Prevalence and Risk factors of Infertility in a Mongolian Population

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Abstract

Background: Worldwide, the median prevalence of infertility is 9%, but rates in different countries vary from 3.5% to 16.7%. Infertility, which is defined by the World Health Organization (WHO) as the failure to conceive after 12 months of unprotected regular sexual intercourse, is reproductive health problems carries a social stigma and can greatly impact a couple's self-esteem and wellbeing. There are a number of risk factors associated with infertility such as: culture, socio-economic factors, age and health care including treatment of sexually transmitted diseases. We have achieved the first population-based study on the prevalence of infertility in reproductive aged women in Mongolia, and the factors that influence it.

Method: We conducted a population-based cross-sectional study in 4 regions (Khangai, Eastern, Western, Central) of Mongolia and the capital city Ulaanbaatar. Our questionnaire consisted of categories that influenced infertility such as: socio-economic status, lifestyle factors, health, reproductive history, present status and sexual function. Trained staff conducted face-to-face interviews with the participants.

Results: A total of 1,920 couples residing in 4 regions of Mongolia and the capital city, Ulaanbaatar were studied. The median prevalence rate of infertility was 7.2%, which is similar to the worldwide infertility rate of 9%. Primary and secondary infertility was 2.4% and 4.8% respectively. Our study showed that the most important risk factors for infertility were age, rural living, low levels of education, obesity and diseases of the female reproductive system. Only 14.8% of infertile patients received hormone therapy, and even fewer infertile patients (0.8%) received *in vitro* fertilization (IVF) treatment.

Conclusions: The prevalence rate of infertility is comparable to global rates among other developing countries. Our study shows that significant risk factors for infertility were: age, living in rural communities, having a low level of education, obesity and diseases of the female reproductive system. Occupational conditions, and monthly household income were not significant risk factors for infertility. Since this is the first population-based study in Mongolia we were not able to measure trends in infertility prevalence but intend to do so in the future.

Plain English Summary

Infertility is one of the most important and underappreciated reproductive health problems and carries a stigma that can affect the wellbeing of a couple, and lead to depression and low self-esteem. The World Health Organization (WHO) defines infertility as the failure to conceive after at least 12 months of regular unprotected intercourse. The average prevalence of infertility worldwide is 9%, although it varies from country to country depending on a number of risk factors. Relevant risk factors are the socio-economic conditions of a country and its health care.

We studied infertility amongst married couples living in 4 regions of Mongolia as well as in the capital city, Ulaanbaatar. In Mongolia the average infertility rate was 7.2%, which is similar to the average infertility rate worldwide. We found that in Mongolia infertility prevalence was significantly higher in rural communities and with couples who had lower levels of education. These two risk factors were often

associated. Besides these two risk factors age and history reproductive system diseases posed risks. Furthermore, Assisted Reproductive Technologies (ART) for the treatment of infertile is rare in Mongolia.

Background

Infertility, as defined by WHO, is the failure to conceive after at least 12 months of regular unprotected sexual intercourse [(1)]. Infertility is a medical issue that also carries a social stigma and leads to a decrease in the quality of life, emotional instability, and low self-esteem, especially in women (2).

There are wide-ranging estimates of infertility prevalence depending on the study and definition of infertility (3) (4, 5). A global study estimated the 12-month infertility prevalence to be 9%. With rates, ranging from 3.5–16.7% in more developed nations and from 6.9–9.3% in less-developed nations (6). There are around 186 million married women in developing countries (excluding China) between the ages of 15 and 49 with primary and secondary infertility (7). The differences between the developed and developing world have been increasing because of the availability, accessibility in infertility care and differing socio-cultural values for procreation and childlessness (8).

The only available data on infertility in Mongolia was represented demographically with a primary infertility occurrence of 1-1.99% while secondary infertility was 13% (9). In certain regions of the world including developing countries unsafe abortion, poor maternity care and sexually transmitted infections contribute to the higher rate of secondary infertility compared to primary infertility (10). Mongolia has one of the highest rates of secondary infertility (9) and this may largely be attributed to high rates of sexually transmitted infections (STIs). For instance, the rate of gonorrhea among women and men in Mongolia was 3.3% and 2.9%, and chlamydia was 19.5% and 15.6% respectively (11). Mongolia has an unregulated growth of the private healthcare sector and poor enforcement of standards and technical guidelines for safe abortion (12).

Mongolian based studies on infertility such as Bayasgalan et al 2004, are in a clinically based they found a female infertility rate of 45.8%, and a male infertility rate of 25.6%, unexplained infertility was 9.8% and the combined rate for couples was 18.8%. In Mongolia, the major factors influencing female infertility were tubal adhesions and endocrinal factors, while in the male they were varicocele, azoospermia and testicular damage(13).

Infertility studies in Mongolia have mainly been hospital-based with limited epidemiological studies. Therefore, accurate assessment of infertility using epidemiological study methods are crucial in order to provide high quality assessment, treatment, and management. The aim of this study was to provide the first 12-month prevalence rate of infertility with a population-based study, including causative factors leading to infertility in women of a reproductive age in Mongolia.

Methods

Study population and sampling

We conducted a population-based cross-sectional study from September 2016 to November 2018 in the four regions of Mongolia as well as the capital city of Ulaanbaatar. Mongolia is divided into four regions based on geographical and economic factors (Eastern, Western, Central and Khangai) while the capital city Ulaanbaatar is viewed as a separate region. Each region is made up of provinces with a total of 21 provinces in all.

The appropriate sample size for the study was calculated by taking the average international rates of infertility of around 8–10%. International infertility rates were used to calculate the appropriate sample size since there were no previous infertility studies undertaken in Mongolia. With an allowable error of 5% and a confidence level of 95%, a total sample size of 2000 couples was required for the study. Incomplete questionnaires (80 respondents) were excluded resulting in a total 1920 couples participating in the study giving in a response rate of 96%.

This was a nation-wide study that involved one or two provinces within each region randomly selected by a multi-stage stratified cluster sampling design. We calculated the study sample of reproductive-age couples in each of four main regions (Govi-Altai province (n = 300) from Western region, Khuvsgul (n = 200) and Orkhon (n = 218) provinces from the Northern region Darkhan (n = 174) and Umnugovi (n = 150) provinces from the Central region and Ulaanbaatar (n = 695) region.

For the study we selected married couples who were citizens of Mongolia and who had been living together at least one year at a permanent residence in one of the selected regions. The women were between 20–45 years of age while there was no age selection for men. Couples excluded from the study were those who had lived apart for longer than three months, used birth control in any form, were presently breastfeeding, or those women in early menopause. After participants agreed to take part in the study, they were asked to sign a consent form. The Mongolian National University of Medical Sciences approved these studies (No 16/3/2016-16).

We randomly approached eligible couples with assistance from the local family healthcare centers from each Sum (territorial administrative unit of Mongolia) and District, the couples that agreed to participate were interviewed at the local family healthcare center. In some cases, participants were not able to come to the local healthcare center, so we conducted the survey in their homes.

A pretested standardized and structured questionnaire was used to gather data from the participants. As precaution to possible difficulties arising from illiteracy and cultural miscommunication errors, we conducted a verbal interview in accordance with the questionnaire. In order to protect the participants privacy and to gather accurate information a trained interviewer conducted the interview individually with each person in a private setting.

Our questionnaire assessed general demographic and socio-economic status, medical history, toxin exposure, reproductive history, female reproductive health (e.g. age of menarche, last menstrual period,

menstrual regularity, menstrual cycle, menstrual blood volume, medical history, operative history), marriage and child bearing status (e.g. length of marriage and cohabitation, pregnancy history including information concerning live births, miscarriage, induced abortions and stillbirths, frequency of sexual intercourse) and past medical consultation on infertility. We also conducted anthropometrics measurements. For gauging alcohol consumption, tobacco use and physical activity we based our questions on WHO STEPS Instrument's NCD (non-communicable disease) risk factor questionnaire(14).

For our study we used WHO's definition of infertility as "a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse" (15). Primary female infertility is defined as a woman who has never before been diagnosed with a clinical pregnancy and meets the criteria of being classified as having infertility", while "secondary female infertility is defined as a woman currently unable to establish a clinical pregnancy but who has previously been diagnosed with a clinical pregnancy" (16). Since infertility is usually defined by the female population we calculated the epidemiology of infertility solely based on female data (4).

Data analysis was performed using the Statistical Program for Social Sciences (SPSS v 20, IBM). Missing data for the variables analyzed were excluded. Continuous measurements were shown as mean standard deviation (SD) and categorical variables were expressed as percentages. For statistical analysis distributions were compared using Pearson's chi-square test and Fisher's exact test when appropriate. Binary logistic regression analyses were then performed within each subgroup, adjusting for confounders. For comparison of variables t-test and ANOVA test were used; 95% confidence interval was considered statistically significant $p < 0.05$.

Results

Study population

Our study population of 1920 participants consisted of residents of Ulaanbaatar city and four regions of Mongolia (Western, Eastern, Central and Khangai). The demographic and socio-economic characteristics of the participants are shown in Table 1.

Table 1. Demographic and socio-economic characteristics of study participants

Characteristics	Women	
	n	% of total
Number of participants	1920	100
Region		
Ulaanbaatar	695	36.2
Eastern	163	8.5
Western	300	15.6
Khangai	395	20.5
Central	368	19.2
Age, years (Mean (SD))	32.57±6.61	
BMI, kg/m^2 (Mean (SD))	25.08±4.52	
BMI, normal	1075	56
Overweight	555	28.9
Obese 1 class	246	12.8
Obese 2 class	35	1.8
Obese 3 class	9	0.5
Education		
Primary school and below	212	11
Middle and high school	533	27.8
College and above	1175	61.2
Occupational Conditions[A]		
Normal	1663	86.6
Hazardous	257	13.4
Annual household income, MNT		
<900000	1232	64.1
900000-1499999	518	27
>1500000	170	8.9
Tobacco use		
No[B]	1810	94.2
Yes	110	5.7
Alcohol consumption		
No	715	37.2
Yes[C]	1205	62.8

A According to Mongolian Labor Legislation, working conditions are divided into normal and hazardous

B Included people who never smoked’

C Included people who consumed alcohol within the past 12 months

Prevalence of infertility and patterns of region

Our study showed an infertility incidence of 7.2% (n=138), with primary infertility at 2.4% (n=46) and secondary infertility at 4.8% (n=92). Geographically the prevalence rate was as follows: Central region (8.2%, n=30), Khangai region (12.4%, n=49), Western region (7%, n=21), Eastern region (8%, n=13), Capital city Ulaanbaatar (3.6%, n=25) (Figure 1). In comparison with the sole urban area of Ulaanbaatar, the prevalence of infertility is significantly higher ($p<0.001$) amongst the rural population. As it is the only territory with a city status in Mongolia, we viewed it as the sole urban area.

Age related patterns of infertility

Our results show that there is a trend of secondary and overall infertility that increases with the women's age. However, the same trend is present in primary infertility (Table 2). Women between 40-45 years of age had the highest rate of infertility (10.6%) compared to women of the 20-24 years of age who had a low infertility rate (1.4%) (n=40) ($p<0.0001$)

Table 2. Infertility prevalence age groups

Age group	Fertile women n=1782		Infertile women n=138		
	n	(%)	Overall infertility (%)	Primary infertility (%)	Secondary infertility (%)
20-24	216	11.3	1.4	1.4	0
25-29	482	25.1	5.4	2.9	2.5
30-34	471	24.5	7.9	3	4.9
35-39	373	19.4	8.6	1.6	7
40-45	378	19.7	10.6	2.4	8.2

Furthermore, when we map the prevalence of infertility as individual ages instead of groups, we notice a slow decline from ages 30-36 and then a sudden spike at ages 36-39 followed by a plateau until age 45. (Figure 2).

Risk factors for infertility

We then divided our participants into two groups of either infertile or fertile females. Adjusting for age we calculated for the association between infertility and risk factors among women.

We calculated the risk of infertility compared to the 20–24-year age group. Among the risk factors age was the most significant risk factor, with the risk increasing by 4 to 8-fold with each progressing age group. Social factors, such as: occupational conditions and monthly household income were not significent risk factors for infertility however alcohol consumption, obesity, rural living and lower levels of education were significant risk factors (Table 3)

Table 3. Infertility risk factors

Characteristic	Fertile woman n=1782	Infertility women n=138		
		Overall infertility n=138	Unadjusted OR (95 CI)	Age adjusted OR (95% CI)
Age groups (women) (%)				
20-24	12	2.2	ref	
25-29	25.6	18.8	4.04 (1.21-13.52)*	
30-34	24.4	26.8	6.05 (1.84-19.85)**	
35-39	19.1	23.2	6.66 (2.01-22.02)**	
40-45	19	29	8.4 (2.56-27.5)***	
Education				
Primary school and below	10.9	13	1.44 (0.84-2.47)	1.18 (0.68-2.05)
Middle and high school	27.2	35.5	1.57 (1.07-2.3)**	1.4 (0.95-2.06)
College and above	62	51.4	ref	ref
Living region				
City region	58.1	37.7	ref	ref
Rural region	41.9	62.3	2.29 (1.06-3.27)***	2.05 (1.38-3.04)***
BMI				
Normal	53.4	45.7	ref	ref
Underweight	3.6	1.4	0.47 (0.11-1.99)	1.2 (0.08-17.34)
Pre-Obesity	27.9	31.3	1.41 (0.93-2.13)	0.93 (0.49-1.79)
Obesity	15.1	21.7	1.8 (1.17-2.98)**	2.9 (1.21-6.99)*
Physical activity				
Active[A]	18	19.6	ref	ref
Inactive	82	80.4	0.9 (0.58-1.39)	0.89 (0.57-1.38)
Smoking				
No[B]	94.1	92	ref	ref
Yes	5.9	8	1.3 (0.72-2.64)	1.33 (0.69-2.55)
Alcohol consumption				
No[C]	37.2	23.2	ref	ref
Yes	62.8	76.8	2.05 (1.37-3.09)***	1.98 (1.31-2.98)***

*<0.05, **<0.01, ***<0.001

[A] Defined as at least 150–300 minutes of moderate-intensity aerobic physical activity or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week

[B] Included people who have never smoked

[C] Included people who consumed alcohol within the past 12 months

We used the participant's self-reported gynecological history to calculate the risks it imposed. We found the following risks associated with infertility: abnormal menstrual cycles 1.5 (CI 1.07-2.15 p<0.01), thyroid disease 1.6 (CI 0.98-2.79 p<0.05), intrauterine growth restriction 2.1 (CI 1.22-3.73 p<0.001), ectopic pregnancy 2.6 (CI 1.2-5.69 p<0.01) recurrent ectopic pregnancy 13.3 (CI 1.87-95.84 p<0.01), ovarian cysts 4.7 (CI 3.12-7.34 p<0.0001), endometrial polyps 4.1 (CI 1.99-8.59 p<0.0001), endometriosis 5.8 (CI 1.78-19.34 p<0.01), gynecological operative history (ovarian cystectomy, oophorectomy, salpingectomy, abortion, cesarean section) 2.6 (CI 1.72-4.06 p<0.0001) .

Clinical consultations for infertile couples

Of the total infertile participants (n=138), 77.5% (n=107) had sought clinical consultation regarding their infertility, while 22.5% (n=31) never sought any type of clinical consultation. Among the group that sought clinical consultation 29.7% (n=41) of the women had received some form of treatment, with hormonal therapy being most commonly used at 14.3%, followed by timing therapy at 4.5%, IUI therapy 0% and assisted reproductive technology ART at 0.8% (n=1) was scarce.

Discussion

Mongolia is a land locked nation that borders the People's Republic China to the south and the Russian Federation to the north. It is comprised of 21 provinces distributed in 4 regions (Khangai, Central, Eastern and Western) and Ulaanbaatar city. Globally it ranks 6th for the least densely populated country at approximately 1.7 persons per squared kilometer.

The Mongolian Government's policy on population development between 2016–2025 is to create favorable conditions for sustainable population growth.

Until now there has not been population-based studies on infertility and its risk factors in Mongolia. Researchers used the number of couples and females with infertility in a certain time and location in relation to the total population to calculate the prevalence rate of infertility. The prevalence of infertility can be defined as the total number of women or couples who experience infertility within a given period of time and in a given place, in proportion to the total population in the same time and place(3). Our study was done using this definition, for the population of Ulaanbaatar and the four regions of Mongolia. We found an infertility prevalence of 7.2% which is in agreement with similar studies from around the world

that had a median infertility prevalence ranging from 6.9–9.3% [4]. Mongolia is a developing country and our result of 7.2% was similar to the global rate of infertility in developing countries at 6.9–9.3%(9).

Larsen et al.'s study of primary and secondary infertility in sub-Saharan Africa showed a prevalence of primary and secondary infertility of 3% and 5% respectively(17). This was in keeping with our study, which showed a prevalence of primary and secondary infertility of 2.4% and 4.8% respectively. However, their definition of infertility as "5 years or more of failure to conceive" was not the same as our definition of infertility, which was 12 months of failed conception. Both Mongolia and the Sub-Saharan region had a high rate of gonorrhea and chlamydia(11) (18), which are risk factors for secondary infertility that could explain the similar results of the two studies. A study done in a fellow low- and middle-income country, Nigeria had a prevalence rate of infertility rate of 31.1%(19). This is much higher than the infertility rate we measured in Mongolia but it may be due to a different study design. A population-based study conducted in our neighboring country China, had a prevalence of 15.5%(20). Although both studies used the same definition of infertility and study methods, we believe the contrasting result of 7.2% is due to governmental policy on reproduction (China's one-child policy), inclusion criteria, the age of the participants, socio-economic values and other factors. Recent meta-analysis study results in Iran showed a very similar result to our own with a total infertility prevalence of 7.8% to our 7.2%. However, these studies had primary and secondary infertility rates of 3.9% and 2.18% while our data showed 2.4% and 4.8% respectively. (21)

There are numerous risk factors that contribute to female subfertility and it is important to diagnose each carefully in order to treat patients appropriately(22). Risk factors which vary between different regions of the world, include: the genetics of the population, socio-economic factors, differences in government policy, health care, nutrition, age of the participants, and STIs. High levels of STIs present in the population contribute to secondary infertility (23). Our study shows that important risk factors for infertility in Mongolia are age of the woman, alcohol consumption, obesity, rural living, and the level of education of the couple

In women, the quantity and quality of oocytes is known to decline with age, with the resulting decline in fecundity becoming clinically relevant by the mid 30s (24). Interestingly our results showed a steady decline in fertility through the ages of 30–36 followed by a sudden spike then plateauing until age 45. Another possible contributing factor for infertility increasing with age in women is that susceptibility to infection also increases with age. A Scottish fertility clinic study found that women over 35 were more likely to be diagnosed with tubal factor infertility than younger women (OR 2.2, CI 1.7–2.7) (25). In a study conducted in Turkey infertility was significantly higher among women aged between 35 and 49 ($p < 0.01$)(26).

In our study a women's level of education was one of the factors affecting female infertility. This is agreement with a study China which showed that increasing levels of education was inversely correlated with a decreased the risk of infertility(27). This may be due to a link between higher levels od education healthier lifestyles and better healthcare.

We also found that obesity contributed to infertility which may be related to abnormal metabolism. Clinical studies definitively demonstrate an impact of obesity on the risk of subfertility(28). Cohort studies showed that there is an increased risk of anovulation in extremely heavy exercisers (> 60 min/day), but vigorous exercise of 30–60 min/day was associated with reduced risk of anovulatory infertility(29).

We attribute the higher rates of infertility in rural areas compared to urban areas due to limited the access to healthcare. For instance, all 6 of the fertility clinics in Mongolia are located in the city of Ulaanbaatar. Among the infertile women in our study, only 0.8% had undergone IVF therapy, compared to China's 5.6% IVF therapy and 29.4% traditional Chinese medicine rates. (27) Furthermore with only 14.3% of our infertile participants who received hormone therapy had poor access to advanced fertility treatment.

Infertility is expected to change in populations over time. In a US National Health report it was shown that infertility fell from 8.5% in 1982 to 7.4% in 2002(30). Further declines in infertility were seen in 2006 (31). These declines in infertility may be due to improved nutrition and general health of the population and improvements in assisted reproductive techniques (ART). In Mongolia we were unable to look for these trends as this was our first report, but we hope in the future to conduct further studies on infertility.

Our study calls for further quantitative and qualitative research specifically designed to identify the causes of declining fertility, the socio-demographic and medical factors contributing to infertility and the links between infertility and the use of ART in Mongolia. Furthermore, we hope our results can help highlight the need for legislation and policies to increase ART accessibility and availability to patients in rural areas.

Strengths And Limitations

We used a population-based method to study infertility in 4 regions of Mongolia and the city Ulaanbaatar. The sample size and methods were rigorous for this study. We used only one definition to determine infertility, which limited us to using strict inclusion criteria. We used a self-reporting method to assess infertility and this can be subject to bias.

Conclusions

In conclusion, the overall 12 months prevalence of infertility was 7.2% and primary and secondary infertility was 2.4% and 4.8%. Our study shows the most significant risk factors for infertility were: age, obesity alcohol consumption, rural living and having a low level of education. An unfavorable gynecological history also posed a risk to fertility. Occupational conditions, and monthly household income were not significant risk factors for infertility. Since this is the first population-based study in Mongolia we were not able to measure trends in infertility prevalence but intend to do so in the future.

Abbreviations

ANOVA: Analysis of variance

ART: Assisted reproductive technology

IVF: in vitro fertilization

SD: Standard deviation

SPSS: Statistical Program for Social Sciences

STI's: Sexually transmitted infections

WHO: World Health Organization

Declarations

Details of ethics approval

Ethical approval was obtained from the Ethics Committee of Mongolian National University of Medical Sciences (No16/3/2016-16) to conduct our survey. All participants agreed to an informed consent form, after accepting to be included.

Consent for publication:

Not applicable

Availability of data and materials:

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests:

The authors declare that they have no competing interests

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Authors' contributions

OE, MM, ET, LE, have drafted the work and substantively revised it as well as the design conception. TN, KhB, AE, AG, BM, have participated in the acquisition and analysis of data, as well as drafted this

manuscript. KhN worked on the interpretation of data. All authors read and approved the final manuscript.

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References

1. Zegers-Hochschild F, Adamson GD, de Mouzon J, Ishihara O, Mansour R, Nygren K, et al. International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009. Fertility and sterility. 2009;92(5):1520-4.
2. Chachamovich JR, Chachamovich E, Ezer H, Fleck MP, Knauth D, Passos EP. Investigating quality of life and health-related quality of life in infertility: a systematic review. J Psychosom Obstet Gynaecol. 2010;31(2):101–10.
3. Thonneau P, Spira A. Prevalence of infertility: international data and problems of measurement. Eur J Obstet Gynecol Reprod Biol. 1991;38(1):43–52.
4. Gurunath S, Pandian Z, Anderson RA, Bhattacharya S. Defining infertility–a systematic review of prevalence studies. Hum Reprod Update. 2011;17(5):575–88.
5. Vander Borght M, Wyns C. Fertility and infertility: Definition and epidemiology. Clinical biochemistry. 2018;62:2–10.
6. Boivin J, Bunting L, Collins JA, Nygren KG. International estimates of infertility prevalence and treatment-seeking: potential need and demand for infertility medical care. Human reproduction (Oxford England). 2007;22(6):1506–12.
7. Rutstein SO, Shah IH. Infecundity, infertility, and childlessness in developing countries. Maryland: ORC Macro;: Calverton; 2004.
8. Ombelet W. Global access to infertility care in developing countries: a case of human rights, equity and social justice. Facts, views & vision in ObGyn. 2011;3(4):257 – 66.
9. Mascarenhas MN, Flaxman SR, Boerma T, Vanderpoel S, Stevens GA. National, regional, and global trends in infertility prevalence since 1990: a systematic analysis of 277 health surveys. PLoS Med. 2012;9(12):e1001356.
10. Abebe MS, Afework M, Abaynew Y. Primary and secondary infertility in Africa: systematic review with meta-analysis. Fertility research practice. 2020;6(1):20.
11. Badrakh J, Zayasaikhan S, Jagdagsuren D, Enkhbat E, Jadambaa N, Munkhbaatar S, et al. Trends in adult chlamydia and gonorrhoea prevalence, incidence and urethral discharge case reporting in

Mongolia from 1995 to 2016 - estimates using the Spectrum-STI model. Western Pacific surveillance response journal: WPSAR. 2017;8(4):20–9.

12. Beck C, Berry NS, Choijil S. Health system reform and safe abortion: a case study of Mongolia. Glob Public Health. 2013;8(2):174–86.
13. Bayasgalan G, Naranbat D, Tsedmaa B, Tsogmaa B, Sukhee D, Amarjargal O, et al. Clinical patterns and major causes of infertility in Mongolia. J Obstet Gynaecol Res. 2004;30(5):386–93.
14. World Health Organization. Regional Office for South-East A. WHO STEPS survey: step towards a healthier world: monitoring noncommunicable diseases and their risk factors. New Delhi: World Health Organization. Regional Office for South-East Asia; 2018 2018.
15. Zegers-Hochschild F, Nygren KG, Adamson GD, de Mouzon J, Lancaster P, Mansour R, et al. The International Committee Monitoring Assisted Reproductive Technologies (ICMART) glossary on ART terminology. Fertility sterility. 2006;86(1):16–9.
16. Zegers-Hochschild F, Adamson GD, Dyer S, Racowsky C, de Mouzon J, Sokol R, et al. The International Glossary on Infertility and Fertility Care, 2017. Human reproduction (Oxford, England). 2017;32(9):1786 – 801.
17. Larsen U. Primary and secondary infertility in sub-Saharan Africa. Int J Epidemiol. 2000;29(2):285–91.
18. Dubbink JH, Verweij SP, Struthers HE, Ouburg S, McIntyre JA, Morré SA, et al. Genital Chlamydia trachomatis and Neisseria gonorrhoeae infections among women in sub-Saharan Africa: A structured review. Int J STD AIDS. 2018;29(8):806–24.
19. Polis CB, Cox CM, Tunçalp Ö, McLain AC, Thoma ME. Estimating infertility prevalence in low-to-middle-income countries: an application of a current duration approach to Demographic and Health Survey data. Hum Reprod. 2017;32(5):1064–74.
20. Zhou Z, Zheng D, Wu H, Li R, Xu S, Kang Y, et al. Epidemiology of infertility in China: a population-based study. BJOG: an international journal of obstetrics gynaecology. 2018;125(4):432–41.
21. Saei Ghare Naz M, Ozgoli G, Sayehmiri K. Prevalence of Infertility In Iran: A Systematic Review And Meta-Analysis. Urology journal. 2020;17(4):338–45.
22. Farquhar CM, Bhattacharya S, Repping S, Mastenbroek S, Kamath MS, Marjoribanks J, et al. Female subfertility. Nature reviews Disease primers. 2019;5(1):7.
23. Tsevat DG, Wiesenfeld HC, Parks C, Peipert JF. Sexually transmitted diseases and infertility. American journal of obstetrics gynecology. 2017;216(1):1–9.
24. Baird DT, Collins J, Egozcue J, Evers LH, Gianaroli L, Leridon H, et al. Fertility and ageing. Hum Reprod Update. 2005;11(3):261–76.
25. Maheshwari A, Hamilton M, Bhattacharya S. Effect of female age on the diagnostic categories of infertility. Human reproduction (Oxford England). 2008;23(3):538–42.
26. Sarac M, Koc I. PREVALENCE AND RISK FACTORS OF INFERTILITY. IN TURKEY: EVIDENCE FROM DEMOGRAPHIC AND HEALTH SURVEYS, 1993–2013. J Biosoc Sci. 2018;50(4):472–90.

27. Zheng D, Zhou Z, Li R, Wu H, Xu S, Kang Y, et al. Consultation and treatment behaviour of infertile couples in China: a population-based study. Reprod Biomed Online. 2019;38(6):917–25.
28. Broughton DE, Moley KH. Obesity and female infertility: potential mediators of obesity's impact. Fertility sterility. 2017;107(4):840–7.
29. Hakimi O, Cameron LC. Effect of Exercise on Ovulation: A Systematic Review. Sports medicine (Auckland, NZ). 2017;47(8):1555–67.
30. Chandra A, Copen CE, Stephen EH. Infertility and impaired fecundity in the United States, 1982–2010: data from the National Survey of Family Growth. National health statistics reports. 2013(67):1–18, 1 p following 9.
31. Stephen EH, Chandra A. Declining estimates of infertility in the United States: 1982–2002. Fertility sterility. 2006;86(3):516–23.

Figures

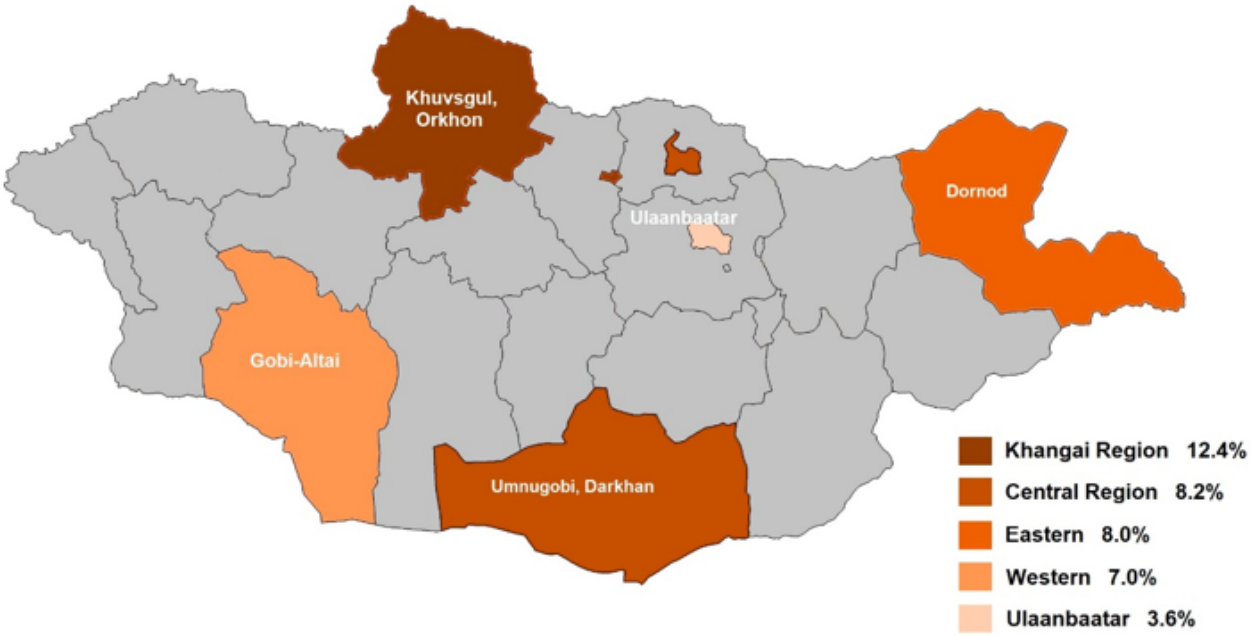

Figure 1

Infertility prevalence by region. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

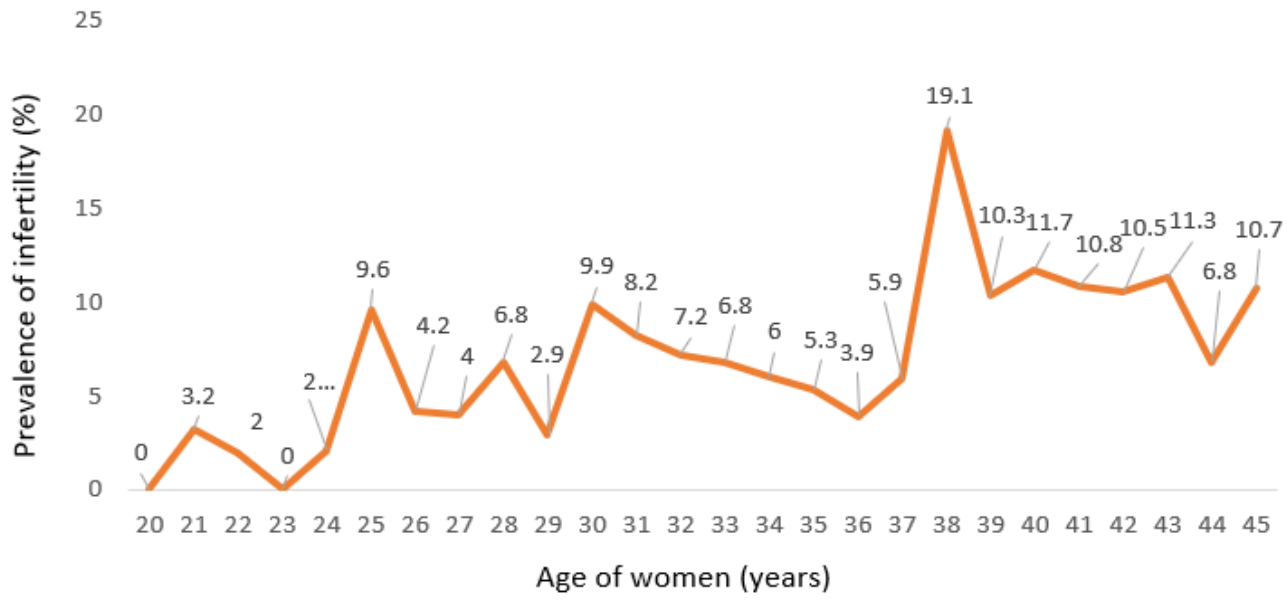

Figure 2

Infertility prevalence by age

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- Data.sav