



Contents lists available at ScienceDirect

Taiwanese Journal of Obstetrics & Gynecology

journal homepage: www.tjog-online.com

Review Article

Understanding the COVID-19 pandemic from a gender perspective

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ARTICLE INFO

Article history:

Accepted 28 July 2020

Keywords:

Coronavirus
Women
COVID-19
SARS-CoV-2
Gender

ABSTRACT

Under the threat of the new coronavirus pandemic, women have been uniquely impacted financially, economically, and socially. However, in terms of disease incidence and lethality, women perform better than men. The main reason is that, in addition to women's own hormonal protection, women's immune systems are superior to those of men. Women also exhibit more protective behavior (e.g., hand-washing) and more closely follow protection guidelines, which greatly reduces the chance of infection. In the future, more studies that adopt a gender perspective are needed to understand the various dilemmas faced by women in infectious diseases and pandemics; only then can women demonstrate better outcomes.

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Introduction

The new coronavirus continues to spread throughout the world, and the number of confirmed cases globally has proliferated. The outbreak of coronavirus has continued to grow. According to confirmed cases, since the outbreak in December 2019, the rate of male infections has always been higher than that of women (about 2:1). On March 12, 2020, the World Health Organization (WHO) declared coronavirus to be a global pandemic [1]. Taiwan's pandemic prevention measures have been outstanding, and they have been recognized by countries around the world. However, the biggest challenge for most countries is how to confront the immediate threat of the virus. Chen Shusheng, the commander of Taiwan's Central Epidemic Command Center, also recently admitted that, in the future, further infection may be difficult to avoid [2]. He acknowledged that he must be prepared for the outbreak of the virus in Taiwan. Experts have also suggested that, in addition to quarantine and isolation measures, the implementation of the quarantine space of cabins and the diversion of severe diseases will be the focus of future pandemic prevention efforts. For prevention and treatment in women, it is helpful to understand

whether women belong to a high-risk group or a group with weak resistance.

Impact

For women around the world, coronavirus has impacted not only their physical health but also their family, work, and everyday life. The coronavirus pandemic caused most schools to suspend classes, forcing many working women to take time off to care for their children, which greatly affected their work. In addition, the pandemic has impacted industries such as catering and tourism, and many factories have been forced to shut down. Many low-income women financially depend on these jobs and are now facing unemployment. United Nation (UN) Women has asserted that women who work in low-wage work, female bosses of small businesses, and women working in the informal sector will be hit the hardest [3–5]. According to Maria Hertzberg, a humanitarian and disaster risk consultant for the Asia-Pacific region of UN Women, "Crisis always exacerbates gender inequality [6]." The British Broadcasting Corporation (BBC) pointed out that coronavirus has spread rapidly throughout Asia [7]. Women, including medical staff, scientists, and researchers, play an important role in slowing the pandemic. The BBC summarizes the six levels of Asian women seriously affected by the pandemic as follows [7]:

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Women who are affected by the suspension of classes

As the coronavirus pandemic continues to grow, kindergartens, elementary schools, junior high schools, and high schools around the world have announced the suspension of classes. Many schools have postponed the start of the academic year, which has forced many women to take leave to stay at home with their children, affecting their right to work. Married women in East Asia traditionally bear excessive family responsibilities, and this new coronavirus crisis has made women feel depressed [8–10]. In most families, men are the mainstay of the family's economy, so they cannot take leave. Therefore, women are obligated to take leave to care for their children at home. For this reason, many companies' crisis-related layoffs have focused on female employees [11–13]. While this act may not clearly be stated among companies, companies generally assert that working mothers are a burden, reflecting the difficult situation of women and gender inequalities in the workplace [14].

Women facing domestic violence and divorce

The spread of the new coronavirus pneumonia pandemic has caused hundreds of millions of people to be quarantined at home, which has also led to a continuous increase in domestic violence and divorce cases. Feng Yuan, co-founder of the Beijing-based non-profit organization Wei Ping Women's Rights and Interests Institution, revealed that its organization received three times as many inquiries from female victims as it had before isolation measures [15]. Reports of domestic violence related to the outbreak of the new coronavirus have also been followed and discussed by social media in various countries [16–18].

Women who are front-line medical staff

Compared with the male-dominated health care system, female medical staff are more likely to be exposed to the risk of the spread of coronavirus. During the fight against the coronavirus pandemic in Wuhan, female medical staff had to be at the forefront of the crisis to assist in patient care. In addition, if a female nurse is pregnant, both the nurse and her fetus are at risk of infection, which causes psychological stress to the mother. Wearing protective clothing can restrict the movement of medical personnel, such as going to the toilet or eating. If the hospital lacks adequate protective clothing, it is very inconvenient for first-line medical staff who work long hours, especially women [19,20]. Female providers may also be uncomfortable during menstruation and unable to regularly change their menstrual supplies, which highlights the additional difficulties faced by female medical staff during the pandemic [21].

Women migrant workers from various countries who face exploitation

About 400,000 women in Hong Kong work as domestic helpers, and most of them have migrated from the Philippines and Indonesia. In some places, they have become infected because they do not wear masks. Since their employers do not provide masks, female migrant workers must purchase them at their own expense. However, masks can be expensive, and some women cannot afford them, which makes women vulnerable to infection. Reports also indicate that some people have used the same masks for a week despite receiving masks from their employer [22–24].

Women who are under significant physical and mental pressure

The new coronavirus appears to affect everyone, but the degree of risk is often related to specific social factors. Since the outbreak of the global pandemic, the elderly, children, women, people with physical and mental disabilities, and chronically ill people who are socioeconomically vulnerable have faced relatively serious risks. The elderly, especially those with chronic diseases such as hypertension, cardiovascular disease, and diabetes, face a particularly high risk of mortality due to coronavirus [25,26]. In addition, elderly women suffer greater psychological and emotional health effects than elderly men [27].

It is worth noting that gender can also provide different perspectives to examine the development of the pandemic and health inequalities. In fact, women may endure a greater physiological and psychological impact because of the pandemic. A survey from UN Women shows that, although men are more likely to die from coronavirus, women may disproportionately shoulder the psychological and emotional impact of the pandemic [20,28]. For example, increased unpaid care and domestic work, income loss, and domestic violence under quarantine measures may cause women to fall into a more serious predicament [29].

Women who face negative long-term economic consequences

Economists predict that global economic growth will be altered due to the coronavirus pandemic, and there may even be a global economic crisis [30–32]. Dr. Christina Maags, a lecturer at the School of Oriental and Asian Studies (SOAS), University of London, believes that coronavirus will have a huge impact on tourism, manufacturing, and consumption and will affect both men and women [33]. However, low-income women are particularly vulnerable to slower rates of consumption because they often work in hospitality, retail, or other service industries. Without an employment contract, the pandemic has prevented them from working and has caused them to lose their income. These women are forced to stay at home to exhaust their savings and may take on debt to pay for accommodation [34].

Literature review

The Chinese Center for Disease Control and Prevention (China CDC) recently published a study on coronavirus in the *Chinese Journal of Epidemiology* [35]. The study revealed that 77.8% of the confirmed cases represented patients between the ages of 30 and 69. In addition, 51.4% of cases were male, 80.9% of cases were mild/moderate, and the crude mortality rate was 2.3%. Viruses easily attack people with low immunity [36–38]. Different viruses affect the population with a range in severity. In 1918, the Spanish flu caused the death of 50 million people worldwide and mostly infected young people between the ages of 20 and 39. Primarily people younger than 65 accounted for the total number of deaths [39,40]. In 2003, 92% of severe acute respiratory syndrome (SARS) cases represented young people, and in 2015, the outbreak of Zika virus was particularly dangerous for pregnant women and fetuses [41–43].

Coronavirus mainly affects in concern of seniors, people with chronic diseases, and men. An estimated 87% of those infected in China have been between 30 and 79 years old. In a *JAMA* study, among Chinese patients diagnosed with coronavirus, only 1% of cases occurred among people aged 1–9 and aged 10–19, and their mortality rate approached 0%. Regardless of gender, infected people older than 70 had an 8% mortality rate, and the mortality rate for

people older than 80 was closer to 15%. In addition, the mortality rate for patients with chronic diseases was as follows: 10.5% (cardiovascular disease), 7.3% (diabetes), 6.3% (chronic respiratory diseases), 6.0% (hypertension), and 5.6% (cancer) [44,45]. The *New York Times* reported that coronavirus does not infect children, and middle-aged and older men face a higher risk of infection [46].

Physiological and health effects of women in the face of coronavirus

Women have demonstrated better resistance to and a higher survival rate against coronavirus. During the Severe Acute Respiratory Syndrome (SARS) and Middle East respiratory syndrome (MERS) outbreaks, male mortality was higher. According to a study published in the *Annals of Internal Medicine*, in 2003, women in Hong Kong were infected with SARS at a higher rate than men, but the mortality rate of men was 50% higher. About 32% of men infected with MERS died compared to only 25.8% of women. During the Spanish flu pandemic of 1918, the mortality rate of young men was also higher than that of their female counterparts. Recent studies have found that the death rate of coronavirus was 2.8% among infected men in Wuhan and 1.7% among infected women in Wuhan [47].

Many scientists have put forward different theories to explain the low mortality rate of women infected by coronavirus. Dr. Klein, a microbiologist at Johns Hopkins University, discovered that men and women are different in terms of co-morbidity and biology. In addition, men's immune systems make them more vulnerable to infection. There may also be various biological and lifestyle factors that are unfavorable to men [48,49]. Sabra Klein, a scientist at the Johns Hopkins Bloomberg School of Public Health who studies gender differences in viral infections and vaccination responses, pointed out that, among many respiratory viral infections, male prognosis is poorer than that of women. In addition, other historical cases have demonstrated that women have been better able to fight off viruses. After vaccination, women also have a stronger immune response and strengthen their immunological memory. This feature protects female adults from pathogens they were exposed to in childhood. Dr. Janine Clayton, director of the Office of Women's Health Research at the National Institutes of Health, noted that there is something more active in women's immune systems that can help fight viruses. She also stated that nearly 80% of patients with autoimmune diseases are female. Experts suggest that the reasons for the stronger female immune response are not fully understood, and further study is still necessary in next stage [50–52].

One hypothesis posits that women's stronger immune system brings survival advantages to their offspring [53]. When a baby's immune system is still developing, it can absorb antibodies from breast milk to help resist disease. This transfer may be caused by a series of biological factors, including female estrogen, which seems to play a role in the immune system. In addition, women carry two X chromosomes containing genes related to immunity, while men carry only one. Experiments on mice exposed to coronavirus found that males are more susceptible to infection than females, and this difference increases with age. Male rats become infected when exposed to a smaller amount of coronavirus. In addition, their immune response and the virus removal rate are slower [54,55]. Research by Dr. Stanley Perlman, a professor of microbiology at the University of Iowa, has shown that infected men's symptoms are more seriously by coronavirus and have higher mortality. When researchers blocked estrogen in infected female mice or removed their ovaries, the mice were more likely to die. However, blocking testosterone in male mice had no effect, which suggested that estrogen may play a protective role. Dr. Perlman's research demonstrates that the protection caused by female hormones is an

exaggerated pattern of human response, supporting the idea that the difference between human males and females is quite subtle [56,57].

In some societies, differences in health behavior, including smoking and drinking, may also play a role in infection rates. Nearly one-third of the world's smokers account for 40% of world tobacco consumption. In addition, China has the largest number of smokers in the world. However, only a little more than 2% of Chinese women smoke while more than half of Chinese men smoke [58,59]. Compared to Chinese women, Chinese men also have higher rates of type 2 diabetes and high blood pressure, both of which increase the risk of complications after coronavirus infection. Lastly, the proportion of Chinese men who suffer from chronic obstructive pulmonary disease is almost twice as high as that of Chinese women [60,61].

The difference in mortality between men and women may also be explained by differences in health seeking behavior. In the United States, women seek health care more actively than men [62,63]. Some small studies have found that this conclusion is equally applicable to Chinese students studying in American universities [64]. In unpublished studies, Chinese researchers emphasized that patients who are not diagnosed in a timely manner or who are diagnosed with severe pneumonia for the first time have the greatest risk of death [65]. A study of 4021 patients with coronavirus noted the importance of early detection, especially for older men. Men tended to only visit the hospital when their condition was more serious [66]. Analysis by the China CDC showed that, in addition to the high mortality rate in Wuhan, the mortality rate in other regions seems to be much lower, and the infection rate of men is much higher than that of women [67]. Yako University's immunology professor Akiko Iwasaki, who specializes in studying the impact of viruses on women, said that men may not take coronavirus seriously, which produces a false sense of security⁶⁹. Women tend to be more sensitive to the pandemic and actively seek help, which helps reduce the spread and incidence of the virus. Public health experts agree that collecting and analyzing coronavirus data by gender is important for scientists and the public [68]. For example, since the outbreak, public health officials have emphasized the importance of frequent hand-washing to prevent infection. However, several studies have found that men—even male medical staff—are less likely to wash their hands or use soap than women [69].

Comparison of women infected by coronavirus and the flu

According to the same study by JAMA, up to eight patients from Chengdu, China, demonstrated mild symptoms of coronavirus [70]. The remaining 20% of people faced severe conditions, were critically ill, or have died. Severe symptoms of those affected include dyspnea, viral pneumonia, and organ failure⁷¹. According to the report of Tedros Adhanom Ghebreyesus, the mortality rate of coronavirus has increased to 3.4% [71,72]. This mortality rate is less than 1% higher than that of seasonal influenza, and it is lower than the 10% mortality rate of SARS, which is also a coronavirus. As of March 1, 2020, the cumulative death toll. China's mortality rate is 5.6%, while China's overseas mortality rate is 15.2%. According to an epidemiological model, the death rate of COVID-19 in Wuhan, the origin of the outbreak, may be as high as 20% [73,74].

Coronavirus status and symptoms in women

The WHO pointed out that more than 80% of patients with coronavirus have mild symptoms and will recover [75]. An estimated 14% of patients will have severe symptoms including pneumonia and shortness of breath. Approximately 5% of patients

may have a life-threatening case and experience severe symptoms, including respiratory failure, septic shock, and organ failure. However, about 6% of patients (0.372/6.15 per million) die as a result of average in the worldwide until June 1, 2020 [76]. According to the latest research, the number of initial incubation days and symptoms of the infection vary according to gender. Women experience mild symptoms and an incubation period longer than 14 days, which is longer than that of males. *The Lancet* analyzed the outbreak from the end of December 2019 to February 20, 2020, and collected information on the age, gender, condition grade, and diagnosis date of all Wuhan coronavirus patients. The study also stratified the data by gender. Of the cases, 1092 cases exhibited mild and moderate conditions (454 males [47.6%] and 612 females [56.0%]). An additional 112 males (11.8%) and 76 females (7.0%) were considered critically ill [77]. These signs suggest that coronavirus may cause less damage to women and have a longer incubation period in women than in men. This may be related to women's antiviral immunity, and it is also a key factor in viral infection [78].

Women deaths due to coronavirus

According to a paper by the National Health Commission of China, the characteristics of coronavirus are mild or moderate, and the male mortality rate is three times that of women. A research team of the University of Florida and Peking University studied 8900 diagnosed patients in China and found that half of the patients were over 50 years old, and the mortality rate was about 3.1%. More specifically, the mortality rate of male patients was about 4.5%, which is more than three times the mortality rate of female patients (1.3%). At present, the research team has not yet provided a complete explanation. Furthermore, more men than women demonstrate smoking habits. According to a 2010 survey, 54% of males have smoking habits while only 2.6% of females do. This discrepancy may greatly reduce the risk of infection in women [79].

Discussion

Analysis of why men suffer more from coronaviruses than women

Global epidemiologists analyzed data from the first 44,000 cases in China and summarized the major characteristics. According to these figures, both men and women were infected by coronavirus in the first six weeks of the outbreak. While the number of cases of men and women were almost equal, the situation has since changed significantly. Male patients died from coronavirus at a twice rate compared to female [44]. This difference in mortality can be explained by differences in the lifestyles of men and women [80]. For example, men do not wash their hands as frequently as women, which may affect the infection rate but cannot independently explain the significant difference in mortality. In addition, most Chinese men are smokers, and smoking weakens the body's immunity and lung function, which can lead to pneumonia after infection [81,82].

Scientists still have limited knowledge about this new coronavirus. However, the most recent statistics show that the number of infected males is substantially greater than the proportion of infected females, and women's immune systems seem to be stronger. One study in *The Lancet* demonstrated that the death rate due to coronavirus disproportionately affects elderly men, especially those who already suffer from diseases such as heart disease and diabetes. It is worth noting that a similar situation was seen during the SARS outbreak, which claimed 780 lives nearly 20 years ago [83]. After an analysis of 1800 SARS patients, researchers determined the mortality rate in males to be 22% and the

mortality rate in females to be 13%. A 2019 study of MERS also showed that the mortality rate was as high as 32% in men and 26% in women. Possible reasons for such disparities include differences in smoking habits, testing methods, and sex-related immune responses [84].

It was noted that there are indeed gender differences in the characteristics of coronavirus infection. The differences between male and female mice are greater than those of humans. Males comprise the majority of those infected, and the condition of infected middle-aged male mice is particularly poor. Dr. Perlman believes that hormones, especially estrogen, may be key [85]. Recent studies have claimed that although some female immune systems are weakened to accept a fetus, most immune systems become stronger to compensate [86]. From the viewpoint of evolutionary biology, female immune function is powerful, which may be explained by pregnancy and childbirth. In theory, the female immune system should eliminate new coronaviruses faster than that of men [87]. According to various reports, men of all ages are more likely to die from coronavirus than women. However, some researchers in England and Wales have found that more women above the age of 90 have died of coronavirus than men of the same age.

Generally, women of all ages are at a lower risk of contracting the virus, but men are more susceptible to more serious infections related to coronavirus that can lead to death. Among people aged 55–84, more men are infected with the virus than women (56% vs. 44%). Studies have revealed that women above the age of 90 are infected with coronavirus at a higher rate than men (61% vs. 39%); however, at this age, women's immune systems are weaker than men and die at a higher rate (54% vs. 46%). Previous research suggests that women are more likely to recover from COVID-19 because they exhibit a stronger immune response than men. However, it is not clear why women at this age have not followed that general trend. Future research and analysis are needed to understand this phenomenon.

A recent study published by Guoshuai Cai showed that cross-sections of smokers' lungs have a relatively high number of angiotensin converting enzyme 2 (ACE2) receptors. The ACE2 receptor is the receptor used by coronavirus to infect humans. Guoshuai Cai believes that this finding can also explain why the proportion of males infected by coronavirus has always been higher than that of females [88,89].

While various studies have reported a higher mortality rate among Chinese male patients, the reason for this difference has not yet been explained. One study compared the level of coronavirus antibody SARS-CoV-2 IgG in male and female patients, which may be a potential cause of the difference in mortality rates. The data showed that the concentration of IgG antibodies in patients with mild and general cases and in recovering patients did not differ between male and female patients. In people with severe cases, female patients had a relatively higher number of SARS-CoV-2 IgG antibody concentrations than male patients. In addition, in the early stages of the disease, the production of IgG antibodies was greater in female patients than in male patients [90].

The impact of the COVID-19 pandemic on women's sexuality

Some studies have compared the frequency of sexual intercourse, pregnancy intention, contraceptive use, and menstrual abnormalities in women between six and 12 months before the pandemic and during the pandemic to understand the impact of COVID-19 on women's sexual behavior. The study contacted the participants by phone and found that, during the pandemic, the frequency of sexual desire and sexual intercourse increased significantly, while the quality of sexual life decreased significantly.

The pandemic is associated with a decreased desire for pregnancy, a decreased use of female contraception, and an increase in menstrual disorders [91].

Prevention of coronavirus in women

Scientists are currently accelerating the development of therapeutic drugs and preventive vaccines for coronavirus, but it will still take time before they can be widely available in the market. Until then, prevention is critical. Coronavirus can be transmitted by droplets or by indirect or direct contact with an infected person's mouth, mucus secretions, or bodily fluids [92,93]. To effectively reduce human-to-human contact, the most effective prevention methods for people at present include frequently washing their hands, rinsing their mouth, wearing masks, and maintaining social distance. It is also reinforced the behavior important of avoiding contact with the eyes, nose, and mouth to block the virus from entering the body. It is always recommended to maintain the body's health by working normal hours and getting enough rest. These practices will reduce the likelihood of infection. It may also be beneficial to regularly measure body temperature. While this measure is unable to prevent infection, it can remind people to be aware of any discomfort and promote the early identification of symptoms. It is important to note that women's body temperatures can increase during ovulation, so a higher temperature in women may not always be indicative of a fever. Women in proximity to their children may find it difficult to maintain social distance and should be aware of any emerging symptoms to avoid cross-contamination. It is essential to avoid contact with people who may get sick and avoid contact with wild animals. Experts also emphasize the need to avoid long-term close contact without protection, especially in confined spaces [94,95].

Conclusion

Women have been significantly impacted by the coronavirus pandemic and face difficulties related to society, the economy, employment, and their health, which has caused considerable harm. While the incidence of coronavirus in women and the mortality rate among women are much lower than those of men, the relatively weak social and economic situation still requires government attention. In this epidemic, the government needs to plan for women as follows: 1. In the work aspect, to regulate the working conditions of women reasonably, to extend the working hours by medical staff properly compensated, and to provide the quality of work conditions, including appropriate rest and increase the time to go to the toilet; 2. In the material aspect, to provide women's menstrual supplies and protective equipment avoiding wearing clothing longer over; 3. In the social aspect, to take care of women who have been quarantined or infected, to take home epidemic prevention completely and to provide a safe place for accompanying their families; 4. In the education aspect, to strengthen school epidemic prevention measures and to adopt distance teaching methods away from cross infection among students; 5. In the economic aspect, to provide women with cheaper epidemic protection equipment, unemployment benefits, lower tax burden, and to increase job opportunities; 6. In the family aspect, to provide manpower to help women raise children and take care of their families, and to protect women from domestic violence or marital problems advisory. As we known, the number of new cases is still increasing. It is essential to effectively protect women from coronavirus and improve their resistance to infection to ultimately reduce their chance of infection and mortality.

Disclaimer

Some of the cited part in this article from web-sites has not been peer-reviewed; it cannot replace the expert's clinical judgment, nor has it examined the credibility of its cited source in detail.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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