant

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Mahlangu (2019) was determined *M. genitalium* in 8.9% of urine and 10.6% of endocervical swab specimens which collected from males and females with genital discharge syndrome [71].

Baumann (2017) performed a meta-analysis on prevalence of *M. genitalium* and found that: the prevalence among women is similar to men and was 1.4% in developed countries and 3.9% in developing countries among general population. He showed that the prevalence among pregnant women were 0.9%, and the prevalence among men who have sex with men in the community was 3.2%, and among female commercial sex workers.
was 15.9% in the world [72]. Huang performed meta-analysis study (2015) and investigated the association between *U. urealyticum* and *M. hominis* positive rate (5.2% & 14.9%) and risk of male infertility. While the *M. genitalium* prevalence did not showed any correlation to male infertility [73]. Kasprzykowska (2018) indicated that the prevalence of Ureaplasma spp in women (14.4%) and men (3.9%) is higher than *M. hominis* in women (0.2%) and men (0.2%) with urogenital tract infection in Poland [74]. Cassell estimated that the *U. urealyticum* can be found in 40 to 80% of cervicovaginal samples from sexually mature women [74, 75]. Zinzendorf (2008) investigated *M. hominis* in 23.8% of infertile men in Africa [76]. Taken (2016) could determine *M. hominis* in 3% of infertile men in Turkey [77]. Abusarah (2013) detected *U. urealyticum* in 10.8% versus 5.7% and *M. genitalium* in 3.2% versus 1.4% among infertile and fertile men respectively in Jordan [78]. Jensen indicated *M. genitalium* in 17% of male patient with urogenital tract infection in Denmark [79]. Al- Sweih (2012) in Kuwait detected *M. hominis* in 17.1% & 32.4%, *M. genitalium* in 4.7% & 3.2% and *U. urealyticum* in 24.4% & 26.1%, among infertile and fertile men respectively [80]. Lee (2013) displayed *U. urealyticum* in 48% & 25%, *M. hominis* in 14% & 6.3% of infertile and fertile men, while, *U. urealyticum* in 40% & 22.9% and *M. hominis* in 8% & 4.2% of infertile and fertile women in Korea [81]. Andersen reported that the prevalence of infection due to *M. genitalium* in general

### Forest plot of the meta-analysis of the prevalence of *M. hominis* in Iran based on analytical method

| Study ID | ES (95% CI) | Weight |
|----------|-------------|---------|
| culture  | 6.40 (6.37, 6.43) | 3.45    |
| ajeyasir (2005) | 7.20 (7.17, 7.23) | 3.45    |
| badami (2001)  | 25.60 (25.52, 25.68) | 3.45    |
| badami (2001)  | 1.80 (1.78, 1.82) | 3.45    |
| moosavian (2011) | 5.90 (5.87, 5.93) | 3.45    |
| moradi (married female) (2018) | 7.00 (6.95, 7.05) | 3.45    |
| moradi (2018) | 4.00 (3.98, 4.02) | 3.45    |
| nadjari (2008) | 8.27 (5.32, 11.22) | 24.14   |
| Subtotal (\(I^2\) = 100.0%, \( p = 0.000\)) | 15.00 (14.95, 15.05) | 3.45    |
| PCR      | 4.00 (3.97, 4.03) | 3.45    |
| ahyad (2010)  | 16.00 (15.96, 16.04) | 3.45    |
| ahyad (2016)  | 39.00 (38.93, 39.07) | 3.45    |
| effekhari moghadam (2015) | 6.00 (5.93, 6.07) | 3.45    |
| ghazisadi (2008) | 15.00 (14.92, 15.08) | 3.45    |
| golshani (2007) | 11.00 (10.96, 11.04) | 3.45    |
| jamalizadeh (2014) | 18.00 (17.92, 18.06) | 3.45    |
| jamalizadeh (2014) | 7.00 (6.95, 7.05) | 3.45    |
| maleki (2013)  | 4.00 (3.98, 4.02) | 3.45    |
| moosavian (2011) | 12.80 (12.76, 12.84) | 3.45    |
| moradi (married female) (2018) | 8.00 (7.95, 8.05) | 3.45    |
| mousavi (2014) | 3.00 (2.97, 3.03) | 3.45    |
| nadjari (2006)  | 6.20 (6.17, 6.23) | 3.45    |
| rahrab (2007)  | 3.00 (2.97, 3.03) | 3.45    |
| saelfi (2015)  | 0.10 (0.09, 0.11) | 3.45    |
| salari (2003)  | 2.40 (2.37, 2.43) | 3.45    |
| seifoloeslam (2014) | 1.50 (1.48, 1.52) | 3.45    |
| seifoloeslam (2014) | 5.30 (5.26, 5.34) | 3.45    |
| sobouti (pregnant) (2014) | 15.10 (15.05, 15.15) | 3.45    |
| vosoghi (2013) | 22.00 (21.88, 22.11) | 3.45    |
| Subtotal (\(I^2\) = 100.0%, \( p = 0.000\)) | 10.13 (7.63, 12.63) | 75.86   |
| Overall (\(I^2\) = 100.0%, \( p = 0.000\)) | 9.68 (7.75, 11.61) | 100.00  |

NOTE: Weights are from random effects analysis
The prevalence rates of Mycoplasma and Ureaplasma are not well established and varies from one study to another. The heterogeneity of prevalence of mycoplasma urinary tract infection in different reports can be probably caused by differences in the geographic areas, the sensitivity of the identification method, the condition of the group (fertile/infertile), population was 2.3% in women and 1.1% in men whereas that was about 19% in men with urethritis and 11% in women with cervicitis in Denmark [82]. Also Grzeško indicated *M. genitalium* from 19.6% of specimens obtained from cervical canal of infertile women, whereas it was 4.4% in control group (women with proven fertility) in Poland [83].

![Forest plot of the meta-analysis of the prevalence of *U. urealyticum* in Iran based on analytical method](image-url)

### Table: Prevalence of Mycoplasma and Ureaplasma

| Study ID            | ES (95% CI) | Weight |
|---------------------|-------------|--------|
| culture             | 32.30 (32.74, 32.86) | 3.45   |
| badami (2001)       | 19.20 (19.15, 19.25) | 3.45   |
| badami (2001)       | 32.30 (32.72, 32.88) | 3.45   |
| najjar pirayeh (2008)| 12.00 (11.96, 12.04) | 3.45   |
| moosavian (2011)    | (Excluded)   | 0.00   |
| Subtotal (I-squared = 100.0%, p = 0.000) | 24.20 (14.02, 34.38) | 13.79  |
| PCR                 |             |        |
| ahmadi (2010)       | (40.00 (39.94, 40.06) | 3.45   |
| ahmadi (spontaneous abortion) (2014) | 16.50 (16.43, 16.57) | 3.45   |
| ahmadi (pregnant) (2014) | 7.30 (7.25, 7.35) | 3.45   |
| anirmozafarin (2009) | 31.90 (31.84, 31.96) | 3.45   |
| bahrami (married female) (2016) | 37.50 (37.45, 37.55) | 3.45   |
| eslamii (prostatitis) (2015) | 0.80 (0.75, 0.85) | 3.45   |
| ghazisaidi (2008)   | 25.00 (24.90, 25.10) | 3.45   |
| irjani (prostatitis) (2016) | 3.50 (3.47, 3.53) | 3.45   |
| javadian (pregnant) (2017) | 11.30 (11.26, 11.34) | 3.45   |
| maleki (2013)       | 10.60 (10.56, 10.64) | 3.45   |
| mirmajd (2011)      | 42.40 (42.39, 42.41) | 3.45   |
| moosavian (2011)    | 5.00 (4.97, 5.03) | 3.45   |
| mousavi (2014)      | 37.00 (36.91, 37.09) | 3.45   |
| najjar pirayeh (2005) | 10.25 (10.22, 10.28) | 3.45   |
| najjar pirayeh (2006) | 15.90 (15.86, 15.94) | 3.45   |
| najjar pirayeh (2007) | 22.50 (22.46, 22.54) | 3.45   |
| najjar pirayeh (2008) | 3.00 (2.97, 3.03) | 3.45   |
| najjar pirayeh (2008) | 15.70 (15.64, 15.76) | 3.45   |
| rahbar (2007)       | 17.00 (16.93, 17.07) | 3.45   |
| salari (2003)       | 19.20 (19.13, 19.27) | 3.45   |
| sefooleslami (2014) | 2.50 (2.48, 2.52) | 3.45   |
| sefooleslami (2014) | 6.60 (6.56, 6.64) | 3.45   |
| sobouti (pregnant) (2014) | 15.10 (15.05, 15.15) | 3.45   |
| zheighami (2007)    | 3.00 (2.97, 3.03) | 3.45   |
| zheighami (2007)    | 12.00 (11.94, 12.06) | 3.45   |
| Subtotal (I-squared = 100.0%, p = 0.000) | 16.46 (9.62, 23.30) | 86.21  |
| Overall (I-squared = 100.0%, p = 0.000) | 17.53 (11.40, 23.66) | 100.00 |
other infection accompanied agents, the sample size, and the operator proficiency.

Based on present meta-analysis study the prevalence rates of genital Mycoplasma infection are due to *U. urealyticum* (17.53%), *M. genitalium* (11.33%) and *M. hominis* (9.68%) respectively in Iran which is parallel to Christian Leli (Italy) and Xiaofei (China) results. According to other researcher results, this study shows that the rate of *M. genitalium*, *M. hominis* and *U. urealyticum* infections in women with symptoms of genitourinary tract infection is higher than men with genitourinary tract infection (6.46% Vs 5.4, 7.67% Vs 5.88 and 21.04% Vs 12.13%, respectively). That is in line with kasprzykowska and Mahlangu results. Iranian researches indicated that the prevalence of *M. genitalium*, *U. urealyticum* and *M. hominis* among infertile women (12.73, 19.58 and 10.81%) are higher than fertile women (3%, 10.85% and 4.35%), which is similar to Lee (2013) report. However, the prevalence of *M. hominis* and *U. urealyticum* in infertile men (14 and 21.18%) is higher than fertile men (4 and 3%), which is like Lee (2013) result.

According to analysis result, the prevalence of *M. genitalium*, *M. hominis* and *U. urealyticum* in Middle provinces is higher than other provinces in Iran. This may be due to the presence of infertility centers and specialized STD clinics in the capital of the country; Tehran. There are some different diagnostic equipment and facilities to research and attract infertile couples for treatment all over Iran.

Conclusions

Based on our meta-analysis, the most common Mycoplasma in Iran, in descending order are: *U. urealyticum*, *M. genitalium*, and *M. hominis*. There is statistically significant relationship between couple infertility and *U. urealyticum*, *M. genitalium* and *M. hominis* infections. There is the higher rate of mycoplasmas infection in women than men and their correlated infertilities.

However, obstetricians should consider mycoplasmas infection as a major agent of infertility. Since mycoplasmas are resistant to common antibiotics and the high prevalence of some mycoplasmas like *U. urealyticum*, Iranian physicians should be careful in the treatment of genitourinary tract infections to the possible presence of mycoplasmas agent and the sensitive antibiotics.

Further epidemiological and phylogenetic studies in different provinces will be needed to clarify the exact prevalence and distribution pattern of *U. urealyticum*, *M. genitalium* and *M. hominis* in Iran, and proposed routine screening of the pathogens in patients with infertility.

**Abbreviations**

M: Mycoplasma; U: Ureaplasma; PCR: polymerase chain reaction

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**Authors’ contributions**

MK & HM collected information from database and writing the article. FMH and KAH performed Meta-analysis and interpretation. HM and AA and GK contributed to the design of the study and supervised the research. The author(s) read and approved the final manuscript.

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