

Microbial Infections and Female Infertility: Investigating Their Association among Women in Baquba, Diyala, Iraq

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Abstract: Background: The inability to become pregnant after a year of regular, unprotected sexual activity is known as infertility. According to estimates, 8 % and 12 % of childbearing couples worldwide are affected, and many factors play a part, including microbial illnesses. **Aims:** The study aimed to ascertain the prevalence of infertility and its relationship to microbes among women in Baquba city. **Methods:** The subjects of a cross-sectional study were 308 women admitted as outpatients to the Al-Batool Teaching Hospital for Maternity and Children in Baqubah City, Diyala. From 1st January until 31st December 2018, Iraq. Seventy infertile women between 18 and 48 years had their urine and vaginal swabs taken, and different microbial agents were examined in the lab to make a clinical and laboratory diagnosis. **Results:** The study found that the infertility incidence among women in Baquba City was 22.7%, with primary infertility at 69.60% and secondary infertility at 30.40%. Additionally, 65.7% of the population had microbiological infections. The infections included *Candida albicans* (17 cases) and *Chlamydia trachomatis* (7 cases). The most affected age group was 18 to 28 years (47.8%), followed by 29 to 38 years (30.4%). *Trichomonas vaginalis* was also present, with 63.6% of infected individuals having one infection, while 27.3% had *Candida albicans* co-infection. Among those with *Candida albicans*, 64.7% had a single infection, and 35.3% had *Trichomonas vaginalis* co-infection. In contrast, 42.9% of *Chlamydia trachomatis* cases involved a single infection, while 57.1% had co-infections. **Conclusion:** The study conclude the prevalence of the primary type and *Trichomonas vaginalis* as the primary infectious cause of infertility are moderate in Baquba City's female population.

Keywords: Infertility, *Trichomonas vaginalis*, *Candida albicans*, *Chlamydia*, Baqubah.

INTRODUCTION

The World Health Organization describes infertility as a disorder of the reproductive system. characterised by difficulty conceiving after a normal, unprotected 12-month period of sexual activity [Vander Borgh, M., Wyns, C., 2018]. Infertility affects 186 million people globally, most of whom reside in underdeveloped nations (23.5% – 16.7 % of industrialized nations [Masoumi, S.Z et al., 2015] and 6.9 % –9.3 % of developing nations suffer from infertility [Inhorn, M.C.& Patrizio, P., 2015]. Age at conception for women is the most potent contraindicator of fertility [Hart, R.J, 2016]. At least 35% of all fertility issues are attributable to female factors, which include a wide range of variables affecting growth of the ovary, maturation of the oocyte, and ability to fertilize, and the potential for preimplantation growth, implantation, and fetal growth in fertilized eggs [Yatsenko, S.A.& Rajkovic, A 2019]. Infertility comes in two different forms: primary and secondary. We define primary infertility. As the iSecondary infertility is defined as the inability to conceive within two years after being exposed to pregnancy following a prior pregnancy, whereas primary infertility is defined as the inability to conceive within two years of being exposed to pregnancy. Primary infertility affects the majority

of infertile couples worldwide [Inhorn, M.C., 2003].

Depending on the age of the partners and the length of the marriage, several causes of infertility apply. Infections continue to play a significant role, even though Infertility due to the tubal factor is still most frequently caused by polycystic ovarian syndrome (PCOS) [Ambildhuke, K. et al., 2022].

The most typical sexually transmitted diseases and gonorrhea infections that result in infertility [Deshpande, P.S.& Gupta, A.S., 2019]. Infections frequently interfere with human infertility by harming the peritoneum, tubal tissues, and cervical regions in females. Problems with sperm quality, motility, and movement are increasingly thought to be caused by coinfections in addition to direct infections [Pai, M.O. et al., 2020].

Infertility can be brought on by genital region infections like endometritis, inflammation of the pelvis, and bacterial vaginosis. Increased risk of STDs is one of the most probable causes of infertility Ravel, P.J., Moreno, P.I, 2021; Verit, F.F., et al., 2017]. In addition, lipid metabolic abnormalities, a history of abortion, and obesity have all been linked to a higher risk of female infertility [Verit, F.F. et al., 2017].

Serious reproductive issues such as Salpingitis, cervicitis, acute urethritis, and pelvic inflammatory disease, a disease that can result in tubal infertility, can be brought on by *Chlamydia trachomatis* infection in the genital tract [Chen, H. *et al.*, 2022]. It is the second most common gram-negative obligate intracellular bacterium in the world. In terms of the frequency of microbial STIs after *Neisseria* infection [Malhotra, M. *et al.*, 2013]. Up to 70% of instances are asymptomatic in females [Hoenderboom, B.M. *et al.*, 2017].

One of the most prevalent non-viral forms of sexually transmitted diseases is trichomoniasis, a parasitic illness. The most common non-viral STI in the world, *Trichomonas vaginalis*, is a flagellate human parasite associated with cervical abnormalities and infertility [Merdaw, M.A.-Z *et al.*, 2018; Vander, H., & Prabha, V., 2015].

Given that sperm can be immobilized by *Candida* infection and that there were no clinical or histological alterations to the reproductive organs, no sperm-harming bacterial microorganisms may be the cause of infertility in women [Moragianni, D. *et al.*, 2019]. Common female genital tract commensal *Candida albicans* can lead to illnesses including potentially fatal infections and minor vaginitis and cervicitis [Abdulrazaq, A.F.& Noori, H.M., 2019].

The current research aimed to estimate the prevalence of infertility among women in Baquba City as well as the associated microbial agents.

PATIENTS AND METHODS

Study Design and Sample Collection

The cross-sectional study was conducted from the 30th of January until the 30th of December 2018, with 308 female outpatients at the Al-Batool Teaching Hospital for Maternity and Children in Baqubah City, Diyala, Iraq.

After a thorough history and clinical examination, all samples were examined for the presence of *Trichomonas vaginalis* using a wet mount preparation under the microscope; a vaginal swab was collected, a thorough urine examination was performed, and a sample was taken from the vagina's posterior fornix, then used *Chlamydia* rapid diagnostic test, saline and 10% KOH smears to look for the presence of *Candida albicans* [Benksim, A., *et al.*, 2018] to check for *Chlamydia trachomatis* being present in female cervical were all performed by the manufacturer's instructions (BiotechTM Corp., China).

Statistical Analysis

Statistical Analysis done by using SAS software (version 22), and the chi-square test was used to calculate counts, percentages, and relative proportions, and the effects of the study's various components were examined. A statistical significance level of 0.05 was adopted for comparisons.

RESULTS

The rate of infertility was 22.7%. (70 out of 308), with microbial infection about 65.7 % (46 out of 70) and without infection about 34.3 % (24 out of 70). (Figure 1). There were 69.6% (32 out of 46) cases of primary infertility and 30.4% (14 out of 46) cases of secondary infertility.

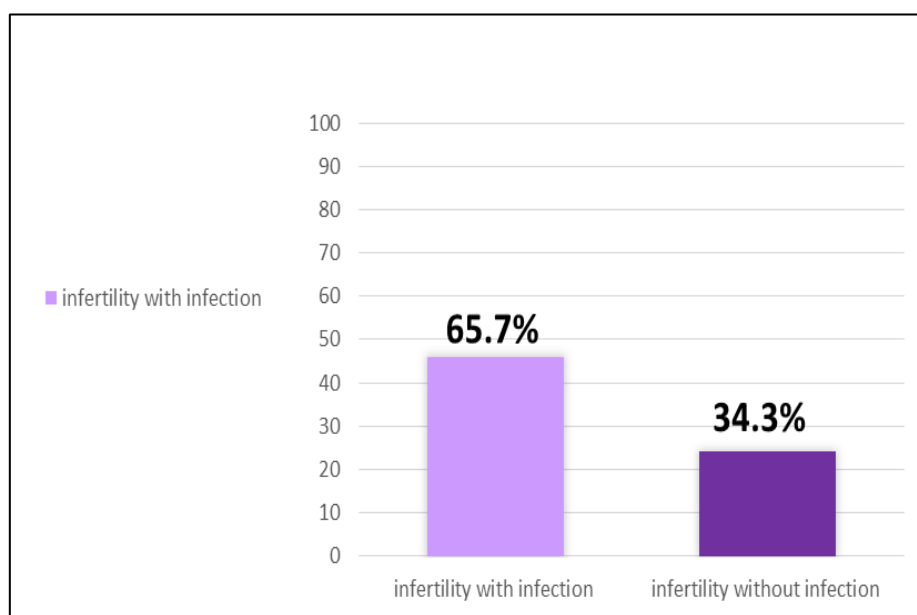


Figure 1: The Association between Infertility and Infection Type

As shown in Figure 2, microbial infections showed that *Trichomonas vaginalis* was the most common cause, 47.8% (22 out of 46), followed by *Candida*

albicans, 37% (17 out of 46), and the less common infection was *Chlamydia trachomatis* with a frequency of 15.2% (7 out of 46).

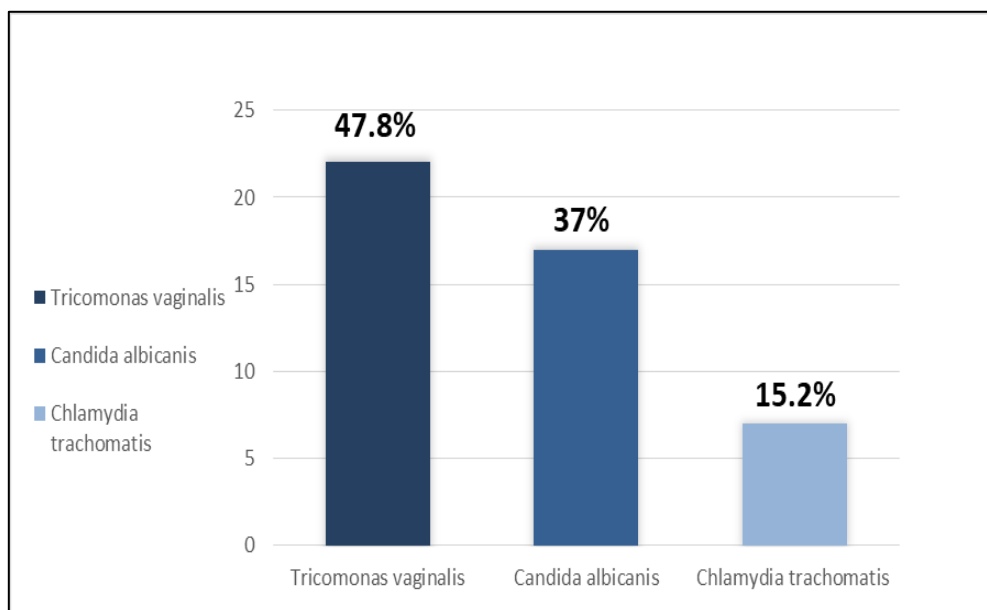


Figure 2: Microbial Infection Distribution and Fertility Status.

Regarding age, the age range was 18 to 48 years old, with a mean of 30.4 ± 8.2 . The most common age group for infection diagnoses was 18 to 28

years old, about 47.8%, followed by 29 to 38 years old (30.4%) and 39 to 48 years old (21.7%). As shown in Figure 3.

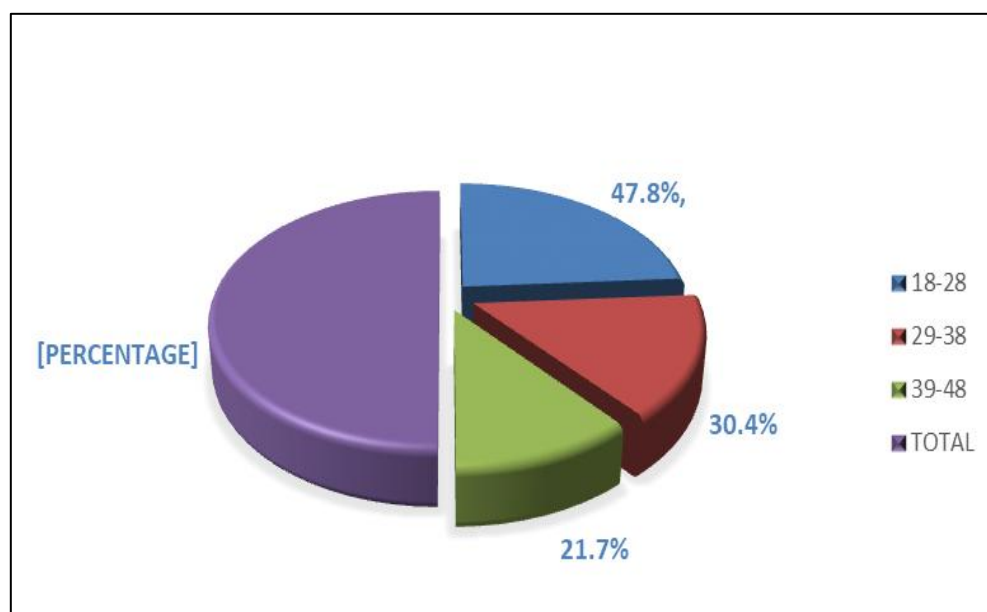


Figure 3: Age-specific Distribution of Infertile Women with Infections.

On the other hand, 63.6% of patients had a single *Trichomonas vaginalis* infection, 27.3% had a concurrent *Candida albicans* infection, and 9.1% had a co-infection with *Chlamydia trichromats*. Nevertheless, 64.7% of individuals with a *Candida albicans* infection only had one infection, while 35.3% also had a *Trichomonas vaginalis* infection.

42.9% of patients with *Chlamydia trichromats* infections have only one infection, whereas the remaining 57.1% also have another infection. Table 1 shows that two of the four have *Trichomonas vaginalis* and the other two have different microorganisms.

Table 1: The Study Population's Infection Types.

Microorganism	No. (%)	single infection	Co-infection		P-value
Trichomonas vaginalis	22 (47.8%)	14 (63.6%)	8 (36.4%)		0.8NS
			6 (75%) <i>Candida albicans</i>	2 (25%) <i>Chlamydia trichromats</i>	
Candida albicans	17(37%)	11(64.7%)	6 (35.3%) <i>Trichomonas vaginalis</i>		
Chlamydia trichromats	7 (15.2%)	3 (42.9%)	4 (67.1%)		
			2 (50%) <i>Trichomonas vaginalis</i>	2 (50%) Other bacteria	
NS = Non-Significant					

DISCUSSION

According to the most recent study, 22.7 % of women in Baquba city were infertile, with the main type accounting for 69.6 % of cases and the secondary type accounting for 30.4 %. These findings were comparable to those of studies conducted in other governorates, such as one conducted in the Al-Anbar governorate, which found that 38 % of Secondary infertility affected women and 62 % had primary infertility [Abdulrazaq, A.F.& Noori, H.M., 2019]. Another study conducted in the city of Erbil revealed that 63% had primary infertility and 37% had secondary infertility [Ahmed, A.S., Othman, S.M., 2016]. Another study in Morocco had a frequency of primary and secondary infertility outside of Iraq of 67.37 % and 32.63 %, respectively [Benksim, A. *et al.*, 2018]. The results of this study were very modest when compared to a study conducted among the entire population of Iraq, which found that the primary and secondary kinds of female infertility were 79.1% and 78%, respectively. These results compare with other studies, such as in the general Turkish population, where infertility rates were 5.94%, as a result of this study's results being greater than those of research from similarly dull neighboring nations like Turkey [Beyhan, Y.E., 2021]. In Iran, the primary infertility rate among couples was 17.3 % [Kazemijaliseh, H. *et al.*, 2015].

The different socioeconomic structures in which the study was conducted, the time of year the samples were taken, the atmosphere and surroundings at the time of sample collection, or the method employed to make the diagnosis could all contribute to the variances.

The results of the study showed that 65.7% of cases of infertility were caused by microbial infections, with *Chlamydia trachomatis* accounting

for 15.2%, Intestinal *Trichomonas* for 47.8%, *Candida albicans* for 37%, and *Trichomonas vaginalis* for 37%. According to the current study, the prevalence of *Trichomonas vaginalis* infection among couples was 47.8% greater than that of previous Iraqi studies, which included 27.9% in Iraq's Al-Hamza city in Al-Qadisiyah governorate [Al-Ardi, M.H. 2021], and 34.41 % among infertile women in the province of Baghdad [Merdaw, M.A.-Z. *et al.*, 2018]. The study of *Trichomonas vaginalis* infection among infertile couples in the IVF and infertility treatment facility in Erbil yielded 70% favorable results, even though the results were less favorable [Al-Marsomy, H.D.& Hassan, F.A., 2020].

The current study's results were higher than those of studies conducted in neighboring countries, such as Turkey, where 18% of infertile patients were found [Kaya, O.A., 2015]. In Tehran, it affected about 3.3% of pregnant women and 8.3% of sick women with symptoms [Rajabpour, M. *et al.*, 2020]. However, in Beni-Sueif, Egypt, the infection associated with infertility was found in 11.1% of instances of secondary infertility and 88.9% of patients with primary infertility [Ibrahim, S.S. *et al.*, 2021]. Whereas internationally, it was 12.8 % among infertile women in the USA [Wirring, A.E.*et al.*, 2020].

The current study shows a higher prevalence of reproductive tract infections as compared to earlier reports, which may be due to differences in population, geography, sample size, and diagnostic methods. Such differences could also be explained by differences in sexual health practices, access to health care, and awareness of sexually transmitted infections. Higher rates may reflect important associations with infertility, with significant differences between primary and secondary infertility indicating different mechanisms by

which reproductive health is being affected. Therefore, the findings should be interpreted in the local epidemiological context.

The recent study found that *Candida albicans* was present in 37% of infertile women. The results were poor when compared to the study's findings from Babylon province, which revealed that 38.46% had secondary infertility and 61.53% had primary infertility [Zaidan, A., & Imran, K., 2016]. Outside of Iraq, 67.7 % of infertile Iranian women had *Candida albicans* infection [Ghajari, A. *et al.*, 2018], and in India, 35 % of patients had vaginal candidiasis [Chakraborty, A. *et al.*, 2017].

Comparing the results of this study to those of other studies from various governorates, such as Al-Nasiriyah, showed that infertile women had a lower risk of contracting *Chlamydia trachomatis* infection 15.2% compared to other women (9.5%) [Atiyah, S.A.A.*et al.*, 2019]. The prevalence of infertility was 13.75 % among Iraqi women visiting many facilities in Baghdad, including the gynecology departments at Al-Elwyia Obstetrics Hospital, Ibn Al-Balady Maternity, and Children's Hospital [Mohammed, I.H. *et al.*, 2017], and 43.2 % among Basra's infertile women [Sahi, A.A.H., & Mohammed, K.A.S., 2020].

The frequency of infection with chlamydia in nearby nations. According to reports, the percentage in Jordan is 3.9 % [Al Ramahi, M. *et al.*, 2008], while in Saudi Arabia, it is 8 % for infertile women [Alfarraj *et al.*, 2015]. In Tehran, infertility and pregnancy-related issues affected 10.8% of women, 10.6% of those who experienced symptoms, and 11.1% of those who did not [Rajabpour *et al.*, 2020]. Iran has a 12.4 % prevalence of *Chlamydia trachomatis* infection among infertile women [Rashidi, B.H. *et al.*, 2013].

Infertility may result from the fallopian tubes being permanently damaged by *Chlamydia trachomatis*, including proximal and distal tubal occlusions [Tsevat, D.G. *et al.*, 2017]. This is particularly the case when it results in tubal inflammation [Steiner, A.Z. *et al.*, 2015]. In contrast, the epithelia of the human fallopian tube react to *Chlamydia trachomatis*. Heat shock protein synthesis is elevated as a result of an inflammatory immune response that causes tubal damage and scarring blockage [Linhares, I.M., & Witkin, S.S., 2010].

Variations in infection rates may be caused by several factors, including sample size, kind, time

period, diagnosis technique, and societal traditions. The outcomes are more difficult to measure when the infection rate is lower. Given that long-lasting immune responses to the parasite can be generated, serological tests can be useful.

The results of the study showed that infections were more common in those aged 18–28 (47.2%), 29–38 (30.4%), and 39–48 (21.7%), and people aged 39 to 48 had a lower prevalence of infections (21.7%). These results are in agreement with a study that revealed 42% of infertile women were under 30 years [Moragianni *et al.*, 2019]. A study in the Iraqi city of Al-Hamza found that in the age group 38–43 years old had among infertile women, *Trichomonas vaginalis* infection occurs at the lowest rate, while the age group 28–32 years old had the highest percentage of infection [Al-Ardi, M.H. 2021], and another study carried out in Al-Muthanna province found that the 20-25-year-old age group had the highest percentage of *Trichomonas vaginalis* infection [Hawel, N.H., Alasadiy, Y.D.K., 2018]. While in Al-Diwaniya governorate, the infection was more prevalent in people aged 26 to 35 [Al-Hamzawi, S.A. & Al-Awsi, G.R.L., 2023].

Even though infections were more prevalent among women over 25 years old in central India's metropolitan population [Katole, A., Saoji, A. V., 2019]. In contrast, another study discovered that 26% of infertile women between the ages of 31 and 35 had chlamydia infection [Sukatendel, K. *et al.*, 2019], and that the age at which infertility related to infection occurred was 40 years [Tao, X., Ge, S. *et al.*, 2018].

The results of the study are unique and at variance with those of other research, such as one that examined Malaysian women who visited obstetrics and gynecology clinics and found no link between chlamydial infection and age [Cheong, H.C. *et al.*, 2019]. Furthermore, studies conducted at Cairo University's Department of Obstetrics and Gynecology in Egypt found no correlation between age and *Trichomonas vaginalis* infections [Ibrahim, S.S. *et al.*, 2021].

Variations in proportions between age groups can be caused by a variety of variables, including progesterone, estrogen, and PH levels in the vagina, multiple pregnancies and miscarriages, a weakened body following the menstrual cycle, and defences [Enwuru, C.A. *et al.*, 2024]. The decrease in infection in older women may be due to a rise in the pH of the vagina, which will approach 6–8, as

well as declining levels of the hormones progesterone and estrogen, which do not promote infection [Ferrando, M.L. *et al.*, 2025].

In this study, there was a co-infection of *Candida albicans* in 27.3 % of individuals with *Chlamydia trichromats* and *Trichomonas vaginalis* in 9.1 % of patients. On the other hand, 35.3% of patients have *Candida albicans* infection with *Trichomonas vaginalis* infection.

About 57.1 % of patients with *Chlamydia trichromats* infections also have *Trichomonas vaginalis* in two cases and other bacteria in two more. Another study revealed that *Neisseria gonorrhoeae* and *Chlamydia trichromats* were the two most common co-infections, occurring at a rate of 12.5 % and 6.3%, respectively [Sethowa, J.T., 2017].

The risk of an upper genital tract infection may be increased when *Candida albicans*, *Trichomonas vaginalis*, and/or *Chlamydia trichromats* are present together. The invasion of the different bacteria that cause tissue damage and inflammation in the vaginal tract may raise the risk of infertility. This could be because these infectious agents are more powerful and have an effect on patients' immune systems than other single infections [Salman, S.T. *et al.*, 2022].

In conclusion, the most common infectious causes of infertility among women in Baquba City, Diyala, Iraq, are *Candida albicans*, *Chlamydia trichromats*, and *Trichomonas vaginalis*; *Chlamydia trichromats* is a less common cause. Additionally prevalent is the primary form of infertility.

CONCLUSION

The study indicated very important problems of infertility among women in Baquba City; primary infertility is more prevalent than secondary infertility. Many infertile women had microbiological infections, especially *Candida albicans*, *Chlamydia trachomatis*, and *Trichomonas vaginalis*, which are important factors in female infertility. The findings were most pronounced for women aged 18–28 years, suggesting vulnerability at younger reproductive ages. The finding of single and mixed infections necessitates the use of broad microbiological screening. The findings highlight the critical need for early diagnosis and management of reproductive tract infections to enhance reproductive health outcomes in this population.

Acknowledgment

I would like to thank the laboratory workers and the director of the Al-Batool Teaching Hospital for their assistance in the study. We also thank the patients who were included in this study.

Funding

For this study, no specific grant from public, commercial, or nonprofit funding agencies was given.

Declaration Of Competing Interests

There are no competing interests for this study

Ethical Approval

The College of Medicine/University of Diyala approved this study, which was carried out in compliance with the ethical standards outlined in the Declaration of the College's ethics committee. Code number 2026 SKK 940 on August 10, 2026.

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Source of support: Nil; **Conflict of interest:** Nil.

Cite this article as:

Khalaf, S. K. & Salman, S. T. "Microbial Infections and Female Infertility: Investigating Their Association among Women in Baquba, Diyala, Iraq." *Sarcouncil journal of Medical sciences* 5.8 (2026): pp 31-39.