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Economic Burden of Disease, Financial Toxicity, and Social Support: An Empirical Study of Patients Undergoing Assisted Reproductive Technologies from the Stakeholders' Perspective

GENG Ling

Doctor of Management

Supervisor:
PhD Pedro Fontes Falcão, Associate Professor,
ISCTE University Institute of Lisbon

May, 2025

BUSINESS
SCHOOL

Marketing, Operations and General Management Department

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Jury:

PhD Fernando Alberto Freitas Ferreira, Full Professor,
ISCTE University Institute of Lisbon
PhD Victor Maurílio Silva Barros, Associate Professor,
ISEG – Lisbon School of Economics & Management
PhD Renato Jorge Lopes da Costa, Assistant Professor with Habilitation,
ISCTE University Institute of Lisbon
PhD Pedro Ribeiro de Almeida Fontes Falcão, Associate Professor with Habilitation,
ISCTE University Institute of Lisbon
PhD Qian Yi, Professor,
SMU – Southern Medical University

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Abstract

The economic burden of disease and financial toxicity of patients undergoing assisted reproductive technology have become a global challenge, and there lacks authoritative measurement and assessment in this respect in China. In addition, the social support system is complex and variable. The asymmetric information has led to unbalanced supply and demand for support, and conflicting demands of multiple stakeholders have hindered the collaboration.

Based on the theories of stakeholders, asymmetric information and social support, this study adopts mixed research methods to carry out in-depth exploration. In the quantitative study, an authoritative measurement and comparative analysis of economic burden is performed, and research on financial toxicity fills the gap in the field, revealing the mechanism of action of economic burden, financial toxicity and medical social support. It is also found that medical social support plays a negative moderating role in economic burden and financial toxicity. In the qualitative study, the negative moderating role of medical social support is revealed. It is found that stress and support come from the same source and the stigma-driven information-hiding behaviors affect support efficacy, and the conclusions provide a new perspective for explaining ambivalent moderation in the management of comparable chronic illnesses.

Therefore, it is suggested to build a hierarchical and homogenous economic security system and an emotional support system based on patients' needs, strengthen the information support system, and form a data-driven, transparent and open dynamic management mechanism. The research results provide an important decision-making basis for the construction of a social support system.

Keywords: Assisted reproduction; economic burden; financial toxicity; social support
JEL: I18; D82

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Resumo

O fardo económico da doença e as dificuldades financeiras dos pacientes de reprodução assistida tornaram-se um desafio global e a China carece de medições e avaliações fiáveis nesta área. O sistema de apoio social é complexo e variável, com a assimetria de informação a levar a um desalinhamento entre a oferta e a procura de apoio, e as exigências contraditórias de múltiplas partes interessadas a dificultar a colaboração entre elas.

Com base nas teorias das partes interessadas, da assimetria de informação e do apoio social, este estudo adota uma abordagem de investigação mista para explorar esta questão em profundidade. No estudo quantitativo, não só a medição fidedigna e a análise comparativa dos encargos económicos, mas também o estudo das dificuldades financeiras preenchem as lacunas existentes no terreno, revelam os mecanismos dos encargos económicos, das dificuldades financeiras e do apoio social médico, e concluem também que o apoio social médico desempenha um papel moderador negativo na relação entre os encargos económicos e as dificuldades financeiras. No estudo qualitativo, verificou-se a moderação negativa do apoio social aos cuidados de saúde. Descobriu-se que o stress e o apoio provêm da mesma fonte, e que os comportamentos de ocultação de informação orientados pelo estigma afetam a eficácia do apoio, sendo que as conclusões apresentam uma nova perspetiva para explicar a moderação ambivalente na gestão de doenças crónicas semelhantes.

Deste modo, o estudo sugere a construção de um sistema de segurança económica claramente hierarquizado e homogéneo, e de um sistema de apoio emocional baseado nas necessidades dos doentes, bem como o reforço do sistema de apoio informativo para formar um mecanismo de gestão dinâmico, transparente e aberto, baseado em dados. Os resultados da investigação fornecem uma base de decisão importante, simultaneamente científica e operacional, para a construção de um sistema de apoio e garantia social.

Palavras-chave: Reprodução assistida; encargos económicos; toxicidade financeira; apoio social
JEL: I18; D82

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摘　要

辅助生殖助孕患者的疾病经济负担与财务困境已成为全球性挑战，中国在此方面缺乏权威测算和评估，且社会支持体系复杂多变，信息不对称导致支持供需错位，多元利益相关者诉求冲突阻碍协同。

本研究基于利益相关者、信息不对称及社会支持理论，采用混合研究的方法深入探索。量化研究中，不仅对经济负担进行权威测算、比较分析，而且针对财务困境的研究填补该领域空白，揭示了经济负担、财务困境和医疗社会支持的作用机制，还发现了医疗社会支持在经济负担和财务困境的关系中起到反调节作用。质化研究中，通过米切尔评分法识别和分类利益相关者，采用访谈法和主题分析法明确其角色诉求和在提供社会支持中的矛盾分歧。结合社会支持动态模型、最优匹配模型与患者主体特征视角，通过混合研究、三角互证，揭示了医疗社会支持的的反向调节特征，发现了压力和支持同源、病耻感驱动信息隐藏行为影响支持效能，结论为解释同类慢性病管理中的矛盾性调节提供了新视角。

基于此，研究建议构建层次明晰、同频共振的经济保障体系和基于患者需求的情感支持体系，还有强化信息支持体系，形成数据驱动、透明公开的动态管理机制。诸多研究成果为精准构建社会支持保障体系提供了兼具科学性与操作性的重要决策依据。

关键词：辅助生殖；经济负担；财务困境；社会支持

JEL: I18; D82

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Chapter 1: Introduction

1.1 Research background

1.1.1 Continued decline in fertility and high rates of infertility

Declining fertility is a population problem that is commonly faced by all countries across the world in their economic and cultural development. The persistent decline in fertility has led to the emergence of a “low fertility trap”. At present, China’s total fertility rate and the number of births have both reached historical lows. The birth rate has rapidly declined from 13.38 ‰ in 2001 to 7.52 ‰ in 2021, and the total fertility rate has dropped to 1.3 (H. Q. Zhang et al., 2022). By the end of 2022, the national population had amounted to 1,411,750,000, with a decrease of 850,000 compared with the end of the previous year. The natural population growth rate had dropped from 6.45 ‰ in 2002 to -0.60 ‰ in 2022, the first negative population growth since 1962 (Tong & Liu, 2023).

Increase of infertility rate, popularization of contraception measures, and decline in teenage pregnancies have all contributed to the drop fertility rates (Osterman et al., 2023). Studies have shown that infertility affects approximately 8% to 10% of married couples (Casale & Carlqvist, 2021). Infertility has become the third most common disease after tumors and cardiovascular diseases (Zegers-Hochschild et al., 2009), and assisted reproductive technology (ART) is an effective way to solve the infertility problem. From 2007 to 2020, the prevalence of infertility in China has risen from 12% to 18% (J. Qiao et al., 2021), and the number of patients resorting to assisted reproductive technology was about 500,000 (Bai et al., 2020). According to data of the Shandong Provincial Bureau of Statistics, the number of births in Shandong Province has been declining year by year, with a birth rate of 6.71 ‰ and a natural growth rate of -0.93 ‰ in 2022. The proportion of advanced maternal age has increased after the adjustment of the family planning policy, and many families are plagued by infertility. The amount of in-vitro fertilization in Shandong Province was 47,741 cycles in 2015, and the figure increased to 71,117 in 2019, indicating that the general public have strong demands for services related to assisted reproductive technology.

It can be seen that low fertility and high infertility rates have become important issues that must be faced in the social development of Shandong Province, China, or even the whole world.

With the gradual increase in the size of the infertility group and the aging trend of the population, China is facing great challenges in its demographic structure, distribution of social healthcare and old-age resources, national defense, sustained and healthy development of the national economy, and the competitiveness of the country.

1.1.2 High economic burden of assisted reproductive diseases and financial toxicity

The main approaches of infertility treatment include medication, surgery, and assisted reproductive technology (ART) treatment, and ART is considered to be one of the most effective methods. Despite its effectiveness in treating infertility, ART is costly, burdensome, and has a long treatment cycle (Armstrong et al., 2019; Eijkemans et al., 2017). The cost of the treatment imposes a heavy economic burden on both individual families and social resources. It is proved that while an increasing number of patients require infertility treatment, assisted reproduction services are barely accessible, primarily due to the high cost (Domar et al., 2018; Hamilton et al., 2018).

The economic burden of disease refers to the health economic resources consumed in the prevention and treatment of disease and the economic losses incurred by patients due to illness, disability or even death, and it is mainly measured from three perspectives: direct economic burden, indirect economic burden and intangible economic burden (Sgobin et al., 2015). Currently, most countries, including the United States, the United Kingdom, India, and South Africa, have measured and calculated the economic burden of disease for patients undergoing ART, but it is difficult to reach a consensus due to differences in regional economy, measurement time and measurement approach.

Financial toxicity describes the objective economic expenditures of disease treatment and the resulting psycho-social distress, behavioral changes, and reduced quality of life (Zafar et al., 2013). Families with severe financial toxicity often give up the treatment and face the risk of death, resulting in poor prognostic outcomes (Perrone et al., 2016; Zafar, 2015). Patients and families suffering from financial toxicity also alleviate the burden by taking out loans and selling their property (Kale & Carroll, 2016). As an emerging issue in the field of cancer care, financial toxicity is a dual challenge for both individuals and the society, and has become a hot research topic at home and abroad, with many scholars conducting in-depth studies. It has gradually been extended from research on cancer to research on the economic burdens of mental illnesses and chronic diseases (Nedjat-Haiem et al., 2021).

The difference between economic burden of disease and financial toxicity is that the former is an objective measure of how much household income is consumed by medical expenses, and includes direct economic burden, indirect economic burden, and little-studied intangible economic burden. However, the latter attaches more emphasis on the patients and their families, and it focuses on not only out-of-pocket healthcare costs, but also the short-term and long-term harms that the economic stress of disease can cause to the patients and their families in a variety of ways. It is a comprehensive evaluation of the patient’s treatment experience, encompassing healthcare-related expenditures, passive use of financial resources, psycho-social impacts, search for support and coping strategies (Witte et al., 2019).

Although there lacks systematic and authoritative research on financial toxicity for patients undergoing ART, the reality is that the rising financial toxicity of them has resulted in serious financial harms and psycho-therapeutic harms. For example, some patients in severe financial toxicity consider egg donation because they cannot afford the ART treatment (Pennings & Devroey, 2006). In addition, it has also resulted in decreased productivity due to lost work time for patients or family members while seeking treatment (Brouwer et al., 1997). After successful conception, multiple labor can also be economically harmful (Koivurova et al., 2004). Low success rate and huge financial stress can also bring huge emotional harm on women (Genoff et al., 2018). Many couples are also likely to turn to cheaper and less restrictive alternatives, such as seeking help abroad through “reproductive tourism” (F. Taylor et al., 2022; Whittaker et al., 2019), and some women may contact unscreened and unregulated sperm donors for financial reasons (F. Taylor et al., 2022). These steps taken out of financial toxicity are all likely to generate medical risks. Faced with the high cost of ART, some patients even have to abandon their disease treatment (Jing et al., 2020). All of the above are manifestations of the serious financial toxicity of patients undergoing ART.

1.1.3 Establishment of a multi-faceted social support system for fertility

Social support, defined as the subjective belief or objective assistance actually obtained through interaction with others, is considered key to coping with stressful life practices (Lindell et al., 2023). In the United States, Sherbourne and Stewart (1991) conducted a study related to social support for patients with chronic diseases and developed the Medical Outcomes Study Social Support Survey (MOS-SSS), which has shown good reliability and validity in applications within America. The Chinese version of the MOS-SSS investigates patients’ social support from four dimensions: message and emotional support, practical support, social interaction support, and emotional support (D. S. Yu et al., 2004), which covers patients’ economic and material, physiological, and psychological needs in a comprehensive way. Social support is a means of improving health-related outcomes for patients, and is conducive to facilitating self-care behaviors (Fivecoat et al., 2018), and improving compliance with disease treatment (Hammash et al., 2017). Social support is also a determinant of physical and mental health, influencing health-related beliefs and behaviors (Maureen & Truong, 2010). As a buffer against the harmful effects of stress, it is a coping resource that protects against physical and mental health risks (Guruge et al., 2015).

Experts have demonstrated that social support reduces infertility distress (Martins et al., 2013) and reduces depression and anxiety in patients with failed assisted reproduction (Verhaak et al., 2005). The impact of social support on financial toxicity has also been intensively studied by many scholars, and social support can buffer the impact of financial toxicity on mental health and physical and psychological symptoms (Åslund et al., 2014; Viseu et al., 2018).

In order to cope with the financial toxicity of patients undergoing ART, joint stakeholder support is an effective initiative. Social support based on medical insurance policies is an important policy tool to cope with low fertility and can contribute to the goal of an appropriate level of fertility. WHO calls for the establishment of safe, effective, and affordable fertility services across the world (Nargund & Datta, 2022). Most low-fertility countries have also formulated social support policies such as diversified healthcare security coverage (Morshed-Behbahani et al., 2020), which proves to be effective. By establishing a diversified financing mechanism for assisted reproduction (including public financing and commercial insurance financing), relatively high financial support has been provided to patients undergoing ART in terms of population coverage, cost coverage and service coverage, and the trend of declining total fertility rate has been smoothed (H. Q. Zhang et al., 2022). However, attitudes, measures and intensity of support for ART vary widely across countries. For example, some countries in sub-Saharan Africa consider infertility to be a population control program, and ART is not worth introducing (Inhorn & Patrizio, 2015). There are also significant inequalities in access to IVF treatment across countries because of differences in treatment costs and financing opportunities (Chambers & Fauser, 2021).

The Chinese government attaches particular importance to assisted reproduction, and Chinese scholars have conducted numerous academic studies on assisted reproductive technology from the perspectives of medicine, psychology, management and economics, with a view to providing an evidence-based basis for the construction of a systematic support policy system. The different stakeholders have also constructed a positive childbirth support system in terms of economic support, policy guarantee, medical service and reproductive culture.

In terms of economic support for ART, the government has issued a number of policy documents that include ART programs in the scope of payment by the medical insurance fund.

By the end of 2024, a total of 22 provinces and municipalities (autonomous regions) in China had included ART in their medical insurance, accounting for more than 90% of the whole country. In addition, some enterprises also provide benefits such as maternity allowances and maternity leave pay to reduce the financial pressure on employees during childbirth. At the same time, flexible working arrangements, such as flextime and working from home, help employees balance work and family relationships.

With regard to the inclusion of ART in the inclusive commercial insurance, the National Healthcare Security Administration has indicated in relevant documents that it encourages insurance companies to innovate their products and services, and develop and design targeted health insurance products according to the health characteristics, treatment cycles, and medical needs of the infertility patients, so as to effectively alleviate the burden of medical treatment on infertility patients and improve their level of risk protection. The Beijing Inclusive Health Insurance sets a discount for assisted reproduction drugs. With a doctor’s diagnosis and prescription in the designated pharmacies, citizens can enjoy a 60% discount on medication for one cycle of ovulation promotion + one cycle of transfer within one year, and the maximum amount that can be reduced is 5,000 *yuan*. Westlake Yi Lian Insurance is an ART model with a certain limit of reimbursement issued by the Hangzhou government. For the costs of embryo culture and embryo transfer during the treatment at provincial and municipal grade A tertiary medical institutions with specific assisted reproduction qualifications in Hangzhou, the insured can get a reimbursement limit of 1,500 *yuan* for embryo culture and 1,500 *yuan* for embryo transfer per year. The Zhengzhou Yihui Insurance treats women’s reproductive health management service as a value-added service, providing couples of childbearing ages with free scientific guidance on preparing for pregnancy and assessment of fertility.

In terms of policy guarantee, the government has proposed to promote the matching and convergence of fertility policies and related economic and social policies. The social security systems such as maternity insurance, paid leave and paternity leave have been improved to provide maternity protection for couples of childbearing ages. In terms of medical services, medical institutions have accelerated the improvement of women’s life-cycle health service models by upgrading medical service capacity and optimizing resource allocation. In terms of reproductive culture, the government has been actively advocating age-appropriate marriage and childbearing and optimal childbearing, guiding young people to establish a positive outlook on marriage, childbearing and the family, building a new type of marriage and childbearing culture, and fostering a childbearing-friendly social environment.

Despite the great efforts made by different stakeholders, the social support system for patients undergoing ART has not been well implemented and precisely positioned. This is reflected in the fact that the economic support and medical insurance policies for ART treatment are still at an early stage of development, and there is a lack of relevant research (H. Q. Zhang et al., 2022). The measures of policy support, medical service support, and reproductive culture support fail to work together to form a synergy. On the one hand, there is a lack of clarity about the economic burden of disease and financial toxicity of patients undergoing ART, and information asymmetry has exacerbated disagreements among stakeholders, creating barriers to social support for assisted reproduction. Currently, China lacks authoritative cost estimates for assisted reproduction, so there is information asymmetry between the government, medical institutions and patients in terms of the coordination of consultation costs and the use of resources for consultation. It is difficult for the government to obtain and assess the actual information of hospitals in a comprehensive and integrated manner. Medical insurance organizations do not offer full reimbursement, and medical practitioners do not have full knowledge of the medical insurance reimbursement catalog and drugs in the process of treatment. In addition, patients' demand for relatively high levels of medical services increases the economic burden of disease, which objectively stimulates excessive treatment and may lead to increased "moral hazard" in the asymmetry of information. It is proved that due to the different goals and objectives of public and private organizations, the relationship between stakeholders, such as commercial insurance institutions, also has information asymmetry (Roehrich et al., 2020). For example, commercial medical insurance has its own special characteristics, involving the interests of patients, doctors and insurance companies. The insurance companies may hide the ability to pay and the operating conditions before the contract is signed, which may prevent the insured from choosing the right insurance products. The hiding of his/her health condition of the insured may also cause "adverse selection" in the asymmetry of information. The current status and effectiveness of ART treatment guarantee policies in other countries can serve as a reference to China, as a European study of more than 6,000 interviewees shows that attitudes toward assisted reproduction funding vary among different stakeholders and are mainly driven by special interests (Fauser et al., 2019).

Another reason is the complicated relationship of the stakeholders of patients undergoing ART. The provision of social support to patients is related to a wide range of sectors, often involving multiple stakeholders, and conflicts between these stakeholders have also shown a tendency to become more complex. Before the formulation of China's "two-child" policy and "three-child" policy, the government adopts family planning to control the population. The government, as the leading force, is responsible for coordinating the interests of various sectors. For example, in terms of policy support provided by the government, while parental leave and financial subsidies can alleviate time and financial pressures, multiple child-rearing commitments and responsibilities, including feeding, health care, education and housing, are not effectively guaranteed, and time-related and financial barriers to childbearing cannot be fully eliminated by temporary paid leave or financial subsidies. In addition, there is little support for parenting skills and counseling in China (Wang et al., 2024). Commercial insurance companies are concerned about how to develop new products and improve their risk management capabilities; medical institutions, as the third party, are the providers of medical services and are responsible for providing services to both the patients and the insurance companies; and the main goal of the patients is to receive high-quality and timely treatment and more reimbursement for their illnesses when they resort to assisted reproduction. It has been proved that social support must consider the extent to which it meets the needs of the recipients in terms of the quantity and quality of support. Receiving too much or too little social support can both have negative effects (Bar-Kalifa & Rafaeli, 2013; Lorenzo et al., 2018). Patients undergoing ART often receive unhelpful social support from well-meaning people, leading to additional stress (Mindes et al., 2003; Slade et al., 2007). The current status and effectiveness of assisted reproduction treatment policies in other countries can be used as a reference for research in China. A European study with more than 6,000 respondents showed that the attitudes of different stakeholders towards assisted reproduction funding are different, and are mainly driven by special interests (Fauser et al., 2019).

How to pinpoint the needs of various stakeholders in assisted reproduction, resolve conflicts between them, and establish a sound information disclosure system to address information asymmetry is becoming increasingly important and urgent. Solving the financial toxicity of patients undergoing ART and providing them with economic support and medical insurance policies cannot be accomplished by a single subject alone, but requires the participation of multiple subjects such as the relevant government departments, medical institutions, and the patients themselves. It is essential to establish a collaborative governance mechanism among stakeholders, conducting regular communication, needs assessments, and feedback adjustments to precisely address the demands of all parties. Concurrently, leveraging diverse platforms to enhance information transparency can mitigate misunderstandings and conflicts. Building on this foundation, tiered and categorized support policies should be formulated to ensure multi-stakeholders fulfill their respective roles, thereby creating an efficient support framework.

1.2 Research problem

1.2.1 Research dilemma

Assisted reproductive technology (ART) is an effective measure to address infertility, but the economic burden of disease is high, and the treatment cycle is long, so the financial toxicity of the patients is accentuated by a vicious cycle of reduced work hours, decreased productivity, reduced income, and increasing economic burden of disease. Patients feel stressed or worried about the economic burden of disease that they need to pay for, and this leads to inappropriate coping behaviors (including reducing expenditures and increasing financial resources, such as decreasing medication dosages, adjusting non-medical expenditures, borrowing money, and selling assets), which exerts negative impacts on health, quality of life, and clinical outcomes (Lentz et al., 2019; Schröder et al., 2020).

Financial toxicity may result from the economic burden of disease for patients undergoing ART, and the economic burden affects the health and well-being of patients in various forms. Financial toxicity is associated with the coping strategies for expenses, such as borrowing money, using savings, and reducing basic living expenses (Gompers et al., 2023). It is reasonable to believe that the higher the economic burden of disease on patients undergoing ART, the more severe their financial toxicity, and the poorer the quality of their healthy life and mental health. However, there is heterogeneity in the two variables, and it is unclear whether social support plays a key role.

For example, there are real-world scenarios in which patients undergoing ART have a relatively heavy economic burden of disease, but no evident financial toxicity. The economic burden and financial toxicity can also be caused by patients' worries about the potential costs even if the current expenses are relatively low (Pisu & Martin, 2022). It is also found that patients do not view assisted reproduction treatment from a strictly economic perspective, and they believe that the fulfillment of life cannot be measured solely in monetary terms, but research cannot prove what kind of support patients receive (Klitzman, 2017). Although stakeholders are continuously taking steps to reduce the economic burden of ART-related disease, many people in need of the treatment still cannot afford it due to the fact that patients may be unemployed or are at the most vulnerable stage to make money when they face financial toxicity (Mehnert et al., 2013). The above situations suggest that there may be other variables moderating the relationship between the economic burden of disease and financial toxicity.

The mechanism of action of the social support buffering model is that social support acts as a buffer between the subjective experience of stress and disease by buffering the negative effects of stress on the individual, thereby protecting the individual’s mental and physical health (Che et al., 2018). Social support exerts positive health effects in populations facing health-related stress globally, and its potential protective role for patients undergoing ART deserves further attention (Casale & Carlqvist, 2021). Social support is an important protective resource for patients undergoing ART. It has been proved that even if patients are satisfied with their medical care during assisted reproduction, they would like to receive more emotional advice, specialized psychosocial services, and other social support measures (Malina & Pooley, 2017). In cases where the disease results in a high economic burden, material support can reduce the patient’s burden and increase his or her motivation for treatment and the likelihood of recovery. This material support comes from a variety of social resources, including but not limited to national insurance policies, medical assistance, commercial insurance, and charitable donations. Social support can provide not only emotional support to help patients get through difficult times, but also medical information support to help patients better understand the treatment process and precautions of assisted reproduction. Through social support, professional medical information and advice can be obtained, so that patients can cooperate better with doctors for treatment, which can improve the success rate of treatment.

The dynamic model of social support recognizes that social support, stressful events, and health outcomes are not simply linear causal relationships. In fact, they interact and influence each other and change over time. Therefore, social support must consider the extent to which it meets the needs of the recipients in terms of quantity and quality of support. Receiving too much and too little social support will both exert a negative impact (Bar-Kalifa & Rafaeli, 2013; Lorenzo et al., 2018). Patients undergoing ART often receive unhelpful social support from well-meaning people, which will lead to additional stress. Therefore, it is imperative to study the relationship between economic burden of disease, financial toxicity and social support for patients undergoing ART.

The prerequisite for research on the relationship between economic burden of disease, financial toxicity and social support is the accurate measurement of the economic burden of disease and financial toxicity for patients undergoing ART. It is necessary to measure the economic burden of disease and analyze the financial toxicity of patients undergoing ART from the perspectives of both the patients and healthcare resource allocation (Jing et al., 2020). However, there lack accurate data on the measurement of the economic burden of disease as well as in-depth research on financial toxicity, and a variety of stakeholders view their own opinions on the economic support of assisted reproduction, which exacerbates the information asymmetry.

Information asymmetry occurs when one party in a relationship has more or better information than the other. In research on management, it is argued that market participants are prone to high information asymmetry when they have different and unequal market knowledge reserve (Semadeni & Anderson, 2010). Numerous studies have concluded that the healthcare system is rife with severe information asymmetry (G. Bloom et al., 2008), and blockages and asymmetries in the transmission of information across stakeholders are a common feature of healthcare delivery markets.

Because of the stigmatized condition of infertility, patients undergoing ART are discriminated and they are reluctant to share information about the treatment cost and the treatment process (Taebi et al., 2021). This results in the inability to obtain accurate data on the measurement of the economic burden of assisted reproductive diseases at the level of healthcare organizations or government departments. In addition, according to the mainstream literature on economics, moral hazard is a core problem in healthcare risk management and insurance, because insurers do not have equal or complete information about the insured, especially how they use the insurance and how they act responsibly once they have signed the contract.

To secure stable and sustainable economic support, a group effort is necessary to mitigate and correct the information asymmetry among stakeholders. Patients undergoing ART can play a key role in information disclosure and decision-making if they can share their treatment experiences and treatment resources (Choi et al., 2016). Full communication between doctors and patients under the principle of honesty can release the maximum amount of information, establish a real relationship of trust, and gradually build a shared diagnosis and treatment decision-making model based on doctor-patient communication. In order to avoid the occurrence of moral hazard in information asymmetry, government departments should increase the positive incentives for doctors and cut off the relationship between doctors' income and the number of services provided. Healthcare providers can also indirectly reduce information asymmetry by using alternative signals of quality, such as building brands to increase trust (Prabhu & Stewart, 2001), on the grounds that branding reduces search costs, psychological risks, and perceived risks when information is incomplete (Mascarenhas et al., 2013). From the perspective of health regulatory departments, doctors, and patients, it is necessary to strengthen the information disclosure system. This will not only reduce the monopoly of information and promote competition among healthcare suppliers in the market, but also increase the mental cost of the suppliers' demand-inducing behaviors to a certain extent as a result of information disclosure, and inhibit their impulse of over-treatment.

In addition, the stakeholders involved in assisted reproduction are complicated and changeable with varying interests, and it is difficult to build a synergistic social support system. In general, assisted reproduction is considered to be a basic health need, and it has become a consensus to provide economic support such as public funding for assisted reproduction (Fauser et al., 2019). However, the complexity and variability of stakeholder relationships involving assisted reproduction is evolving into a robust ecosystem that brings together embryologists, scientists, physicians, patients, entrepreneurs, and the government (Brayboy & Quaas, 2023), each representing their own interests. There is much debate on whether or not the government, health insurance companies, and other stakeholders should help pay for assisted reproduction, and what percentage of the costs they should pay (Gardner et al., 2023).

Some governments fully reimburse the cost of infertility treatments in order to mitigate the impact of the economic burden of infertility on the social security system (Fauser et al., 2019), while some high-fertility countries consider ART to be contradictory to the basic national situation of population control (Inhorn & Patrizio, 2015). Even in countries with similar prevalence rates, the availability of public funding for assisted reproduction varies dramatically, reflecting differences in funding, regulatory environments, and sociocultural norms across governments. In summary, government provision of economic support for assisted reproduction is an important social benefit. It can alleviate the economic burden on patients and their families and reduce social inequities, thereby maintaining social stability and increasing birth rate. However, fiscal pressure also needs to be considered. The inclusion of assisted reproduction in medical insurance may increase the government's medical expenditures, and it is necessary to strike a balance between fiscal affordability and other social expenditures. The government needs to balance healthcare spending with other social expenditures within its limited financial resources to ensure the sustainability of economic support and proper regulation. In addition, the government needs to ensure that assisted reproduction is equitably covered by health insurance. Reasonable reimbursement standards and policies should be established for families in different regions with different income levels.

The ultimate pursuit of commercial insurance companies is economic benefits, but they also assume social responsibility. By providing medical insurance products for assisted reproduction, commercial insurance companies can help customers share the risk of medical expenses, and at the same time ensure the sound development of their own business. Commercial insurance companies can provide diversified health insurance products to meet the needs of different customer groups, thereby expanding market share and improving profitability. However, they also need to control costs while providing economic support. Assisted reproduction may involve certain technical risks and uncertainties, requiring the development of reasonable risk control strategies. Actuarial pricing and risk management are used to ensure the sustainability of economic support and maintenance of a reasonable level of profitability.

The most direct benefit for patients is to obtain a reduction or waiver of medical expenses. Economic support can alleviate patients' economic burden and make sure that they can obtain necessary medical services. Patients are also concerned about the sustainability and fairness of economic support. It is hoped that the government and insurance companies can provide long-term and stable economic support. Patients are also concerned about privacy protection and do not want too much attention or disclosure of their fertility issues. Doctors believe that assisted reproduction is an embodiment of medical technology advancement and helps to solve medical problems such as infertility. Assisted reproduction treatment can gain professional recognition and respect if it receives stable economic support. However, as increasingly more patients choose assisted reproduction, doctors may need to take on more consultation tasks and work pressure. Doctors act as "dual agents" between patients and commercial insurance companies, as patients want doctors to act as their agents to provide information and services, and insurance providers want doctors to save money on medical services and reduce expected claim settlement costs.

Social groups support assisted reproduction to obtain stable economic support, and they consider it as an act of concern for the disadvantaged and promotion of the social welfare. Social groups also need to consider ethical and moral factors. Assisted reproduction involves human reproductive rights, ethics and morality, and needs to be treated with caution. Social groups may be concerned about feedback from public opinion. If public opinion is generally in favor of the inclusion of assisted reproduction in health insurance or commercial insurance, they may actively promote the introduction of relevant policies.

In order to properly address the complicated relationship between the various stakeholders of assisted reproduction treatment and reach a basic consensus, the stakeholder theory provides a framework. By classifying stakeholders and analyzing the interests and impacts of different stakeholders, we can better identify and understand the resources and capabilities of various types of stakeholders, so that we can allocate and utilize resources in a targeted manner and improve the efficiency and effectiveness of resource utilization. Since stakeholders are dynamic and changing, stakeholder classification can help organizations better adapt to changes in the external environment, understand and respond to the needs and expectations of different stakeholders in a timely manner, and enhance the adaptability and flexibility of the organization. In addition, by focusing on and meeting the needs of various stakeholders, more support and trust can be obtained and the reputation and image can also be enhanced, which contributes to long-term sustainable development.

1.2.2 Research content

1.2.2.1 Quantitative research: measurement and calculation of the economic burden of assisted reproductive diseases

The economic burden measurement and calculation is the basis for subsequent research and provides basic data for the government and society to understand the economic burden of assisted reproduction and the level of financial toxicity. The research contents are as follows.

(1) Construction of a model for the measurement and calculation of the economic burden of assisted reproductive disease. The economic burden includes all direct medical economic burden, direct non-medical economic burden and indirect economic burden. Direct medical economic burden includes outpatient and inpatient disease costs generated by surgeries, examinations, medicines and examinations; direct non-medical economic burden includes meals, transportation and accommodation costs incurred for medical treatment; and indirect economic burden refers mainly to the loss of income caused by taking time off from work due to treatment and the loss of income of the family members incurred by caring for the patient. The measurement model is shown as per Figure 1.1.

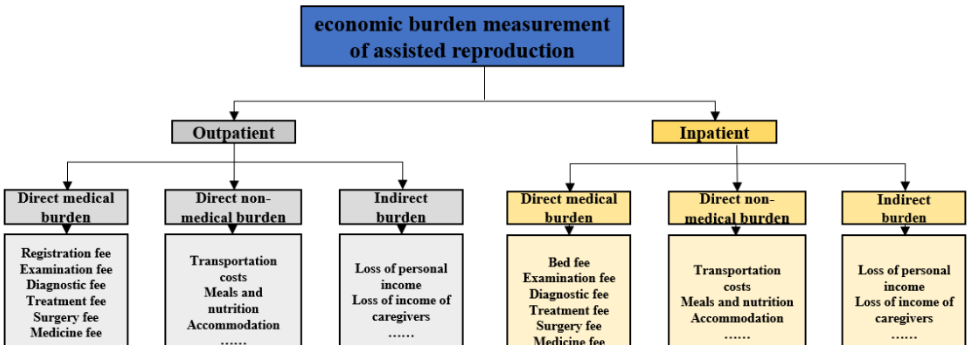

Figure 1.1 Economic burden measurement and calculation model for assisted reproductive disease

(2) Collection of patient data to measure and calculate economic burden. A number of representative reproductive hospitals are selected, and in each hospital, we collect outpatient electronic medical records and inpatient case front sheets of infertility patients from 2023 to 2024 to calculate direct medical economic burden; a questionnaire on direct non-medical economic burden and indirect economic burden is designed to obtain data of direct non-disease

economic burden and indirect economic burden from the patients.

(3) Analysis of the influencing factors of the economic burden of assisted reproductive diseases. Linear regression and generalized linear model are applied to analyze the relationship between factors such as age, assisted reproduction technology, and number of cycles and the economic burden of disease.

1.2.2.2 Quantitative research: relationship between social support, economic burden of disease and financial toxicity in patients undergoing ART

The economic burden measurement questionnaire, financial toxicity comprehensive scoring questionnaire, and medical social support scale are used to survey the patients undergoing ART. In addition, we comprehensively explore the relationship between the economic burden of disease, financial toxicity, and social support under the guidance of the stakeholder theory, the information asymmetry theory, and the social support theory.

(1) Investigate the current situation of financial toxicity and social support of the patients undergoing ART as well as the influencing factors;

(2) Analyze the correlation between the economic burden of disease, financial toxicity and social support of the patients;

(3) Explore the moderating effect of social support in the relationship between patients' economic burden of disease and financial toxicity. Based on the previous theoretical and literature research, we initially illustrate the moderating effect of medical social support on the economic burden of disease and financial toxicity of patients undergoing ART.

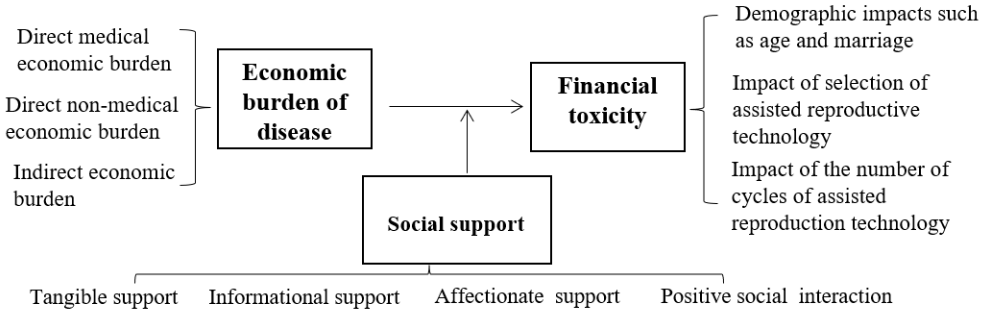

Figure 1.2 Theoretical framework

1.2.2.3 Qualitative research: stakeholder analysis of social support mechanisms for assisted reproduction

The key to the effective construction and smooth operation of an active fertility support system, led by economic support, lies in whether the various stakeholders within the system reach a consensus and put it into practice, so that the interests of all parties can be maintained in a dynamic balance in the end. The health administrative department and the healthcare security department are the authoritative driving force for the construction of the active fertility support system; the coordination of the medical institutions, the insurance department, and the price department is the driving force for the stable operation; and the patients themselves and their families play both positive and negative roles in the system.

Based on the stakeholder theory, we adopt the literature research method and focus group discussion method to initially identify the stakeholders, then the Mitchell score-based approach is used to categorize and identify the stakeholders and design the semi-structured interview outline. We investigate the interests and behavioral strategies of all the stakeholders such as medical institutions, health administrative departments, health insurance companies, and patients undergoing ART. With reference to foreign experiences, by pinpointing the different needs of stakeholders and resolving their conflicts, a sound information disclosure system is established to solve information asymmetry. A social support mechanism for patients undergoing ART is established so as to provide decision-making references for the government to formulate positive fertility support policies and reduce the burden on patients.

1.2.3 Research questions

(1) What is the current economic burden of disease for patients undergoing ART? What are the proportions of direct medical, direct non-medical, and indirect burdens to the total burden? What are the factors affecting the economic burden of disease?

(2) What is the current level of financial toxicity among patients undergoing ART? What are the factors affecting the financial toxicity?

(3) What is the current status of medical social support for patients undergoing ART from various stakeholders? What are the factors affecting the medical social support?

(4) What is the correlation between the economic burden of disease, financial toxicity and social support of patients undergoing ART?

(5) What role does social support play in the relationship between the economic burden of disease and financial toxicity?

(6) What are the interest demands of the stakeholders and what are the divergences between them? How can we comprehensively and accurately construct a social support mechanism?

1.3 Research roadmap

A series of studies has been conducted on the “economic burden of disease - financial toxicity

- social support mechanism construction”, and the technology roadmap of this research is shown as per Figure 1.3.

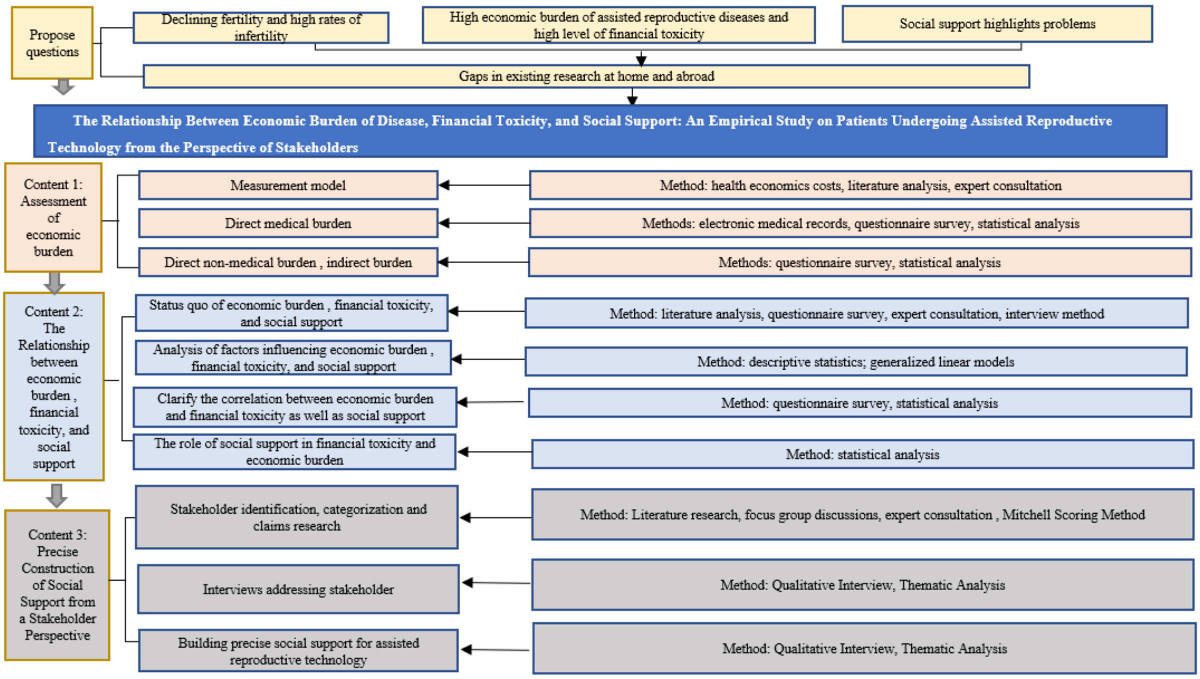

Figure 1.3 Research roadmap

1.4 Research structure

This study follows the logical progression of “problem identification – theoretical modeling – mixed-methods empirical analysis – policy recommendations” and is structured into six chapters: Chapter 1 introduces the research by describing the substantial economic burden, prevalent financial toxicity, and inefficient social support systems experienced by patients undergoing assisted reproductive technology (ART). It first identifies the heterogeneity of economic burden of disease and financial toxicity, then emphasizes on the key issue of unclear mechanisms through which social support exerts its effects. Based on these observations, research questions are formulated, and a mixed-methods research design is presented through a methodological roadmap.

Chapter 2 develops a framework that bridges theoretical foundation and practical analysis through a systematic literature review. At the theoretical level, it focuses on three core theories—stakeholder theory, information asymmetry theory, and social support theory—examining their conceptual foundations, evolutionary trajectories, modeling mechanisms, and classification systems. It also analyzes their application pathways, underlying causes, and countermeasures in the healthcare sector while identifying intersections and overlaps among them.

At the practical analysis level, it reviews measurement approaches and current research on economic burden in ART, investigates outcomes and intervention strategies for financial toxicity, and evaluates the real-world effectiveness of different social support models.

Then, a comparative analysis of healthcare financing realities is conducted, focusing on population coverage, service guarantees, and cost-sharing mechanisms for ART populations across multiple countries. Finally, the research model is built which integrates complex stakeholder relationship mapping, reveals moderating mechanisms, and synthesizes multiple dimensions. Research hypotheses are proposed based on this model.

Chapter 3 elaborates on the mixed-methods research design. The quantitative research part employs mature scales to measure economic burden, financial toxicity and social support levels, along with their influencing factors, while sensitivity analysis is used to test the moderating effects of social support. The qualitative research component utilizes the Delphi method and Mitchell’s score-based approach to identify and classify stakeholders, and uses semi-structured interviews to investigate the state of social support provision and causes of information asymmetry. This chapter also describes sample selection criteria, data collection and processing procedures, quality control strategies, and ethical compliance protocols.

Chapter 4 presents research findings derived from both quantitative and qualitative data. Descriptive statistics illustrate key indicators of economic burden as well as social support and financial toxicity scores. Multiple linear regression is used to identify key influencing factors while moderating effect models are employed to examine how social support moderates the relationship between economic burden and financial toxicity. Thematic analysis of qualitative data extracts four core themes—stakeholder analysis, stakeholder difference, positive effects of social support, and existing problems of social support, along with corresponding nine sub-themes.

Chapter 5 offers a comprehensive discussion of the findings. It systematically analyzes the economic burden borne by ART patients through both cross-sectional and longitudinal comparative assessments. It evaluates affordability and explores the driving forces behind rising economic burdens, based on which actionable burden-reduction strategies are proposed. This chapter also examines the current state of prevalent financial toxicity and medical social support systems, identifying key contributing factors and recommending improvement strategies. Special emphasis is placed on clarifying the mechanisms through which social support moderates the relationship between economic burden and financial toxicity as well as the underlying causes. Finally, the chapter analyzes the roles, core interests, and potential conflicts of key stakeholders’ in the ART sector.

Chapter 6 summarizes the main findings and presents conclusions and recommendations: The study confirms the moderating effect of social support on the relationship between economic burden and financial toxicity through a mixed-methods approach, and identifies stakeholder collaboration mechanisms and pathways for optimizing the support system. These findings provide both theoretically grounded and operationally feasible guidance for building a more effective social support system. The chapter also highlights the theoretical and managerial contributions of the study, acknowledges its limitations, and points out directions for future research.

Chapter 2: Literature Review

2.1 Theoretical foundation

2.1.1 Stakeholder theory

2.1.1.1 Definition of stakeholder

Stakeholder theory, originally a concept of economics and management, was first proposed by the Stanford Research Institute in 1963 as individuals or groups of individuals who can influence or be influenced by the achievement of organizational goals (Freeman, 1984). The theory differs sharply from the shareholder-centered theory, which was generally accepted in the mid-1980s, in that the investment of corporate property and the risks assumed are considered to include not only the shareholders, but all the stakeholders, including the shareholders.

How to define stakeholders is the starting point to study this theory, and it is also a difficult problem baffling many scholars at home and abroad. Mitchell et al. (1997) explored 27 representative conceptualizations of stakeholders in literature from 1963 to 1997. From the following studies on the definition of stakeholder theory given by many scholars, it can be seen that the theory has gone through a process of development from a narrow-sense definition to a broad-sense understanding.

Stakeholder theory was gradually developed in the questioning of shareholder primacy, so it was unavoidable to step into the narrow-sense definition at the beginning of the research. In 1963, the Stanford Research Institute first proposed the concept of stakeholders, defining stakeholders as those groups without whose support the organization would cease to exist (Mitchell et al., 1997). Donaldson and Preston (1995) gave a narrow-sense definition that stakeholders are individuals and groups who have a legitimate interest in the corporate activities as well as in the activities themselves.

With the increasingly fierce competition among enterprises, many scholars have realized that defining the theory only by whether stakeholders affect the enterprise is very limited, and the theory needs to be extended and deepened. Ansoff (1965) argues that the formulation of desirable corporate goals must take into account the conflicting claims of the company’s stakeholders, including managers, employees, shareholders, suppliers and customers. Since then, the stakeholder theory has gradually started to be accepted by entrepreneurs and scholars. Dill (1975) believes that through the development and application of the theory, entrepreneurs have changed from stakeholder influence to stakeholder involvement. These ideas all serve as a foundation for later categorization, innovation, and business application of the theory. In 1977, the Wharton School of the University of Pennsylvania offered a course on stakeholders, and the theory gradually developed into a well-established framework. Among the broad-sense definitions of the stakeholder theory, those proposed by Freeman and Clarkson are the most representative and have become the standard paradigm for stakeholder definition. Freeman (1984) redefined stakeholder theory from the perspectives of social interests, property rights, and economic dependence, identifying stakeholders as any individuals or groups who can influence the realization of business objectives. Freeman’s conception greatly expands the connotation and scope of stakeholders, and shareholders, employees, suppliers, customers, as well as government, the public, the community, the media and other subjects that directly or indirectly influence the enterprise are all included in this concept.

Although Freeman’s definition extends the scope of stakeholders, it is difficult to view stakeholders as a whole in empirical research. Therefore, Clarkson (1994) pointed out in an academic conference that since stakeholders invest physical capital, human capital, and financial capital in the enterprise, they also assume certain risk, and it is recognized that the enterprise as a system composed of stakeholders work jointly with the whole society as a system based on law and market. On the basis of Clarkson’s research, Chinese scholars have given a clearer elaboration of the stakeholder theory. Jia and Chen (2002) believe that stakeholders make specific investments and take risks in the enterprise, and their activities can influence or be influenced by the realization of the enterprise’s goals. The theory emphasizes not only the specific investment but also the extent to which stakeholders are connected to the firm.

2.1.1.2 Classification of stakeholders

With the development of the theory, experts generally recognize that the survival and growth of enterprises are inseparable from the stakeholders, but how to scientifically classify the stakeholders has gone through a long process. Two categories of classification approaches have gradually been developed, including the multi-dimensional classification approach represented by Freeman, Carroll, and Wheeler and the Mitchell score-based approach.

In the multi-dimensional classification approach, Freeman (1984) categorizes business stakeholders from three different perspectives: ownership, economic dependence, and social interests, arguing that the stakeholders who have ownership of the company are those who hold company shares, those who are economically dependent on the company are managers, creditors, employees, consumers, suppliers, competitors, and local communities, and the government leaders and the media have relationship with the company in terms of social interests.

Clarkson (1995) proposed to classify the stakeholders into primary and secondary stakeholders according to the closeness of the relevant groups to the enterprise. Based on the degree of closeness of stakeholders to the enterprise proposed by Clarkson, Wheeler and Sillanpa (1998) categorize stakeholders into the following four categories.

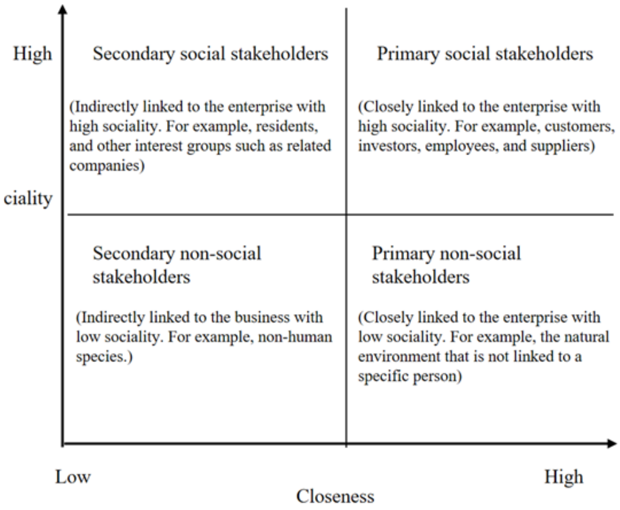

Figure 2.1 Classification of stakeholder by Wheeler and Sillanpa

Source: Wheeler and Sillanpa (1998)

Although the multi-dimensional classification approach greatly broadens the understanding of the enterprise to the stakeholders, its poor operability limits the empirical analysis of the theory and the actual application, the attribute score-based approach thus arises. One of the most representative scores the stakeholders according to the three attributes of legitimacy, power and urgency, and then determine whether they are stakeholders or which type of stakeholders they are according to the score (Mitchell et al., 1997).

The evaluation criteria are as follows. If he/she possesses none of the three attributes of a stakeholder, he/she is not a business stakeholder. If he/she possesses only one of the three attributes of a stakeholder, he/she is categorized as a latent stakeholder. The latent stakeholders can be further subdivided into dormant, discretionary and demanding stakeholders. If he/she possesses two of the three attributes of a stakeholder, he/she is categorized as an expectant stakeholder. The expectant stakeholders can be further subdivided into dominant, dangerous, and dependent stakeholders. If he/she possesses all three attributes of a stakeholder, he/she is recognized as a definitive stakeholder. The specific categorization is shown as per Figure 2.2.

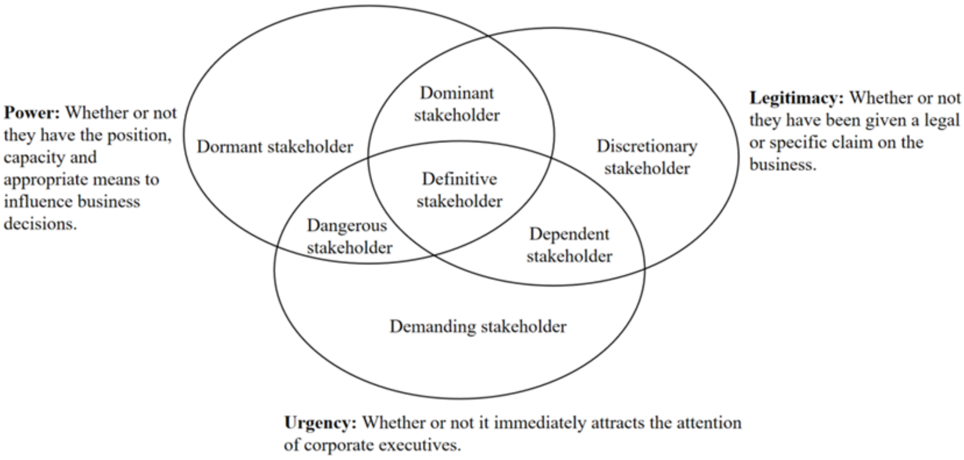

Figure 2.2 Classification of stakeholders by Mitchell

Source: Mitchell et al. (1997)

The model is dynamically changing, that is, any person or group will transform from one form to another after losing certain attributes. The proposed theory strengthens the operability of stakeholders, helps the theory to be popularized and practically applied, and becomes an authoritative evaluation standard for the subsequent research and corporate decision-making.

Based on the existing systematic research, the Chinese scholars and entrepreneurs have carried out extensive and in-depth explorations of stakeholder categorization in the context of the actual national conditions of China. H. H. Chen and Jia (2004) categorize stakeholders of Chinese companies into core stakeholders, dormant stakeholders, and peripheral stakeholders according to the dimensions of initiative, importance and urgency. M. Liu (2010) classifies stakeholders into benefit-seeking stakeholders and socially responsible stakeholders based on the relationship between the organization and the relevant groups.

2.1.1.3 Application of stakeholder theory

Stakeholder theory is now widely applied in various fields such as politics, corporate economics, and social management. It has made great progress in theoretical research and empirical testing. The latest literature review summarizes 988 articles on the application and advancement of stakeholder theory in mainstream management, and the studies are mainly applied in operation management, project management, supply chain management, and sustainable performance management and evaluation (Mahajan et al., 2023).

For a long time, the biggest criticism of stakeholder theory by scholars has been that stakeholders are difficult to identify and empirical findings are too few and fail to pass scientific tests (Key, 1999). The results of previous normative research can only explain the functions of the company in terms of moral or philosophical norms, and do not link stakeholders to core indicators such as the profitability and performance of the company.

Donaldson and Preston (1995) point out the importance of empirical research on stakeholders, arguing that the empirical part of relevant stakeholder theory reflects and explains past, present, and future conditions of the companies and their relevant stakeholders. Since the mid-1990s, with the continuous broadening and deepening of research, the existing drawbacks and research gaps have been gradually explained and filled by scholars and entrepreneurs. Scholars have gradually realized that the difficulty in identifying stakeholders is not only because the theory itself is not systematic and perfect, but also because it reflects the researchers' exploration process under their own academic fields of economics, management and sociology. The quantitative score-based approach promotes the operability of stakeholder theory, and makes scholars realize that quantitative research must be rooted in business practice and focused on stakeholder-business interactions in empirical research. Agle et al. (1999) applied the Mitchell score-based method to define stakeholders as corporate shareholders, employees, customers, government and community, and used the obtained data to further empirically analyze the contribution of shareholders, influence, and the value of the CEO. Descriptive and regression analyses were conducted on the three variables, and it was concluded that the influence of government and community decisions was greater than that of shareholders, employees and customers.

In review of the development history of stakeholder theory, it is not difficult to find that the essence of stakeholder theory is that the realization of organizational goals involves all stakeholders, and scientific and reasonable coordination of the multiple interests of stakeholders can promote the realization of organizational goals. The theory has exerted a great impact in the field of corporate management, and its ideas such as emphasis on influence of stakeholders and promotion of stakeholder participation and shared governance have penetrated into other disciplines involving coordination of interests among multiple parties, such as corporate governance, public management, environmental management, ecological management, tourism and education.

The empirical analyses of many scholars have a distinctive role in guiding corporate decision-making. Enterprises can determine the degree and effect of influence on enterprises according to the different types of stakeholders with different influence in the empirical results, so as to study and adjust the corporate decision-making behavior, and ultimately affect the corporate performance.

2.1.1.4 Application of stakeholder theory in health management

In 1988, Blair and Whitehead in the United States first systematically introduced stakeholder theory and methodology into the health field. Since then, stakeholder theory has been continuously deepened and developed, and many researchers have carried out extensive explorations in the areas of health policy analysis and implementation, and health organization management using different stakeholder analysis strategies. In the healthcare sector, stakeholder analysis is often used as a tool for organizations to achieve specific strengths and goals in their dealings with other organizations by identifying potential allies and mitigating potential threats.

From the perspective of the research field, the formulation and implementation of health policies is a complex process of redistributing and coordinating the power, responsibility, and interests of different stakeholders, so it is very necessary to introduce stakeholder theory for research. Scholars have studied the principles followed, methods used and key techniques used in stakeholder analysis and conducted relevant empirical analysis.

Some scholars have used the stakeholder approach to empirically study and analyze health policies in countries such as the Dominican Republic and India (Nandraj et al., 2001). In order to understand the impact of dengue outbreaks on different stakeholders in Brazil and explore methods of control and prevention by government authorities, as well as identify how to prevent challenges and impacts, Ladner et al. (2017) conducted a qualitative study in 2015 in two Brazilian cities. They utilize semi-structured questionnaires for face-to-face interviews with nine different stakeholders such as doctors and nurses, hospital administrators, and municipal government representatives. It is found that dengue outbreaks have multiple impacts on the medical, social, economic and political sectors. The study provides valid insights to different stakeholders and can guide the local government in planning, designing and initiating public health programs.

With regard to the management of health institutions, scholars have studied different institutions such as health public interest organizations, hospitals, and pharmaceutical distribution networks (Galárraga & Bertozzi, 2008). Perrin et al. (2021) solicited the views of stakeholders in Australia on the economic burden of diabetes-induced foot disease through a three-round Delphi online survey. Ten prioritized research questions were identified to guide health institutions on research agendas and fund raising.

Mantel et al. (2022) utilized a standardized questionnaire to survey multiple public health decision makers, including the National Pediatric Society, Obstetrics and Gynecology Society, national regulatory agencies, and academic institutions, in the implementation of the Group B Streptococcus vaccination to appropriately address the perceptions of various stakeholders on the perceived impact of GBS disease and the potential for vaccination to facilitate informed decision-making.

The application of stakeholder analysis in the health sector in China started in the late 1990s and was gradually extended to a number of areas such as health policy in the early 21st century, with a majority of studies on public hospital policy, drug policy, and the new rural cooperative medical system. Stakeholder analysis focuses on the identification of stakeholders, followed by a comprehensive analysis of stakeholders according to the requirements and objectives, including information on the status and relationship of different stakeholders.

Shi et al. (2003) used the method of stakeholder analysis in positioning and analysis of the social functions of public hospitals to collect the opinions of each stakeholder and propose policy recommendations for the social responsibilities and development of public hospitals. Qian et al. (2010) used stakeholder theory to analyze the stakeholders of community health service institutions that separate management of revenue and expenditure, with a view to improving the efficiency of community health service institutions, increasing work enthusiasm of doctors, ensuring effective use of health insurance funds, realizing the government policy goals, and protecting the residents' interests. In order to gain a deeper understanding of the stakeholder groups in the internal and external environments faced by the remuneration system of public hospitals, H. W. Zhang et al. (2017) adopted the Mitchell score-based approach to score the possible stakeholders from three dimensions of power, legitimacy and urgency, and the types of stakeholders were determined based on the scores. It is concluded that the public hospital compensation system is a link between various stakeholders, and the construction of a reasonable compensation system requires the joint support of all stakeholders. Ultimately, it can help achieve a balance between doctors' own interests and patients' interests as well as the social benefits.

In the development of stakeholder research methods in the health field, more scholars have been adopting different analytical methods to conduct in-depth studies on different characteristics of stakeholders, which has produced different research results. To sum up, the main analytical frameworks include the SWOT analysis (Williams et al., 2009), informed attitudes-expected outputs-implementation key points-major bottlenecks (Hawkes et al., 2014), and supply side-resources-demand side-management/policy (Sarr, 2010).

Galárraga and Bertozzi (2008) used the 360-degree stakeholder survey method to analyze the attributes and unfulfilled expectations of stakeholders in the fight against AIDS, tuberculosis, and malaria regarding resource mobilization, influencing indicators, coherence convergence, effectiveness of the global fund partnership environment, and portfolio characteristics. In an evaluation of the Healthy City Initiative in Bangladesh, Burton (1999) conducted a stakeholder analysis of the two cities that had been included in the Initiative for several years. He categorized stakeholders in a matrix by importance and influence, and evaluated the interests concerned by the stakeholders to explore their power relationships.

Tang et al. (2007) analyzed the resistance and motivation of stakeholder groups in the implementation of rational drug use policies by quantifying the ability, willingness, implementation, and benefits of voluntary implementation measures. Based on these quantified results, a stakeholder group analysis model was then created in the form of a chart, and corresponding policy recommendations were proposed. In addition, in order to increase the participation and coordination of various stakeholders, holding round-table discussions to reach a consensus is also a key method. For example, to develop an authoritative WHF IASC Roadmap on Chagas disease that summarizes the prevention, diagnosis, and management of the disease, describes the ideal patient care pathway, and provides potential solutions based on existing research and practice examples, the World Heart Federation (WHF) and the Inter-American Society of Cardiology (IASC) collaborate to establish an expert panel to release the survey report to all WHF members, believing that bringing together key leaders and stakeholders for a round-table discussion is a critical first step (Echeverría et al., 2020).

The application of stakeholder theory in the economic burden of disease is mainly reflected in medical cost assessment, control, management optimization and disease prediction and prevention. In terms of medical cost assessment, control and management optimization, different subjects can control and manage the medical costs, avoid waste and abuse, improve the efficiency of medical resource utilization, evaluate the cost of lost wages, and provide patients with better support for nutritional costs and transportation costs, thus optimizing the social welfare system.

El-Hayek et al. (2019) categorize the socio-economic costs of Alzheimer’s disease. They systematically describe direct, indirect, and intangible costs, assess the challenges and gaps in existing methods for cost measurement, analyze and discuss the influence on stakeholders including policy maker, healthcare system, association, advocacy group, clinician, and researcher, improve the ability to generate reliable data that can guide evidence-based decision making, and ultimately remove barriers that prevent stakeholders from understanding the scope, magnitude, and nature of the economic burden so that effective strategies can be developed to address the global health crisis caused by Alzheimer’s disease.

Tompa et al. (2021) adopted a top-down approach to develop a cost-incurred framework for estimation of the social burdens of work-related injuries and diseases. It takes into account the direct healthcare costs to the stakeholder, indirect living costs and intangible costs, and has become a template for estimating the economic burden of work-related injuries and diseases in the EU and elsewhere, which can assist policy makers in identifying health and safety priority areas.

In terms of disease prediction and prevention, many scholars have constructed prediction models or frameworks to predict the economic burden of disease based on stakeholder theory. Based on a comprehensive estimation of decomposition costs of different stakeholders, costs in epidemic years, and productivity losses, Castro et al. (2017) proposed a comprehensive framework for estimating the economic burden of dengue disease in any region. Scholars can use the framework to guide scenario simulations, predict the range of costs for items with no available data, and improve dengue disease control.

The Emotional Health and Economic Burden Network (EMOT-ECON) funded by the National Institutes of Health (NIH) convenes researchers, patients, health care providers, and many other stakeholders to discuss the impact of the financial burden of disease on emotional health and formulate intervention strategies that address economic factors (cost, affordability), administrative burden, and other factors (Pisu et al., 2023). J. Li et al. (2023) analyzed different stakeholders in chronic disease management from county-township-village level in China to identify the problems, difficulties, and conflicts of interest in chronic disease management and proposed corresponding countermeasures in order to advance the progress of chronic disease management. Scholars have not only conducted preliminary quantitative statistical studies on the data of economic burden of various diseases, but also further explored many other scientific methods such as clinical medicine, epidemiology, and simulation modeling, with a view to providing data support to various stakeholders in decision-making.

As for research on health financing, stakeholder theory also provides a framework for policy formulation. By analyzing the interests and influences of different stakeholders, the direction and implementation effects of health financing policies can be better understood, and more equitable and effective health financing policies can be formulated. In addition, through the regulation and assessment of different stakeholders, problems arising from the health financing mechanism can be better detected and solved, thus improving the quality of health financing performance.

Peyrot et al. (2013) analyzed the similarities and differences in the opinions of different stakeholders on patient charges for healthcare services in six countries in Central and Eastern

Europe through panel discussions and in-depth interviews with stakeholders such as healthcare consumers, providers, policymakers, and insurance companies, and the results showed that there is barely no consensus on patient charges, which hinders sustainable health care financing. Interviews of stakeholders have also been conducted on the financing of Colorectal Cancer and Schizophrenia in the Philippines, which reveals limitations in the current funding mechanisms and the necessity to improve existing financing mechanisms and formulate alternatives (Antonio et al., 2017).

In response to the narrow coverage of mental health care in low and middle income countries, Abdulmalik et al. (2019) used SWOT analysis to analyze the health and socioeconomic situation in Nigeria and conducted informational interviews with 12 expert stakeholders from the health and finance sectors to develop a viable sustainable mental health financing strategies in the country's specific circumstances, hoping to increase funding for mental health services, reduce the health-related financial burden on families, and ultimately reduce barriers in the treatment of mental disorders and the funding gap in Nigeria.

Zafar and Shaikh (2014) organized interviews on Pakistan's family planning program, and concluded that the implementation of the program has not achieved the expected results. It is suggested that stakeholders should strengthen cooperation and complement each other's strengths, and the government should assume the responsibility of permanent financing, mobilize provinces to develop an effective implementation strategy, and make full use of the funds raised to maximize the implementation effects. P. Q. Fang and Wu (2010) analyzed the stakeholders involved in the financing of public hospitals in China and summarized their interest demands, possession of resources, and ability to use resources, which points out the direction for public hospital fundraising.

2.1.1.5 Relevant research on stakeholder theory and social support theory

Social support is the act of helping others to cope with stress through some mental or material means. Social support is prevalent in stressful situations and everyday life. It includes direct material assistance and social networks, as well as perceived emotional support (the experience of being understood and respected, and sense of satisfaction) (Langford et al., 1997). Social support involves multiple stakeholder entities, including the government, businesses, social organizations, and individuals, each with their own roles and resources. When all parties actively engage and collaborate by leveraging their respective strengths, they can precisely address needs, optimize resource allocation, and thereby effectively enhance the breadth, depth, and quality of social support.

It is generally recognized in research that stakeholder participation can effectively improve the level and effectiveness of social support and achieve the goal of reducing the economic burden of disease and financial toxicity. By applying the stakeholder theory, government departments can better manage and allocate social resources and improve the efficiency and effectiveness of government support; enterprises can better fulfill their social responsibilities and provide better support for patients; social organizations can better understand social needs and feedback and optimize the content and methods of support; and individuals can better understand and support patients and promote the positive role of individual support. It can be seen that stakeholders' participation in social support is closely related.

Kadirvelu et al. (2012) described the key role of social support in the prevention and treatment of type 2 diabetes, the necessity of support from health care providers, the value of support from family and friends, the influence of sexual and cultural factors on self-care behaviors, and the benefits of peer support. Despite the fact that social support is a highly effective approach in the prevention and treatment of type 2 diabetes and has great potential, there are few responses from the stakeholders to reach a uniform guideline. They call for health care workers to recognize the barriers to social support and take an individualized approach to the management of their patients. Vinayagamoorthy et al. (2017) conducted qualitative interviews with various stakeholders and found that social support was the dominant theme of “the home care service” and agreed that “the home care service” improves physical and mental care, relieves symptoms, and reduces healthcare expenditures for patients with chronic illnesses. The study ultimately revealed the concerns of various stakeholders and called for more interdisciplinary collaboration, so that team members can understand each other’s roles in effective collaboration.

Y. Chen et al. (2023) used semi-structured interviews to investigate 29 stakeholders involved in the treatment of Parkinson’s disease to specify that social support plays a key role in Palliative care treatment program plays a key role, but at this stage there are many problems such as lack of communication time and multidisciplinary cooperation. Many scholars have recognized the importance of social support in the interest demands of various stakeholders and solution paths, and they have also actively constructed and optimized the social support system in various fields under the guidance of stakeholder theory.

On the basis of the stakeholder theory, through face-to-face and semi-structured in-depth interviews, L. F. Chen et al. (2019) studied the burden of nursing care, access to nursing care and further need for support of the caregivers of schizophrenia patients in Beijing, and finally constructed three support systems involving financial support, medical support, and information and education support, which provides targeted countermeasures and service suggestions for policymakers.

2.1.2 The theory of asymmetric information

2.1.2.1 Definition of asymmetric information

Asymmetric information means that one party in a relationship has more or better information than the other. Originated in economics in the 1940s, the theory witnessed great development in the 1950s and 1960s, grew to maturity in the 1970s, and became one of the most important branches of world economics in the 1980s and 1990s (Fama, 1980).

The recognized authoritative concept comes from George Akerlof in his article *The Market for "Lemons"* published in 1970. According to Akerlof (1970), due to asymmetric information between buyers and sellers, the buyers are unable to know the quality of every car, so they are only willing to pay a price comparable to the average quality of used cars, and the sellers of cars with relatively high quality withdraw from the market due to the lack of profit, which ultimately leads to the collapse of the used car market.

Although the theory of asymmetric information originated in economics, it has evolved to become the core of strategic management and human resource management in the management science, as well as the sources of the basic elements of the resource-based view, resource dependence theory, and signaling theory. The concept of asymmetric information has many manifestations in the field of management, and Bergh et al. (2019) reviewed the previous literature to summarize multiple commonly-seen definitions.

The first definition considers asymmetric information as private information, where one party has access to privileged or private information and it is possible that this information is legally protected, can be withheld from the public or comes from specialized assert (Ecker et al., 2011) or expertise (Gomez-Mejia et al., 2000). In this case, firms with private information develop better than others, because they know their resources better than their competitors, and can more accurately assess their competitive advantage (Schmidt & Keil, 2013).

The second definition considers asymmetric information as an information difference. Stiglitz (2002) simply describes asymmetric information as "different people knowing different things". Semadeni and Anderson (2010) argue that high levels of asymmetric information tend to arise when market participants have different and unequal stocks of market knowledge. Asymmetric information is even more prominent in the strategic decision-making process when team members have different perspectives, expertise, values and goals, and are unable to understand each other (Hambrick & Mason, 1984).

The third definition considers hidden information leading to opportunism before and after the signing of the contract to be the most obvious feature of asymmetric information, which brings the ex-ante problem of “adverse selection” or the ex-post problem of “moral hazard” to asymmetric information. From an ex-ante perspective, it has been argued that the quality and performance characteristics of an asset are not known, and the information provided by the current owner may be biased, thus giving rise to the problem of adverse selection (Vanhaverbeke et al., 2002). Some scholars have addressed the moral hazard problem arising from the misalignment of principal and agent interests from an ex-post perspective. It is argued that given limited rationality and information asymmetry, a principal may not be able to obtain the best agent service by prescribing performance standards in advance and signing a contract (Gomez-Mejia et al., 2001).

The fourth definition considers asymmetric information as lack of accurate and complete information, and the definition is mainly applied in the situation where participants in the information market utilize each other’s lack of information. Akerlof (1970) describes how incomplete and asymmetric information distributions between two transaction parties can affect the behavior of both parties. Spence (1973) clarifies how information market participants can use signals to distinguish seller quality.

To summarize, the definition and application of asymmetric information theory vary in the field of management. The “private information” theory is often found in explanations of competitive advantage and resource-based theories. The “different information” theory is mainly interpreted as market-level efficiency. The “hidden information” theory is often integrated with agency theory and can lead to adverse selection and moral hazard. The “lack of precise information” theory often leads to buyers and sellers sending and evaluating signals to each other.

2.1.2.2 Main classification of asymmetric information

There are various classifications of asymmetric information, and the most authoritative and widely accepted one is ex ante asymmetric information and ex post asymmetric information according to the third definition. Ex ante asymmetric information, also known as adverse selection, refers to the phenomenon of inferior goods expelling superior goods due to information asymmetry between the two transaction parties and the decline in market prices, which in turn results in a decline in the average quality of the products traded in the market, and at the same time causes distortion in the allocation of market resources. The party that occupies the information advantage tends to make use of this advantage to do things favorable to themselves while unfavorable to others. Akerlof (1970) uses the most classic “used car model” to explain the problem of adverse selection.

Ex post asymmetric information, also known as moral hazard, is a phenomenon in which, under information asymmetry, uncertain or incomplete contracts allow responsible economic agents to act to the detriment of others without assuming the full consequences of their actions, while maximizing their own utility. Arrow (1963) first introduced the concept of moral hazard into economics. He found that since physicians have an information advantage over patients, they may make use of this information advantage to gain more revenue. It is pointed out that when patients have health insurance, they will develop opportunistic and moral hazard motives and tend to use more health care services, which will reduce the overall welfare of the society. Therefore, the patients should also bear a portion of their own health care costs (Pauly, 1968).

2.1.2.3 Causes and solutions of asymmetric information

Asymmetric information arises for both subjective and objective reasons. On the subjective side, the different information obtained by different people indicates that there are differences in the ability of each actor to obtain information, and some actors also deliberately keep information secret and create strategic and behavioral barriers to information sharing so as to benefit themselves or their companies (Connelly et al., 2011). It has been proved that stakeholders will evaluate the environment at the time of strategy implementation, and the present laws, regulations, and contacts determine the extent to which they utilize asymmetric information for their own benefit (Werder, 2011). Research on competitive advantage has proven that suppliers and purchasers have information transfer problems due to barriers to imitation (such as tacitness or social complexity), which creates asymmetric information and information costs (Alston & Gillespie, 1989).

For objective reasons, the amount of information obtained by different actors is related to a variety of social factors. With the development of social division of labor, the difference in information between industry professionals and non-professionals becomes increasingly huge, and the distribution of information among members of society is increasingly asymmetric. The quality of products and partners cannot be fully observed. For example, it is proved that asymmetric information is inevitable when the potential acquirer is unable to conduct a thorough investigation of the target assets or when the two parties do not have any experience in cooperation (Jensen, 2003). On the one hand, the unobservability and uncertainty of complex products and services can lead to asymmetric information (Pierce & Toffel, 2013). On the other hand, unobservable and uncertain idiosyncratic information about actors can also lead to asymmetric information, with major research applications in investment banks (Lee, 2013) and R&D partners (Reuer & Lahiri, 2014).

The problem of asymmetric information can be addressed through the following paths. First, measures and mechanisms for information disclosure should be sought. It has been argued that partners with comparable levels of ability and willingness tend to reduce information disadvantage by increasing the breadth of available information (Jacobides & Croson, 2001). It has also been suggested that information should be gathered by learning from existing partners and uncooperative partners should be excluded (Lumineau & Oxley, 2012). Second, information asymmetry can be addressed through pre-commitment. Debt financing is the best case of pre-commitment when we invest in new infrastructure or when we are interested in a certain type of reward (Ryan & Wiggins, 2001). Since asymmetric information increases uncertainty and risk about the quality of the firm and its intentions for future development, firms can reduce over-payment by pre-commitment, which can not only convince debt investors that the firm itself is operating well, but also reflect that the firm attaches huge importance to investors. The asymmetric information gap will be gradually narrowed after debt investors gradually obtain benign information about the firm. Third, asymmetric information can be reduced through regulation and incentives. The role of regulation is to reduce private information by verifying the agent’s behavior so that it cannot deceive the principal.

2.1.2.4 Application of the asymmetric information theory

Because of its origin in economics, the theory of asymmetric information was initially well studied and applied in microeconomics, finance, organizational economics, political economy, and other fields related to institutional studies. For example, it has been argued that setting minimum quality constraints is a way to mitigate adverse selection (Leland, 1979). Another typical economic application of the theory is in the used car market, where scholars have empirically examined the validity of George Akerlof’s lemon model (Bond, 1982).

The asymmetric information theory has also been applied in various ways in the field of management, with strategic management being the most common application. In the study of corporate mergers and acquisitions, it is argued that each firm has characteristics that are unobservable or uncertain to both buyers and sellers (Reuer et al., 2012). Through in-depth research on mergers and acquisitions of multinational corporations, Balakrishnan and Koza (1993) found that information disadvantages are even more severe because the acquirers face unfamiliar cultures and systems. In addition, due to asymmetric information, the heads of the acquired firms are forced to leave because they believe that they are not understood by the new leaders, and the turnover is strongly associated with the decline in post-merger performance (Bergh, 2001).

The second kind of application is reflected in human resource management. The simplest example is that, in the recruitment of new employees, the head of the firm may exaggerate the recruitment advertisement, but the applicants cannot judge whether their own conditions are suitable for the recruitment requirements of the firm or even hide their own negative information. Even if they are hired, asymmetric information is still persisting for a long time. Another example is that the asymmetric information caused by the pay secrecy system makes it difficult for employees to determine whether their salary is fair or not. Bergh et al. (2019) suggest that since the high-performance work system (HPWS) is closely related to information value, and HPWS can cultivate the knowledge and skills of the employees, it is advocated to utilize HPWS to stimulate the potential of the personnel in the enterprise.

The third kind of application is manifested in entrepreneurship management, and focuses on assessing the asymmetric information in managing crowdfunding behavior. Information asymmetry exists in most entrepreneurial environments and entrepreneurship is characterized with uncertainty and high risk. The enterprise founders master more core information than other key stakeholders, but they rarely communicate with each other, so those participating in the crowdfunding can only determine whether they invest or not through web page information (Vismara, 2016). Therefore, the crowdfunding behaviors initiated by the founders face many problems such as how to design policies to reduce asymmetric information to obtain donations. Entrepreneurship faces risks, but some scholars advocate to integrate entrepreneurial orientation, strategic corporate behavior and asymmetric information.

2.1.2.5 Application of asymmetric information theory in health management

The healthcare market is inherently a highly heterogeneous market with asymmetric information, and the blockage and asymmetry of information transmission among various stakeholders is a common feature of the healthcare service market. Numerous studies have concluded that the healthcare system is riddled with severe asymmetric information (G. Bloom et al., 2008), and therefore service collaboration in the healthcare industry has been slow. It has been demonstrated that asymmetric information is one of the main factors contributing to the inefficiency of the healthcare system in the United States and other countries (D'Cruz & Kini, 2007). In an empirical survey in Italy, it was found that 15% of the problems in patients' complaints were due to professional incompetence and the other 85% were due to systematic incompetence (Josa, 2008). Many stakeholders, including patients, health care providers (doctors and health care organizations), government and other health regulators, health insurance authorities, and commercial insurers, are deeply affected by asymmetric information and they also play a pivotal role in reducing asymmetric information.

Asymmetric information in health management is mainly reflected between patients and health care providers (doctors and health care organizations), namely, the doctor-patient relationship. Patients have relatively little influence over their own choices of health care. Although access to health care information is now easier through the Internet and other channels, the disconnect between what they can learn and their ability to utilize what they have learned makes it impossible for them to truly be the drivers of their own health care decisions.

The adverse selection in the asymmetric information between doctors and patients is reflected on the one hand in the doctors. In other words, in order to maximize their own interests, the doctors, with the advantage of information in their hands, do not take the treatment with high risk but best therapeutic effect as the first choice. Instead, they first choose the treatment with less medical risk, which is more acceptable to the patients. On the other hand, the adverse selection in the asymmetric information between doctors and patients is reflected in the hospitals. In order to chase profits, certain low-standard and poor-quality health care institutions make false propaganda and even offer medical services beyond their business scope. They only promote their own good quality of service, high medical level, and low price, but because of asymmetric information, the patients do not have the ability and channels to identify the information. As a result, low-quality medical institutions tend to prevail in the market. On the contrary, high-quality health care institutions are gradually squeezed out of the market due to the high cost and low profits.

Moral hazard in the asymmetric information between doctors and patients is mainly reflected in the “induced demand” of doctors and hospitals. Doctors may recommend additional treatment services to patients out of self-interest, which are ineffective but profitable, but patients often accept them out of trust in their doctors. Studies have confirmed that doctors may even take advantage of patients’ ignorance to recommend additional services, and in worse cases there is medical collusion to exploit patients (H. Dong et al., 1999; Sheldon, 2001). Patients may also encounter the risk of moral hazard, such as concealing their medical history for self-interest in the case of third-party payment by health insurance, and denying the facts and effects of treatment in the case of medical disputes.

The reasons for between doctors and patients are varied. Asymmetric information in the healthcare market always affects the communication between doctors and patients, and this asymmetry is the characteristic of healthcare services. Therefore, when patients purchase healthcare services, risk and uncertainty will prevail the whole process (Arrow, 1963). In addition, doctors and patients have different knowledge about the disease itself and the treatment of the disease, and there is a big difference between the two parties in their access to medical information and ability to obtain medical information, namely, there is an asymmetry between the two parties themselves. Furthermore, there is also asymmetry of non-professional information between doctors and patients, such as doctors' medical ethics, patients' health status and medical business interests. Poor information flow and lack of information disclosure system are also important reasons for the asymmetric information between the two parties.

In addition to the patient-physician relationship, asymmetric information becomes more prominent when there are sharing interests between stakeholders in health insurance agencies, commercial insurance companies, and the government. These institutions have become intermediaries in the interaction between patients and healthcare providers, and if these non-market institutions are not well developed, they can affect people's accessibility of health (Haas-Wilson, 2001). However, the relationship between the various stakeholders often suffers from asymmetric information due to the differences in the goals and objectives of public and private organizations (Roehrich et al., 2020). Asymmetric information among stakeholders is reflected in the following aspects. It is difficult for the government to grasp and evaluate the actual information of hospitals in a comprehensive manner. Health insurance organizations do not reimburse the full amount of medical expenses, and doctors do not have a full understanding of the list of reimbursement and medicines. The governmental pricing department does not know the real value of medical services and the real cost of pharmaceutical companies to produce certain medicines.

To be specific, the adverse selection of asymmetric information between commercial insurance companies and doctors and patients is reflected as follows. Commercial medical insurance has its own specificity, as it involves the interests of patients, doctors and insurance companies, and before the signing of the contract, the insurance company may hide its payout capacity and operating conditions. As a result, the insured may not be able to correctly select the insurance products suitable for them, and may hide their own physical condition, which can cause adverse selection. However, the evidence on adverse selection in the health insurance market is scarce and contradictory. For example, some experts have found adverse selection in questionnaire data in the purchase of supplemental insurance (Marquis & Phelps, 1987).

The mainstream literature on economics has consistently been arguing that moral hazard is a central issue in healthcare risk management and insurance, because the insurers do not have equal or complete information about the insured, especially how they use insurance and how they act responsibly after signing a contract. It is also demonstrated that moral hazard increases the demand for insurance, but does not necessarily promote health of the insured (Whelan, 2013). Physicians act as the “dual agent” between patients and insurance companies, because patients want physicians to act as their agents to provide information and services. The insurance providers want physicians to save money on healthcare and reduce expected claims costs. Experts believe that as long as the asymmetric information between physicians and insurance companies is not eliminated, patients will not sign the optimal compensation contracts (Blomqvist, 1991).

The ultimate goal of all stakeholders in healthcare is harmonious development, and the fundamental interests of doctors and patients are the same. However, when one transaction party has better or more information than the other, it is difficult to assess the level of performance of healthcare providers, patients, and healthcare programs (Retchin, 2007), and it can bring far-reaching impacts and harms for all parties (Wong et al., 2007). For example, doctors have the absolute advantage of information in the provision of medical services, and for the purpose of avoiding trouble, they often give up some treatment plans that have greater risks but may be more favorable to patients, and tend to choose plans that are less risky but ineffective or even detrimental to life and health. Some patients are unable to rationally view the results of medical treatment, which results in the escalation of medical disputes. In the case of medical insurance, traffic accidents and other third-party payment, in order to use the insurance for self-interest, some patients deliberately conceal personal health status and medical history, which not only increases the burden of the national health insurance institutions and commercial insurance companies, but also affects the doctors to make a correct diagnosis and reasonable treatment. Adverse selection caused by asymmetric information will also obstruct the effective use of good healthcare resources and affect the rational allocation of medical resources. The moral hazard of medical service providers leads to the continuous increase of medical costs, and Chinese urban and rural residents generally feel “expensive to seek medical service”, and “difficult to be discharged from the hospital”. Patients cannot afford to see a doctor or buy medicines, which inhibits their demand for basic medical services. The credibility of the healthcare industry has been undermined, and patients’ trust in doctors has declined.

To ensure that the health management is more efficient and follows the law of the market, it is necessary to make a concerted effort to mitigate and correct the asymmetric information among the various stakeholders. From the doctor-patient perspective, patients are becoming increasingly more knowledgeable, and while they seek relevant clinical information, healthcare professionals have to respond quickly. Therefore, both parties must communicate fully under the principle of good faith, release the maximum amount of information, establish a true relationship of trust, and gradually build a joint diagnosis and treatment decision-making model based on doctor-patient communication. Healthcare providers can also indirectly reduce asymmetric information by using alternative signals of quality, such as building brand to increase trust (Prabhu & Stewart, 2001), on the grounds that branding reduces search costs, psychological risks, and perceived risks when information is incomplete (Mascarenhas et al., 2013).

From the perspectives of the health regulatory authorities, doctors and patients, it is necessary to strengthen the information disclosure system. For example, a system of central information resource should be established. Healthgrades.com, a for-profit listed company, publishes some of its ratings for free but charges a fee for more detailed reports, and it provides comparative data on physicians and hospitals (Krumholz et al., 2002). Even if huge amount of data is provided, it is still possible for patients to be left in confusion as they face complex choices and medical decisions, so it is imperative to train a new team of healthcare information navigators who can guide patients in their medical decisions (Retchin, 2007). Information sharing needs to shift to knowledge creation sharing. When the various stakeholders in the healthcare industry work together to create value by integrating resources, it will promote collective health and service sustainability, and each participant can contribute to the proposal and realization of healthcare services through integration of resources (Barile et al., 2014).

From the perspective of the government, the government needs to use its coercive power to provide a relatively complete legal environment, standardize medical service standards, and improve the doctors' reputation incentive mechanism and the medical service evaluation mechanism. G. Bloom et al. (2008) studied how to disseminate the experts' medical knowledge through the institutional arrangement under the condition of asymmetric medical information. Blomqvist (1991) argues that contractual or legal measures can overcome the problem of asymmetric information and bring about an efficient allocation of resources for the provision of medical services. Other American scholars regard Consumer-Directed Health Plans (CDHPs) as a means to reduce moral hazard in asymmetric information, where patients can learn about the quality and price of health care services and the federal government can serve as an official resource to provide comparative information about health care organizations and health service providers (Retchin, 2007).

In addition to the above studies, the asymmetric information theory has also been thoroughly discussed and applied in the relief of economic burden of disease. The asymmetric information theory is reflected in how principal-agent physicians can reduce the cost of healthcare services, thereby reducing the economic burden of disease for the patients. The current financial environment means that cost consciousness and rational use of scarce healthcare resources are critical, and it has been confirmed that asymmetric information is a major contributor to the high cost of healthcare and administrative costs in the United States (Shmanske, 1996). Asymmetric information can be reduced and unnecessary consumption of resources can be lowered by increasing cost awareness among clinicians (Aguilar et al., 2011). Fabes et al. (2022) examined clinicians' perceptions of costs in five countries and found that there is a general lack of cost awareness among clinicians due to defensive medicine, unfavorable education, and clinical uncertainty. It is recommended that measures such as educational interventions and health economics training should be used to eliminate asymmetric information and improve physicians' cost awareness. The Consumer-Directed Health Plans (CDHPs) in the United States have helped to drive down the cost of healthcare and improve market efficiency, thereby controlling healthcare costs in the long run (D'Cruz & Kini, 2007). Information and communication technologies (ICTs) have become an effective way to improve clinical and administrative quality and save healthcare costs, and can help reduce asymmetric information and lower the economic burden of disease.

As a special commodity, medical service has formed a kind of incomplete information game between doctors and patients, and the high information cost makes it very difficult to reach an effective equilibrium under the market mechanism (X. Li et al., 2010). How the stakeholders such as medical institutions, patients, and insurance providers can reach an agreement, and how the government should be involved in the provision of health services, especially how the government can realize the basic or even free health care services for the whole population, deserve further research. In conclusion, in order to reduce asymmetric information in healthcare management, stakeholders such as health insurance companies, doctors, hospitals, medical technology/drug manufacturers, government and patients must operate in a transparent environment to improve the overall quality.

2.1.3 Social support theory

2.1.3.1 Definition of social support

The scientific definition of social support originates in the field of psychiatry in the 1970s, and it is used to analyze the social factors affecting an individual's physical health (Pratt & Godsey, 2002). With the deepening of research, social support is not only limited to medicine and psychology, but extended to other disciplines such as sociology and management, resulting in diverse research concepts. To summarize, different scholars have divided the definition of social support into three perspectives: psychology, sociology, and communication, based on their own research needs.

From the psychological perspective, many definitions emphasize perceived social support. Sarason et al. (1990) believes that social support is an individual’s perception of being able to obtain external social support. From the sociological perspective, social support focuses on the extent to which an individual is integrated into a social group. It is believed that social support is an external social behavior that helps individuals achieve goals or meet the needs of special situations (George et al., 1989). Chinese scholars argue that more attention should be paid to the resources brought by social support. He (2001) argues that social support is a social network in which individuals receive support from a variety of resources (economic, material, and spiritual resources). From the perspective of communication and interaction, the definition of social support focuses on the implied external interactions, or the interactions between the providers and recipients of social support. Vaux (1988) contends that social support is a complex, continuous, and dynamic process of interaction between an individual and an external social network. Heinrichs et al. (2003) believe that social support is a two-way exchange process based on social relationships, and is an interactive process between social individuals. L. M. Li and Li (2019) consider social support as a potential resource of social relationships, including the exchange of resources between the supporters and the supported. Some scholars have integrated various research perspectives to propose a more comprehensive and systematic concept. For example, Haber et al. (2007) argue that social support is a multidimensional concept that includes the existence, number, and type of interpersonal relationships, as well as the functional content of social relationships and the perceived quality and strength of the support.

2.1.3.2 Classification and measurement of social support

In terms of the content of social support, S. E. Taylor et al. (2007) suggest that social support includes explicit social support, which focuses on the actual content of support, and invisible social support, which focuses on the construction of external relationship networks and the ability to provide support. In terms of the functional division of interpersonal relationships, social support can be categorized as affective support, instrumental support, informational support, and evaluative support (Langford et al., 1997). To be specific, affective support means giving empathy, love and trust to others; instrumental support refers to material help;

informational support means helping others solve problems by giving useful advice and information; and evaluative support means providing useful information about others' self-evaluation. From the perspective of providers, social support can be provided by informal friends, family and community networks, as well as formal healthcare workers and social workers (Gagnon et al., 2013). S. Y. Xiao (1994) divides social support into objective support, subjective support and support utilization. Objective support is the material resources actually obtained, subjective support refers to the support experience felt by the individual, and support utilization refers to the individual's utilization of subjective and objective support from others.

The Norbeck Social Support Scale (NSSQ) measures social support from three perspectives: functional support, network support, and support withdrawal (Norbeck et al., 1983). The Perceived Social Support Scale (PSSS) consists of 12 items and is a social support scale that emphasizes the individual's self-understanding and self-perception (Zimet et al., 1990). It measures the degree of support that an individual perceives from various sources of social support, such as family, friends, and other people, and uses the total score to reflect the total degree of social support perceived by the individuals. The Social Provision Scale (SPS) consists of 16 items that are combined in two different ways into eight sub-scales to show sources and types of social support.

While the aforementioned generic scales exhibit a certain degree of universality in social support measurement, their application within patient populations demonstrates limitations. They often fail to accurately capture the unique characteristics of social support experienced by these individuals, lacking disease-specific relevance. In contrast, the Medical Outcomes Study Social Support Survey (MOS-SSS) is an assessment tool specifically designed for patients. Primarily utilized to measure medical social support levels among individuals with chronic illnesses, its robust reliability and validity were demonstrated in a U.S. study involving over 3,000 patients with chronic diseases (Sherbourne & Stewart, 1991). The Chinese version of this scale comprises 20 items organized into four domains: Emotional/informational support, tangible support, positive social interaction, and affectionate support. This structure facilitates a systematic evaluation of a patient's social support status. The scale offers advantages through its straightforward item wording, appropriate length, concise language, and alignment with Chinese linguistic conventions, making it less affected by educational level. Its well-constructed domains have contributed to its widespread application across diverse patient groups, including those with HIV (M. Xiao et al., 2019), stroke (C. P. Chen et al., 2015), and coronary heart disease (Thompson et al., 2014).

Focusing on social support measurement for infertile patient populations, Chinese scholars employed this scale to conduct an in-depth investigation of their social support status across four core dimensions: Emotional/informational support, tangible support, positive social interaction, and affectionate support. The scale demonstrates strong content validity by effectively encompassing both physical and psychological needs of infertility patients. Its application in empirical studies among infertility patients in China has further confirmed its good reliability and validity.

2.1.3.3 Social support models

As for the role of social support on physical and mental health, there are four models, including main effect model, buffer effect model, degradation model and dynamic model. The so-called main effect model is that social support has a universal gain effect, and as long as an individual receives social support, no matter how much support is received, the support is able to help the individual withstand stress and improve health. The universal effectiveness of social support may stem from stable social networks providing individuals with positive experiences. For instance, when facing stressful events in the past, individuals received support and assistance from others, which alleviated anxiety and fear. When confronting stressors again, these prior experiences coupled with existing social support help individuals better cope with pressure and enhance psychological well-being. Additionally, stable social networks boost individuals' sense of self-worth, while being integrated into social networks helps people avoid adverse experiences. Cohen and Wills (1985) have confirmed the model and described the mechanism of action of the main effect model. Townley (2015) believes that as long as supportive services are provided for people with serious mental illness, they can be fully integrated into the community.

The mechanism of action of the buffer model is that social support is not universal and the individual's mental and physical health can be protected by buffering the negative effects of stress on the individual. There are two buffering pathways, one in which social support influences an individual's perceptual appraisal of potentially stressful events, and the second in which social support acts as a buffer between the subjective experience of stress and illness. The buffering effect can serve as a general function, meaning that any type of social support may buffer the impact of all stressful events. Alternatively, it may function specifically, such as when a particular type of social support buffers the impact of only one specific stressor. Numerous studies have confirmed this model. Che et al. (2018) found that the buffer effect model better explains the relationship between social support and the experience of pain. Amir et al. (1999) demonstrated that social support moderates the relationship between stress and marital quality, and between stress and well-being, arguing that the effects are only significant when there is huge pressure of infertility.

Barrera (1986) proposed the degradation model of social support, and argues that the buffer effect model negates the direct relationship between social support and stress. He suggests that social support acts as an intermediate variable in an individual's mental health and stressful events. That is to say, the occurrence of stressful events directly reduces the level of social support, which leads to a decline in health. There are many research findings that support this model. For example, it is found that a flood destroys communities of the elderly, which leads to a significant decrease in social support and ultimately an increase in distress of the elderly (Kaniasty & Norris, 1993). Park et al. (2021) demonstrated the mediating effects of social support in the relationship between Type D personality and self-care behaviors in patients with heart failure.

The dynamic model of social support suggests that social support, stressful events, and health outcomes are not simply linear causal relationships; instead, they interact with each other, influence each other, and change over time. Many studies have confirmed this model (Cornwell, 2003; Monroe & Steiner, 1986). Scholars in subsequent studies not only agree with this model but also propose to focus on curvilinear relationships, and even consider the stage-change relationship and threshold relationship in specific studies (X. Q. Liu, 2013).

Apart from existing models, the optimal matching model proposed in 1990 posits that social support's effectiveness hinges not on universal applicability, but on precise alignment between support types (e.g., emotional, instrumental, informational) and stressor characteristics (Cutrona & Russell, 1990). While social support is broadly considered beneficial, this model contends it only reaches full efficacy when the support type matches either the stressor's nature or the recipient's preferences. Support mismatched to needs substantially diminishes its impact. Both insufficient and excessive support prove counterproductive, with evidence suggesting overprovision may incur more severe consequences than under provision. Empirical studies confirm that either extreme reduces marital satisfaction, and excessive support potentially yields greater harm than inadequate support. For instance, when husbands provide informational support exceeding wives' actual needs, wives' depressive symptoms may worsen (Lorenzo et al., 2018). Additionally, as most support originates from friends and family, these providers may simultaneously become sources of interpersonal conflict (Revenson et al., 1991).

Social support theory encompasses multiple explanatory frameworks. The main effect model emphasizes social support's direct positive influence, while the buffering effect model highlights its protective role against stress. The degradation model examines how support's effectiveness evolves over time, and the dynamic model addresses its multidimensional complexity. Representing a shift toward precision and personalization, the optimal matching model offers a distinct perspective. Contemporary theoretical research now increasingly adopts longitudinal methodologies over cross-sectional approaches, while theoretical frameworks evolve from examining linear causality toward exploring dynamic interactions among social support, stressful events, and health outcomes.

2.1.3.4 Application of social support in ART

In the healthcare field, social support acts as a buffer against the adverse effects of various stressful life experiences and serves as a vital resource for managing chronic illnesses. Infertility treatment is financially costly, emotionally stressful, and physically painful, often causing couples to experience guilt and depression. Strong social support is crucial for women undergoing infertility treatment to maintain their physical and mental health. It helps individuals cope with challenging circumstances, develop new solutions, and reduce feelings of despair (Erdem & Apay, 2014). Some studies also indicate that pregnancy rates improve following social support interventions compared to outcomes without such interventions (Pinar & Zeyneloglu, 2012). Due to factors such as difference with traditional methods, high costs, and multiple mental and physical traumas, patients undergoing ART are under great stress and are a relatively special group of people. Social support is an important protective resource for patients undergoing ART. Even if the patients are satisfied with the medical services during assisted conception, they would like to receive more social support measures such as emotional advice and specialized psycho-social services (Malina & Pooley, 2017). Adequate social support, especially emotional support, may help protect the mental health of patients undergoing ART, increase the continued treatment cycles as well as achieve positive outcomes (Casale & Carlqvist, 2021).

With the deepening of research, scholars have begun to explore the impact of social support on different groups during assisted reproduction. Support channels for patients undergoing ART include spouses, family, friends, and healthcare professionals, and it has been confirmed that there are disparities in social support received from different channels (High & Steuber, 2014). Patients want to receive emotional and tangible support from their spouses (Montgomery & Terrion, 2023). According to a Swedish study comparing single women who use donor sperm for fertility treatment with women who use gamete transplants from both couples, single women who receive donor sperm have the highest level of social support from their friends (Lindell et al., 2023). Most of the patients undergoing ART are middle-aged, who are burdened with responsibilities and pressures at home and at work, and their age, marital status, literacy, payment for the economic burden of disease, and family care are all influencing factors of social support. Peer support among patients undergoing ART who have the same characteristics and treatment experience is also a useful coping resource for affective and informational support (Lehto et al., 2023). N. Miller et al. (2022) contend that social support obtained through social media platforms exerts a positive impact on the success rates of assisted reproduction, especially in the reduction of miscarriage rates. Results from a Chinese study suggest that healthcare professionals should provide specialized counseling to the Chinese male undergoing their first IVF to improve their mental health and promote the level of social support (Y. Z. Dong et al., 2013).

Based on the dynamic model and optimal matching model of social support, it is clear that not all social support can exert a positive impact on the assisted reproduction. The social support that a person really wants may differ from the social support they receive. For example, some patients undergoing assisted reproduction treatments believe that the overprotective support they receive from their mothers makes them feel more distressed (Skvirsky et al., 2018). Spouses can also experience difficulties with privacy communication (Steuber & Solomon, 2012). In addition, support pathways such as unsolicited offensive advice from others (Malina & Pooley, 2017), inappropriate comments (Bute, 2009), and invasive questioning will not exert positive impacts on assisted conception outcomes.

2.2 Assisted reproductive technology (ART)

2.2.1 Measurement of economic burden of disease on patients undergoing ART

2.2.1.1 Infertility

Infertility is a state of low fertility, defined as the failure of one couple to achieve a clinical pregnancy for at least 12 months of regular sexual intercourse without contraception (Zegers-Hochschild et al., 2017). Clinical pregnancy is defined as the presence of clinical signs of pregnancy and the existence of one or more gestational sacs confirmed by ultrasound examination (Zegers-Hochschild et al., 2009). In women it is called female infertility, and in men it is called male infertility.

The prevalence of infertility has been on the rise in recent years. As a reproductive health defect, infertility puts couples preparing for pregnancy through trials and tribulations, including prolonged grief, frustration in life, and chronic stigma (Inhorn & Patrizio, 2015; Luk & Loke, 2015). In some areas of Asia and Africa, infertility has even led to loss of dignity, violence, and suicide (Hammarberg & Kirkman, 2013).

2.2.1.2 Assisted reproductive technology (ART)

Assisted reproductive technology (ART) provides an option for infertility patients with significantly increased cure rates. It mainly includes artificial insemination (AI), in vitro fertilization-embryo transfer (IVF-ET), intracytoplasmic sperm injection (ICSI), preimplantation genetic diagnosis (PGD), embryo cryopreservation, and frozen-thawed embryo resuscitation.

AI is a commonly used method of assisted reproduction, which is an assisted conception technique in which semen is optimally processed and injected into the female reproductive tract. Depending on the source of sperm, AI is classified as husband insemination and donor insemination. AI is non-invasive, with fewer complications, and is economical and convenient. IVF refers to the process of completing the union of sperm and oocyte in an artificially controlled environment outside of the body to form a fertilized egg.

The IVF process includes oocyte collection, sperm collection, in vitro fertilization and embryo culture. Fertilized eggs are cultured in vitro under artificial incubation conditions for 2-3 days to develop into cleavage stage embryos or blastocysts, and then transferred into the patient’s uterine cavity for embryo implantation and pregnancy (Diao et al., 2021).

ICSI is a microscopic injection of a single sperm into an oocyte to fertilize it, and is indicated for patients with severe oligozoospermia, asthenospermia, or teratozoospermia, and is a very effective treatment for patients with severe male sperm abnormalities or unexplained fertilization disorders that result in infertility (Blavier et al., 2021).

PGD is an important part of ART, which is a pre-pregnancy diagnostic technology formed by combining ART with genetic diagnostic technology to screen embryos without chromosomal abnormalities, diagnose and select embryos without genetic defects for implantation into the uterus to ensure successful pregnancy and reduce birth defects (N. Y. Zhang et al., 2018).

ART has developed rapidly in recent years, and since the birth of the first test-tube baby in 1978, more than 10 million people have been born through ART worldwide till 2019 (Vasilescu et al., 2023). Globally, more than 2 million cycles of IVF are performed annually (Banker et al., 2021).

In China, IVF utilization rate accounts for 1.7% of newborn babies (Bai et al., 2020). The number of IVF cases per year exceeds 200,000, making it the world’s leading country for ART treatment, and the success rate and technical level of ART are at the forefront of the world (W.

X. Liu et al., 2019). China's two-child and three-child policies may increase the demand for childbirth, which in turn will increase the demand for assisted reproduction. ART is rapidly developing, but it is not prioritized as a treatment for infertility in some countries, especially the low and middle-income countries, and the reasons are overpopulation, higher importance of other health issues (family planning, vaccination), lack of ART experience and limited infrastructure (Ombelet & Campo, 2007). In addition, religion, culture, and ethics in different countries are also factors affecting the limited development of ART.

ART is the ultimate treatment option for many infertile couples, but the high cost, as well as the need for specialized knowledge, medical equipment, and the large number of medications cause patients to suffer from a disproportionate economic burden of disease, and it is often considered a luxurious healthcare service by policy makers and the general public. There are many factors that contribute to the high cost of ART. On the one hand, it comes from the patients themselves or the disease itself. For example, it has been demonstrated that the older the patient, the higher the cost, and this is because she needs more cycles to make up for the opportunity, and accordingly the cost of medication will also increase (Eijkemans et al., 2017). Complications of ART-related surgeries also increase the cost, and these complications include ovarian hyperstimulation syndrome, bleeding, infections, cysts, and anesthesia, which are also considered by researchers to be a significant component of IVF costs (Goldfarb et al., 1996).

On the other hand, the high cost comes from the use of additional ART treatment plans, which refer to the use of procedures, techniques or medications other than the standard regimen to improve success rates, such as endometrial scratching, assisted hatching of embryos and complementary therapies such as acupuncture. Most additional therapies are not supported by strong evidence of increased likelihood of conception or safe use, but are widely used and even commercialized, resulting in increased costs to patients. Expensive and unproven additional treatment plans have been widely debated and condemned by many scholars (Armstrong et al., 2019). These additional treatment plans not only increase the economic burden on patients, but also lower the public's trust in reproductive technology.

2.2.1.3 Economic burden of disease on patients undergoing ART

The earliest study of the economic burden of disease was conducted by William Pretty, an English political economist in the mid-17th century, who discussed the economic costs of the plague epidemics in England from the perspective of the labor theory of value, and further analyzed the costs needed and benefits (Petty & Graunt, 1899). It was not until the 1950s that authoritative studies of the economic burden of disease were formally conducted in the Western countries, with Malzberg's study of the indirect economic costs of mental illness carried out in 1950 being widely recognized as the first formal study of the economic burden of disease (Malzberg, 1950).

The theoretical framework of the economic burden of disease was gradually established after 1960. A study on the economic cost of disease for syphilis was carried out and a general methodology for the economic cost of disease was established, including discounting methods, employment rate calculations, how to deal with the simultaneous presence of many diseases, transfer payments, and many other issues (Klarman, 1964). Rice (1967) proposed a theoretical methodological framework for calculation of the annual economic burden of disease, namely, a method to calculate the direct economic burden of disease by primary diagnosis and primary health care services as well as a method to analyze the indirect economic burden by gender and labor force status. Rice also conducted a study on the cost and burden of major diseases in the U.S. in 1963.

After 1970, many scholars focused their research on the prevention and treatment methods of different kinds of diseases, disease characteristics, and the economic costs and burdens caused by diseases, and there were about several hundreds of studies on similar topics. After 1980, the theoretical research on the economic burden of disease made a qualitative leap, and the methodology basically took shape. One of the major representative scholars is Thomas who proposes guiding principles for the analysis of the direct and indirect economic costs of disease and systematically explains the issues of cost classification, data collection and methodology, indirect cost, discount rate, non-pecuniary costs, and specific disease costing characteristics (Hodgson & Meiners, 1982).

At this stage, the economic burden of disease is defined as the health economic resources consumed in the process of disease prevention and treatment and the economic losses incurred by patients due to illness, disability, or even death. It focuses on analyzing the impacts of disease on individuals, families, and society from the economic level, and includes three categories: direct economic burden, indirect economic burden, and intangible economic burden (Sgobin et al., 2015).

The direct economic burden includes direct medical economic burden (outpatient/emergency costs, examination costs, medication costs, surgery costs, hospitalization costs, rehabilitation costs, and self-treatment costs) and direct non-medical economic burden (transportation costs, accommodation costs, and nutritional costs), which are economic resources directly consumed by individuals, families, and societies in order to prevent and treat diseases. The measurement method mainly includes two categories: the top-down approach and the bottom-up approach. To be specific, the top-down approach is to assess the total direct medical costs and average direct medical costs of a certain disease by obtaining the total medical costs of the disease within a certain time and space through the health insurance accounting system or the medical payment system (B. S. Bloom et al., 2001). The advantage of the top-down approach is that the data are generated by the payment system, with no need for additional data collection and survey, and are not confounded by factors such as memory bias and selection bias. The bottom-up approach, also known as the micro-cost approach, is by far the most common method to measure disease-specific costs from the patient's perspective (Onukwugha et al., 2016). This approach investigates the actual medical costs of each patient, which can both obtain the direct medical costs of the disease and estimate the loss of productivity due to the disease by identifying the patient's missed work. This approach has certain recall bias and selection bias in retrospective studies.

Indirect economic burden refers to the current or future economic loss due to the reduced work capacity of the patient himself and his companions as a result of the disease, and it is also an important component of the economic burden of disease. There are mainly three methods for the measurement of indirect economic burden, including human capital method, frictional cost method and willingness-to-pay method (Jo, 2014). The core of these methods is how to evaluate the value of effective labor per unit of time lost by the patient or the companion. Intangible economic burden mainly focuses on subjective factors such as mental anguish, psychological burden, and reduced quality of life, and it is difficult to measure specific indicators in actual research, so little research has been conducted.

Early studies have found that ART is nearly inaccessible or very expensive for individuals, because they cannot afford infertility treatment, and the costs are catastrophic for poor families (Dyer et al., 2013). With the increase of patient age, ART becomes increasingly more expensive with lower success rates, as more cycles of treatment are needed to make up for the opportunity, while the cost of medication per cycle progressively increases (Bouwmans et al., 2008). This situation creates a vicious cycle for individual fertility, as in many cases one cycle of treatment may be unsuccessful, leading to the need for additional cycles. Each cycle accrues costs that quickly reach tens of thousands of dollars, and even after three cycles, the success rate cannot reach 100% (Patrizio et al., 2022). ART technology also contributes to a decrease in productivity due to the loss of time for work while the patients or their family seek treatment (Brouwer et al., 1997). It is found that the cost of ART treatment for a single couple ranges from 10% of annual household expenditures in European countries to 25% of annual household expenditures in Canada and the United States (Collins, 2002). The global infertility market, of which ART treatment is a major component, is projected to be worth $27 billion by 2026 (Keller & Chambers, 2022), which is a significant economic burden on the healthcare system, government, insurance companies, and patients.

The heavy economic burden of assisted reproduction is reflected not only in its high medical costs but also difficulty in accurate measurement, and it is caused by a number of factors such as differences in countries and regions, time of measurement, method of measurement, and currency inflation. As a result, the cost of ART varies even within the same region of a country or at the same time.

In terms of country-region differences, there are huge variations in ART utilization rate and cost per cycle across countries, and developed countries generally have higher ART costs than developing or low-income countries over the same period of time. The United States is among the countries with high cost of IVF, countries with medium cost of IVF include Canada and Saudi Arabia, and countries with low cost of IVF include China, South Korea, and Iran (Collins, 2002). The countries with the highest cost of IVF include Italy, United Kingdom and Spain. A comparison of costs over the same time period shows that the cost per IVF cycle in the United States ranges from $12,000 dollars to $14,000 dollars, which will increase to nearly $20,000 dollars if ICSI is utilized to fertilize the eggs (Sterling & Garcia, 2020). The cost of IVF in the United Kingdom in 2017 was typically 5,000 pounds (6,500 US dollars) per cycle and the average cost per IVF cycle in Brazil was 4,000 US dollars (Kushnir et al., 2022). In Kolkata, India, the cost of IVF is 100,000 to 120,000 rupees, which is approximately 2,000 US dollars (Banerjee & Baranwal, 2020). The total cost of IVF treatment in Turkey is 8,500 US dollars (Yildiz & Khan, 2016). In 2016, South African scholars estimated the average cost of each fresh cycle of IVF to be 785 US dollars based on resource use conditions and a sample public clinic in South Africa (Connolly et al., 2021). There lacks accurate data on the cost of assisted reproduction in China, with rough estimates ranging from 30,000 to 200,000 *yuan* or more (H. Q. Zhang et al., 2022). J. J. Qiao et al. (2022) measured the cost of assisted reproduction for 174 patients and found that the average economic burden for the first embryo transfer for a couple was 39,215.13 *yuan*.

In terms of different measurement times, the costs of the same country or region vary greatly in different periods of time. With the United States as an example, in 1999, the average cost was 8,039 US dollars, 25% of the GNI per capita ($31,010). In 2002, the average cost per IVF/ICSI cycle was 9,547 US dollars (Collins, 2002). According to a study on multiple centers in the U.S., the median price of an out-of-pocket cycle of IVF was 19,234 US dollars (Wu et al., 2014). In 2020, the IVF cost reached 23,000 US dollars, along with drug costs of around

5,000 US dollars (Martin et al., 2021).

The different methods of assisted reproduction lead to difficulty in cost measurement. The NHS England website shows that the cost of an IVF cycle (with one fresh and one frozen cycle) is between £ 3,100 and £ 3,500, and the cost of ICSI is between £ 3,500 and £ 4,000. It has been suggested that the cost of intrauterine insemination ranges from 500 US dollars to 2,500 US dollars, with each in vitro fertilization cycle costing between 12,000 US dollars and 14,000 US dollars, and this cost can increase to nearly 20,000 US dollars if ICSI is used for insemination. In Australia, the out-of-pocket cost of IVF is around AUD $3,000 to 4,000, with an average of an additional AUD $6,250 per PGD cycle.

The difficulty in measuring and unifying costs also lies in differences in how they are measured. It is generally agreed that IVF and ICSI are expensive technologies mainly because of the direct medical costs of medical counseling, medications, laboratories, and egg retrieval and transfer (Jing et al., 2020), but there is disagreement on the measurement of indirect costs. It is suggested that indirect costs (cost of lost time) are not relatively standardized and are relatively small and negligible (Collins, 2002). However, as the economy continues to develop, patients tend to take vacations for ART treatment, so the proportions of direct non-medical and indirect costs are increasing, even accounting for 45%-52% of the total cost (Le et al., 2018). In addition, there are hospitals that offer a fixed package price for IVF, which includes the cost of monitoring, ultrasound, doctor's consultation, egg retrieval, and transplantation, as well as the cost of transportation, hotel accommodations and itinerary arrangements, and interpreting fees (Yildiz & Khan, 2016). Since it is difficult to make international comparisons of IVF costs in different countries because of price changes, inflationary factors should also be taken into account when measuring the economic burden of ATR. Collins (2002) projected an average cost of 9,547 US dollars per IVF cycle in the U.S. as of 2002 based on the inflationary trend in U.S. healthcare costs, but most countries do not have access to inflationary data on health care costs.

Experts believe that health care utilization declines when cost sharing rises from 0 to 25% of total costs (Manning et al., 1987). The theoretical studies have demonstrated an inverse relationship between a decrease in the cost of IVF services and an increase in utilization (Collins, 2002). In reality, the UK and some European countries endeavor to make the treatment cycle affordable, which leads to an increase in the number of treatments (De Geyter et al., 2020). Since there is a consensus that ART utilization is closely related to the affordability, many stakeholders are beginning to take steps to reduce costs.

From the perspective of patients, they are likely to forgo stimulated cycles in favor of natural cycles for IVF because of the advantages of natural cycle IVF in terms of lower risk and lower cost. Empirical studies prove that there is a 75% reduction in the cost of natural cycle IVF compared to stimulated cycle due to the reduction in the cost of medications, monitoring, and various costs of treatment for ovarian hyperostosis (Shahin, 2007). Some patients also use IVM immature egg culture approach, which not only prevents ovarian hyper syndrome but also reduces the need for costly gonadotropins. It helps lower the cost of medications (Paulson et al., 2016) and cut down the cost of outpatient visits and ultrasound examinations (Rose et al., 2014). Other patients are unable to afford treatment and consider egg donation to reduce the economic burden. Pennings and Devroey (2006) found that more than two-thirds of women who donated eggs were motivated by discounted treatment costs. Since restrictions and fees for reproductive healthcare vary from country to country, many patients turn to cheaper and less restrictive countries as an alternative (F. Taylor et al., 2022; Whittaker et al., 2019), such as going to Turkey and Greece through “reproduction tourism” for ART treatment.

From the perspective of healthcare providers, hospitals may consider reducing the number of embryos transferred to reduce the financial burden and the risk of multiple pregnancies. For routine IVF and ICSI, the development of a simplified low-cost IVF culture system (SCS) can also reduce the economic burden, as the system is less costly but equally effective and safe (Van Blerkom et al., 2014). Another initiative to reduce the cost of treatment in IVF laboratories is to realize automation in the laboratories. Currently, the reproduction centers are still using the same techniques and methods used in the 1980s. Namely, the embryologist opens the incubator door, removes the petri dish, closes the incubator door, and then manipulates the embryo or medium, opens the incubator door again, returns it to the petri dish, and then closes the incubator door, and these steps are repeated in each IVF case. Experts believe that the introduction of artificial intelligence into medicine, automation of IVF laboratories and other future technological developments will make IVF treatment cheaper and more efficient (Costa-Borges et al., 2021). In addition, with the advancement of technology, telemedicine will also play a part in reducing the economic burden of infertility (Berg et al., 2020). Through specialty medical associations or specialty medical alliances, the transportation, accommodation, and food costs consumed by patients for medical treatment can be reduced, as well as the indirect economic burden of taking time off from work due to frequent medical visits and treatment needs (J. J. Qiao et al., 2022).

As part of the healthcare providers, pharmaceutical companies have introduced generic drugs with lower price to reduce the economic burden. For example, the biosimilar version of follicle stimulating hormone (FSH) is a more cost-effective option for women receiving ART treatment in France (Lehmann et al., 2023). For another example, the use of FOL α biosimilars in the control of ovarian hyperstimulation can bring real cost savings to healthcare stakeholders (Goldštajn et al., 2021).

From the perspective of the government, many underdeveloped countries have recognized that ART is expensive, so they do not place human resources and financial resources on the introduction of medical technologies, but rather on prevention and education. Ombelet and Campo (2007) argue that the use of public funds for education and preventive healthcare is the most cost-effective way to address infertility in developing countries.

2.2.2 Financial toxicity

2.2.2.1 Definition of financial toxicity

Bullock et al. (2012) first introduced the concept of financial toxicity, suggesting to conceptualize the costs in the cancer treatment process. Scholars have continued to interpret the concept of financial toxicity. Zafar et al. (2013) contend that financial toxicity is a harmful personal financial burden faced by patients undergoing cancer treatment, including the patient's objective financial burden and subjective financial distress, which affects the patient's quality of life and treatment outcome, or leads to the patient's abandonment of treatment due to the inability to afford the costs, and in severe cases may accelerate the patient's death. Financial toxicity is defined by some scholars as a situation in which 20% and more of household income is spent on healthcare (Davidoff et al., 2013). Gordon et al. (2017) defined financial toxicity as an economic side effect of cancer treatment, arguing that high out-of-pocket costs lead to financial suffering for patients, which in turn leads to reduced quality of life and healthcare behaviors. Carrera et al. (2018) argue that the objective economic burden and subjective financial distress of cancer patients caused by the use of innovative drug treatments and their accompanying health services can also be referred to as financial toxicity, and the specific research framework is shown as per Figure 2.3.

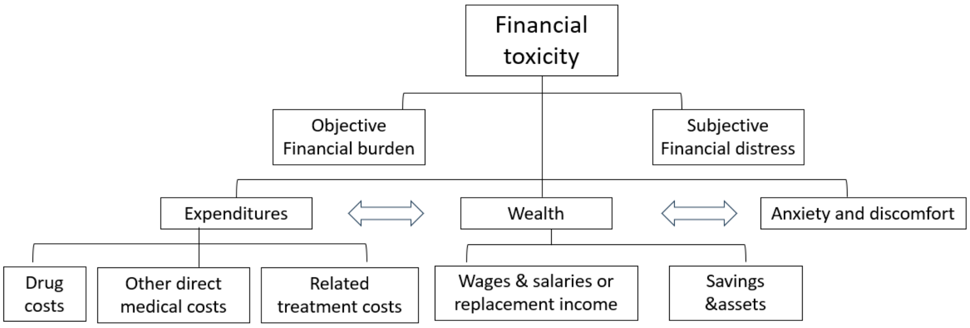

Figure 2.3 Research framework of financial toxicity

Source: Carrera et al. (2018)

Both the concepts of economic burden of disease and financial toxicity focus on patients' medical costs and loss of income, and are sometimes used interchangeably by researchers, but there is a clear distinction between the two that needs to be discerned. Studies on the economic burden of disease focus on the impact on the country, region, and society, and quantitatively describe the economic loss, including medical costs, transportation and accommodation costs, economic loss of income due to disease, and economic loss caused by psychological burden due to disease (Chung, 2015). On the other hand, financial toxicity focuses on the patient and the family, and is not only concerned about out-of-pocket medical costs, but also about the short-term and long-term harm of financial pressure caused by the disease on the patients and their families. It is a comprehensive evaluation of the patient's treatment experience, including healthcare-related expenditures, passive use of financial resources, psychosocial impacts, and search for support and coping strategies (Witte et al., 2019). Gordon et al. (2017) reviewed more than 200 studies on financial toxicity from 2013 to 2016, and found that a total of 28% to 48% of patients were measured using objective monetary indicators, and 16% to 73% of patients were measured using subjective measures. Pisu and Martin (2022) explicitly articulated the causative factors, moderating factors, and potential impacts of financial toxicity through graphing, which also clearly demonstrates the relationship between the economic burden of disease and financial toxicity. As illustrated in the figure, it is evident that socioeconomic conditions, material resource availability, national healthcare infrastructure, and disease-specific contextual stressors collectively serve as moderating variables in this framework. However, the precise nature of their regulatory influence — specifically whether they amplify, mitigate, or differentially redistribute risks — remains insufficiently characterized. Further empirical investigations are critically needed to quantify the magnitude of these effects, clarify directional causality, and elucidate the interplay between these variables and health outcomes.

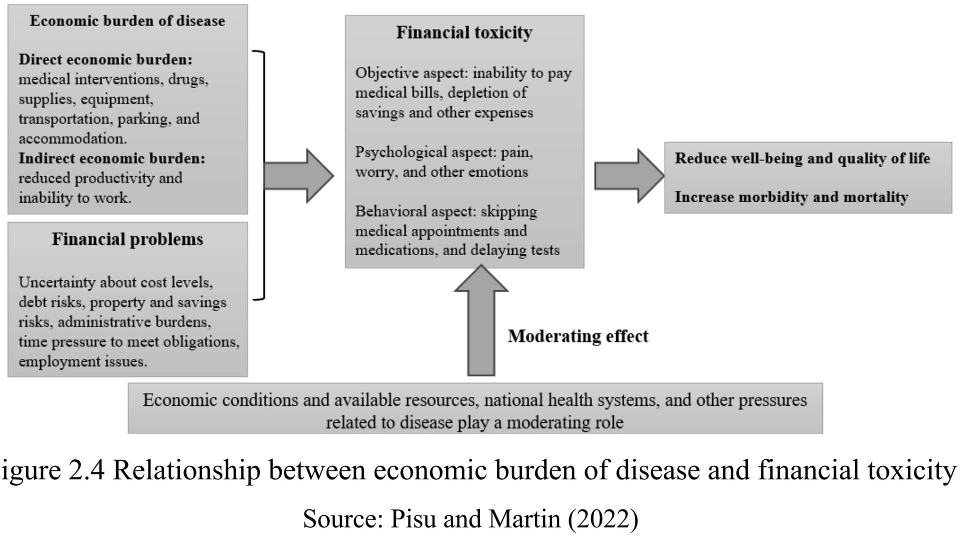

Figure 2.4 Relationship between economic burden of disease and financial toxicity

Source: Pisu and Martin (2022)

To summarize, both economic burden of disease and financial toxicity describe the economic impact of healthcare expenditures at the individual and household level, but economic burden of disease is an objective measure of how much household income is consumed by healthcare costs, and encompasses direct, indirect, and little-studied intangible economic burdens, while financial toxicity incorporates both objective economic burdens and subjective financial distress into the common components of the concept (Azzani et al., 2015; Zafar & Abernethy, 2013), and the subjective financial distress is more frequently studied.

2.2.2.2 Measurement of financial toxicity

Measurement of financial toxicity consists of three main methods. The first is monetary measurement, which refers to the measurement of the proportion of out-of-the-pocket medical costs to income. The second is objective measurement, which refers to the collection of issues such as raising debt levels, selling assets, and borrowing money in order to reduce financial burden. The third is subjective measurement, which refers to the measurement of the actual impact on the level of distress caused by the disease (Gordon et al., 2017). The financial toxicity is divided into four criteria, including mild (level 1), moderate (level 2), severe (level 3) and life-threatening (level 4) (Khera, 2014). Level 1 includes changing way of life to pay for medical expenses and resorting to donations to pay for medical expenses; level 2 includes temporary unemployment, selling stock investment products, and using savings to pay for medical expenses; level 3 includes mortgaging property, losing one’s job, and not being able to pay for necessities; and level 4 includes selling one’s property, going bankrupt, giving up treatment due to the inability to afford the cost, and even intention to commit suicide.

The commonly used measurement tool at this stage is the Comprehensive Scores for Financial Toxicity (COST) based on patient-reported outcomes, which is a five-point Likert scale consisting of 11 items (de Souza et al., 2014). COST is the first tool for assessment of financial toxicity that has been proved to have high reliability and validity, and has been translated and applied in Arabia (Mejri et al., 2022), India (Dar et al., 2021), the Chinese mainland (H. H. Yu et al., 2021) and Hong Kong (Ng et al., 2021). In addition, the Financial Index of Toxicity Questionnaire (FIT) has been used to measure the financial toxicity of patients with head and neck tumors and the financial impact on patients losing their jobs due to cancer (Hueniken et al., 2020).

2.2.2.3 Factors influencing financial toxicity

The main factors influencing financial toxicity include patients’ demographic characteristics, socioeconomic factors, clinical disease status, health insurance, and healthcare provider behaviors. In terms of demographic characteristics, several studies have shown that patients' varying age, race, marital status, work status, education, and place of residence exert an impact on financial toxicity (Pearce et al., 2019; Ripamonti et al., 2020; Yabroff et al., 2016). In terms of socio-economic factors, the patient's income and contribution to the total household income, family asset status, and employment status also affect financial toxicity to varying degrees (Smith et al., 2019). Patients and families as a whole are threatened and challenged by severe financial toxicity, so food and housing security for patients and families are also influencing factors of financial toxicity (Scheinemann, 2017). In terms of disease status, many scholars have found that cancer patients' disease site, severity, treatment modality, and the impact of treatment on their ability to work are also closely related to financial toxicity (Giordano et al., 2016; Russell & Bernhardt, 2016). In terms of health insurance, there are also differences in the impact on financial toxicity between patients who have and not have health insurance and patients covered by different types of insurance (Bernard et al., 2011; H. Fang et al., 2019). As for physicians who are the medical service providers, factors such as age, education, level of training, whether or not they recommend high-cost treatments, and whether or not they discuss out-of-pocket costs with patients also affect financial toxicity to varying degrees (Hershman et al., 2009; Kimmick et al., 2015). Malpractice due to professional inadequacy of physicians or "moral hazard" in asymmetric information can also expose patients to financial toxicity (Su, 2022).

In addition, the occurrence of financial toxicity is also related to pain, anxiety and depressed mood of patients (Gordon et al., 2017; Thronicke et al., 2020). In other studies, it has also been found that the severity of financial toxicity changes dynamically over time with irregular patterns. For example, it is suggested that the severity of financial toxicity decreases over time (Liang et al., 2021; Stone et al., 2021). However, Friedes et al. (2021) found that financial toxicity was prevalent from diagnosis to the first six months of cancer treatment and rose progressively later with the increase of out-of-pocket costs.

2.2.2.4 Influence of financial toxicity and its countermeasure

Financial toxicity leads to consequences in terms of both livelihood and economic harm and psychological and therapeutic harm to patients and their families. First, the impacts of financial toxicity are not only felt by the patients themselves, especially the reduced health-related quality of life (Ramsey et al., 2016), but also by their families, as the economic level of the family as a whole determines the severity of financial toxicity. Financial toxicity leads to corresponding decrease in the family's income and asset, so that the families are unable to pay for basic consumption expenses such as housing and food, and may even face family debt and bankruptcy. It has been demonstrated that the opportunity costs incurred by the patients themselves during the treatment process, namely, loss of wages and income, may exert a more severe impact than the existing household healthcare expenditures (Kent et al., 2016). During the treatment, there may be many other issues such as unemployment, absenteeism, and job discrimination (Bradley et al., 2018; de Boer et al., 2009).

The measures taken by different families facing financial toxicity are different from each other. Middle and high-income families choose expensive programs to prolong life expectancy and improve quality of life, but the measure leaves the patients in a deep financial quagmire. Low-income families tend to forgo treatment and face the risk of death, resulting in poor prognostic outcomes (Perrone et al., 2016; Zafar, 2015). Patients and families suffering from financial toxicity also alleviate the burden by taking out loans and selling their properties (Kale & Carroll, 2016; Zafar et al., 2013), an approach that provides patients with immediate treatment costs but increases various adverse risks.

Another consequence of financial toxicity is that the patient's psychological burden increases and the treatment process becomes difficult. Studies show that economic stress in patients facing financial toxicity is consistently associated with an increased risk of adverse psychological outcomes, and in particular closely related to major depressive disorder and anxiety (Sharp et al., 2013). Collado and Brownell (2019) argue that financial toxicity is a key impediment to patients' access to high-quality care, and nearly a quarter of patients with cancer develop psychological problems due to financial toxicity, which greatly reduces their treatment adherence. In addition, financial toxicity can lower spending and change lifestyle and attitudes due to high out-of-pocket costs, which can lead to a decrease in subjective well-being (Thom & Benedict, 2019).

Social support act as a buffer against economic stress, promote psychological well-being, and improve physical and psychological symptoms in the general healthy population. In addition, it can also allow patients, especially those with cancer, to feel a sense of belonging, improve adherence, increase confidence in treatment, and therefore improve their quality of life (Sun et al., 2017). Social support can provide patients with material, emotional, and information support to help them improve their lives, alleviate negative emotions, and reduce stress disorders. Numerous studies have confirmed the correlation between social support and financial toxicity (Sharif et al., 2020; H. H. Yu et al., 2021), showing that good social support is an important protective factor for patients undergoing chemotherapy for cancer to improve their quality of life and reduce financial toxicity (Harvey-Knowles & Faw, 2018; Sauer et al., 2019).

Recommendations to mitigate financial toxicity and increase social support begin with policy support. For example, the American Society of Clinical Oncology (ASCO) defines the value of cancer care by emphasizing the three key elements of clinical benefit (efficacy), toxicity (safety), and cost of treatment (efficiency), and advocates to offer patient-centered, safe, effective, timely, efficient, and equitable healthcare services (Schnipper et al., 2015). The European Society for Medical Oncology (ESMO) developed the Magnitude of Clinical Benefit Scale (ESMO-MCBS), which assesses the extent of clinical benefit of novel treatment regimens and is designed to help facilitate shared decision-making between oncologists and patients regarding clinical benefits and costs (Cherny et al., 2015). China, on the other hand, has addressed the financial risks of healthcare security by continuously improving the health insurance system and accelerating the construction of a multi-level healthcare security system. In addition, asymmetric information between the doctor-patient relationship is addressed by mandating full disclosure of estimated treatment-related costs and sources by doctors through formulation of relevant policies (Gordon et al., 2017).

The second initiative to alleviate financial toxicity and increase social support is to improve communication between physicians and patients. A study shows that 94% of patients believe that their doctors should discuss with them on the cost of treatment, but in reality, only 14% of patients report that their physicians have a discussion with them, and 64% of patients are unaware of the society’s contribution to their treatment (Irwin et al., 2014). Therefore, physicians should proactively identify patients with financial toxicity during treatment and assess the level of risk by communicating with them, which will ultimately enable patients to fully understand the full cost of treatment, available healthcare resources, and financial means, and scientifically and rationally assess the value of their treatment. Physicians can also use screening tools to identify high-risk patients and refer them to support service agencies. Nurses can also play an important role in addressing patients’ financial toxicity with their clinical experience and communication skills. The American Association for Oncology Nursing identifies that oncology nurses should assume the role of Oncology Nurse Navigator, believing that knowledge of insurance reimbursement and knowledge of financial toxicity and payment coverage are key to realizing high-quality care (Baileys et al., 2018).

In addition, patients should proactively participate in discussions on optimal decision-making during the treatment process. Huang et al. (2017) argue that discussion on cost can help patients choose treatment options with lower costs, but the reality is not optimistic. According to Barcellos et al. (2014), only 42% of patients are able to accurately describe the amount of out-of-pocket medical expenses. Therefore, patients' own ability to improve their conceptual knowledge of health insurance and finances can also help to keep track of the potential costs and available resources during their treatment.

Clinic staff, communities, and families are also key players in reducing financial toxicity and increasing social support for the patients. For example, clinic staff and the communities distribute standardized pre-treatment questionnaires to screen patients with high levels of financial toxicity (Slavin et al., 2021). Trained community health workers have been proved to have the potential to reduce total healthcare expenditures, primarily through lowering hospitalization rates and saving costs for the healthcare system and patients (Jacob et al., 2019).

2.2.2.5 Status quo of financial toxicity

Financial toxicity has become a common phenomenon all over the world, and increasingly more studies have proved that different countries, regions and different types of diseases have all been suffering from financial toxicity. Studies on financial toxicity are carried out mainly in developed countries, such as the United States, Australia and Canada. A study on financial toxicity for various diseases in the United States shows that about 137 million (56%) American adults suffer from the impacts of financial toxicity, and the most common impact is psychological burden such as worries about medical expenses (Yabroff et al., 2019). The severity of financial toxicity also varies by disease. For example, it is reported that 54% of adults with atherosclerotic cardiovascular disease and 41% of adults with cancer suffer from financial toxicity (Valero-Elizondo et al., 2021). To increase the emphasis on financial toxicity among patients and healthcare providers, Dottino and Rauh-Hain (2020) recommended that the adverse event of financial toxicity should be included in the black box warning. In low and middle-income countries such as Vietnam and India, there are different manifestations of financial toxicity due to influencing factors such as trans-regional medical service and delayed disease diagnosis (Basavaiah et al., 2018). Chinese scholars have systematically evaluated the occurrence of financial toxicity in patients with malignant tumors, and find that the incidence of financial toxicity is 67.4% through Meta-analysis of 8,799 patients in 24 studies (L. Liu et al., 2023).

Research on financial toxicity originates from research on cancer (Gordon et al., 2017), due to the very expensive cost of oncology drugs, the diversity of treatment options, and the increasing incidence of cancer because of the aging population, and studies have confirmed that cancer survivors have significantly higher financial toxicity than non-cancer patients (Gordon et al., 2017). In spite of its origin in research on cancer, financial toxicity is also widely used in non-cancer fields such as Crohn's disease (Voit et al., 2019) and multiple sclerosis (Sadigh et al., 2021). Gompers et al. (2023) utilized the scoring tool of COST to measure the current status and impact of financial toxicity among obstetric patients during pregnancy and after childbirth. In addition, scholars have studied the psychosocial and economic problems of families undergoing ART and find that parents of twins and multiples are more likely to be affected (V. Miller et al., 2020). There lacks research on the financial toxicity of patients treated with assisted reproductive technology during treatment.

2.2.3 Diverse financing mechanism for patients undergoing ART

2.2.3.1 Overview of health financing

Health financing mechanism refers to the institutional arrangements for the raising, distribution and effective use of health funds in a given socioeconomic environment over a certain period of time. Universal Health Coverage (UHC) provides a guiding framework for the analysis of healthcare security policies and health financing mechanisms (Morshed-Behbahani et al., 2020). UHC ensures that all people can have access to needed healthcare services and protection from economic risks, and can be assessed in terms of guaranteed population coverage, health service coverage and healthcare cost coverage (Evans & Etienne, 2010).Generally speaking, health financing security consists of two parts: the national healthcare security system and the supplementary healthcare security system (commercial insurance, charitable assistance, and medical mutual aid) (C. X. Yu et al., 2019).

At the governmental level, the presentation and provision of appropriate financial health services for the whole society has become one of the main objectives of governments around the world today (Devlin et al., 2011), but the level of governmental support varies considerably from country to country, with under-funding of the health sector in many developing countries being an important reason (Gustafsson-Wright et al., 2009). At other levels such as commercial insurance, capital inflows can also accelerate the commercial development of health services, bringing many positive effects (Patrizio et al., 2022). For example, it can promote an increase in the number of healthcare institutions, improve accessibility of healthcare services, and enhance the level of medical care for diseases. Public charity aid can send positive messages to the public and eliminate public misconceptions about the disease. In addition, well-capitalized business enterprises can advocate to promote the enactment of insurance regulations and bills by legislators.

2.2.3.2 Diverse financing of patients undergoing ART

Although ART is developing rapidly, the financing mechanisms for assisted reproduction vary widely across the world. Many countries do not include ART in health insurance or public healthcare (Stephen et al., 2016). Even in countries where ART is included in the healthcare insurance, the coverage of insurance on ART is limited, and the out-of-the-pocket costs are still high. The latest research on ART conducted by the International Federation of Fertility Societies in 2019 showed that only 47% of the reported countries provide varying degrees of financial support for ART, while this figure was 64% in 2016. The financial support for ART has been declining across countries, with only 20% of the countries in the investigation providing full reimbursement for ART (Allan et al., 2019). Even patients who are subsidized by insurance have upper limits in reimbursement, and they have to pay for the excess treatment costs on their own (McLaughlin et al., 2019).

Health financing for infertility, particularly assisted reproduction, in the core dimensions of population coverage, service coverage, and cost coverage ratios in several representative countries around the world has been summarized through a literature study. In terms of population coverage, the literature summarizes the criteria (gender, age, income, and disease type) for the inclusion of infertility patients in the following countries (IFFS, 2022). As per Table 2.1, there is no restriction on gender coverage in the countries. Since infertility is the failure to achieve a clinical pregnancy for at least 12 months of regular sexual life, all the countries set the duration of the disease at 1 year and above. Germany and Russia do not set criteria for age limit, while the rest of the countries set the age between 18 years old and 50 years old. The United Kingdom covers only patients with primary infertility, while the rest of the countries cover patients with both primary and secondary infertility, and 10 states in the United States extend the target population to patients with medically induced infertility (Koniares et al., 2022).

Table 2.1 Criteria for the inclusion of infertility patients in healthcare security

	Age	Income	Infertility type	
			Primary	Secondary
The US	25-42	No restriction	No restriction	
Australia	Under 50			
The UK	18-39, 40-42		Covered	Not covered
France	Under 43 (F), no restriction (M)		No restriction	
Germany	No restriction			
Russia	No restriction			
Singapore	Under 45			
Japan	Under 43 (F), no restriction (M)	Annual income lower than 57,670 US dollars		
South Korea	No restriction	Lower than 180% of the middle income		

Service coverage refers to the type and number of infertility services that are covered. As shown in Table 2.2, 12 countries, including the United States and the United Kingdom, cover eight services, including diagnostic tests and fertility drugs, to varying degrees. Diagnostic examinations are covered in all countries except Singapore and India. Eight countries, including Australia and the United Kingdom, provide cost reimbursement for fertility drugs, while the United States and Singapore do not cover this expense. Seven countries, including Australia and the United Kingdom, cover the cost of intrauterine insemination, while the United States, Russia, Japan, India, and Brazil do not cover this expense. Ten countries, including Australia and the United Kingdom, cover both in vitro fertilization and intracytoplasmic sperm injection, and five countries also cover the cost of assisted hatching. For both fertility preservation programs, five countries, including the United Kingdom, France, Russia, Singapore, and Japan, provide financial support for cold storage of oocytes, and eight countries, including Australia and the United Kingdom, support cold storage of embryos. In terms of breadth of service coverage, France is the widest, covering all services (IFFS, 2022).

Table 2.2 Coverage of national public funds in 12 countries on the infertility services

				IVF technology			Fertility preservation	
	Diagnostic examination	Fertility drugs	Intrauterine insemination	In vitro fertilization	Intracytoplasmic sperm injection	Assisted hatching	Cold storage of oocytes	Cold storage of embryos
The US	√							
Australia	√	√	√	√	√			√
The UK	√	√	√	√	√		√	√
France	√	√	√	√	√	√	√	√
Germa	√	√	√	√	√			

				IVF technology			Fertility preservation	
	Diagnostic examination	Fertility drugs	Intrauterine insemination	In vitro fertilization	Intracytoplasmic sperm injection	Assisted hatching	Cold storage of oocytes	Cold storage of embryos
ny								
Russia	√	√		√	√	√	√	√
Singapore			√	√	√	√	√	√
Japan	√	√		√	√	√	√	√
South Korea	√	√	√	√	√	√		√
India				√	√			
Brazil	√							
South Africa	√	√	√	√	√			√

Note: "√" indicates that the service is covered; U.S. public health insurance reimburses the cost of infertility diagnostic tests, oocyte and embryo cryopreservation for patients with medical indications, and other costs are covered selectively by commercial insurers based on state policies.

Cost coverage refers to the proportion of infertility medical expenses that are reimbursed by the government and commercial insurance companies. As shown in Table 2.3, national public health insurance funds in seven countries, including Australia and the United Kingdom, are the main providers of infertility medical costs, with reimbursement rates ranging from 75% to 100%. In the United States and Japan, local public health insurance funds reimburse part of the medical costs of infertility, and Japan sets a maximum ceiling. In Russia, the national and regional public health insurance funds reimburse the entire medical expenses of infertility patients. Four countries, including the United States and Australia, have also introduced commercial insurance products to cover infertility medical expenses. Infertility medical costs in the United States account for 52% of per capita disposable income, which is reduced to 13% after reimbursement by commercial insurance (Chambers et al., 2014). In addition, infertility mutual aid healthcare has been established in the United States. Through an online crowdfunding platform (Go FundMe), 3,332 infertility-related fundraising campaigns are posted with a target amount of 52.6 million US dollars, and 22.5 million US dollars has been successfully raised (Lai et al., 2021). International comparative studies reveal that infertility medical security policies serve as crucial instruments for addressing low fertility rates, effectively contributing to the attainment of optimal population growth targets. In policy implementation, it is imperative to integrate governmental healthcare funds, market-based insurance mechanisms, and social assistance resources to establish a multi-tiered security network, which constitutes the fundamental element for sustaining policy continuity. Given that the prevalence and per capita medical expenditures of assisted reproductive treatments significantly exceed those of conventional medical conditions (typically by multiple-fold), it is recommended to implement dynamic adjustment of compensation standards based on regional fiscal capacities. Specifically, higher reimbursement ratios should be formulated according to financing capabilities, thereby substantially alleviating the economic burden of medical expenses for affected patients.

Table 2.3 Coverage of infertility medical expenses by different health insurance subjects in 9 countries

	National public healthcare fund	State/province/regional public healthcare fund	Commercial insurance
The US	0	Partial reimbursement	Maximums from $15,000 (Arkansas) to $100,000 (Maryland and Rhode Island); Rhode Island reimburses 80%; Massachusetts has no deductible, co-payment, or coverage limits
Australia	80%	—	Partial reimbursement
The UK	100%	0	0
France	100%	0	Partial reimbursement
Germany	Partial reimbursement	1,921 US dollars at most	Payment of the first 3 assisted reproductive surgeries
Russia	100%	100%	—
Singapore	75%	—	—
Japan	0	1,125 US dollars at most	0
South Korea	90%	Partial reimbursement	—

2.3 Theoretical framework and research hypotheses

Guided by stakeholder theory, the theory of information asymmetry, and social support theory, this study establishes a multi-level theoretical framework to investigate the relationship between economic burden, financial toxicity, and social support among patients undergoing ART. The framework is shown as per Figure 2.5. The model identifies economic burden as the independent variable, financial toxicity as the dependent variable, and social support as a moderating variable. From the perspective of stakeholders, we analyze the impact pathways through which the entities such as healthcare security bureau, medical institutions, commercial insurance companies and patient family members influence the patients' economic burden and financial toxicity.

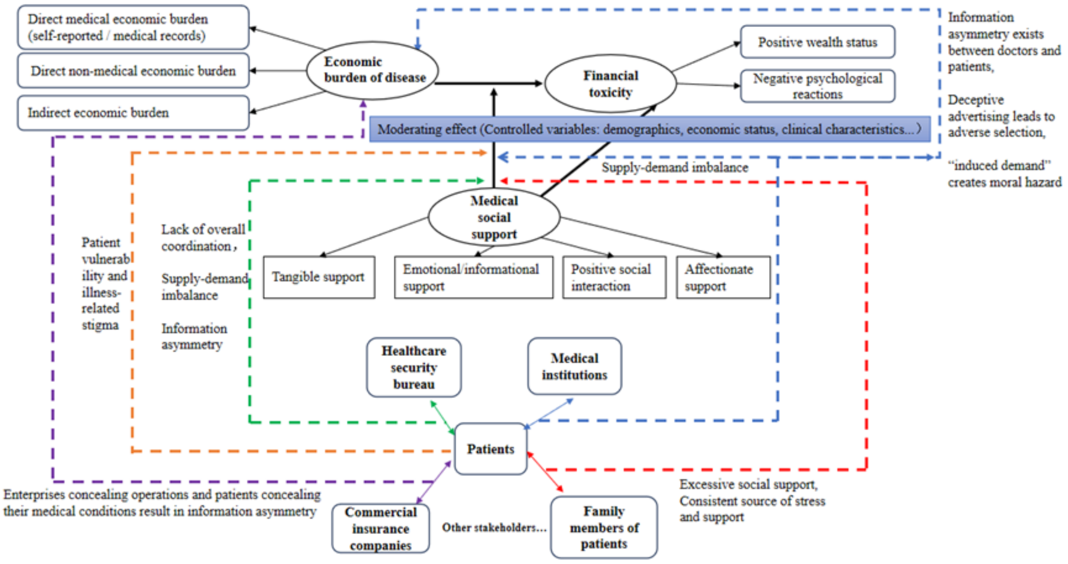

Figure 2.5. Theoretical framework

The economic burden of disease is conceptualized across three dimensions: direct medical economic burden, direct non-medical economic burden, and indirect economic burden. This burden directly contributes to financial toxicity, which manifests both in positive wealth status and negative psychological reactions. Social support, encompassing tangible support, emotional/informational support, positive social interaction and affectionate support, may buffer or intensify this relationship. The theoretical framework suggests that the moderating effect of social support could influence the relationship between the independent variable (economic burden) and dependent variable (financial toxicity) through patient vulnerability and illness-related stigma.

The stakeholder lens reveals critical pathways of influence. The actions and decisions of different stakeholders exert impacts on patients' economic burden and financial toxicity. For example, the coverage of health security bureau, commercial insurance payments, and out-of-pocket medical expenses directly impact economic burden. Asymmetric information between patients and providers can lead to false advertising (adverse selection) or induced demand (moral hazard) by healthcare institutions, further worsening economic burden. Medical and affectionate support from healthcare providers may alleviate financial toxicity. The influence of family support on mitigating financial toxicity varies.

Through systematic literature review, this study identifies contradictions and disagreements among various stakeholders, with their role definitions and interest demands exhibiting multi-dimensional heterogeneity. Notably, existing research reveals that social support may exert a moderating effect in the relationship between disease-related economic burden and financial distress. Particularly noteworthy is that theories such as the homology of stressors and support, and the inhibitory effect of stigma-driven information concealment on support efficacy, provide an innovative theoretical framework for dissecting the moderating mechanisms of social support. This opens new analytical dimensions for subsequent empirical research. Illustrative stakeholder conflicts include those between healthcare security bureau and patients: lack of overall coordination, demand-supply mismatches, information asymmetry. Commercial insurance and patients: insurers concealing information about their operations or patients withholding medical conditions lead to information asymmetry; Healthcare providers and patients: mismatched supply and demand for social support; Patients and family Members: excessive social support or pressure coinciding with support may potentially exacerbate the effects of economic burden on financial toxicity.

Based on literature review, the framework model proposes hypotheses regarding the main effect of economic burden of disease on financial toxicity and the moderating role of social support. Accordingly, the following hypotheses are proposed:

Hypothesis 1: Economic burden of disease is positively correlated with financial toxicity.

Hypothesis 2: Medical social support is negatively correlated with financial toxicity.

Hypothesis 3: Medical social support moderates the relationship between economic burden of disease and financial toxicity.

Chapter 3: Research Methods

Based on literature research, we integrate quantitative research and qualitative research to give full play to the respective advantages of the two methods, so that quantitative data and qualitative results can complement each other. The quantitative research aims at prediction and validation. We hope to explore the causal relationship between variables by describing the variables and testing the relationship between them, to ultimately verify the theoretical hypotheses. To be specific, the calculation of economic burden serves as the foundation for subsequent research, while also providing baseline data for governments and society to understand the economic burden and financial toxicity levels associated with ART. The Questionnaire for Measurement and Calculation of the Economic Burden of Disease, the Comprehensive Scores for Financial Toxicity Based on the Patient-Reported Outcome Measures, and the Medical Outcomes Study Social Support Survey are used to survey patients undergoing ART. We investigate the status quo of the financial toxicity and medical social support and analyze the influencing factors, systematically explore the relationship between the economic burden of disease, financial toxicity, and medical social support, and validate the moderating role of medical social support in the relationship between the economic burden of disease and financial toxicity.

Qualitative research is a holistic study of social phenomena adopting a variety of data collection methods in a natural context with the researcher himself/herself as the research tool. The greatest advantage is that descriptive data can be collected on the object or phenomenon of interest, from which, through a process of induction and deduction, the researcher can explain the reasons for the relationships found in quantitative research. To be specific, we first adopted literature research and focus group discussion to initially identify stakeholder candidates. Then, based on the Mitchell score-based approach, the stakeholders are categorized, identified and researched for their interest demands. In-depth interviews are conducted through the design of a semi-structured outline to investigate the level of social support provided by the stakeholders and the status of and reason for asymmetric information. Ultimately, we explore solutions to cope with the financial toxicity of patients undergoing ART and provide precise social support for them in a coordinated manner.

3.1 Quantitative research

3.1.1 Study population

Research has proven that infertility affects women more than men (Oddens et al., 1999). To a large extent, it is the medical and social burden on women (Chambers & Fauser, 2021). Specifically speaking, women are the central subjects of treatment in ART. As egg providers and pregnancy carriers, women undergo critical steps in assisted reproduction such as egg retrieval and embryo transfer, and their physiological conditions and health status directly determine the success of the technology. In addition, women face unique psychological, social and economic pressures. Therefore, the target population of this research is female patients undergoing ART.

3.1.1.1 Sample size determination

First, based on the method of estimating sample size in medical statistics (Yan, 2005), the sample size is usually more than 10 times the number of variables. With a total of 30 variables in the research, and taking into account the 20% sample invalidity rate, the sample size is determined to be more than 360 cases. Second, based on the list of reproduction centers published in the List of Medical Institutions Approved to Carry Out Assisted Human Reproductive Technology, and taking into account the level of economic development and geographic distribution of Shandong Province, the reproductive hospitals in four cities of Shandong Province, namely Jinan, Weifang, Qingdao, and Linyi, are sampled as the surveyed hospitals. Finally, we use the quota sampling method to select 100 patients undergoing ART in each of the four hospitals (400 patients in total), including Hospital for Reproductive Medicine Affiliated to Shandong University, Weifang Reproductive Hospital, Qingdao Women and Children's Hospital, and Linyi People's Hospital, as the survey respondents from June to September 2024.

3.1.1.2 Inclusion and exclusion criteria

Inclusion criteria: female patients who go to the hospital for assisted reproduction treatment, and the time frame for the measurement of the economic burden of disease starts from the establishment of the patient's file in the outpatient clinic during one cycle of assisted reproduction treatment to the end of obtaining a clinical pregnancy.

Exclusion criteria: patients with serious primary diseases, cognitive disorders or other situations which prevent them from participating in the survey.

3.1.2 Data collection tool

In this research, the economic burden of disease is the independent variable, financial toxicity is the dependent variable, medical social support is the moderator, and socio-demographic characteristics and patient’s treatment status are the control variables. We use a general information questionnaire, an assisted reproduction disease economic burden measurement model, Comprehensive Scores for Financial Toxicity Based on the Patient-Reported Outcome Measures, and Medical Outcomes Study Social Support Survey to survey the patients undergoing ART and provide on-site guidance for completion of the questionnaires, so as to comprehensively explore the relationship between economic burden of disease, financial toxicity, and medical social support.

(1) General information questionnaire

This questionnaire is designed based on literature review and on-site research, and it includes variables such as gender, age, educational background, work status, assisted reproductive technology mode, and number of cycles.

(2) Measurement model of the economic burden of assisted reproductive diseases

The previously described measurement model is used, including three parts: direct medical economic burden, direct non-medical economic burden and indirect economic burden. The direct medical economic burden is obtained through two ways, one by querying and calculating the costs in the medical record system, and the other by asking patients about their self-reported costs.

(3) Comprehensive Scores for Financial Toxicity Based on the Patient-Reported Outcome Measures (COST-PORM)

The scale was compiled at the University of Chicago in 2014, and the Chinese version is translated and revised in 2004. The Chinese version still contains 11 items of the original scale, including 2 dimensions: positive wealth status, and negative psychological reactions. A Likert 5-point scale ranging from 0 to 4 points is used. Except for items 1, 6, 7, and 11, all the items are reversed-scored, with a total score of 0 to 44. The lower the score, the greater the financial toxicity. A COST-PORM score of no less than 26 indicates no impact on quality of life (level 0), 14-25 indicates mild impact (level 1), 1-13 indicates moderate impact (level 2), and 0 indicates high impact (level 3). Level 1 and above are considered to have financial toxicity (Saeki et al., 2023). The Cronbach’s α coefficient of the scale in this study is 0.919, which indicates relatively high reliability.

(4) Medical Outcomes Study Social Support Survey (MOS-SSS)

The Medical Outcomes Study Social Support Survey (MOS-SSS) has shown good reliability and validity in applications in America (Sherbourne & Stewart, 1991). The Traditional Chinese version of the MOS-SSS investigates patients' social support with 20 items, including item 1 (a subjective question measuring the size of the patient support network), message and emotional support (8 items), practical support (4 items), social interaction support (4 items), and emotional support (3 items) (D. S. Yu et al., 2004). It is rated on a Likert 5-point scale, with 1 to 5 representing "never - always", and the scores of each dimension are standardized to be between 0 and 100. The Cronbach's α coefficient of the scale in this study is 0.974, which indicates a relatively high reliability.

3.1.3 Data collection steps

Implementation of pre-survey. The researcher conducted a pre-survey of 100 patients in a hospital that meet the inclusion criteria, identified inappropriate aspects of the scale and questionnaire in a timely manner, and adjusted some of the questionnaire items by obtaining patient feedback on the questionnaire and consulting experts.

Survey method. From June to September 2024, the researcher went to four reproductive medicine centers in Jinan, Weifang, Qingdao, and Linyi and surveyed the respondents by distributing printed questionnaires on the spot. After obtaining the consent of the respondents, the investigator first introduced the purpose, significance and method of the study, informed the confidentiality and harmlessness, eliminated the respondents' concerns and signed the informed consent form. The investigator told the respondents to complete the questionnaire independently according to the actual situation, and the time was controlled within 10 minutes.

Questionnaire collection. The questionnaires were collected on the spot after completion and the researchers performed logical check and quality assessment. In case of minor oversights and non-standardization, the researchers revised it on the spot. In case of serious logical errors, too many blank questions or other irremediable situations, the questionnaire would be considered as invalid.

3.1.4 Data processing steps

SPSS 25.0 was used to analyze the survey data collected. The researcher checked the quality of the data before analyzing, and all information was entered twice and double-checked. Technical data were described statistically using frequencies and percentages. All tests were performed using a two-sided test with a test level of $\alpha=0.05$, and it was considered statistically significant when $p<0.05$.

3.1.4.1 Measurement method of economic burden of disease and analysis of influencing factors

(1) Cost identification and measurement. Based on the health economics cost measurement model, the measurement of the economic burden of assisted reproductive diseases needs to include direct medical economic burden, direct non-medical economic burden and indirect economic burden. The direct medical economic burden can be obtained by data from patients' electronic medical records and questionnaires. The direct non-medical economic burden can be obtained by questionnaire survey, in which the investigator asks patients about the costs incurred during the consultation process, such as transportation, food, accommodation and nutrition. Indirect economic burden, mainly the loss of income due to consultation and accompanying, can be measured using the human capital approach (HCA), namely, average salary * (consultation time + accompanying time), and the consultation time and accompanying time can be collected through questionnaires.

(2) Aggregation of the direct medical economic burden, direct non-medical economic burden and indirect economic burden from the patient's perspective.

(3) Descriptive statistical analysis of economic burden of disease. One-way ANOVA was used to explore the effect of categorical covariates (education, place of residence, type of health insurance) in patients' general information on the economic burden of disease. Pearson correlation analysis was used to explore the effect of continuous covariates (age, household size) in patients' general information on the economic burden of disease.

(4) The generalized linear model is a direct generalization of the general linear model, which can be used to analyze the relationship between the influence of independent variables on non-normally distributed dependent variables. We choose the generalized linear model to analyze the influence of the factors such as age, assisted reproductive technology methods, number of cycles, level of regional economic development, patient's educational level, and income on the economic burden of disease.

3.1.4.2 Status quo of financial toxicity and medical social support and the influencing factors

One-way ANOVA was used to explore the influence of categorical covariates (education, place of residence, and type of health insurance) in patients' general information on financial toxicity and medical social support for analysis of variance. Pearson correlation analysis was used to explore the effect of continuous covariates (age and number of household members) in patients' general information on financial toxicity and medical social support for analysis of variance. Generalized linear model was applied to analyze the effects of factors such as age of patients undergoing ART, assisted reproductive technology methods, number of cycles, level of regional economic development, patients' educational level, income, and economic burden of disease on financial toxicity and medical social support.

3.1.4.3 Relationship between economic burden of disease, financial toxicity and medical social support

Pearson correlation coefficient was used to analyze the correlation between economic burden of disease, financial toxicity, and medical social support. The variable M is called a moderator if the relationship between the dependent variable Y and the independent variable X is affected by a third variable M, namely, M is able to change the direction and strength of the relationship between the independent variable X and the dependent variable Y. This study used the non-parametric bootstrap method to test the moderating effect, using PROCESS macro in SPSS. In the bootstrap analysis, the number of resamples was set to 5,000.

3.2 Qualitative research

3.2.1 Research subject

Initial stakeholder identification. Based on the literature research, we identify candidates of stakeholders including patients, hospitals, government, media, insurance companies, foundations and other social groups, adopt focus group discussion to obtain more information, and add some new candidates of stakeholders at the proper time.

Categorization and identification of stakeholders based on the Mitchell score-based approach. Drawing on the multidimensional classification method and the Mitchell score-based approach, we develop our own Assisted Reproduction Stakeholder Identification Questionnaire. The questionnaire is used to empirically investigate the boundaries and attributes of stakeholders. Through the questionnaire survey and the statistics and analysis of the data, the scores and rankings of the stakeholders in the three dimensions of power, legitimacy and urgency are obtained, and based on the Mitchell score-based approach, the stakeholders can be classified as definitive stakeholders, expectant stakeholders and latent stakeholders.

Stakeholder interview. A semi-structured interview outline is designed to interview stakeholders from healthcare organizations, the health administrative department, health insurance companies, and patients undergoing ART, with a view to understanding the current status and outlook of different stakeholders in terms of their social support strategies and interest demands.

3.2.1.1 Sample size determination

Based on the principle of maximum differentiation sampling, this qualitative research interview adopts the method of theoretical sampling. The sample size criterion is identified based on the extent to which information provided by the interviewees to reach a saturation state, that is, a state in which increase of the number of interviewees will not generate any new topics and themes.

3.2.1.2 Inclusion and exclusion criteria

The criteria for the inclusion of patients and their families are patients who are undergoing or have completed an assisted reproduction treatment, have certain language organization and expression skills, and are willing to share their personal experiences and feelings.

For the inclusion of other stakeholders such as the government, health insurance department, hospitals, and commercial insurance companies, the criteria are that the relevant staff who play a role in the development and implementation of policies, access to health care, and introduction of commercial insurance in the provision of social support to patients, and willing to cooperate with the researchers in the relevant interviews and the follow-up surveys.

3.2.2 Research tool

3.2.2.1 Interview outline

An interview outline is a supportive interview tool that allows the researcher to switch freely between pre-prepared topics of necessity and unintended topics, so that the interview can be limited to a certain range. In addition, the outline allows the researcher to think more clearly and guide the research team in conducting the interview without getting lost in strings of tracking questions.

The semi-structured interview outline was designed based on stakeholder theory, asymmetric information theory, social support theory, and the conclusions of the previous quantitative research.

3.2.2.2 MAXQDA

MAXQDA is a professional data analysis software for qualitative and mixed-methods research.

It is capable of processing a wide range of data such as text, audio, and video. It provides functions such as coding, visualization, and data retrieval, which can assist the researcher to manage and analyze the data efficiently. In order to better record the interview information, there are other supporting tools such as audio recorder, diary and summary sheet during the interview.

3.2.3 Data collection steps

3.2.3.1 Definition of stakeholder through focus group discussion

Based on literature research, the candidates of stakeholders are selected, including patients, hospitals, government, media, insurance companies, foundations and other social groups. A focus group discussion was held in October 2024 to obtain more information and add some new candidate options at proper time.

3.2.3.2 Categorization and identification of stakeholders by Delphi and the Mitchell score-based approach

Drawing on the multidimensional classification method and the Mitchell score-based approach, we develop our own Assisted Reproduction Stakeholder Identification Questionnaire. The questionnaire is used to empirically investigate the boundaries and attributes of stakeholders. From the first round of expert questionnaire distribution to the last round of expert questionnaire collection, the duration of each round of questionnaire distribution and collection is basically controlled within one week.

The first round of questionnaire distribution: the experts are provided with the information and background of the study, and are asked to determine whether the provided stakeholder candidates can be included or not. If they agree that the candidate can be included as the stakeholder, they will assign a five-point scale in terms of the three dimensions of power, legitimacy, and urgency, and give their opinions on improvement.

The second round of questionnaire distribution: after the statistical analysis of the collected questionnaires, based on the statistical results as well as the opinions given by the experts, we make modifications and distribute the second round of expert questionnaires, and attach the first round of statistical results for the reference of the experts. We will continue the procedure until the results of the present round of expert questionnaires are basically consistent with those of the previous round of expert questionnaires.

Through the questionnaire survey and the statistics and analysis of the data, the scores and rankings of the stakeholders in the three dimensions of power, legitimacy and urgency are obtained. Based on the Mitchell score-based approach, they can be classified as definitive stakeholders (scores of 3 or more on all three dimensions), expectant stakeholders (scores of 3 or more on two dimensions) and latent stakeholders (scores of 3 or more on one dimension).

3.2.3.3 Qualitative interview

The semi-structured interview outline is designed based on stakeholder theory, asymmetric information theory and social support theory as well as the problems found in the quantitative study and the corresponding conclusion. In November 2024, pre-interviews were conducted with a small sample of people who met the requirements for inclusion, and the outline was revised in a timely manner according to the actual content of the interviews and the occurring problems to ensure that the content of the interviews was more in line with the purpose of the study.

During the formal interview, the researcher contacted the respondents to determine the time and place of interview, clearly informed them of the purpose and process of the study, and signed an informed consent form. The in-depth interview was semi-structured and audio-recorded. The question items are open-ended such as “Do you know the support policy for assisted reproductive technology?”, so as to avoid inducing and suggestive language, and the statements, expressions, and behavioral responses of the interviewees were all faithfully recorded. The interviews lasted from 60 to 90 minutes, and if the interviewee dropped out, the reason for dropping out should be recorded in a timely manner. In the final stage, the interviewee was asked if he/she had anything else to add, and if he/she had new ideas and feelings later, he/she can contact the researcher for additional explanations.

3.2.4 Data processing steps

3.2.4.1 Data collation

Within 24 to 48 hours, the researcher transcribed the audio recordings into Chinese characters sentence by sentence, and integrated them with the behavioral expressions of the interviewees to organize them into text. An exclusive document with a serial number was created for each interviewee. For example, data of the patients were represented by A, and the first interviewee was labeled as A-01 in the order of the interviews starting from number 01. Data of the healthcare security office staff were represented by B, and the first interviewee was labeled as B-01. After the data were finally collated, all the information from the interviewees was recorded into EXCEL.

3.2.4.2 Data analysis

After the data were organized, the interviewer transcribed and coded the data in the first instance. Interview data were analyzed using thematic analysis. Thematic analysis is an independent qualitative descriptive method used to identify, analyze, and report patterns or themes in the data (Braun & Clarke, 2006). The specific analysis process includes the following steps.

(1) Get familiar with the material. Transcribe the information word by word and sentence by sentence according to the original meaning, read repeatedly and get familiar with the whole information, then look for the meaning and pattern, and record the most original ideas.

(2) Form the initial code. Systematic coding of all the data is carried out in MAXQDA. The specific steps are as follows: find the data corpus related to this study, extract the data item from the data corpus, and then refine the data extract to form the code.

(3) Find the themes. The codes are constantly compared and categorized, and the data with the same attributes are grouped into the same category to form potential themes. All data related to each potential theme are collected together.

(4) Check the themes. Carefully check whether the themes are relevant to the coded text and the entire data set, so as to form a thematic map.

(5) Define and name themes. Continuously compare and analyze the codes under different potential themes, refine the themes and sub-themes, and form clear names for the themes.

(6) Form a report. Select appropriate example excerpts, analyze selected excerpts, relate them to the research questions, and finally write the report.

3.3 Quality control

In the quantitative study, the following measures are taken for quality control of this study.

(1) The selection of patients undergoing ART is made in strict accordance with the inclusion criteria. Printed questionnaires are used for field research rather than using e-mail to collect information, so that the respondents can get explanations at any time when they encounter doubts, which can improve the quality of questionnaire completion.

(2) Patients undergoing ART generally have strong resistance and psychological defense. In order to establish a relationship of trust with them, the researcher explains at the beginning of the survey that the questionnaire involves personal privacy or sensitive issues, and promises that the information will be kept confidential. Unified and standardized instructions are used to ensure the accuracy of filled information.

(3) The questionnaires are distributed and collected on the spot, and are checked for any omissions or serious errors. When problems are found, the respondents are requested for completeness or modification in a timely manner.

(4) At the data entry stage, healthcare professionals familiar with the questionnaire are invited to double-check the questionnaires together with the investigators, and the data are corrected immediately if there are differences to ensure accurate entry. In the data processing stage, data analysis experts are invited to offer guidance and assistance.

In qualitative research, the investigator adheres to the principle of authenticity, which means that the phenomena and facts of the study are reflected in an authentic manner (Luczun, 1990). In this study, quality control of authenticity is carried out in the following ways.

(1) Reliability. Theoretical sampling is used in this study to cover the characteristics and feelings of the respondents as much as possible, and the interviews are audio-recorded and transcribed in an interview log. The audio-recorded information is listened to repeatedly after the interviews and transcribed into text.

(2) Stability. In order to avoid too much subjectivity on the part of the researcher during data analysis, the researcher invites an associate professor engaged in health management and familiar with the field of assisted reproduction to carry out the thematic extraction in accordance with the above steps of data analysis after the completion of thematic analysis by the researcher. When the extracted themes of the researcher and the professor vary greatly, the research team will discuss and determine the final themes to ensure the stability of the research results.

(3) Objectivity. The researcher does not have any interest relationship with the research subjects. Before the start of the study, the researcher has attended the systematic course on qualitative research and mastered the interviewing skills. During the formal interviews, the researcher keeps listening, does not take a position, and accurately records the expressions and body language of the research subjects. In the data collation and analysis phase, all text data are coded anonymously and analyzed in a neutral manner at all times.

3.4 Human rights protection and research ethics

The following principles are followed in this study.

(1) Principle of voluntariness. Before the start of quantitative and qualitative research, the researcher explains the purpose, significance, and precautions of the study to the subjects to improve cooperation and sign the informed consent form. In addition, at the end of the survey, the researcher expresses gratitude to every subject participating in the survey by giving small

gifts.

(2) Principle of nonmaleficence. The researcher encourages the research subjects to speak out their true feelings and opinions without causing any harm to them. However, if the patients have mood swings during the interview, the researcher will pacify them in a timely manner. The research subjects can withdraw from this study at any time without any reason at any stage of the study.

(3) Principle of confidentiality. In the course of the study, codes are used to indicate the research subjects, and the information and privacy of the interviewed subjects are not disclosed. This study has received ethical approval from the Medical Ethics Committee of Shandong University (No. ECSHCMSDU20230701).

Chapter 4: Results

4.1 Quantitative research findings

In this study, 413 printed questionnaires are distributed. Except for 17 missing and invalid questionnaires, there are 396 valid questionnaires, with a response rate of 95.88%.

In this study, the independent variable is the economic burden of disease, which consists of direct medical economic burden, direct non-medical economic burden and indirect economic burden. The direct medical economic burden is obtained in two ways, one is by querying and calculating costs in the medical record system, which is defined as the direct medical economic burden (medical records), and the other is by asking the patient for their self-reported costs, which is defined as the direct medical economic burden (self-reported). Then, there are also two ways to measure the patients' economic burden of disease. The first is the sum of direct medical economic burden (self-reported), direct non-medical economic burden, and indirect economic burden, which is defined as the economic burden of disease (self-reported). The second is the sum of direct medical economic burden (medical records), direct non-medical economic burden and indirect economic burden, which is defined as the economic burden of disease (medical records). The dependent variable is financial toxicity. Medical social support is the moderator. Specific variable assignments are shown as per Table 4.1.

Table 4.1 Variables as well as their definitions and assignments

Covariate	Variable type	Definition and assignment
Age	Continuous variable	22 to 46 years old
Educational background	Categorical variable	Junior high school and below, high school/secondary vocational school, junior college, and university and above, with values assigned as 1, 2, 3, and 4 respectively
Place of residence	Categorical variable	Urban area and rural area, with values assigned as 1 and 2 respectively
Number of household registered population	Continuous variable	1 to 9
Type of medical insurance	Categorical variable	Basic medical insurance for urban and rural residents, basic medical insurance for urban workers and others (including commercial medical insurance, self-financed medical care, free medical care and medical aid), with values assigned as 1, 2 and 3 respectively

Covariate	Variable type	Definition and assignment
Employment situation	Categorical variable	Employed, unemployed and other, with values assigned as 1, 2 and 3 respectively.
Annual per capita household income	Categorical variable	Below 20,000 yuan, 20,000 - 40,000 yuan, 40,000 - 60,000 yuan, 60,000 - 80,000 yuan, 80,000 - 100,000 yuan and above 100,000 yuan, with values assigned as 1, 2, 3, 4, 5 and 6 respectively.
Chronic disease	Categorical variable	No and yes, with values assigned as 0 and 1 respectively
Number of treatment cycles	Categorical variable	First treatment cycle, second treatment cycle, third treatment cycle and above, with values assigned as 1, 2, and 3 respectively
Complications	Categorical variable	No and yes, with values assigned as 0 and 1 respectively
ART treatment used in this cycle	Categorical variable	IVF, ICSI, and PGTD, with values assigned as 1, 2, and 3 respectively

4.1.1 Common method bias test

In this study, the Harman one-way test is used to determine whether the data are affected by common method bias. The results show that the variance explained by the first factor (unrotated) is 20.71%, which is less than 40%, indicating that the study does not have common method bias.

4.1.2 Basic characteristics of survey respondents

There are a total of 396 female patients undergoing ART in this quantitative study. The basic information is as follows. 21.72% have junior high school education or below, 16.67% have high school or secondary vocational school education, 24.24% have junior college education, and 37.37% have university education or above. The percentage of those living in urban areas is 65.91%, and the percentage of those living in rural areas is 34.09%. Those using basic medical insurance for urban and rural residents account for 34.85%, those using basic medical insurance for urban workers account for 61.87%, and those using other insurance (assisted reproduction commercial insurance) account for 3.28%. Employed respondents account for 69.95%, jobless or unemployed respondents account for 23.99%, and others account for 6.06%. Those with annual per capita household income below 20,000 yuan, between 20,000 and 40,000 yuan, between 40,000 and 60,000 yuan, between 60,000 and 80,000 yuan, between 80,000 and 100,000 yuan and above 100,000 yuan account for 10.61%, 16.67%, 20.20%, 14.90%, 15.91%, and 21.72% respectively. The percentage of those who do not suffer from chronic diseases is 93.94% and those who suffer from chronic diseases is 6.06%. The percentages of patients who undergo the first, second, and third or more treatment cycle of assisted reproductive technology are 83.08%, 13.13%, and 3.79% respectively. 93.18% of them have complications, and 6.82% do not have complications. The percentages of patients treated with IVF, ICSI, and PGT are 74.75%, 19.19%, and 6.06% respectively. The details are shown as per Table 4.2.

Table 4.2 Basic characteristics of survey respondents

Variables and categorization	N	%
Educational background		
Junior high school and below	86	21.72
High school/secondary vocational school	66	16.67
Junior college	96	24.24
University and above	148	37.37
Place of residence		
Urban areas	261	65.91
Rural areas	135	34.09
Type of medical insurance		
Basic medical insurance for urban and rural residents	138	34.85
Basic medical insurance for urban workers	245	61.87
Others	13	3.28
Employment situation		
Employed	277	69.95
Jobless/Unemployed	95	23.99
Others	24	6.06
Annual per capita household income		
Below 20,000 yuan	42	10.61
20,000 - 40,000 yuan	66	16.67
40,000 - 60,000 yuan	80	20.20
60,000 - 80,000 yuan	59	14.90
80,000 - 100,000 yuan	63	15.91
Above 100,000 yuan	86	21.72
Chronic disease		
No	372	93.94
Yes	24	6.06
Number of treatment cycle		
First	329	83.08
Second	52	13.13
Third and more	15	3.79
Complications		
No	369	93.18
Yes	27	6.82
ART treatment		
IVF	296	74.75
ICSI	76	19.19
PGT	24	6.06
Total	396	100.00

The average age of the respondents is 33.23±4.29 years, with a minimum of 22 and a maximum of 46 years old. The average household registered population is 3.24±1.23, with a minimum of 1 and a maximum of 9 persons. The medical social support score is 75.61±17.16, with a minimum of 20 and a maximum of 100 points. The average economic burden of disease (self-reported) is 57,900±37,800 yuan, with a minimum of 11,000 yuan and a maximum of 358,700 yuan. The average economic burden of disease (medical records) is 28,400±14,100 yuan, with a minimum of 500 yuan and a maximum of 99,700 yuan. In addition, the average direct medical economic burden (self-reported) is 40,400±18,200 yuan, with a minimum of 8,500 yuan and a maximum of 120,000 yuan. The average direct medical economic burden (Medical records) is 45,800±32,2000 yuan, with a minimum of 10,400 yuan and a maximum of 32,800 yuan. The average direct non-medical economic burden is 8,500±13,200 yuan, with a minimum of 0 and a maximum of 95,000 yuan. The average indirect economic burden is 8,900±20,600 yuan, with a minimum of 0 and a maximum value of 266,700 yuan. The details are shown as per Table 4.3.

Table 4.3 Basic characteristics of survey respondents

	N	Min	Max	Mean	SD	SE
Age	396	22.000	46.000	33.227	4.290	0.216
Household registered population	396	1.000	9.000	3.237	1.230	0.062
Medical social support	396	20.000	100.000	75.612	17.163	0.862
Economic burden of disease (self-reported)	396	1.102	35.867	5.786	3.782	0.190
Direct medical economic burden (self-reported)	396	0.850	12.000	4.043	1.824	0.092
Direct non-medical economic burden	396	0.000	9.500	0.852	1.315	0.066
Indirect economic burden	396	0.000	26.667	0.892	2.062	0.104
Economic burden of disease (medical records)	396	1.040	32.800	4.580	3.223	0.162
Direct medical economic burden (medical records)	396	0.050	9.970	2.836	1.408	0.071

4.1.3 Statistical analysis of economic burden of disease (self-reported), financial toxicity, and medical social support

4.1.3.1 Statistical analysis of economic burden of disease (self-reported)

Table 4.4 shows that the differences in the economic burden of disease (self-reported) are statistically significant ($p<0.05$) in terms of different educational background, type of medical insurance, annual per capita household income, number of treatment cycles, and ART treatment methods. To be specific, those with junior high school and below educational background have a heavier economic burden of disease compared to others. Compared with those using the basic medical insurance for urban and rural residents and basic medical insurance for urban workers, the economic burden of disease is heavier for those who do not use medical insurance or only use commercial insurance. The economic burden of disease for those with an annual per capita household income of less than 20,000 yuan is the highest among respondents with different annual per capita household income. The economic burden of disease for those who have undergone three or more cycles of treatment is higher than those with one or two cycles. The economic burden of disease for patients using PGT is highest and patients using IVF is the lowest.

Table 4.4 Statistical analysis of economic burden of disease (self-reported)

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
Categorical variable	Educational background					3.840[a]	0.010
	Junior high school and below	6.987	4.947	5.926	8.047		
	High school/secondary vocational school	5.289	2.103	4.772	5.806		
	Junior college	5.427	3.393	4.740	6.115		
	University and above	5.544	3.714	4.940	6.147		
	Place of residence					0.183[a]	0.669
	Urban areas	5.728	4.026	5.237	6.219		
	Rural areas	5.900	3.271	5.343	6.456		
	Type of medical insurance						
	Basic medical insurance for urban and rural residents	6.341	4.024	5.664	7.019	8.375[a]	$<$ 0.001
	Basic medical insurance for urban workers	5.305	3.495	4.865	5.745		
	Others	8.970	4.284	6.381	11.559		
	Employment situation						
	Employed	5.621	3.809	5.171	6.072	1.477[a]	0.230
	Jobless/Unemployed	6.361	4.039	5.538	7.184		
	Others	5.420	1.750	4.682	6.159		
	Annual per capita household income					3.106[a]	0.009
	Below 20,000 yuan	7.560	5.412	5.873	9.246		
	20,000 - 40,000 yuan	5.822	3.119	5.055	6.589		
	40,000 - 60,000 yuan	5.272	2.982	4.608	5.935		
	60,000 - 80,000 yuan	5.150	2.357	4.536	5.765		
	80,000 - 100,000 yuan	5.200	2.225	4.640	5.760		
	Above 100,000 yuan	6.238	5.168	5.130	7.346		
	Chronic disease					2.053[a]	0.153
	No	5.717	3.779	5.332	6.103		
	Yes	6.857	3.744	5.276	8.438		
	Number of treatment cycle					5.662[a]	0.004
	First	5.517	3.406	5.148	5.887		
	Second	6.833	5.204	5.384	8.281		
	Third and more	8.060	4.669	5.475	10.646		

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
	Complications					0.111^{a}	0.739
	No	5.804	3.863	5.408	6.199		
	Yes	5.552	2.451	4.583	6.522		
	ART treatment method					20.605^{a}	＜ 0.001
	IVF	5.368	3.561	4.960	5.775		
	ICSI	6.004	3.915	5.110	6.899		
	PGT	10.262	3.128	8.941	11.583		
	Total	5.786	3.782	5.413	6.160		
Continuous variable	Financial toxicity	24.477	7.810	-0.272	-0.361	-0.179^{b}	＜ 0.001
	Age	33.227	4.290	0.002	0.197	0.101^{b}	0.046
	Household registered population	3.237	1.230	-0.098	0.099	0.000^{b}	0.995
	Medical social support	75.612					＜0.001
	Direct medical economic burden (self-reported)	4.043	1.824	0.605	0.716	0.664^{b}	＜ 0.001
	Direct non-medical economic burden	0.852	1.315	0.656	0.755	0.709^{b}	＜ 0.001
	Indirect economic burden	0.892	2.062	0.756	0.829	0.795^{b}	＜ 0.001
	Direct medical economic burden (medical records)	2.836	1.408	0.114	0.302	0.210^{b}	＜ 0.001
	Economic burden of disease (medical records)	4.580	3.223	0.867	0.909	0.890^{b}	＜ 0.001

For categorical variables, mean and standard deviation were reported as statistics for the dependent variable (economic burden of disease), with between-group differences analyzed using one-way ANOVA (F), denoted by superscript a. For continuous variables, mean and standard deviation were presented as statistics for the covariates themselves, and their correlation with the dependent variable was assessed using Pearson correlation coefficient (r), denoted by superscript b.

Correlation analysis shows that economic burden of disease (self-reported) is positively related to age (r=0.10, $p<0.05$). There is a significant positive correlation between economic burden of disease (self-reported) and economic burden of disease (medical records), direct medical economic burden (self-reported), direct medical economic burden (medical records), direct non-medical economic burden, and indirect economic burden. Among them, the correlation between economic burden of disease (self-reported) and economic burden of disease (medical records) has the highest significance (r=0.89, $p<0.001$).

4.1.3.2 Statistical analysis of financial toxicity

Table 4.5 shows that the financial toxicity score of patients undergoing ART is 24.48±7.81. To be specific, 181 patients are in level 0, with an average score of 30.851±4.54, a minimum of 26 and a maximum of 44; 184 patients are in level 1, with an average score of 21.01±3.16, a minimum of 14 and a maximum of 25. 31 patients are in level 2, with an average score of 7.84±3.69, a minimum of 7.84 and a maximum of 3.69. The incidence of financial toxicity among patients undergoing ART in this survey is 54.29%.

Table 4.5 Statistical data of financial toxicity

Level of financial toxicity	N	Min	Max	Mean	SD	Variance
0	181	26	44	30.851	4.542	20.628
1	184	14	25	21.011	3.157	9.967
2	31	2	13	7.839	3.689	13.606
Total	396	2	44	24.477	7.810	60.989

Table 4.6 demonstrates statistically significant associations ($p<0.05$) between educational attainment, medical insurance typologies, employment status, household annual per capita income, chronic disease comorbidity, and treatment cycle frequency with financial toxicity. Specifically, patients with lower educational qualifications exhibited significantly lower financial toxicity scores, a finding that mirrors their heightened real-world financial burden, potentially attributable to limited financial literacy and reduced access to income-generating opportunities. In contrast, higher-educated individuals demonstrated elevated scores, which may reflect greater capacity for financial planning and resource mobilization. Urban and rural residents enrolled in basic medical insurance presented the lowest scores on the financial toxicity scale, yet concurrently exhibited the most severe actual financial strain, likely due to inadequate coverage for high-cost therapies and limited catastrophic expenditure protection. Conversely, urban employee basic medical insurance recipients recorded the highest scores but the mildest real-world financial impact, underscoring the critical role of comprehensive insurance coverage in mitigating economic toxicity. Unemployed patients or those unable to secure employment evidenced the lowest scores, a paradox that signals profound financial toxicity stemming from income instability and reduced access to employer-sponsored benefits. This pattern was mirrored in lower-income households, where individuals with annual per capita incomes of 20,000-40,000 yuan experienced the most acute financial stress, possibly due to the disproportionate impact of healthcare costs on subsistence-level budgets. Patients with chronic diseases, increased treatment cycles, or complications exhibited lower scores, a counterintuitive finding that may reflect prolonged healthcare utilization, cumulative out-of-pocket expenses, and the compounding effect of concurrent medical conditions on household financial stability. These results highlight the multifactorial nature of financial toxicity and underscore the need for targeted interventions addressing socioeconomic vulnerabilities in healthcare populations.

Table 4.6 Statistical analysis of financial toxicity.

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
Categorical variable	Educational background					6.622[a]	＜0.001
	Junior high school and below	22.070	7.746	20.409	23.730		
	High school/secondary vocational school	23.864	7.454	22.031	25.696		
	Junior college	23.927	6.898	22.529	25.325		
	University and above	26.507	8.122	25.187	27.826		
	Place of residence					1.611[a]	0.205
	Urban areas	24.835	8.142	23.843	25.828		
	Rural areas	23.785	7.101	22.576	24.994		
	Type of medical insurance						
	Basic medical insurance for urban and rural residents	22.804	7.009	21.625	23.984	5.204[a]	0.006
	Basic medical insurance for urban workers	25.449	8.128	24.426	26.472		
	Others	23.923	7.182	19.583	28.263		
	Employment situation						
	Employed	25.090	8.164	24.125	26.056	3.158[a]	0.044
	Jobless/Unemployed	22.779	7.044	21.344	24.214		
	Others	24.125	5.310	21.883	26.367		
	Annual per capita household income					7.175[a]	＜0.001
	Below 20,000 yuan	22.238	7.811	19.804	24.672		
	20,000 - 40,000 yuan	21.818	7.791	19.903	23.734		
	40,000 - 60,000 yuan	22.675	7.369	21.035	24.315		
	60,000 - 80,000 yuan	25.119	6.706	23.371	26.866		
	80,000 - 100,000 yuan	25.952	6.649	24.278	27.627		
	Above 100,000 yuan	27.767	8.384	25.970	29.565		
	Chronic disease					5.627[a]	0.018
	No	24.712	7.590	23.939	25.486		
	Yes	20.833	10.171	16.539	25.128		
	Number of treatment cycle					4.211[a]	0.015
	First	24.957	7.575	24.136	25.779		
	Second	22.615	8.759	20.177	25.054		
	Third and more	20.400	7.808	16.076	24.724		
	Complications					4.628[a]	0.032
	No	24.705	7.788	23.907	25.502		
	Yes	21.370	7.571	18.375	24.365		
	ART treatment method					2.749[a]	0.065
	IVF	24.686	7.515	23.826	25.546		
	ICSI	24.803	8.246	22.918	26.687		
	PGT	20.875	9.317	16.941	24.809		
	Total	24.477	7.810	23.706	25.249		

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
Continuous variable	Age	33.237	4.290	-0.222	-0.028	-0.126^{b}	0.012
	Household registered population	3.237	1.230	-0.080	0.117	0.018^{b}	0.714
	Medical social support	24.477	7.810	0.262	0.435	0.351^{b}	＜0.001
	Economic burden of disease (self-reported)	75.612	17.163	-0.361	-0.179	-0.272^{b}	＜0.001
	Direct medical economic burden (self-reported)	4.043	1.824	-0.356	-0.173	-0.267^{b}	＜0.001
	Direct non-medical economic burden	0.852	1.315	-0.304	-0.116	-0.212^{b}	＜0.001
	Indirect economic burden	0.892	2.062	-0.224	-0.030	-0.128^{b}	0.011
	Direct medical economic burden (medical records)	2.836	1.408	-0.216	-0.022	-0.120^{b}	0.017
	Economic burden of disease (medical records)	4.580	3.223	-0.313	-0.125	-0.221^{b}	＜0.001

For categorical variables, mean and standard deviation were reported as statistics for the dependent variable (financial toxicity), with between-group differences analyzed using one-way ANOVA (F), denoted by superscript a. For continuous variables, mean and standard deviation were presented as statistics for the covariates themselves, and their correlation with the dependent variable was assessed using Pearson correlation coefficient (r), denoted by superscript b.

Correlation analysis revealed a significant positive correlation between medical social support and financial toxicity (r=0.35, p<0.001), while age, disease economic burdens, and direct/indirect costs showed significant negative correlations, indicating severer actual financial toxicity.

4.1.3.3 Statistical analysis of medical social support

The medical social support score after standardization is 75.61±17.16 for this study. The results are shown as per Table 4.7.

Table 4.7 Statistical data of the four dimensions of medical social support

Medical social support dimension	N	Min	Max	Mean	SD	Variance
Tangible support	396	20	100	77.008	17.684	312.73
Emotional/informational support	396	20	100	71.780	17.738	314.64
Positive social interaction	396	20	100	75.379	18.664	348.34
Affectionate support	396	20	100	78.283	18.094	327.40
Total	396	20	100	75.612	17.163	294.57

Table 4.8 shows that the differences of medical social support in patients with different educational level, place of residence, type of medical insurance, employment status, annual per capita household income, and number of treatment cycles are statistically significant (p<0.05). The higher the level of education, the higher the level of medical social support. The medical

social support of urban patients is higher than that of rural patients. The medical social support of patients with other insurances (commercial insurance) is higher than that of patients with basic medical insurance for urban and rural residents and basic medical insurance for urban workers. The medical social support of the employed is higher than that of the jobless or unemployed. The medical social support of patients undergoing the first cycle of treatment is higher than that of other patients, suggesting that the level of medical social support may be decreasing as the number of treatment cycles increases.

Table 4.8 Statistical analysis of medical social support

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
Categorical variable	Educational background					13.891[a]	＜0.001
	Junior high school and below	66.519	17.752	62.713	70.325		
	High school/secondary vocational school	73.801	15.320	70.034	77.567		
	Junior college	77.494	16.393	74.172	80.815		
	University and above	80.484	15.994	77.886	83.082		
	Place of residence					6.381[a]	0.012
	Urban areas	77.169	17.627	75.020	79.317		
	Rural areas	72.603	15.863	69.903	75.304		
	Type of medical insurance						
	Basic medical insurance for urban and rural residents	71.661	16.675	68.854	74.468	5.802[a]	0.003
	Basic medical insurance for urban workers	77.649	16.788	75.536	79.761		
	Others	79.183	22.655	65.493	92.873		
	Employment situation						
	Employed	77.829	16.708	75.853	79.806	8.881[a]	＜0.001
	Jobless/Unemployed	69.421	16.764	66.006	72.836		
	Others	74.531	18.483	66.727	82.336		
	Annual per capita household income					5.132[a]	＜0.001
	Below 20,000 yuan	70.238	19.720	64.093	76.383		
	20,000 - 40,000 yuan	70.388	17.071	66.192	74.585		
	40,000 - 60,000 yuan	75.195	15.075	71.841	78.550		
	60,000 - 80,000 yuan	73.598	15.684	69.511	77.686		
	80,000 - 100,000 yuan	78.525	16.368	74.403	82.647		
	Above 100,000 yuan	81.882	17.305	78.172	85.592		
	Chronic disease					2.240[a]	0.135
	No	75.940	16.991	74.208	77.672		
	Yes	70.538	19.325	62.378	78.698		
	Number of treatment cycle					3.395[a]	0.035
	First	76.434	16.901	74.601	78.267		

Variables type	Variables and categorization	Mean	SD	95% CI		F/r	*p*
				Lower	Upper		
	Second	73.265	18.340	68.159	78.371		
	Third and more	65.722	15.891	56.922	74.523		
	Complications					0.349^{a}	0.555
	No	75.750	17.334	73.976	77.525		
	Yes	73.727	14.789	67.877	79.577		
	ART treatment method					0.953^{a}	0.387
	IVF	75.402	17.611	73.387	77.416		
	ICSI	74.967	16.121	71.283	78.651		
	PGT	80.252	14.458	74.147	86.357		
	Total	75.612	17.163	73.917	77.308		
Continuous variable	Age	33.237	4.290	-0.263	-0.071	-0.169^{b}	0.001
	Household registered population	3.237	1.230	-0.128	0.069	-0.030^{b}	0.557
	Financial toxicity	24.477	7.810	0.262	0.435	0.351^{b}	＜0.001
	Direct medical economic burden (self-reported)	75.612	17.163	-0.235	-0.041	-0.139^{b}	0.006
	Direct non-medical economic burden	4.043	1.824	-0.284	-0.094	-0.191^{b}	＜0.001
	Indirect economic burden	0.852	1.315	-0.201	-0.006	-0.105^{b}	0.038
	Economic burden of disease (self-reported)	0.892	2.062	-0.284	-0.094	-0.190^{b}	＜0.001
	Economic burden of disease (medical records)	2.836	1.408	-0.191	0.004	-0.095^{b}	0.060
	Direct medical economic burden (medical records)	4.580	3.223	0.016	0.211	0.114^{b}	0.023

For categorical variables, mean and standard deviation were reported as statistics for the dependent variable (medical social support), with between-group differences analyzed using one-way ANOVA (F), denoted by superscript a. For continuous variables, mean and standard deviation were presented as statistics for the covariates themselves, and their correlation with the dependent variable was assessed using Pearson correlation coefficient (r), denoted by superscript b.

Correlation analysis shows that medical social support is negatively related ($p<0.05$) to economic burden of disease (self-reported), economic burden of disease (medical records), age, direct medical economic burden (self-reported), direct non-medical economic burden, and indirect economic burden, indicating that the higher the above variables, the lower the medical social support. Medical social support is positively related to direct medical economic burden (medical records) ($p<0.05$).

4.1.4 Correlation analysis of economic burden of disease (self-reported), financial toxicity, and medical social support

Table 4.9 shows that financial toxicity has a significant negative correlation with economic burden of disease (self-reported) (r=-0.27, $p<0.001$), indicating that the higher the economic burden, the lower the financial toxicity score, and the more severe the actual financial toxicity. Financial toxicity has a significant positive correlation with medical social support as well as the dimensions of social support, and the correlation between financial toxicity and tangible support is the strongest (r=0.37, $p<0.001$). It indicates that the higher the social support, the higher the financial toxicity score and the less severe the actual financial toxicity. There are also significant positive correlations between the dimensions of medical social support.

Table 4.9 Correlation analysis of economic burden of disease (self-reported), financial toxicity, and medical social support

Variable		Economic burden of disease (self-reported)	Financial toxicity	Medical social support	Tangible support	Emotional/informational support	Positive social interaction	Affectionate support
Economic burden of disease (self-reported)	Correlation	1						
Financial toxicity	Correlation	-0.272***	1					
Medical social support	Correlation	-0.190***	0.351***	1				
Tangible support	Correlation	-0.218***	0.369***	0.926***	1			
Emotional/informational support	Correlation	-0.161***	0.345***	0.961***	0.851***	1		
Positive social interaction	Correlation	-0.171**	0.305***	0.961***	0.833***	0.915***	1	
Affectionate support	Correlation	-0.175***	0.319***	0.956***	0.842***	0.889***	0.905***	1

Note: ***$p<0.001$, **$p<0.01$

4.1.5 Regression analysis of economic burden of disease (self-reported), financial toxicity, and medical social support

4.1.5.1 Regression analysis of economic burden of disease (self-reported)

Table 4.10 shows that patients with annual per capita household income of 40,000-60,000 yuan (B=-1.66, $p<0.05$), 60,000-80,000 yuan (B=-2.05, $p<0.05$), and 80,000-100,000 yuan (B=-1.69, $p<0.05$) have a lower economic burden of disease compared to patients with an annual per capita household income of less than 20,000 yuan. The economic burden is significantly higher in patients treated with PGD compared to those treated with IVF (B=4.50, $p<0.001$). Medical-social support is also an influencing factor of the economic burden of disease, and the higher the medical social support, the lower the economic burden of disease (B=-0.04, $p<0.05$).

Table 4.10 Regression analysis results of economic burden of disease (self-reported)

Variable	B	SE	95% CI		p
			Lower	Upper	
Age	-0.002	0.045	-0.089	0.086	0.972
Educational background					
University and above	-0.781	1.225	-3.183	1.62	0.524
Junior college	-0.64	1.07	-2.736	1.456	0.549
High school/secondary vocational school	-1.201	0.844	-2.855	0.454	0.155
Junior high school and below	Ref.				
Place of residence					
Rural areas	-0.488	0.44	-1.351	0.374	0.267
Urban areas	Ref.				
Household registered population	0.06	0.166	-0.264	0.385	0.715
Type of medical insurance					
Others	1.59	0.992	-0.354	3.534	0.109
Basic medical insurance for urban workers	-1.086	0.668	-2.395	0.223	0.104
Basic medical insurance for urban and rural residents	Ref.				
Employment situation					
Others	-0.608	0.574	-1.734	0.518	0.29
Jobless/Unemployed	-0.901	0.534	-1.947	0.146	0.092
Employed	Ref.				
Annual per capita household income					
Above 100,000 yuan	-0.361	0.981	-2.284	1.562	0.713
80,000 - 100,000 yuan	-1.693	0.769	-3.2	-0.186	0.028
60,000 - 80,000 yuan	-2.049	0.84	-3.694	-0.403	0.015
40,000 - 60,000 yuan	-1.664	0.832	-3.295	-0.034	0.045
20,000 - 40,000 yuan	-1.292	0.827	-2.912	0.328	0.118
Below 20,000 yuan	Ref.				
Chronic disease					
Yes	0.986	0.722	-0.430	2.402	0.172
No	Ref.				
Number of treatment cycle					
Third and more	1.986	1.182	-0.332	4.303	0.093
Second	0.615	0.628	-0.616	1.847	0.328
First	Ref.				
Complications					
Yes	-0.875	0.4513	-1.759	0.010	0.053
No	Ref.				
ART treatment method					
PGT	4.498	0.722	3.084	5.913	<0.001
ICSI	0.358	0.415	-0.455	1.171	0.388
IVF	Ref.				
Medical social support	-0.042	0.018	-0.078	-0.006	0.021

4.1.5.2 Regression analysis of financial toxicity

As can be seen in Table 4.11, compared with those with an annual per capita household income of less than 20,000, the financial toxicity score of patients with an annual per capita household income of more than 100,000 yuan (B=4.05, $p<0.05$) is higher, and the financial toxicity for them is less severe in reality. Patients with complications have lower financial toxicity scores and actually experience more severe financial toxicity than patients without complications. Medical social support significantly affects financial toxicity (B=0.11, $p<0.001$), indicating that the stronger the medical social support, the higher the financial toxicity score and the less severe the actually experienced financial toxicity. Economic burden of disease also has a significant influence on financial toxicity (B=-0.39, $p<0.001$), indicating that the higher the economic burden, the lower the financial toxicity score and the more severe the actually experienced financial toxicity.

Table 4.11 Linear regression analysis of financial toxicity

Variable	B	SE	95% CI		*p*
			Lower	Upper	
Age	-0.059	0.087	-0.231	0.112	0.496
Educational background					
University and above	1.196	1.221	-1.197	3.589	0.327
Junior college	-1.205	1.162	-3.483	1.073	0.300
High school/secondary vocational school	-0.02	1.209	-2.39	2.35	0.987
Junior high school and below	Ref.				
Place of residence					
Rural areas	0.795	0.871	-0.912	2.502	0.361
Urban areas	Ref.				
Household registered population	0.481	0.294	-0.096	1.058	0.102
Type of medical insurance					
Others	2.176	2.323	-2.376	6.729	0.349
Basic medical insurance for urban workers	0.973	0.979	-0.946	2.891	0.320
Basic medical insurance for urban and rural residents	Ref.				
Employment situation					
Others	0.254	1.519	-2.723	3.231	0.867
Jobless/Unemployed	0.88	0.997	-1.073	2.833	0.377
Employed	Ref.				
Annual per capita household income					
Above 100,000 yuan	4.046	1.337	1.425	6.667	0.002
80,000 - 100,000 yuan	2.163	1.339	-0.462	4.787	0.106
60,000 - 80,000 yuan	1.857	1.34	-0.769	4.483	0.166
40,000 - 60,000 yuan	-0.787	1.351	-3.435	1.862	0.56
20,000 - 40,000 yuan	-0.863	1.39	-3.587	1.861	0.535
Below 20,000 yuan	Ref.				
Chronic disease					
Yes	-2.662	1.687	-5.969	0.645	0.115
No	Ref.				
Number of treatment cycle					
Third and more	-2.526	2.158	-6.756	1.704	0.242
Second	-0.943	1.084	-3.067	1.18	0.384
First	Ref.				
Complications					
Yes	-2.725	1.215	-5.107	-0.343	0.025
No	Ref.				
ART treatment method					
PGT	-2.5	1.819	-6.066	1.066	0.169

Variable	B	SE	95% CI		p
			Lower	Upper	
ICSI	0.405	0.882	-1.323	2.133	0.646
IVF	Ref.				
Medical social support	0.11	0.023	0.065	0.155	<0.001
Economic burden of disease (self-reported)	-0.393	0.114	-0.616	-0.171	0.001

4.1.5.3 Regression analysis of medical social support

Table 4.12 shows that age affects the level of medical social support (B=-0.54, *p*<0.05), indicating that the level of medical social support decreases with increasing age. Patients with the educational background of junior college (B=8.05, *p*<0.05) and university and above (B=11.41, *p*<0.001) have higher medical social support compared to patients with the educational background of junior high school and below. It indicates that as the level of education increases, the level of medical social support increases accordingly. Patients experiencing three and more cycles of treatment present a decrease in the level of medical social support compared to patients experiencing the first cycle (B=-7.36, *p*<0.05). Patients treated with PGD show a significant increase in the level of medical social support compared to patients treated with IVF (B=11.43, *p*<0.001). Economic burden of disease is also an influencing factor of medical social support (B=-0.88, *p*<0.05), indicating that the higher the economic burden of disease, the lower the level of medical social support.

Table 4.12 Linear regression analysis of medical social support

Variable	B	SE	95% CI		p
			Lower	Upper	
Age	-0.544	0.175	-0.887	-0.200	0.002
Educational background					
University and above	11.407	2.992	5.543	17.272	<0.001
Junior college	8.05	2.932	2.303	13.798	0.006
High school/secondary vocational school	5.248	2.718	-0.079	10.574	0.053
Junior high school and below	Ref.				
Place of residence					
Rural areas	0.135	1.990	-3.764	4.035	0.946
Urban areas	Ref.				
Household registered population	0.254	0.671	-1.061	1.569	0.705
Type of medical insurance					
Others	4.901	5.4078	-5.698	15.5	0.365
Basic medical insurance for urban workers	-3.771	2.584	-8.836	1.293	0.144
Basic medical insurance for urban and rural residents	Ref.				
Employment situation					
Others	0.564	3.969	-7.215	8.342	0.887

Variable	B	SE	95% CI		*p*
			Lower	Upper	
Jobless/Unemployed	-3.588	2.541	-8.568	1.392	0.158
Employed	Ref.				
Annual per capita household income					
Above 100,000 yuan	5.753	3.707	-1.514	13.019	0.121
80,000 - 100,000 yuan	4.052	3.599	-3.002	11.106	0.26
60,000 - 80,000 yuan	-1.361	3.565	-8.349	5.627	0.703
40,000 - 60,000 yuan	0.263	3.424	-6.447	6.973	0.939
20,000 - 40,000 yuan	-1.679	3.386	-8.316	4.957	0.620
Below 20,000 yuan	Ref.				
Chronic disease					
Yes	-4.007	3.445	-10.759	2.746	0.245
No	Ref.				
Number of treatment cycle					
Third and more	-7.36	3.644	-14.502	-0.217	0.043
Second	-2.21	2.489	-7.088	2.668	0.375
First	Ref.				
Complications					
Yes	-1.468	2.679	-6.720	3.783	0.584
No	Ref.				
ART treatment method					
PGT	11.432	3.565	4.444	18.419	0.001
ICSI	-1.125	2.052	-5.146	2.897	0.584
IVF	Ref.				
Economic burden of disease (self-reported)	-0.881	0.446	-1.755	-0.006	0.048

4.1.6 Analysis of the moderating role of medical social support

Table 4.13 shows that the economic burden of disease (self-reported) and medical social support interaction item is incorporated in the model to test the moderating effect of medical social support. The R-squared value of Model 3 was significantly higher than that of Model 1 and Model 2, suggesting that after controlling for other variables, the moderating effect of medical social support had a stronger ability to explain financial toxicity. The coefficient of the interaction term is -0.01 and it is significant ($p<0.05$) in both Model 2 and Model 3, which suggests that medical social support has a moderating effect on the relationship between economic burden of disease (self-reported) and financial toxicity. To be specific, the relationship between economic burden of disease (self-reported) and financial toxicity is relatively weak in patients with low medical social support and strong in patients with high medical social support. Medical social support plays a negative moderating role in economic burden and financial toxicity, which subverts the traditional assumption of social support buffer. This finding uncovers theoretically unexpected interactions and is contrary to the generalized conclusion of the buffering effect of social support.

Table 4.13 Analysis of the moderating role of medical social support in the relationship between economic burden of disease (self-reported) and financial toxicity

Model	Variable	Coefficient	SE	T	*p*	95% CI		R	R^2
						Lower	Upper		
Model 1	Constant term	16.339	1.841	8.874	< 0.001	12.719	19.959	0.409	0.167
	Economic burden of disease (self-reported)	-0.440	0.097	-4.546	< 0.001	-0.631	-0.250		
	Medical social support	0.141	0.021	6.623	< 0.001	0.099	0.183		
Model 2	Constant term	12.945	1.679	7.710	< 0.001	9.644	16.246	0.424	0.18
	Economic burden of disease (self-reported)	0.201	0.280	0.717	0.474	-0.350	0.751		
	Medical social support	0.151	0.022	7.000	< 0.001	0.109	0.193		
	Interaction term	-0.009	0.004	-2.438	0.015	-0.017	-0.002		
Model 3	Constant term	10.137	4.589	2.209	0.029	1.113	19.160	0.502	0.252
	Economic burden of disease (self-reported)	0.265	0.276	0.958	0.339	-0.279	0.808		
	Medical social support	0.117	0.023	5.181	< 0.001	0.073	0.162		
	Interaction term	-0.009	0.004	-2.478	0.014	-0.017	-0.002		

Note: Model 1 is the model without controlling the covariates and interaction term; Model 2 is the unadjusted model; Model 3 is the adjusted model with all covariates controlled.

Figure 4.1 shows the average effect of the economic burden of disease (self-reported) on financial toxicity in different levels of medical social support. From the slope plot, it can be seen that the slope of the economic burden of disease (self-reported) on financial toxicity changes as the level of medical social support increases, indicating that medical social support has a moderating effect. In addition, the slope becomes steeper with the increase of medical social support, implying that medical social support increases the influencing relationship between the independent and dependent variables. It is also found that medical social support plays a negative moderating role in economic burden and financial toxicity, which subverts the traditional assumption of social support buffer.

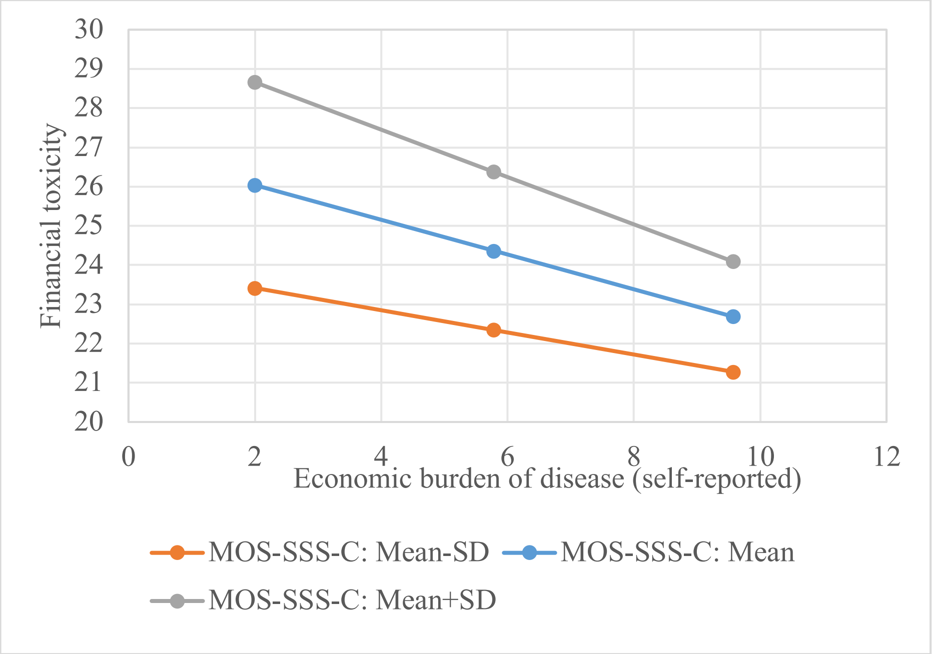

Figure 4.1 Moderating effect of medical social support in the relationship between economic burden of disease (self-reported) and financial toxicity

The robustness analysis aims to verify the stability of the moderating role of medical social support in the relationship between the independent and dependent variables under different measures of economic burden of disease. The moderating role of medical social support is re-examined in the subsequent part with economic burden of disease (medical records) as the independent variable, so as to confirm the robustness of previous findings based on the data of economic burden of disease (self-reported).

Table 4.14 presents the results of a linear regression of economic burden of disease (medical records) and financial toxicity with all covariates controlled.

Table 4.14 Linear regression of economic burden of disease (medical records) and financial toxicity

Variable	B	SE	95% CI		*p*
			Lower	Upper	
Medical social support	0.116	0.023	0.071	0.16	<0.001
Economic burden of disease (medical records)	-0.434	0.124	-0.681	-0.187	0.001

Note: All covariates are controlled.

Table 4.15 shows that the economic burden of disease (medical records) and medical social support interaction item is incorporated in the model to test the moderating effect of medical social support. The coefficient of the interaction term is -0.01 and it is significant (p<0.05) in both Model 2 and Model 3, which suggests that medical social support has a moderating effect on the relationship between economic burden of disease (medical records) and financial toxicity. To be specific, the relationship between economic burden of disease (medical records) and financial toxicity is relatively weak in patients with low medical social support and strong in patients with high medical social support.

Table 4.15 Analysis of the moderating role of medical social support in the relationship between economic burden of disease (medical records) and financial toxicity

Model	Variable	Coefficient	SE	T	*p*	95% CI		R	R^2
						Lower	Upper		
Model 1	Constant term	15.115	1.763	8.573	< 0.001	11.649	18.582	0.399	0.159
	Economic burden of disease (self-reported)	-0.459	0.113	-4.077	< 0.001	-0.681	-0.238		
	Medical social support	0.152	0.021	7.170	< 0.001	0.110	0.193		
Model 2	Constant term	12.299	1.669	7.370	< 0.001	9.019	15.580	0.41	0.168
	Economic burden of disease (self-reported)	0.152	0.317	0.478	0.633	-0.472	0.775		
	Medical social support	0.160	0.022	7.466	< 0.001	0.118	0.203		
	Interaction term	-0.009	0.004	-2.058	0.040	-0.017	0.0004		
Model 3	Constant term	10.220	4.600	2.222	0.027	1.176	19.265	0.497	0.247
	Economic burden of disease (self-reported)	0.145	0.312	0.464	0.643	-0.469	0.759		
	Medical social support	0.159	0.033	4.824	< 0.001	0.094	0.224		
	Interaction term	-0.008	0.004	-1.975	0.049	-0.017	-0.00004		

Note: Model 1 is the model without controlling the covariates and interaction term; Model 2 is the unadjusted model; Model 3 is the adjusted model with all covariates controlled.

Figure 4.2 shows the average effect of the economic burden of disease (medical records) on financial toxicity in different levels of medical social support. From the slope plot, it can be seen that the slope of the economic burden of disease (medical records) on financial toxicity changes as the level of medical social support increases, indicating that medical social support has a moderating effect. In addition, the slope becomes steeper with the increase of medical social support, implying that medical social support increases the influencing relationship between the independent and dependent variables. Therefore, According to the quantitative analysis, whether the independent variable is economic burden of disease (self-reported) or economic burden of disease (medical records), medical social support plays a moderating role between economic burden of disease and financial toxicity and aggravates the influencing relationship between the independent and dependent variables. This finding uncovers theoretically unexpected interactions and is contrary to the generalized conclusion of the buffering effect of social support.

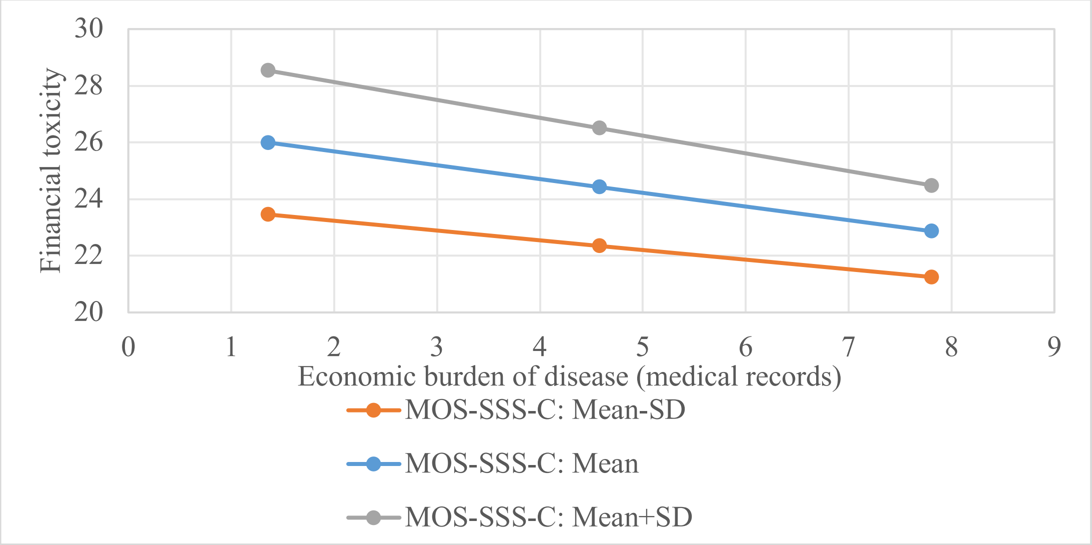

Figure 4.2 Moderating effect of medical social support in the relationship between economic burden of disease (medical records) and financial toxicity

4.2 Qualitative research findings

4.2.1 Stakeholder identification and categorization

4.2.1.1 Literature research and focus group discussions to identify initial stakeholder options

Based on the analysis of the current situation and characteristics of patients undergoing ART in existing literature as well as the existing problems from the perspective of interests, we identified stakeholders including patients, doctors, nurses, health commission, healthcare security bureau, and commercial insurance companies. The focus group discussion was held in October 2024, in which we not only identified stakeholder options from the previous literature, but also added new options such as think-tank experts (healthcare policy, demographics, ethics), patients’ family members, embryologists, and foundations.

4.2.1.2 Multi-dimensional classification by experts based on Delphi and Mitchell score-based approach

In the Mitchell score-based approach, it is important to consider expert authority, number of experts, and variability of viewpoints (Green, 2014). It is required to select experts whose research interests are closely related to the research topic with more than 10 years of research experience in the field. An increase in the number of experts leads to improved prediction accuracy, but as the number of experts approaches 15, a further increase in the number of experts has little effect on prediction accuracy (Turoff, 1970).

A total of 14 experts were selected for this study to complete two rounds of score-based survey. The analysis results of the general information, positivity, authority and opinion coordination of the experts show that the research works well with desirable results.

(1) General information of the experts

The general information of the experts is shown as per Table 4.16.

Table 4.16 General information of the experts (N=14)

Item		Amount (person)	Proportion (%)
Age			
	30-39 years old	8	57.1%
	40-49 years old	6	42.9%
Educational background			
	Bachelor	1	7.1%
	Master	7	50%
	Doctor	6	42.9%
Professional title			
	Intermediate	3	21.4%
	Senior	11	78.6%
Specialty			
	Reproductive medicine	5	35.7%
	Social policy	3	21.5%
	Humanistic nursing	2	14.3%
	Insurance management	2	14.3%
	Public welfare	1	7.1%
	Hospital management	1	7.1%
Length of service			
	Less than 10 years	2	14.3%
	10-20 years	7	50%
	More than 20 years	5	35.7%

(2) Positivity of the experts

The positive coefficient of experts is generally expressed through the response rates of expert consultation questionnaires. The formula is: the positive coefficient of the experts = the number of questionnaires returned / the number of questionnaires distributed * 100%. All the questionnaires were returned in the two rounds of questionnaire survey. As a result, the experts recognize that this study has great significance and importance, and they are highly motivated to participate in this study.

(3) Authority of the experts

The authority coefficient of experts (Cr) is mainly affected by two factors, the coefficient of expert familiarity with the indicators (Cs) and the coefficient of expert judgment on the indicators (Ca), and it is calculated by the formula of Cr = (Ca + Cs)/2. When Cr ⩾ 0.7, the results are considered to be reliable (Okoli & Pawlowski, 2004). The degree of authority is judged mainly by calculating the expert familiarity score and expert judgment score. In this study, according to the degree of familiarity (Cs) with ART, the values are assigned as follows: very familiar 1.0, familiar 0.8, generally familiar 0.5, unfamiliar 0.2, and uninformed 0.0. The basis for judgement on the indicators (Ca) is divided into four dimensions, each of which is classified into three levels of influence on the expert's judgment: large, medium, and small. The values are assigned as follows: work experience (0.5, 0.4, 0.3), theoretical analysis (0.3, 0.2, 0.1), peer understanding (0.1, 0.1, 0.1), and intuition (0.1, 0.1, 0.1). As shown in Table 4.17, the mean value of the degree of expert familiarity in this study is 0.96. As shown in Annex D d.1, the coefficient of expert judgment is 0.92. Therefore, the coefficient of expert authority in this study is (0.96+0.92)/2=0.94. The above results indicate that the degree of expert authority in this study is relatively high, and it also reflects the fact that the experts are very familiar with the diagnosis and treatment of assisted reproduction. The feedback information provided by them is reliable and has high reference and application value.

Table 4.17 Calculation of familiarity of consulting experts (N=14)

Degree of familiarity	Uninformed	Unfamiliar	Generally familiar	Familiar	Very familiar
Number of experts	0	0	0	3	11
Weights	0	0.2	0.5	0.8	1
Expert familiarity coefficient	Cs=(11×1+0.8×3)/14=0.96				

(4) Coordination degree of expert opinions

The coordination degree of expert opinions can be expressed by the coefficient of variation, and the formula is coefficient of variation = standard deviation/mean. The smaller the value, the smaller the divergence of experts' judgments on an indicator, and the higher degree of coordination among experts on the indicator. A standard deviation of less than 1 and a coefficient of variation of less than 0.2 are generally considered to be acceptable levels (Okoli & Pawlowski, 2004).

As shown in Annex E Table e.1, as for the power indicators among stakeholders, the standard deviations of all expert ratings in the second round are less than 1, and the coefficients of variation fluctuate around 0.2, which is generally within a reasonable range, except for the coefficients of variation of the patients' family members, health-promotion groups, and pharmaceutical companies, which are slightly higher than 0.2.

As shown in Annex E Table e.2, as for the legitimacy indicators among stakeholders, the standard deviations of all expert ratings in the second round are less than 1, and except for health-promotion groups and pharmaceutical companies, whose coefficients of variation are slightly higher than 0.2, the coefficients of variation of other stakeholders fluctuate around 0.2, which is generally within a reasonable range.

As shown in Annex E Table e.3, as for the urgency indicators among stakeholders, the standard deviations of all the expert ratings in the second round are less than 1, and the coefficients of variation of the stakeholders are within reasonable ranges except for the health-promotion groups, workplace or community of patients, and the pharmaceutical companies, whose coefficients are slightly higher than 0.2.

4.2.1.3 Stakeholder definition and categorization

The first round of the stakeholder questionnaire shows that all the 14 stakeholder candidates have expert approval. In addition, some experts have proposed new options, including workplace or community, pharmaceutical companies, and the people’s mediation committee for medical disputes. The approval ratings of healthcare security bureau, doctors, nurses, patients, patients’ family members, and think-tank experts are 100%, as shown in Annex F Table f.1.

The second round of stakeholder questionnaire shows that all the 16 stakeholder candidates have expert approval, with 11 candidates, including health commission and healthcare security bureau, having approval ratings of 100%.

According to the results of the two rounds of stakeholder expert ratings,

(1) Those with scores of three or more on three dimensions are defined as definitive stakeholders, including health commission, healthcare security bureau, civil affairs department/foundation, reproductive clinicians, and think-tank experts.

(2) Those with scores of three or more on two dimensions are defined as expectant stakeholders, including embryologists, patients and patients’ family members.

(3) Those with scores of three or more on one dimension are defined as latent stakeholders,, including reproductive clinical nurses, commercial insurance companies, and management staff of medical institutions.

4.2.2 Stakeholder interview

4.2.2.1 Basic information of the interviewees

In this study, interviews are conducted on the different types of stakeholders identified by the expert consultation method and the Mitchell score-based approach. The total number of interviewees is 35, of which 13 are definitive stakeholders (1 from health commission, 2 from healthcare security bureau, 1 from foundation, 5 reproductive clinicians, and 4 think-tank experts), 12 are expectant stakeholders (2 embryologists, 7 patients, and 3 patients' family members), and 10 are latent stakeholders (5 reproductive clinical nurses, 3 from commercial insurance companies, and 2 management staff of medical institutions). After the interviews were completed, the interview team continued to interview six more respondents to test theoretical saturation and found that the data collected no longer developed a particular category of characteristics and no new themes emerged, proving that theoretical saturation was achieved.

The total valid interview time for the 35 interviewees was 21 hours, with an average interview time of 40 minutes. 314,242 words of valid textual information were collated after transcription. Details of the interviewees are shown as per Annex G.g.1.

4.2.2.2 Encoding results

Four themes were developed by encoding the interview data, including stakeholder analysis, stakeholder difference, positive effects of social support, and existing problems of social support. The themes, sub-themes, and coding are shown as per Annex H. h.1.

(1) Theme One: Stakeholder analysis

In this theme, two sub-themes are included, which are the role positioning and interest demands of different stakeholders. The coding of role positioning is as follows.

The governmental departments represented by health commission and healthcare security bureau have multiple roles, which include policymakers, and implementation supervisors.

Coding 1: Policymaker

We (the health commission) are responsible for developing policies and regulations related to assisted reproduction and ensuring the legality of the technology. (A-01)

We (the healthcare security bureau) are responsible for formulating and improving policies on the inclusion of assisted reproduction in health insurance, including the items to be included, reimbursement rates and standards. (B-01)

Coding 2: Implementation supervisor

We (the healthcare security bureau) are responsible for the enforcement of the policy to ensure that hospitals and patients comply with the relevant regulations. In addition, we also supervise assisted reproductive technology to prevent misuse of the technology and waste of health insurance funds. (B-01)

We (the healthcare security bureau) continuously monitor the utilization of the health insurance fund to ensure its sustainability and adjust the policies to cope with the financial health of the fund. (B-02)

Stakeholders represented by civil affairs department/foundation are characterized by the following roles: economic supporters, educational promoters.

Coding 1: Economic supporter

Currently, many philanthropic foundations show great potential, especially in the field of disease, and patient organizations and foundations are playing an increasingly important role. (E-04)

By providing financial assistance, such as fee waiver, health insurance reimbursement, and special funds, foundations alleviate the economic burden of patients so that they can realize their fertility desire. (C-01)

Coding 2: Educational promoter

The foundation is concerned with issues of social justice...It is also committed to promoting public education and raising social awareness of infertility issues. Through organizing lectures and increasing publicity, it eliminates discrimination and prejudice against patients. (C-01)

The foundation carries out public welfare and compassionate activities so that the collaborated hospitals can gain positive publicity results and earn a good word of mouth. (C-01)

Stakeholders represented by doctors, nurses, and embryologists are characterized by the following roles: medical service provider, counseling supporter.

Coding 1: Medical service provider

Our main appeal is to let patients have access to hospital services and retain them. (K-01)

Medical order is the professional guidance formulated by doctors according to the patient condition, and the execution of medical order is the first priority...and I, as a nurse, bear the important responsibility of transforming these professional guidance into practical nursing actions. (I-03)

Embryologists are primarily responsible for professional work, and we work behind the scenes to perform specialized embryo cultures. (F-02)

Coding 2: Counseling supporter

Medical safety is the first priority, followed by publicity and education as well as psychological counseling. (I-03)

It is hoped that the patients can have earlier, longer-term, and stable counseling treatment. (D-02)

Stakeholders represented by commercial insurance companies are characterized by the following roles: business operator, and healthcare insurance supplement.

Coding 1: Business operator

Our company's vision is to be a modern financial insurance group that leads the financial services. (J-01)

Our business philosophy is customer-orientation and benefit-first... (J-03)

Coding 2: Healthcare insurance supplement

One of the significant advantages of commercial insurance is its flexibility to complement and supplement according to the individual's specific situation. Medical insurance is the basic medical guarantee, but when faced with special medical needs, integrating commercial insurance with medical insurance can provide more comprehensive coverage. (D-03)

The total cost of IVF treatment can reach 100,000 yuan, which is unaffordable for the average family. Commercial insurance, on the other hand, is tantamount to a kind of financial subsidy transfer and provides certain financial protection if the treatment fails. (J-01)

Commercial insurance can also complement with basic medical insurance to build a medical insurance system with a wide coverage and a high level of protection. The integrated payment model of "commercial insurance + medical insurance" can further reduce the medical burden of patients. (J-03)

The patients are the major subjects of this study, and they are characterized by high expectation and perceived stigma.

Coding 1: High expectation

Especially patients who have experienced miscarriages, ectopic pregnancies, and major traumas, (they) want to solve all their problems in one visit at the psychological outpatient clinic, which puts a very high pressure on us (psychologists). (D-02)

Patients have very high expectations of IVF success rates, especially in the post-embryo transfer phase. This further exacerbates their anxiety. (D-05)

I believe the assisted reproduction is very easy, as I have spent money and efforts and complied with the medical orders, so I have high expectations for the final result. (G-04)

I have very high expectations for myself and I am very concerned about my expenditures during each visit. (G-01)

Coding 2: Perceived stigma

In the process of filing for insurance, many male family members refuse to do so because of traditional thinking. Although they can enjoy the health insurance reimbursement policy after filing, they still choose not to do so out of pride or embarrassment. (I-05)

The patient said that she was just a reproductive tool. (D-01)

The number of patient visits surged during the Chinese New Year because they could not bear the finger-pointing of their family members and friends during the festive season and wanted to avoid them. (K-02)

Some girls choose to take out loans (for infertility treatment). They think that they can do things according to their own will and do not have to look at other people's faces. (D-03)

Coding 3: Forbearance and bigotry

Patients who are particularly stressed are not even able to notice it themselves. Sometimes the patients are numb and say to themselves that they are not stressed. (D-02)

Since you have chosen this path, you should trust the doctor. If we can't make it this time, we can do it again, right? We will never give up until all hope is gone. (G-05)

As the number of failures increased, I became more and more reluctant to give up. Each time I put in effort but failed to meet expectations, this reluctance became stronger and stronger. I have started the treatment, and I am trapped in a dilemma, so I always think that I might succeed if I try one more time. (G-04)

Coding 4: Poor mental adjustment and psychological resilience

Psychologically speaking, the amount of stress is closely related to mental flexibility. If you are psychologically resilient, you can easily adjust to external influences. If the patient is vulnerable, the more external support he has, the more stressful he will be on his own. (D-01)

A patient's psychological state is closely related to his self-adjustment ability. For example, some patients may over-interpret their spouse's behavior due to insecurity, which in turn leads to self-doubt and conflict-seeking...and a tendency to interpret and react negatively to everyday situations. (I-03)

For the relationship between stress and support, self-perception and personal adjustment are highly relevant. (H-01)

As one of the stakeholders, think-tank experts have the following role positioning: knowledge disseminator, policy facilitator.

Coding 1: Knowledge disseminator

We experts are the bridge between patients and scientific knowledge. (E-04)

We need to make sure that patients have access to accurate and authoritative information so that they are not misled or caught in a misconception. We also need to translate complicated professional knowledge into easy-to-understand language to help patients better understand and cope with the various issues involved in assisted reproduction. (E-02)

We make publicity through WeChat to raise the general public's awareness of the disease, thereby reducing the psychosocial pressure on patients. (E-03)

Coding 2: Policy facilitator

...write policy briefs...(E-04)

We will reach out to patients through research projects and combine their demands with research theories. We try to become a bridge between patients and government policy makers, and perhaps push for relevant legislation to regulate assisted reproduction practices and reduce the incidence of medical disputes. (E-03)

Another sub-theme is interest demands, and the role positioning is coded as follows.

The government departments represented by health commission and healthcare security bureau have the following interest demands: protect basic livelihoods and achieve a win-win situation for all parties.

Coding 1: Protect basic livelihoods

As a government department, the health commission is actively involved in building a fertility-friendly society and promoting the long-term balanced development of the population through the popularization and application of assisted reproductive technology. (A-01)

Family conflicts and social problems arising from infertility issues are reduced by strengthening regulation and services in the field of assisted reproduction. The negative impact of technology abuse and illegal behaviors on the society is avoided. (A-01)

The reason why health insurance adopts universal treatment and sets the basis without distinguishing technical differences such as IVF, ICSI and PGD is to avoid deviating from the principle of fairness. (B-01)

Coding 2: Achieve a win-win situation for all parties

In collaboration with hospitals, we have conducted public lectures and publicity campaigns on assisted reproductive technology (ART) to increase public awareness and acceptance. (A-01)

In the formulation of health insurance policies, it is necessary to take into account the fundamental interests of all three parties: economic sustainability, hospital viability and the insured. By forecasting the expenditure on health insurance, measuring the needs of different groups of people and the cost-sharing situation of hospitals, we strive to achieve a win-win balance among the three parties. (B-01)

The civil affairs department/foundation has the following interest demands: technology research and development, and policy advocacy.

Coding 1: Technology research and development

The foundation is concerned with the development and application of assisted reproductive technology and scientific research advances in the field of reproductive health. By supporting *advances in medical technology, we hope to provide patients with more comprehensive and more effective treatment options. (C-01)*

Coding 2: Policy advocacy

The foundation also actively participates in policy formulation and advocacy, pushing the government to introduce more patient-friendly policy measures. It works with the government, medical institutions and the community to build a more inclusive, understanding and supportive social environment. (C-01)

As healthcare organization personnel, physicians, nurses, embryologists, and other stakeholders have the following interest demands.

Coding 1: Fulfill duties

Healthcare professionals must ensure that their duties are fulfilled successfully to avoid any mistakes or even medical errors. We are responsible for ourselves first and foremost, and it is difficult to help others effectively if we are not even able to fulfill our own duties. (I-04)

We have to consider the issue of medical risk...we usually take a relatively conservative attitude. This is because if we give our patients too high expectations but the final outcome of the treatment fails to meet their expectations, they may feel disappointed or even blame us... (D-05)

Coding 2: Focus on treatment outcomes

We (embryologists) all expect to breed embryos well. If we do not do well, we ourselves feel sad and unfulfilled. (F-01)

From a physician's point of view, our first concern is the success rate. We weigh the costs and benefits in our decision-making, and even if it costs an extra one or two thousand yuan, if we can induce the patient to grow a few more eggs and obtain a few more embryos, we think it is worth it. (D-05)

Coding 3: Enhance career achievement

Because psychology is a relatively small niche in assisted reproduction treatment and receives less attention, it is hoped that hospitals and leaders can increase their focus and investment in psychological building. (D-01)

Some healthcare professionals need to carry out research (with patients as the sample) for their own purposes. (K-02)

We hope to be recognized and praised by patients. (D-04)

As one of the stakeholders, commercial insurance companies have the following interest demands: profitability, fulfillment of social responsibility.

Coding 1: Profitability

Benefits are the root of business operation, without which the companies are unable to survive. The companies cannot develop unless they adhere to the priority of benefits. (J-01)

My performance pay is proportional to the number of commercial insurance purchases, following the principle of more pay for more work. (J-03)

In the face of assisted reproduction, a product with a naturally favorable outlook, our most basic claim is to attract more, and even physically better, patients to purchase this insurance. (J-02)

Coding 2: fulfillment of social responsibility

Safeguarding epidemic prevention and control...helping students in poverty...(J-01)

As an enterprise that operates risks, it is our corporate responsibility to undertake the regulation and diversification of social risks. (J-02)

As one of the stakeholders, the patients have the following interest demands: pregnancy outcome, financial support, emotional support, and informational support.

Coding 1: Pregnancy outcome

The patient has already paid a lot up front, as in silent costs. They have a hard time getting pregnant and will do anything to keep the baby... (D-03)

My request is to be able to fulfill my wish to have a healthy baby. (G-06)

My greatest hope now is that persistence will lead to success, so that all the money I have spent is worthwhile. (G-02)

Coding 2: Financial support

Can the assisted reproduction reimbursement rates be any higher? ...(H-02)

I'm very realistic, and I have been through a lot as I am getting old. As long as the problem can be solved financially, I don't care or value anything else. (G-07)

Coding 3: Emotional support

We should focus on not only the outcome of assisted reproduction, but also the psychological state of the individual. (E-01)

(Patients) want their doctors to respect their privacy and not disclose their personal information and condition, and they also want their doctors to treat them in an equal and respectful manner and give them enough care and comfort. (I-03)

I feel in my heart that even if the doctors and nurses say a word of comfort, we are quite relaxed psychologically. (G-04)

What I want most is that my family can give me the emotional support I want, but right now they don't know or understand me, and the help they offer can be ignored or doesn't help me at all. (G-04)

Coding 4: Informational support

Patients are most concerned about how the disease will be treated and want their doctors to provide a clear and unambiguous treatment plan, including treatment methods, steps, expected results, and possible risks and side effects. (I-03)

We are very eager to learn about embryo development... (G-03)

What the patients need most is a precise explanation given by the doctor so that they can clearly understand the conditions. ...Their main demand is not to find comfort or emotional value, but to expect the doctor to solve the problem directly. (D-04)

As one of the stakeholders, the interest demands of think-tank experts are: reference for clinical medicine, policy advocacy, research output.

Coding 1: Reference for clinical medicine

We hope to intervene through scientific research to adjust the patient's mood and daily activities, so as to observe whether it can improve their conception results. (E-01)

We manage the disease well and give feedback to patients through scientific research to improve their social support. (E-03)

Coding 2: Policy advocacy

We play the role of a platform that provides multiple perspectives and facilitates multiple exchanges to jointly explore effective solutions. (E-04)

Demographers mainly investigate the needs of relevant stakeholders and remind government departments to pay due attention to them in policy design. (E-02)

Coding 3: Research output

Demography does not pay enough attention to assisted reproductive technology, and it is necessary to conduct sufficient research in combination with survey data. Scientific countermeasures should be proposed based on empirical research, and cause widespread concern in the whole society through academic publication. (E-02)

We have the need to conduct topic research on and achieve scientific outputs because of the pressure of appraisal. (E-01)

(2) Theme Two: Stakeholder difference

In this theme, a total of three sub-themes are involved, namely, economic support conflict, emotional support conflict, and informational support asymmetry. The sub-theme of economic support conflict involves coding of lack of integrated planning, existence of contradictions, limited health insurance coverage, operational difficulties, and lack of feedback and evaluation.

Coding 1: Lack of integrated planning

It is true that the government has failed to keep up with the current trend of the population fertility policy at the macro-control level, that is, the top-level design. (B02)

In promoting assisted reproduction legislation, especially the formulation of relevant regulations in Shandong Province, we have encountered refusal of cooperation from the healthcare security department, and the health commission and disease control and prevention department have considered themselves unsuitable to act as the leading organizations. Whenever the issue of funding is involved, we will encounter evasive attitudes. (E-03)

At present, there is no clear regulation by the health insurance for the common program (for reimbursement of treatment for couples), and I have repeatedly consulted the healthcare security bureau to seek an answer, but I have not received an accurate reply. They said that as long as the hospital explains it well, it will be fine. This response is vague and does not clearly express their position. (I-05)

The government has not fully established a top-level design... (G-01)

Coding 2: Existence of contradictions

The biggest contradiction lies in the fact that we should not only meet the needs of patients in terms of treatment costs, but also take into account the affordability of the health insurance fund to ensure the fairness and sustainability of the policy. We cannot focus on a certain aspect, and neglect the overall protection and waste of resources. (B-02)

We do face some challenges and contradictions. For example, in promoting technological development, we need to balance safety and innovation. (A-01)

During the implementation of the health insurance policy, hospitals need to adapt to the new payment method, including re-applying for designation, expanding their scope of business and familiarizing themselves with the health insurance-related policies. The insured also need to understand the new reimbursement policy...Both parties need to go through the process of change and adaptation... (B-01)

At the health insurance level, it is impossible to focus entirely on assisted reproduction and give it priority because of its broad scope of management. (E-04)

There is a conflicting relationship between the interests of patients, healthcare security bureaus, hospitals, and hospital practitioners. Patients want to minimize their costs, healthcare security bureau thinks the costs are too high, hospitals are concerned about timely payment, and reduced hospital revenues have an impact on practitioners' salaries... (F-02)

There are conflicts between the medical insurance and commercial insurance in certain items, such as overlapping reimbursement coverage...The two have yet to effectively form a harmonious relationship. (J-02)

Coding 3: Limited health insurance coverage. This is reflected in the limited coverage of health insurance costs, limited coverage of services and inconsistency in coverage of populations.

As patients can get reimbursement only after they meet the criteria for infertility and assisted reproduction treatment, the basic lab tests in the preliminary stage are not reimbursable, but this is a very high percentage of the cost. (G-06)

The use of petri dishes made in China does bring down the cost of hospital supplies. However, health insurance fixes these prices so that even if the cost of supplies goes down, hospitals cannot directly adjust prices to reduce the cost of patient treatment. Although hospitals are reducing costs and increasing efficiency, these efforts cannot be directly fed back to patients, and the health insurance policy instead limits hospitals' autonomy to some extent. (F-02)

There is a downward trend in the current health insurance participation rate, and not all people of childbearing age are entitled to health insurance. How to obtain coverage for the flexibly employed has become an urgent challenge. (E-02)

The diagnostic criteria for infertility are too dogmatic. For example, a patient is married at age 40 with ovarian failure, but has not had normal sex for more than 12 months. According to medical insurance regulations, this patient does not meet the diagnostic criteria for infertility and therefore is not eligible for medical insurance reimbursement. (D-05)

Coding 4: Operational difficulties. This is reflected in cumbersome and rigid processes, huge pressure to raise funds, being challenged, and difficulties in departmental coordination.

If a refund of a particular item is processed for a patients participating in medical insurance in other regions, we have to refund all the charges, which is a very complicated and cumbersome process...patients will also experience unexplained medical insurance payment difficulties. (I-05)

It is very difficult to introduce commercial insurance in public hospitals, and if patients are advised to purchase commercial insurance, they are likely to challenge us and lead to doctor-patient disputes. (J-02)

Our foundation is non-publicly funded, with funds coming from donations from specific individuals or organizations, and we are not allowed to raise funds from the public...The qualification of the foundation requires an annual review, which requires that the account must have a certain amount of funds, and this requirement poses a certain amount of pressure on us. (C-01)

Whether there are gray transactions and irregularities in the foundation is something I am concerned about and challenge. (F-02)

A lot of work involves the coordination of several departments, and there are a number of difficulties. (C-01)

Coding 5: Lack of feedback evaluation

When dealing with the professional issues of health insurance, it becomes very difficult for us to communicate with the healthcare security bureau, which is due to the lack of sufficient research and feedback when the policy was formulated... (I-05)

The policy (assisted reproduction included in health insurance) has been implemented for one year, and the problems revealed have not yet received feedback, which is rather lagging behind. (F-02)

The second sub-theme is emotional support contradiction, including lack of empathy, ineffective communication, cold violence, contradiction in consultation duration, and lack of assessment.

Coding 1: Lack of empathy

Some doctors use inappropriate words to patients, saying that patients are "unlucky" and "you have to accept the bad luck", and rigidly suggesting the patients to see a psychiatrist, but in fact, these words will have an adverse effect on the psychological state of the patients. (D-02)

I would like the doctor to point out the specific reasons for my failure, rather than reassuring me with the "probability of IVF". I am like a headless fly and don't know what to do. (G-04)

Several times I was in tears and broke down in the hotel, and I cannot communicate with my family because they do not understand... (G-04)

Coding 2: Ineffective communication

When the woman experiences failure, she is very concerned about her partner's reaction. For example, her partner's silent attitude and her parents' lack of concern may be interpreted by the woman as indifference. (I-02)

The couple also do not comfort each other and both avoid talking about the topic. (G-06)

Coding 3: Cold violence

Some men commit cold violence against their partners on a daily basis, ignoring their partner's needs and leaving it entirely up to their partners to fight for them. If their partners ask for it, the marriage continues. If not, they will choose divorce. (D-02)

My husband has been showing an indifferent attitude, which puts a lot of pressure on me and I feel very depressed and cranky. (G-07)

My husband does not bother to pay special attention to me (emotional outbursts, crying and choking), and I am the one who have to deal with and bear the brunt of both the injections and other treatments. (G-06)

Coding 4: Contradiction in consultation duration

Self-service and internet-based psychological interventions have attracted much attention, but we face some challenges in promoting and using them. How to allocate resources appropriately to guide patients in the use of these tools under staffing constraints is a big question. (E-01)

It took me a long time to get treatment, but the doctor just gave me two or three simple sentences, I felt perfunctorily treated with no warmth and care. (I-02)

Due to the large number of patients, we can only start treatment once we have a general understanding of the condition, just like an assembly line. We have little time to discuss with patients about their family-related situations, and understand whether their emotions are high or low, so our support is limited to the technical level. (D-03)

Individual healthcare professionals have little emotional support, and sometimes I can understand that because there are too many patients and they are too busy. (G-04)

Coding 5: Lack of assessment

The current moods of anxiety and depression are universal in nature, with relatively little research on the necessity and differences for groups such as patients undergoing ART. (E-01)

I believe that there is a lack of systematic and effective assessment of the emotional support currently given to patients by medical professionals. Are we just giving it superficial attention without in-depth evaluation of its actual effectiveness? (K-01)

The third sub-theme is informational support asymmetry, including research limitations and discrepancy, lack of publicity, cumbersome channels, professional gaps, and moral hazard.

Coding 1: Research limitations and discrepancy

Some of our experts do not take the initiative to make suggestions, but rather assist behind the scenes to corroborate the government's ideas and reinforce their positions. (E-02)

In the process research implementation, there are challenges in terms of human and financial resources, which will affect the implementation and effectiveness of the project. (E-01)

In my opinion, the existing research on the psychology of assisted reproduction is not yet robust enough in terms of evidence. (E-01)

Coding 2: Lack of publicity

There are also some patients who are not eligible for medical insurance reimbursement because they do not understand the policy or have concerns. (B-02)

Patients with multiple cycles of treatment are entitled to a fee waiver policy, but we face difficulties in implementing the policy. The process is not initiated by the patient, but is applied by the physician after assessing the patient's condition. If the physician does not take the initiative to explain the policy to the patient, then the patient is likely to be unaware of it. (F-02)

Patients' lack of knowledge about assisted reproduction information and the treatment process is also a factor that affects the sale of commercial insurance. Despite the promotion of the commercial insurance by means of the hospital's WeChat official account and online publicity, many patients were still unaware of it. (J-03)

The staff of the township healthcare security departments do not quite understand the policies of the higher level departments and they ask me to resort to the municipal healthcare security bureau. The current health insurance policy confuses me. (G-03)

Coding 3: Cumbersome channels

Many people are reluctant to inquire about medical information and therefore rely more on advertisements, resulting in deviation in access to information. (I-02)

Patients take a lot of detours in the process of consultation, including those who are deceived and those who misuse medicines. (I-01)

From the second year of our marriage, we have been seeking various ways. Our family members even divined and guided us to visit a certain place for consultation, then we sought consultation from folk Chinese medicine practitioners who did not have a physician's license, and we also took a lot of Chinese medicines... (G-07)

Coding 4: Professional gaps

It is possible that the data provided by demographers may have underestimated the actual infertility problem. If the government formulates relevant policies on this basis, the relevant policies lag behind the development of actual problems and cannot meet the actual needs of patients in a timely and effective manner. (E-02)

The selection of surgical instruments becomes a major cost expense when performing lumpectomy. Due to the lack of clear indications, the exact type of medical device to be used is often left to the doctor's discretion, and domestic versus imported instruments mean different financial burdens for patients. (I-04)

Patients are unaware of the complications and risks and may even avoid them automatically. (I-03)

In the program of fertility preservation treatment, there is a problem of poor information, patients are often reluctant to listen to the doctor's explanation, and only focus on the outcome of the pregnancy and do not want to have a miscarriage. However, doctors need to consider more complex factors when formulating the treatment plan, including whether it creates problems for the offspring as well as the mother. (D-03)

Shouldn't the success rate of IVF treatment be 100%? After spending so much money, why it still doesn't work? (H-03)

Coding 5: Moral hazard

Some hospitals may use assisted reproductive technology to help some families achieve desired child structure preferences, which violates the original demographic purpose. (E-02)

The primary objective of the irregular organization is to pursue profit and consider how to attract patients...Additional tactics such as unindicated surgery and excessive fertility preservation will also be used to induce patients to spend money in order to gain profit. (K-01)

Patients sometimes hide their history of miscarriage or physical defects, usually to protect their privacy, and there is also the possibility of malicious concealment in an attempt to defraud the insurance. (K-01)

Some healthcare professionals need scientific research studies for their own purposes, so they increase treatment items or prescribe more drugs, and these treatment items are all excessive or unnecessary. (K-02)

The foundation may engage in behaviors such as misappropriation of funds. (C-01)

My doctor told me to go to a designated pharmacy to buy medicines, and then I realized that there was a link between the sale of medicines and the doctor's income. (H-02)

(3) Theme Three: Positive effects of social support

There are 2 sub-themes under this theme, namely, effective economic support and emotional support benefits. To be specific, effective economic support includes reduced direct economic burden, standardization and authority, improved accessibility of technology, release of pressure on doctors, full health coverage, flexible and easy operation.

Coding 1: Reduced direct economic burden

For the seventh consecutive year, we (the healthcare security bureau) have adjusted the health insurance catalog to include medicines for assisted reproductive technology, reducing the burden on patients, increasing the maternity insurance benefits for employees and residents, and including flexibly employed persons in the coverage. (B-02)

Starting from April 2024, assisted reproduction medical services have been included in the medical insurance, and the number of people filed in Jinan has reached 7,500, and the medical insurance fund has paid 31 million yuan. (B-01)

...Parents and family members tend to give more financial support to their offspring. This is because family members share the same common goal and see the offspring as the future and hope of the extended family, not just the responsibility of the couple. (D-01)

The hospital currently has formulated a policy for patients with three or more cycles, and the hospital is able to reduce the surgery costs by 2,000 yuan for their egg retrieval and transplantation. (I-03)

In view of the financial pressure on patients, the foundation gives financial assistance to a portion of patients with difficult cases and repeated failed transplants. (C-01)

...standardization and authority, improved accessibility of technology, and many other codes are detailed in the thematic analysis table.

The second sub-theme is emotional support benefits, including improvement of pregnancy rate and relief of mental stress.

Coding 1: Improvement of pregnancy rate

The client purchased our product (commercial insurance), and the psychological pressure is completely relaxed, so the success rate of pregnancy is rather higher. (J-01)

The pregnancy success rate of patients in high-end medical outpatient clinics is 6%-7% higher than that of general outpatient clinics, which is most likely attributed to the psychological and emotional comfort that patients receive... (K-01)

Coding 2: Relief of mental stress

It has been five years since the commercial insurance service was launched. It effectively relieves patient stress of out-of-pocket expenses, reduces anxiety and provides great support. (J-03)

The foundation also pays attention to the mental health of patients, helping them to better cope with the physical and mental stresses in the treatment process through the provision of psychological counseling, nutritional guidance, and other ancillary services... (C-01)

A simple smiling expression from doctors and nurses has a great encouraging effect on us, and can make us feel warm and cared for. It is so lucky to meet a good doctor who is full of care. (G-06)

After patients have purchased insurance, we provide a series of additional services. The service design focuses on providing a suitable platform for patients to communicate their *experiences, share their feelings, and receive professional answers and psychological support when needed. (J-02)*

(4) Theme Four: Existing problems of social support

This theme contains two sub-themes of low utilization of social support and excessive inappropriate social support. Low utilization includes questioning, barrier to access, and denial of support.

Coding 1: Questioning

Patients questioned the safety of the insurance and the timeliness of claims at a later stage. (J-01)

Commercial insurance comes into the hospital as a third party, right? ...I have no idea about this... (G-05)

Coding 2: Barrier to access

Some patients have certain concerns and hesitations in utilizing support measures, and this may be related to their concerns about the treatment process, financial pressure and many other factors. In addition, due to the complexity and professionalism of assisted reproductive technology, some patients have difficulty in understanding and accepting it, which leads to low utilization. (A-01)

It is difficult to talk about it, there is a sense of shame, and there are resources but I don't know how to utilize them (helpless sigh)... (D-02)

Conflicts are often encountered when recommending patients to purchase commercial insurance: some patients have the desire to purchase, but their doctors believe that their treatment has a high success rate and suggest that they do not need to purchase. Instead, patients with poor conditions and problems are advised to purchase... (J-02)

Coding 3: Denial of support

My family said, why is it so difficult for you to get treatment, while everyone else can succeed. When I heard these words, feelings of grievance, and even anger followed, so I took the initiative to say to my family that you should not ask me or care about me any more, and I would just let you know the final result when the time came. (G-04)

I feel aggrieved myself, because it is useless to tell others, since I still need to bear it myself (crying). (G-03)

I don't want others to offer financial help out of pity; I want to earn my own money for treatment. (G-02)

The second sub-theme is excessive inappropriate social support, including inappropriate content of support, consistent source of stress and support, full accompaniment and excessive intervention.

Coding 1: Inappropriate content of support

A rational, reasoned approach is not the kind of help the patient wants to get; in fact, what the woman needs for her family is an emotional support. (D-01)

Her husband is not emotionally supportive in the least and just provides financial support. If she cannot get pregnant, they will have to divorce. She is very dependent on her husband and cannot accept divorce. (D-01)

Her husband said to her that I'm not even putting pressure on you (tone of complaint), if we fail this time, we'll come back and continue with the treatment, once or twice, all the way to the end. (D-02)

You are not young, (pregnancy) can't be delayed any longer (commanding tone). (H-02)

Coding 2: Consistent source of stress and support

The many kinds of social support that the family gives to the patient can be a strain. One patient said that her family was too good to her, so that she felt guilty, as it was because of her that her husband's family cannot have an offspring. (I-04)

Behind the financial support given by the parents is the reinforcement of control; if you are given money, you have to hurry up and get pregnant. They unconsciously reveal this sense of pressure. So instead of perceiving financial support, the patient feels increased pressure. (D-01)

Some patients have high expectations, and the higher the expectations, the more they want to realize the value. The more emotional and financial support the family gives her, the more stress she will feel by herself. (K-02)

I really appreciate the care and support from my family and friends, but as time goes by, I find that the attention from my family and friends makes me more anxious. (G-04)

Coding 3: Full accompaniment and excessive intervention

All of these supports are positive for the patient, but can be counterproductive when they are excessive. For example, some parents and friends ask patients about their privacy too often, which may increase the patient's psychological burden and create resentment. (K-01)

The parents of the wife may think that they have no face because their daughter cannot get pregnant. They bring about a lot of pressure on the wife, even accompanying her to the hospital again and again, or even pushing her repeatedly. (D-01)

Sometimes, the couples receive interference in their sexual life from their parents. They would say things like "you have to do it". There are also women whose mothers overcontrol their daughters, and they ask very detailed questions... (D-02)

Coddling parents can really add to the stress of childbearing...Over-supportive parents leave their children with no sense of boundaries. (D-01)

My daughter-in-law does not allow me to come (to accompany her to the clinic), but I insist on accompanying her. I came to be able to offer them a helping hand. (H-03)

Whenever there is a family or friend gathering, people always ask me various questions and some even over-interpret my every subtle emotional change. This excessive social support makes me feel like a loser, and every failure is like falling short of everyone's expectations. (G-04)

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Chapter 5: Discussion

5.1 The economic burden of assisted reproduction

5.1.1 Current status of economic burden and comparative analysis

According to Table 4.4, the economic burden on patients undergoing ART is 57,860 *yuan* per cycle, which exceeds the willingness to pay (30,000-50,000 *yuan*) in previous surveys (J. J. Qiao et al., 2022). Compared with previous measurements of economic burden of assisted reproduction, the economic burden measured in this survey is higher than the figure (21,718 *yuan*) measured in 2008 (Zheng & Qiu, 2012) and the figure (39,215.13 *yuan*) measured in 2018 (J. J. Qiao et al., 2022).

The direct medical economic burden per cycle is about 40,430 *yuan*, which is much higher than the cost measurements in previous studies (Jing et al., 2020). The reason is that previous studies were conducted before 2020, and with the economic growth and rising prices, the healthcare charging standards have been adjusted, resulting in an increase in total healthcare costs. In addition, previous studies do not have data of PGT, the direct economic burden of which is higher than that of IVF-ET and ICSI, while data of PGT are included in this survey. The direct non-medical economic burden (8,520 *yuan*) and indirect economic burden (8,920 *yuan*) per cycle are also measured in this survey and the figures are higher than those in similar studies (J. J. Qiao et al., 2022). The reason is that the surveyed patients came from a wide range of sources, including patients from the surveyed area as well as patients from other regions, so the direct non-medical costs such as transportation, accommodation and catering fees are higher than those in other studies. With the economic development, the average salary of the employed also increases, and the cost of lost wages climbs accordingly, so the indirect economic burden is also higher than that in other studies.

Patients with junior high school education and below have a higher economic burden compared to those with other educational backgrounds, which may be related to the relatively poor economic status of this group, limited access to medical resources and insufficient health knowledge. Patients with low educational background may face higher employment pressure and have lower income; therefore, it is difficult for them to afford high treatment costs. In addition, they may have relatively limited knowledge about treatment options, assisted reproductive technologies and health insurance policies, which may also increase their economic burden.

Patients who do not use medical insurance or only use commercial insurance have a higher economic burden of disease compared to those with basic medical insurance for urban and rural residents and basic medical insurance for urban employees, suggesting that the medical insurance system may play an important role in the economic security of patients. International comparative studies have also found that the inclusion of assisted reproductive technology in medical insurance not only relieves patients' economic burden, but also helps to achieve the goal of moderate fertility (H. Q. Zhang et al., 2022).

The economic burden is highest for patients who have already undergone three or more cycles of treatment. ART is an effective treatment plan for infertility, but the length of the treatment cycle may have a significant impact on the economic burden. With the increase of treatment cycles, patients are required to pay more medical expenses, including medication fees, lab test fees, and surgery fees (Eijkemans et al., 2017). Therefore, the economic burden is undoubtedly more severe for patients who require multiple cycles of treatment.

5.1.2 Assessment of the affordability of assisted reproduction

Affordability is usually assessed using the ratio of medical costs to average household income (Emanuel et al., 2017). The affordability of assisted reproduction in 31 high-income countries has been assessed using the ratio of medical costs of IVF per cycle to disposable income per capita (Chambers et al., 2014). The affordability of assisted reproduction in 17 low and middle income countries has also been assessed using the ratio of medical costs per cycle to GDP per capita (Njagi et al., 2023). In this study, the ratios of direct medical economic burden of ART per cycle to disposable income per capita and GDP per capita are used to assess affordability, respectively. To be specific, the ratio of the direct medical economic burden (40,430 *yuan*) to the per capita disposable income in Shandong Province in 2024 (42,077 *yuan*) is 96%, which is much higher than the average ratio (17%) of the OECD member countries (Chambers et al., 2014). The ratio of the direct medical economic burden (40,430 *yuan*) to GDP per capita of Shandong Province (98,000 *yuan*) is 41%, which is higher than that of South Africa (20%) and Brazil (23%), and lower than that of India (52%) and Vietnam (64%) (Njagi et al., 2023). Studies have also proved that the economic burden of chronic disease varies widely across countries due to socio-economic, cultural and political factors (Crews et al., 2019). However, it can be seen that the affordability of ART in China is undesirable.

Catastrophic health expenditure is considered to occur when medical expenditures exceed 40% of household consumption expenditures (Xu et al., 2007). It may lead to problems such as reduced basic expenditures, high debt or bankruptcy, and assisted reproduction treatment may lead to catastrophic health expenditure for the family. According to the research results, the direct medical burden of assisted reproduction (40,430 *yuan*) far exceeds the per capita consumption expenditure (25,645 *yuan*) in 2024 in Shandong Province. The success rate of ART is about 50%, meaning that patients need multiple cycles to have a successful pregnancy. A study in South Africa proved that 22% of patients undergoing ART suffered from catastrophic health expenditures, and 51% of low-income patients suffered from catastrophic health expenditures (Dyer et al., 2013). At present, there lack studies on the occurrence of catastrophic health expenditures for patients undergoing ART in China, but without taking into account the coverage of medical insurance policies, and the willingness and ability of the family to pay, a rough calculation of the above data indicates that the proportion of patients who suffer from catastrophic health expenditures is relatively high, and the affordability of assisted reproduction diagnostic and therapeutic services is relatively poor.

5.1.3 Influencing factors of economic burden of disease

Annual per capita household income is an influencing factor of the economic burden of disease. The lower the annual income, the higher the economic burden of disease. It reflects the fact that low-income families have more limited financial capacity when facing infertility diseases. With relatively low income, these families may find it difficult to afford the high cost of treatment and may even give up, which not only affects the physical health of the patients, but may also impose a greater burden on their families and the society.

The means of assisted reproduction treatment is also an influencing factor of the economic burden of disease. Patients treated with PGT technology have the highest economic burden and patients treated with IVF have the lowest economic burden of disease. This is related to the cost difference of different assisted reproductive technologies. PGT, as a high-precision genetic testing technology, has a relatively high cost, and thus the economic burden is higher. IVF has a relatively low cost, so the economic burden is correspondingly lower.

In summary, in order to reduce the economic burden on patients, the medical insurance system should be further improved to raise the level of healthcare security for low-income families, which is consistent with the appeal of international experts (Ali et al., 2022). Popularization of health knowledge should be strengthened to increase patients' knowledge of infertility treatment and ART. In addition, medical institutions should be encouraged to optimize treatment options and reduce treatment costs to provide patients with more effective treatment options. Most of the high-quality medical resources in China are concentrated in prefectural cities and provincial capitals, which increases the cost of medical care for patients and affects the accessibility and fairness of medical services. It is suggested to form an association of assisted reproduction specialty alliance to realize the sharing of high-quality medical resources. Internet and telemedicine technologies can also be adopted to improve accessibility and convenience of medical services. For example, the tele-consultation system of the medical alliance can eliminate patients' transportation costs and accommodation expenses and effectively reduce their non-medical costs.

5.2 The financial toxicity of patients undergoing ART

5.2.1 Current status of financial toxicity and comparative analysis

According to Table 4.5, the score of financial toxicity for patients undergoing ART is 24.48±7.81, with an incidence of 54.29%. There lack studies on financial toxicity of patients undergoing ART, but compared with other similar chronic diseases, the incidence is higher than the that of patients with heart failure in the United States, which is 33% (Ali et al., 2022), lower than that of patients with stroke in China, which is 81.18% (Y. Zhang et al., 2023), and similar to that of patients with diabetes, which is 50% (Patel et al., 2022).

According to Table 4.6, there are differences in the financial toxicity of patients with different educational backgrounds. Education may influence patients’ ability to pay for infertility treatments and how they pay for them. Patients with junior college education and below are more likely to experience financial toxicity due to medical costs, while patients with high education may have higher incomes and richer information resources to adapt to financial toxicity. This conclusion is similar to the findings of previous studies (Ali et al., 2022). Different types of medical insurance directly determine the proportion of treatment costs borne by patients, so the differences of financial toxicity in this respect are statistically significant. Employment status and annual per capita household income are important indicators of the financial situation of the patients. Patients with stable employment and relatively high income are more able to bear the costs and reduce financial stress. Conversely, patients who are unemployed or have low incomes may face greater financial toxicity. Patients with chronic illnesses may have to bear more treatment costs, thus exacerbating their financial toxicity. The increase in the amount of treatment cycles directly leads to a rise of treatment costs, which further aggravates the economic burden on patients. The occurrence of complications not only increases the difficulty and cost of treatment, but may also reduce the effectiveness of treatment, thus exacerbating the financial and psychological burden on patients.

5.2.2 Influencing factors of financial toxicity

The regression analysis in Table 4.11 shows that annual per capita household income is an influencing factor of financial toxicity. The higher the annual income, the higher the financial toxicity score, and the less severe the financial toxicity actually suffered by the patients. This finding is consistent with numerous studies in the Chinese and foreign literature (Blinder et al., 2017; Jagsi et al., 2018). High-income households may present relatively low feelings of financial toxicity in reality, because they have more financial resources to cushion the shock of healthcare costs. Low-income households feel the pinch or even resort to loans when faced with such expenditures, which increases the risk of financial toxicity. Qualitative research also shows that a single source of income or an unstable working environment may lead to fluctuations in the financial situation of the household, thus exacerbating financial toxicity. It is recommended that the impact of annual per capita household income on financial toxicity can be better addressed through measures such as strengthening income monitoring, raising the economic level of low-income households and enhancing financial management education.

The findings emphasize the negative impact of complications on patients’ financial status. Complications increase the difficulty of treatment and healthcare costs, thus exacerbating patients’ financial toxicity, and this finding is consistent with previous studies (Ma et al., 2023). In addition, complications may incapacitate the patients or reduce their work efficiency, which will further reduce family income and exacerbate financial toxicity. Therefore, preventing and treating complications is important to alleviate patients’ financial toxicity. Measures that can be taken include raising public health awareness, strengthening the medical assistance system, promoting medical technology innovation and cost control, and enhancing cross-sector cooperation and information sharing.

Economic burden of disease is also a significant influencing factor of financial toxicity. The higher the financial burden, the lower the financial toxicity score, and the more serious the financial toxicity actually suffered by the patients. This result is in line with expectations and emphasizes the direct impact of economic burden of disease on patients’ financial toxicity.

Medical social support exerts a significant impact on financial toxicity. The stronger the medical social support, the higher the financial toxicity score, and the less severe the financial toxicity actually suffered by the patients. This result suggests that medical social support plays a positive role in alleviating patients’ financial toxicity, which is consistent with the findings of previous studies (C. Li et al., 2024). In particular, financial support is especially important for patients from low-income families. Emotional support, on the other hand, plays a significant role in improving patients’ quality of life and recovery outcomes. Informational support is an important means to improve patients’ medical decision-making ability and reduce medical costs. Therefore, how to strengthen the construction of the medical social support system is a complex and critical issue.

5.3 The current status and advantages and disadvantages of medical social support

5.3.1 Current status of medical social support

It is found in this survey that the score of medical social support after standardization is

75.61±17.16, which is higher than the score (60.38±11.50) of Chinese infertility patients in 2019 (D. Li et al., 2020), and also higher than that of HIV patients with a similar privacy and high sense of stigma (Y. Yu et al., 2015). This finding not only reflects the great increase in social attention to infertility in recent years and the continuous improvement of related support systems, but also reveals the variability and complexity of medical social support for different disease groups, and the possibility of falling into the trap of excessive social support.

It is found that the patients' level of medical social support presents significant variability in demographic and socioeconomic dimensions. In terms of educational background, patients with higher education may achieve higher social support due to stronger self-awareness and greater ability to acquire social resources. Older patients may actively curtail social support due to pressures such as lower rates of their own embryo implantation and parental care, resulting in lower scores. Urban patients may obtain higher levels of social support compared to rural patients because of richer medical resources, which also reflects the clustering effect of medical resources in provincial capitals and tertiary hospitals. The influence of the health insurance type on medical support for patients may be reflected in the reimbursement policy and the distribution of medical resources. Patients with good employment status and high per capita family income are able to bear more medical expenses and seek more social support due to their good financial status, which is consistent with the research findings concerning the influencing factors of economic burden. With the increase of treatment cycles, patients in the third and higher treatment cycles have lower levels of medical social support compared to patients in the first cycle. A possible reason may be a decrease in self-efficacy as a result of prolonged treatment, which leads to "treatment fatigue syndrome". Stigma leads to results such as social avoidance behaviors.

5.3.2 Effectiveness of medical social support

Good social support is an important protective factor for patients to improve their quality of life and reduce financial toxicity (Harvey-Knowles & Faw, 2018). Adequate social support, especially affective support, protects the mental health of patients undergoing ART, increases curability, and helps achieve positive outcomes (Casale & Carlqvist, 2021). In the qualitative interviews, the above findings are also confirmed by the thematic analysis.

In the analysis of the interviews, positive effects of social support encompass the sub-themes of effective economic support and emotional support benefits. Numerous interviewees suggest that social support can reduce the direct economic burden. For example, the healthcare security bureau has adjusted its policy for seven consecutive years to include assisted reproductive technology drugs in health insurance (B-02). This move not only improves patients' maternity insurance benefits, but also includes flexibly employed people in health coverage, reflecting the comprehensiveness of the policy. Jinan has included assisted reproduction in health insurance since April 2024, with a rapid increase in the number of filings and a significant amount of payments from the health insurance fund (B-01), which visualizes the effect of the policy implementation. In addition, family members (D-01), hospitals (I-03), and foundations (C-01) have provided economic support to varying degrees, alleviating the economic burden and financial toxicity of patients. Compared with foreign countries, the assisted reproduction health insurance coverage in China reflects great government efforts in policy formulation and implementation. In some developed countries, although the healthcare system is well-developed, health insurance coverage is still limited (Koniares et al., 2022). However, developing countries have difficulties in providing comprehensive financial support because of limited resources (Njagi et al., 2023).

The standardization and authority of economic support is also an important finding from the interview. The normativity and strictness of the health insurance system prompts hospitals to pay more attention to quality and safety (A-01, I-05), which helps to combat illegal assisted reproduction facilities and their gray practices (I-05), thus protecting patients' legitimate rights and interests. This is consistent with the view of foreign literature that policy regulation enhances the quality and safety of medical services (Greil, 1997). It is recommended that the government establish a sound regulatory mechanism for economic support policies to ensure that the use of funds is transparent and compliant. The audit and supervision of hospitals, foundations and other organizations should be strengthened to prevent misuse and waste of funds.

Economic support also leads to significant improvement in access to ART. As reimbursement rates increase and coverage expands, increasingly more patients are able to choose assisted reproductive treatment (A-01). This is consistent with the findings of previous studies that decline of costs leads to more utilization of ART (Collins, 2002). Doctors in the interviews mentioned that the cost-effectiveness of treatment is a key factor in whether or not a patient receives the treatment (D-05), and the increase of economic support has certainly improved the cost-effectiveness of treatment. In addition, the availability of fertility preservation programs has further broadened the application scope of ART (C-01).

Economic support also indirectly releases doctors' pressure. Doctors in the interviews mentioned that if the most or all of the IVF costs can be reimbursed, doctors will be more flexible and practical in their medication and surgical recommendations (D-05), and will no longer give too much consideration to the contradiction between the patient's financial condition and medication. This view echoes research in the foreign literature that economic support for patients can reduce doctors' professional pressure and improve the quality and efficiency of medical services (Balen et al., 2016).

In terms of health coverage, insurance companies not only provide traditional insurance services, but also cooperate with medical institutions to introduce value-added services such as off-site medical care and green channels. For example, Ping An Insurance presents the comprehensiveness and humanization of its services through its comprehensive service coverage from pre-examination to post-transplantation surgical fees, as well as reimbursement of psychiatric outpatient and nutritional expenses (J-02). This service model is not only well received within China, but also compares favorably with some advanced international health insurance companies.

In the qualitative interview results, the positive effects of social support also include the sub-theme of the positive role of emotional support. It is found in the interviews that not only the patients' mental stress is relieved, but the success rate of pregnancy has increased, which is consistent with the findings of related studies. Research has proven that psychological interventions and emotional support can significantly increase pregnancy rates in infertility patients (Casale & Carlqvist, 2021). From the interviews, it can be inferred that the positive role of emotional support in infertility patients cannot be ignored. For example, the support of family members (D-01), humanistic care of healthcare workers (G-06), and value-added services of commercial insurance (J-01, J-02, J-03) all alleviate the psychological pressure of patients to a certain extent.

Compared with foreign countries, the practices in emotional support in China have certain characteristics, but they still need to be more systematic and professional. For example, some foreign medical institutions have established specialized psychological counseling teams and patient support groups. It suggests that our medical structure and social organizations should establish a more systematic and professional support system to provide patients with more comprehensive and professional emotional support through the introduction of professional services such as psychological counseling and nutritional guidance, and the establishment of communication platforms such as patient support groups.

5.3.3 Influencing factors of medical social support

The quantitative research reveals the factors influencing the level of medical social support of patients undergoing ART through a generalized linear regression model, and its mechanism of action presents significant group heterogeneity. It is found that patients’ age, education, treatment cycle and treatment modality are the influencing factors of medical social support, which is consistent with the results of an earlier similar study in China (Min et al., 2007).

The higher the age, the lower the medical social support score. This is mainly because of their excessive pressure in the workplace, more concern about the obstruction of career development, and the decreased probability of obtaining financial support from their parents. The government should strengthen the social support system and improve the policy protection to provide more help and support for patients with high age. The higher the education level, the higher the medical social support score. This is related to the high ability of highly educated patients to obtain resources and their smooth communication with healthcare workers. It is suggested that when formulating relevant policies and offering medical services, the differentiated needs of patients with different educational background should be fully considered to provide them with more personalized and differentiated services. The more the treatment cycles, the lower the medical social support score. This is because with the increase in treatment time, the superimposed effects of economic pressure, psychological depletion and rejection occur. Special attention should be paid to this group of people by setting up a special fund for multi-cycle treatment in economic support, giving special attention to the health insurance policies for them, as well as setting up a multidisciplinary consultation and treatment model and establishing a mutual support group to improve the effect of economic support and medical support. Different assisted reproduction treatment programs are also one of the influencing factors of medical social support. PGT patients have higher social support scores than ICSI patients, which is mainly related to the lower family identity of ICSI patients and the discrimination against male infertility. In contrast, the ethical legitimacy of PGT for blocking genetic diseases is better supported by families. It is recommended to pay special attention to this group of people and establish a specialized male reproduction clinic. Multidisciplinary diagnostic and therapeutic teams and specialized psychological counseling clinics should be established to jointly formulate treatment pathways and develop technical specifications. Meanwhile, mutual support groups should be developed so that ICSI patients can receive emotional empathy and support.

5.4 Moderating role of medical social support

According to the quantitative analysis, whether the independent variable is economic burden of disease (self-reported) or economic burden of disease (medical records), medical social support plays a moderating role between economic burden of disease and financial toxicity and aggravates the influencing relationship between the independent and dependent variables. This finding uncovers theoretically unexpected interactions and is contrary to the generalized conclusion of the buffering effect of social support. However, there is also a multitude of literature demonstrating that when high-level social support exacerbates the effect of stressors, there may appear reverse moderating effects (Kaufmann & Beehr, 1986; Viswesvaran et al., 1999). Similar research shows that workers' lack of workload variability leads to more dissatisfaction, and this dissatisfaction can be more pronounced in workers with high levels of superior support than in those with low levels of support (Ganster et al., 1986). Another study demonstrates that group cohesion moderates the relationship between role ambiguity and role stress, but group support tends to increase the effects of role ambiguity on job dissatisfaction (Beehr, 1976). In response to the complexity of the sources and roles of social support in infertility treatment, more studies have concluded that social support is a double-edged sword (Bute, 2009; Casu et al., 2019). The present qualitative study is consistent with the results of the above literature for several possible reasons as follows.

5.4.1 Mismatch between supply and demand for social support due to patient characteristics

The social support optimal match model proves that social support is much less effective if it does not match needs, and the support behaviors are only effective when they match the needs or goals of the recipients (Bar-Kalifa & Rafaeli, 2013). Social support optimal matching theory and adequacy studies have demonstrated that support effectiveness depends on the characteristics and preferences of the recipients (Brock & Lawrence, 2009). Patients undergoing ART are characterized by high perceived stigma, high sensitivity, stoic paranoia, and high expectations, and their specific psychological states and social support preferences make it difficult to achieve an accurate “demand-supply” match for medical social support. In the interviews, it is found that the perceived stigma leads to information hiding behavior and high expectation triggers over-consumption tendency, which leads to a significant reduction in the utilization of social support, and even produces counteraction.

First, the information asymmetry caused by perceived stigma leads patients to actively construct “privacy barriers”, and studies have confirmed that infertility patients refuse or hide social support because of stigma and shame (Bute, 2009). This alertness to support sources leads to the rejection of external support, as stated by patient G-04: “I don’t want others to offer help out of pity”, and by patient I-05: “The male patients refuse to file with insurance and forgo reimbursement out of self-esteem”. This paradox corroborates the conflict between private information and public assistance (Bute, 2009). When fertility issues are seen as “stigmatized private information” to be hidden, public acceptance of social support implies exposing the risk of privacy, thus forcing patients to adopt strategies of economic autonomy for their treatment, as stated by D-03: “Girls choose to take out loans for treatment, so they can do things on their own will, without having to depend on the whims of others”. The patients are also characterized by stoicism and paranoia, such as patient G-05, who said, “It doesn’t matter if I fail this time, there will be a next time, I will never giver up until all hope is gone”, and patient G-04, who said, “The more failures I have, the more determined I am to never give up, and I always think that I will succeed if I try once more”. The patients’ poor self-regulation ability and psychological resilience (D-01, I-03), coupled with the inappropriate approaches of support, cannot help them get out of the shadow of perceived stigma, but, instead, will deepen their stoicism and paranoia, which further impedes their social integration and mental health recovery.

Second, the high expectation psychology triggers the high consumption effect of patients, and the supply of social support reinforces the patients' pursuit of high-cost healthcare options, such as patient K-02's statement, "The expectation is very high...if it is a good option, no matter how much it costs, I will not hesitate to choose it." When patients perceive social support, their treatment goals may shift from "basic needs" to "optimal outcome realization". For example, the involvement of commercial insurance (J-01) can theoretically reduce financial risk, but may prompt some patients to choose more expensive treatment options, which ultimately increases their debt burden. Furthermore, patients with high expectations tend to borrow money from relatives and family members, and they are more likely to seek more expensive treatments because they feel that they have "financial backing", thus increasing their economic burden and financial toxicity. In addition, emotional support reinforces patients' expectations of treatment and increases their anxiety by not wanting to disappoint their family members (D-05).

5.4.2 Consistent source of stress and support

According to the dynamic model of social support, social support, stressful events, and health outcomes are not simply linearly causal relationship, but rather interact and influence each other, and change over time (Cornwell, 2003). The effectiveness of social support depends on whether it is independent of stressors or not (Kaufmann & Beehr, 1986). Infertility patients receive consistent sources of stress and support, including offending inquiries and suggestions, and invasion of privacy from the same subjects (Bute, 2009; Steuber & Solomon, 2012). In qualitative research, interviewees mention that patients' primary support come from their spouses and close family members (D-01, H-03), which happen to be those who exert the fertility stress.

This homology results in a "double-bundle" feature of supportive behaviors. Relatives alleviate the direct economic burden through financial assistance, but the supportive behavior implies a conditional expectation (you have to get pregnant if you pay for it, D-01), (you are too old to wait...H-03), and the social support is transformed into a new source of stress. In addition, patients themselves generate stress by receiving social support. For example, H-04 describes that excessive support from family and friends creates anxiety of “guilty and failure to live up to expectations.” D-02 mentions that informational support from spouses such as “we can continue the treatment, and if we fail once, we can try the second time...” instead reinforces the financial fear of treatment failure. This symbiotic relationship of support and stress validates the double-edged sword theory of social support (Casu et al., 2019). It is also proved that receiving a large amount of positive support does not prevent patients from receiving problematic support from the same person (Revenson et al., 1991), and the negative aspects of social support are more predictive of psychological outcomes than positive aspects (Fiore et al., 1983). In other words, when supporters themselves form part of the stress system, their behavior can compound the impact of economic burdens on financial toxicity through emotional debt.

5.4.3 Excessive inappropriate social support

From the interview results, it is found that excess quantity and quality deviation of medical social support constitute the “excessive support trap”. Although patients receive relatively high levels of formalized support, more passive support (H-03) and intrusive support (D-02) occur. It is confirmed that excessive attention can generate negative effects, even worse than the effects of no attention (Brock & Lawrence, 2009). For example, infertility patients receiving excessive protection from their mothers suffer more severe pains (Skvirsky et al., 2018). Wives who receive more informational support from their husbands experience more severe depressive symptoms (Lorenzo et al., 2018).

Excessive intervention by relatives, such as parents accompanying the patients to the clinic (D-01, H-03), prompts the patients to adopt a strategy of financial independence. They reject reasonable sources of support and resort to loans, leading to severe financial toxicity. There are also excessive supportive scenarios in which family members frequently inquire about privacy, such as over-interpretation of the patient’s subtle changes (G-04) and inquiry about sexual life (D-02). Such behaviors make the patients feel lack of a sense of boundary (D-02), and even if the supporter is well-intentioned, his or her behavior may turn into a financial risk factor.

In order to address the above issues and improve the precision and effectiveness of social support, stakeholders need to gain a deeper understanding of patients’ needs and preferences, and adopt more refined and personalized support strategies. For example, it is necessary to be alert to the moral hazard that may arise from social support, and establish a cost-benefit analysis and constraint mechanism in the policy. Psychological interventions should be embedded in financial assistance and emotional support to minimize the distortion of medical decision-making caused by a sense of “debt of gratitude”. It requires not only the expertise and sensitivity of stakeholders, but also the concerted efforts of all sectors of the society to build a friendly environment of tolerance, understanding and support.

5.5 Interest demands and divergence among stakeholders

Stakeholders who are related to patients undergoing ART and provide them with social support are characterized with multidimensional division of labor and coexistence of cooperation and conflict. There are positive interactions such as resource complementarity, policy synergy, and service support, as well as negative conflicts such as economic game, responsibility shifting, and information asymmetry. Annex I Figure h.1 clearly illustrates the relationship between stakeholders and the divergence of interests.

5.5.1 Divergences in economic support

With dual functions of policy formulation and supervision, the government departments (the health commission, healthcare security bureau, and financial regulation bureau) are at the core position, with wide-ranging impacts involving all the other stakeholders, and they are considered to be definitive stakeholders. However, it is found in the interviews that policy implementation has problems such as a lag in top-level design and a lack of integrated planning. For example, the government cannot keep up with the trend of population fertility policy in terms of macro-control (B-02). The health insurance policy lacks clear planning in terms of coverage and reimbursement standards, leading to disagreements and conflicts such as insufficient policy articulation and poor reimbursement, increased tediousness, and limitations on hospital initiative among patients, healthcare security bureaus, hospitals, and healthcare practitioners (I-05, F-02). Commercial insurance and health insurance have not formed a harmonious relationship (J-02). The policy advocacy of think-tank experts and the government responsibilities are incompatible (E-03). The foundation has to coordinate with hospitals, patients, and the government in many aspects of its operation, and it faces difficulties such as high pressure on fundraising and being questioned by the public (C-01, F-02).

The existence of divergence in economic support is also reflected in the contradiction between the rigidity of government policies and the maximization of healthcare demands by various stakeholders. To be specific, the government’s interests are focused on safeguarding basic livelihoods, such as “universal treatment (B-02),” “no special treatment for assisted reproduction (E-04),” and “taking into account medical safety and innovation (A-01)”. However, patients seek to maximize financial support (H-02), while doctors want to alleviate stress on medication and surgical choices and prioritize success rates (D-05). Commercial insurance, as an important component of economic security, is primarily driven by profitability, but there is an overlap in scope between government-led health insurance and commercial insurance (J-02), and a synergistic payment model is yet to be formed. The interviews also reveal that there are major cooperation barriers for commercial insurance to enter public hospitals (J-02). It is in sharp contrast with the high commercial insurance coverage in the United States, where the per capita proportion of infertility medical costs has been reduced to 13% (Chambers et al., 2014).

The above divergent conflicts indicate that there is tension between stakeholder role positioning and policy flexibility, as well as insufficient resource integration capacity. In contrast to international experience, the United States has achieved good results by clarifying health insurance coverage standards in legislation, and establishing mechanisms such as mutual medical care for infertility and cross-sector collaboration (Lai et al., 2021). The current policy making in China is seriously fragmented, and the divergence of interests among stakeholders affects the efficiency and fairness of coverage. The government needs to strengthen its leading role, enhance top-level design, and develop a diversified and multilevel coordinated coverage system that is appropriate for China’s population development strategy, the fertility intentions of the population, and the government ability to raise funds for healthcare insurance.

5.5.2 Divergences in emotional support

The hospital (doctors, nurses, embryologists) provides medical services and psychological support, and the family provides financial assistance and psychological support. These stakeholders are the direct contacts in the patients’ treatment process.

It is found that there are divergences in communication breakdown. In terms of the content of emotional support, some healthcare professionals lack empathy for patients and use inappropriate words (D-02). The patients have to face and bear their partners’ cold violence by themselves (G-06), which may produce depression and irritability (G-07). Parents’ silent attitude makes the patients feel indifference (I-02). In terms of emotional support time, healthcare workers need to fulfill their job duties and ensure basic medical safety, so the time for psychological communication support is greatly squeezed (E-01, I-02, G-04), which is in great contrast to the patient’s expectation of adequate emotional support (G-01), and the pressure of time reduces emotional support to an “accessory to the technical process” (D-03). The above situation suggests that communication barriers between healthcare professionals, families and patients lead to inadequate emotional support for patients.

Additional divergences arise from excessive inappropriate social support for patients by stakeholders. The excessive concern of family members may aggravate the patients’ sense of guilty: “The better my family treats me, the more I feel like just a reproductive tool” (D-01). Parents even intervene in the details of the couple’s sexual life (D-02) and accompany and over-intervene throughout the clinical visit (H-03). The contradiction of support and pressure from the same source (K-02) implies intensive control over the patient, revealing a deep-seated conflict between traditional family ethics and the patients’ claim for privacy.

In response to the above problems, it is recommended to strengthen the training of emotional communication among healthcare professionals to enhance the level of psychological assistance. In the mean time, clinical work arrangements should be optimized and practitioners’ workload should be reassessed. It is also necessary to clarify the roles and responsibilities of family members in the treatment process and define the boundaries of family support, so as to build a reproductive emotional support system solution with Chinese characteristics.

5.5.3 Asymmetry in informational support

Asymmetric information is reflected, on the one hand, in the lack of precision in the informational support provided by stakeholders. Research has demonstrated that asymmetric information will be exacerbated by differences in expertise and values among stakeholders (Hambrick & Mason, 1984). For example, doctors tend to take a conservative attitude toward medical information due to their own professional risk considerations (D-05), which generates information conflicts with patients' high expectations and paranoia about medical outcomes ("I will never give up until all hope is gone... G-04)". Similarly, the cognitive mismatch between doctors who possess more specialized and complex medical knowledge and patients who are only concerned with the outcome of pregnancy (D-03) highlights the importance of building a mechanism of trust between doctors and patients. In addition, experts believe that psychological research on assisted reproduction is not yet robust in terms of evidentiality (E-01). The reason for the lack of precision in informational support is lack of publicity. Some patients have little knowledge on the health insurance policy (B-02) and the hospital's reduction and waiver of surgical fees (F-02), while others question the commercial insurance (J-03). Some patients rely too much on the advertisements with information bias, and therefore are deceived for treatment (G-07). It is also due to the professional gap between patients and social support providers, for example, patients believe that IVF success rate should be 100 percent (H-03), while have little knowledge on complications or even avoid them automatically (I-03).

Asymmetric information is also reflected in the lack of feedback assessment. Research has concluded that increasing available information to reduce information disadvantage and strengthening information-revealing disclosure mechanisms can help address information asymmetry (Jacobides & Croson, 2001). Interviewees express difficulties in communication with hospitals and healthcare security bureaus, and they believe that there lacks investigation and feedback in policy formulation and there is policy lag (I-05, F-02). Healthcare workers lack systematic and effective evaluation of emotional support for patients, and only give superficial attention without in-depth evaluation (K-01).

Asymmetric information is also reflected on "adverse selection". In order to pursue profitability, some irregular hospitals among the stakeholders make false advertisements (I-02) or even practice beyond their scope of business (G-07), and patients are unable to identify them because of information asymmetry, which leads to the dominance of low-quality medical institutions. Doctors act as "dual agents" between patients and commercial insurance companies. With professional medical knowledge, they advise high-risk patients to buy commercial insurance and suggest low-risk patients to give it up, and force insurance companies to adjust their marketing strategy (J-02). Research has demonstrated that the “moral hazard” of information asymmetry is reflected in the additional treatment services recommended by stakeholders such as doctors out of their own private interests, and some doctors even collude with pharmaceutical sales to exploit patients (Sheldon, 2001). Some healthcare organizations pursue profits by inducing patients to spend money through measures such as surgery without medical indication and excessive prevention of miscarriage (K-01). Some healthcare professionals increase the number of diagnostic and treatment programs or medicines and perform over-treatment for their own scientific and research purposes (K-02). Doctors’ income is linked to drug sales (H-02). The foundations may engage in behaviors such as misappropriation of funds (C-01).

To resolve the problem of asymmetric informational support, stakeholders need to operate in a transparent environment to improve the overall quality. The government needs to provide a complete legal environment, regulate medical service standards, and improve the incentive mechanism for doctors and the evaluation mechanism for medical services. It is necessary to strengthen the information disclosure mechanism, establish a platform for sharing medical risk data, reduce the monopolization of information, and promote healthy competition among medical entities. The doctors and patients communicate in good faith and establish a joint diagnosis and treatment decision-making model based on doctor-patient communication. In addition, the publicity guidance mechanism and feedback optimization mechanism should be strengthened. On the one hand, through multi-channel and in-depth interpretation of healthcare insurance and commercial insurance in publicity window, public welfare lectures, and new media platforms, the information bias of patients can be reduced, and the knowledge of the insurance, data sharing mechanism and their own rights and interests can be improved. On the other hand, a multi-party information feedback system can be established to form a closed-loop treatment of “policy advocacy - practice feedback - dynamic optimization”, which enhances information transparency and increases the trust and synergy of various stakeholders.

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Chapter 6: Conclusion

6.1 Major findings and recommendations

This study systematically measured the economic burden of disease, assessed the current status of financial toxicity, and explained the mechanism of action of medical social support with female patients undergoing ART in Shandong Province as the research subjects. The cross-examination and triangulation in the quantitative and qualitative studies revealed the negative moderation of medical social support in the relationship between economic burden of disease and financial toxicity. The study simultaneously completed the identification, classification and contradiction analysis of stakeholders, providing theoretical and empirical evidence for the construction of a precise social support system. The core conclusions are as follows.

First, the growing economic burden of disease for female patients undergoing ART is significantly higher than ever before. Poor technology affordability and prolonged treatment cycles multiply the risk of catastrophic health expenditures. Quantitative studies have yielded a higher single-cycle economic burden (57,860 *yuan*) for patients undergoing ART than in previous studies. The single-cycle direct non-medical burden (8,520 *yuan*) and indirect burden (8,920 *yuan*) for patients are significantly higher than the historical records. The direct medical economic burden (40,430 *yuan*) accounts for 96% of per capita disposable income in Shandong province in 2024, which is much higher than the average figure (17%) of OECD (Organization for Economic Cooperation and Development) member countries. The ratio of direct medical economic burden to GDP per capita in Shandong province is 41%, higher than the figures in South Africa and Brazil, and lower than the figures in countries such as India and Vietnam. The direct medical burden far exceeds the 2024 per capita consumption expenditure standard in Shandong province, and multiple cycles of treatment lead to increased catastrophic health expenditure. The economic burden of disease presents significant group heterogeneity: annual per capita household income and means of treatment are the factors influencing the economic burden of disease. The lower the annual income, the higher the economic burden of disease. The economic burden of disease is highest for patients using PGT and lowest for patients using IVF.

Second, the high incidence of financial toxicity in female patients undergoing ART should not be ignored. Driving mechanisms include factors such as the economic burden of disease and medical social support. The quantitative study shows a 54.29% incidence of financial toxicity among patients, which is higher than that of similar chronic diseases. The severity is significantly correlated with family income, complication rates and level of medical social support. The higher the annual income, the less severe the status quo of financial toxicity actually suffered. Qualitative study shows that a single source of income or an unstable work environment may lead to fluctuations in the family's financial situation, thus exacerbating financial toxicity. Complications also increase the difficulty of treatment and the cost of medical care, thus exacerbating the patient's financial toxicity. The higher the financial burden, the more severe the status quo of financial toxicity actually suffered, which emphasizes the direct impact of the economic burden of disease on the patient's financial toxicity. Hypothesis 1 is verified, namely, economic burden of disease is positively correlated with financial toxicity. Medical social support plays a positive role in alleviating financial toxicity. The stronger the medical social support, the less severe the actual financial toxicity suffered. Hypothesis 2 is verified, namely, medical social support is negatively correlated with financial toxicity.

Third, medical social support for female patients undergoing ART is higher than those undergoing similar diseases with higher privacy and stigma, and is an important protective factor for patients to improve their quality of life and reduce financial toxicity. The qualitative study shows that social support effectiveness contains two sub-themes: economic support and emotional support. Under the sub-theme of economic support, social support reduces the direct economic burden, and the standardization and strictness of the system prompts hospitals to pay more attention to quality and safety, and protect the legitimate rights and interests of patients. Economic support also significantly improves the accessibility of assisted reproductive technology, indirectly releasing pressure on doctors and improving the quality and efficiency of medical services. In terms of full health coverage, economic support enables full coverage of population, services and costs. Under the sub-theme of emotional support, patients not only have their mental stress relieved, but also have a higher success rate in getting pregnant. Research proves that the positive role of emotional support in infertility patients cannot be ignored. The quantitative study shows that the level of medical-social support among patients undergoing ART presents significant group heterogeneity. The age, education, treatment cycle and treatment modality of the patients are all factors affecting medical social support. The higher the age, the lower the score of medical social support. The higher the education, the higher the score of medical social support. The more the treatment cycles, the lower the score of medical social support.

Fourth, medical social support moderates the relationship between economic burden of disease and financial toxicity. According to quantitative research, medical social support plays a moderating role between economic burden of disease and financial toxicity no matter the independent variable is economic burden of disease (self-reported) or economic burden of disease (medical records), and it aggravates the relationship between the independent and dependent variables. Hypothesis 3 is verified. This finding is contrary to the generalized finding that emphasizes the buffering role of social support. The qualitative study reveals that the reason for this finding lies, on the one hand, in the mismatch between supply and demand of social support due to the patients' own characteristics. Patients undergoing ART are characterized by high stigma, high sensitivity, stoic paranoia, and high expectations, and their special psychological state and social support reception preferences make it difficult to achieve an accurate match of "demand-supply" in medical social support. Another reason is that the support and stress come from the same source. When the supporters themselves form part of the stress system, their behavior will increase the impact of economic burden on financial toxicity through emotional debt. The last reason is excessive and inappropriate social support. This behavior leaves the patients with no sense of boundaries and may turn into a risk factor for financial toxicity.

Fifth, the stakeholders are identified and categorized through the Mitchell score-based approach, and their role positioning, interests, and conflicting differences are explained. Literature research and focus group discussions initially identify stakeholder candidates, and after two rounds of expert consultation, the government (health commission, healthcare security bureau), civil affairs departments/foundations, physicians, and think tank experts are identified as definitive stakeholders. Embryologists, patients and their families are identified as expectant stakeholders. Nurses, commercial insurance companies, and healthcare organization administrators are identified as latent stakeholders. Through qualitative interviews, data coding and construction, and thematic analysis, a total of four themes are formulated including stakeholder analysis, stakeholder disagreement, positive effects of social support, and existing problems of social support, with nine sub-themes such as role positioning and interest claims, as well as a number of codings such as policy makers, and implementation supervisors. It is found that stakeholders are characterized by multidimensional division of labor and coexistence of cooperation and contradiction. There are positive interactions such as resource supplementation, policy collaboration and service support, as well as negative conflicts such as economic games, responsibility shifting and information asymmetry. The economic support conflicts are reflected in not only the government's lagging top-level design and lack of integrated planning, but also the rigidity of policies and contradiction between various stakeholders’ demands for healthcare. The emotional support conflicts are reflected in communication breakdowns and excessive inappropriate social support. Information support asymmetry is reflected in the lack of precision of information, lack of feedback assessment, adverse selection and moral hazard.

Currently, patients undergoing ART suffer from heavy economic burden of disease and severe financial toxicity. The relationship between the stakeholders surrounding patients and providing social support is complex, and there is an urgent need to systematically identify the differentiated demands of each participant in the chain, establish a coordination mechanism, and accurately provide social support. Therefore, we have proposed major recommendations as follows.

First, the top-level design should be strengthened, and the government should take the lead in coordinating the construction of a “medical insurance-based, commercial insurance-supplemented, special foundation assistance, and medical institution collaboration” economic security system in the context of compatibility among population development strategy, fertility desire, and the fundraising ability of medical insurance in China. Specific measures include expanding the scope of people covered by medical insurance and establishing a differentiated step-by-step security mechanism. For groups with family incomes below the regional average, adopting high-cost technologies such as PGT, and undergoing repeated transplant failures, a special fund for assisted reproduction should be set up and a dynamic reimbursement system should be implemented, complemented with subsidies for treatment failures. The government should improve laws and regulations and strengthen coordinated supervision by departments. The government should provide a complete legal environment, regulate medical service standards, and improve the incentive mechanism for physicians and the evaluation mechanism for medical services. Supervision groups should be formed by the health commission, healthcare security bureau, and the civil affairs department to focus on the standardized use of funds, delayed rate of policy implementation, and the use of non-indicated technologies. In addition, commercial insurance companies, as one of the stakeholders, should differentiate and innovate their products, allowing patients to classify and adjust the amount of coverage according to their own conditions, adding value-added health management services, and providing free reproductive health counseling, assessment, and psychological screening for the insured. Stakeholders such as medical institutions and foundations should make concerted efforts to form an association of assisted reproduction specialty alliances, reduce the indirect burden on patients through remote consultation and mutual recognition of test results by medical associations, and achieve regional sharing and optimal allocation of high-quality resources.

Second, an emotional support system based on the characteristics of patients' needs should be established to improve the precision and effectiveness of social support. Patients should strengthen self-regulation and psychological resilience, enhance self-compassion and acceptance, and proactively accept social support. The government and medical institutions should jointly implement treatment-stage-specific strategies. For example, patients should be provided with psychological counseling and therapeutic decision-making aids during ovulation stimulation, financial assistance and risk management team support for complications should be strengthened during embryo transfer, and a joint follow-up mechanism with obstetrics, nutrition, and psychologists should be constructed during pregnancy. In addition, the government and medical institutions should strengthen the emotional capacity of stakeholders. Reproductive health counseling hotlines should be set up to reduce stigma-induced support avoidance. Free training for family members on emotional and psychological management should be increased to embed psychological interventions in financial assistance and emotional support, so as to reduce the distortion of medical decision-making caused by "emotional indebtedness". The workload of practitioners should be reevaluated, the consultation process should be optimized, a precise triage system should be implemented, a "whole process treatment consultant" model should be built to compress non-necessary time loss, and the certification of communication skills of healthcare workers should be incorporated into the professional title promotion system. The government should take the initiative to build an ecosystem of social support, work together with foundations and the media to launch publicity campaigns on themes such as "reproductive equality", and promote the inclusion of reproductive health as a mandatory benefit for enterprises. Think-tank experts should establish a policy advocacy alliance, and organically embed psychological interventions in economic assistance, so as to create an inclusive and professional support environment.

Third, population development should be included as a national strategy, and the construction of an information support system should be strengthened to build a data-driven, transparent and open dynamic management mechanism. The government should first elevate the social support of assisted reproduction to the height of national strategy, enhance the people's reproductive values and social consensus, and regard it as a core issue, so as to form a multi-dimensional support system of cultural guidance, institutional guarantee, economic support and service provision. In addition, the government should establish a big data platform for reproductive health and share medical risk data. Data on the success rate of assisted reproductive technology in medical institutions, insurance actuarial models, and government supervision indicators should be integrated to set an early warning for catastrophic health spending. The specialized disease treatment norms and clinical guidelines with national credibility should be accessible to the patients, and a recommendation system for treatment plans should be developed. Information on price fluctuations of medicines and consumables should be publicized, the nationally unified platform for complaints should be launched simultaneously, and medical institutions are required to accurately answer patients' requests, so as to break down information barriers and promote conscientious competition among medical institutions. Medical institutions, foundations and other stakeholders should improve the closed loop of information governance. Knowledge of medical insurance policies and patients' rights and interests should be popularized through public lectures, new media and other channels to reduce the patients' information bias, and a whole-process tracking mechanism of "policy release - implementation and feedback - dynamic optimization" should be established. Think-tank experts should strengthen research on the specificity of assisted reproduction, embed cost-effect analysis in policy design, and set constraints on possible moral risks, so as to ensure the synergy of information transparency and medical fairness. Finally, a co-diagnosis and treatment model based on doctor-patient communication should be established to form a two-way transparent information interaction system. The medical institutions should improve the informed consent and risk notification system, and implement hierarchical information supply for individual patient differences. The generalized fill-in-the-blank style of information notification should be abandoned, and it is suggested to accurately deliver key decision-making information through visual data and contextual simulation tools. Patients should improve their ability to identify and distinguish medical resources and master the methods to verify the qualification of formal medical institutions. Through the two-way efforts of accurate information supply from the medical side and the enhancement of the patients' ability to tell the truth from the false, a collaborative decision-making model based on mutual trust will eventually be formed.

6.2 Research contributions

(1) Theoretical contributions:

This research overturns the social support buffering model and deepens the optimal matching model, emphasizes that social support must be dynamically adapted in stages based on the evolving needs of patients. In the field of ART, we discover and verify that medical social support exerts an inverse moderating effect on the relationship between economic burden and financial toxicity. Specifically, particular forms of social support not only fail to alleviate the financial toxicity caused by economic burden but also, in certain contexts, even exacerbate its negative impact. This finding fundamentally overturns the core assumption of traditional social support theory, which widely posits that support inherently has a protective buffering effect. It powerfully demonstrates the highly context-dependent and complex nature of social support efficacy, particularly in managing diseases with strong disease stigma and heightened privacy sensitivity. This discovery provides a key theoretical breakthrough for understanding the "paradoxical support outcomes" observed in similar research.

This research provides a novel perspective on the paradoxical support effects in managing diseases characterized by strong stigma and high information sensitivity. By integrating the dynamic model of social support, the optimal matching model, and a patient-centered characteristics perspective through mixed-methods research and triangulation, this research constructs a more comprehensive analytical framework. This framework distinctly identifies and reveals several critical phenomena: the 'conflation of stress and support sources', where supporters may simultaneously function as stressors – their behaviors or expectations (such as moral coercion and entangled social expectations) acting upon patients to amplify emotional burdens and even induce feelings of indebtedness; 'stigma-driven information concealment behavior', wherein patients, driven by intense disease stigma, heightened sensitivity, and privacy preservation needs, deliberately or involuntarily conceal their true feelings, needs, and financial status, leading to severe supply-demand information distortion and the failure of precise matching; and 'inappropriate or excessive support,' referring to boundary-lacking support behaviors that disregard patient autonomy (e.g., excessive intervention in decisions, indiscriminate aid) – which are alienated into additional economic or psychological burdens and thereby transformed into potential risk factors contributing to patient financial toxicity.

(2) Managerial contributions:

This research provides a scientifically grounded blueprint and actionable pathway recommendations for establishing a social support security system characterized by " precise matching, systemic synergy, data-driven operations, and demand orientation" to address the economic burden and financial toxicity of patients undergoing ART, offering significant practical utility and policy reference value.

First, it furnishes the scientific basis for constructing a precision-targeted social support system: through authoritative measurement of the economic burden of disease and heterogeneity analysis of patients undergoing ART (identifying key impacts of per capita income, treatment cycles, and technology), we systematically reveal the high prevalence and highly concealed nature of their financial toxicity as well as its driving mechanisms, while providing an in-depth analysis of the inverse moderating mechanism between economic burden, financial toxicity, and medical social support. This establishes a solid data foundation and decision-making basis for the scientific design and targeted implementation of social support policies and protective measures.

Second, it uncovers the roots and impacts of conflicts among multiple stakeholders: systematically identifying and classifying relevant interest groups using Delphi methods and Mitchell score-based approach. Through qualitative analysis, we clarify the role expectations, motivational differences, and contradictory conflicts of each stakeholder within the social support system, revealing how these conflicts become critical barriers hindering effective collaboration and system functionality.

Third, it proposes a systematic and precisely targeted social support security system while introducing innovative policy implementation tools, providing practical guidance for resolving stakeholder conflicts and promoting synergy. This includes establishing a hierarchically clear and harmonized economic security system, creating an emotionally supportive framework centered on patient needs, and strengthening an information support system to form a data-driven, transparent, and dynamic management mechanism.

6.3 Research limitations and future research directions

There is data bias due to lagged policy effects and difficulty in capturing long-term effects in cross-sectional data. The implementation of the assisted reproduction health insurance policy in Shandong Province since April 2024 has effectively reduced the direct medical financial burden of patients, but this quantitative study (June to September 2024) and qualitative study (November 2024 to January 2025) were conducted during the initial stage of policy implementation, and at the same time the updating of the health insurance catalogs and the patients' knowledge of the policies were in a transitional period. The samples that have not yet benefited from the subsidy of the health insurance fund may lead to an overestimation of the economic burden of disease, which in turn leads to systematic bias in the assessment of financial toxicity. Future researchers can conduct a longitudinal cohort study to establish a multi-center reproductive health economic cohort to track the evolution of economic burden over a 5 to 10 years of treatment cycle and continuously monitor the effects of policy implementation.

There is information bias arising from sample characteristics. In the economic burden measurement, we used patients’ self-reported income and expenditure data, which is at typical risk of response bias. Respondents generally tend to under-report the income and over-report the expenditure, and this systematic reporting bias may have contributed to the inflated evaluation of medical economic burden.

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Annex A: Questionnaire for Patients Undergoing ART

Questionnaire SN: ____________
Hospital surveyed:____________
Department surveyed:_________
Patient name:______________
Tel: ______________
Date of survey: ______(Year)______(Month)______(Day)
Name of investigator: ___________

If you have any questions about this interview, you can contact us by phone or email.

Tel: 0531-85651392 E-mail: gengling78@126.com

Informed consent

Thank you for your time! We are the research team of the Relationship between Economic Burden of Disease, Financial Toxicity, and Social Support among Patients Undergoing ART from a Stakeholder Perspective. Your participation in this study is completely voluntary. Even if you have agreed to participate in this study, you may withdraw at any time without conditions.

Why are you invited to participate in the study? The subjects for this study are patients undergoing ART who seek outpatient treatment or are hospitalized at our hospital. You are invited to participate in this study because you meet this inclusion criterion.

How do you participate in the study? If you agree to participate in our study, please take about ten minutes to fill out the questionnaire on economic burden, which includes basic personal information, disease history, disease diagnosis, treatment modalities, medical expenses, and family financial status. We will give small gifts for appreciation.

What are the benefits of participation in the study? You can learn about the cost and burden of your treatment, which can help your clinical decision-making; we use the results of the study to provide cost measurement and economic burden reports to the government and healthcare organizations to improve relevant policies.

What are the risks of participation in the study? In principle, there are no losses or risks associated with participation in this study.

Will the information be kept confidential? Yes, all of your information will be used for research purposes only. We will not tell anyone else that you have taken part in the survey, and any information we collect about you will be kept confidential. We will also replace your name with a number for analysis purposes, and no one knows your number except the researchers. The information we collect will be kept securely and safely. If you have any questions, you can ask us or your doctor.

What happens to the results of the survey? The results of our survey will be used in a study on the cost measurement of assisted reproduction and multiple funding mechanisms. The results will be published in relevant journals for the reference of other researchers, or submitted to the government in the form of policy briefs to improve the relevant policies and reduce the out-of-pocket medical costs of assisted reproduction, but your name and personal information will be kept confidential.

If you have any further questions, feel free to ask any of the investigators.

Person in charge_____; Investigator:_______; Tel:______; Date:___(Y)___(M)___(D)

☐ **I have read and understood the above and I agree to participate in this survey.**
Respondent:__________; Date:___(Y)___(M)___(D)

[Instructions for filling in the form]

1. This questionnaire is filled out by the investigator. All data must be fair, objective and accurate, and the investigator is responsible for the authenticity of the data and materials provided.

2. There is no right or wrong answer to questions in this questionnaire, but the answer must accurately reflect the true situation of the respondents.

3. The questions in this questionnaire are divided into two categories: one is multiple-choice and the other is fill-in-the-blank.

4. Single-choice questions: please tick one of the options in the answer.

5. Multiple-choice questions: please tick the appropriate options.

6. Fill-in-the-blank questions: please fill in the answers (words or numbers) that reflect the actual situation of the respondents.

7. If you choose “Other” for elaboration, please explain accordingly.

8. In the case that some of the questions are not applicable, the patient is unable to answer, or refuses to answer, please put a “×” on the question number and mark the reason next to the question number.

I. Basic information

A1	Your date of birth: _______(Y)_______(M)
A2	Gender: ①Male ②Female
A3	Your level of education: ①No school education ② Elementary school ③ Junior high school ④ Senior high school or vocational school ⑤ Junior college ⑥ University ⑦ Graduate school or above
A4	Address:_______(City)________(County/district)
A5	Place of residence: ①Urban area ②Rural area
A6	Number of people in household?________
A7	Your health insurance (multiple options available): ① Basic Medical Insurance for Urban and Rural Residents ② Basic Medical Insurance for Urban and Rural Workers ③ Commercial medical insurance ④Out-of-pocket ⑤Free medical care ⑥Medical assistance ⑦ Others
A8	Your employment status: ① Employed (including flexible employment) ② Unemployed ③ Jobless ④Others
A9	Your occupation (for the employed): ①State civil servants ②Professionals and technicians ③Officials and related personnel ④Commercial/service workers ⑤ Agricultural, forestry, fishery and water conservancy workers ⑥ Operators of production and transport equipment ⑦ Freelancers ⑧Self-employed workers ⑨Others
A10	What is your annual household per capita income in 2023? (Including income from wages, business, property, and transfers of all kinds, deducting personal income tax, social security payments, alimony payments, and interest payments, and excluding income from the sale of property and borrowing as well as inheritance or one-time gifts.) ① Less than 20,000 yuan ② 20,000-40,000 yuan ③ 40,000-60,000 yuan ② ④ 60,000-80,000 yuan ⑤ 80,000-100,000 yuan ⑥ More than 100,000 yuan
A11	What is your annual household per capita consumption expenditure in 2023? (Including consumption expenditure on food, tobacco and alcohol, clothing, housing, daily necessities and services, transport and communication, education, culture and entertainment, health care and other items, and excluding non-consumption expenditure such as social security expenditure, purchase of commercial insurance, wedding/funeral gifts, and expenditure on purchasing and constructing a house) ① Less than10,000 yuan ② 10,000-30,000 yuan ③ 30,000-50,000 yuan ④ 50,000-70,000 yuan ⑤ 70,000-90,000 yuan ⑥ More than 90,000 yuan
A12	As for the expenditure: A. What percentage was spent on food (including food purchases and food services)? ①more than 50% ② 25%-50% ③10%-25% ④ less than 10% B. What percentage was spent on medical care (including medical instruments, medicines and medical services)? ① more than 50% ② 25%-50% ③ 10%-25% ④ less than 10% C. What percentage was spent on health care (including health care instruments, supplies and services)? ① more than 50% ② 25%-50% ③ 10%-25% ④ less than 10%

II. Infertility and treatment

B1	Etiology of visit (multiple choice): ① Tubal factors ② Ovarian hypoplasia ③ Ovulation disorders ④ Endometriosis ⑤ Oligo-weak spermatozoa ⑥ Aberrant spermatozoa ⑦ Azoospermia ⑧ Both factors ⑨ Unknown ⑩ Others
B2	Presence of any of the following chronic diseases (multiple answers allowed): ① Hypertension ② Diabetes mellitus ③ Hyperlipidemia ④Cardiovascular disease ⑤Autoimmune disease ⑥Blood disease ⑦Nephritis ⑧Others ⑨None of the above
B3	Date of first assisted reproduction treatment: ____________
B4	Amount of treatment cycle:______ Medical Card No.__________
B5	Assisted reproductive technologies used in this cycle ① IVF ② ICSI ③ PGT
B6	Any of the following complications during assisted reproduction treatment (multiple choice) ① Moderate to severe ovarian hyperstimulation syndrome (OHSS) ② Postoperative bleeding (>300ml) ③ Post-operative pelvic infection ④Others ⑤ None of the above

III. Medical expenses

Direct medical costs	**Answer**
What is the approximate total medical expenses **after starting this cycle of assisted reproduction in our hospital?**	
What is the approximate out-of-pocket medical expenses **after starting this cycle of assisted reproduction in our hospital?**	
What is the approximate medical expenses reimbursed by the health insurance **after starting this cycle of assisted reproduction in our hospital?**	
Direct non-medical costs	
What is the cumulative number of hospital visits (including outpatient and inpatient) **after starting this cycle of assisted reproduction in our hospital?**	
What is the average approximate cost of transportation per round trip?	
What is the average approximate cost of lodging per visit?	
What is the average approximate cost of accommodation per visit?	
What is the approximate cost of nutritious food **after starting this cycle of assisted reproduction in our hospital?**	
Indirect costs	
How many days have you been off work **after starting this cycle of assisted reproduction in our hospital?**	
How many days have your family members accompanying you been off work **after starting this cycle of assisted reproduction in our hospital?**	
What is your approximate monthly salary?	
What is the approximate monthly salary of the family member accompanying you?	

IV. Financial toxicity

Comprehensive financial toxicity rating scale based on patient-reported outcomes

	Item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
D1	I know I have enough money in my savings or other assets to cover my medical expenses.	0	1	2	3	4
D2	I have more out-of-pocket medical expenses than I thought I would.	0	1	2	3	4

D3	Due to my illness or treatment, I am concerned that I may have financial problems in the future.	0	1	2	3	4
D4	I don't think I have a choice about my medical expenses (I have to spend that much whether I want to or not).	0	1	2	3	4
D5	I am frustrated that I cannot work or contribute as much as I usually do	0	1	2	3	4
D6	I am satisfied with my current financial situation	0	1	2	3	4
D7	I can afford the monthly expenses.	0	1	2	3	4
D8	I feel pressured financially.	0	1	2	3	4
D9	I am worried about whether I'll be able to keep my job and my paycheck.	0	1	2	3	4
D10	My illness or treatment reduces my satisfaction with my financial situation.	0	1	2	3	4
D11	I think my financial situation is still within my control.	0	1	2	3	4

V. Social support

Medical Social Support (MOS-SSS-C)

1. How many familiar family members and friends do you have (people you find easy to get along with and talk to)?

Family members: __________ Friends: ___________

2. Sources of financial support and help in solving practical problems that you have received in the case of emergency: ___

① No

② The following sources (you may choose more than one) A. Spouse; B. Other family members; C. Relatives; D. Colleagues; E. Workplace; F. Official or semi-official organizations such as party groups and trade unions; G. Unofficial organizations such as religious and social organizations; H. Others (please list) _______

③ People sometimes resort to others for companionship, help or other forms of support, how often do you get each of the following support when you need it?

SSS	Never	Seldom	Sometimes	Most of the time	Always
3. If you are confined to bed mobility, there are people who can give you help.	1	2	3	4	5
4. You can count on certain people to listen to	1	2	3	4	5

you when you need to talk.					
5. Someone gives you good advice or counsel in times of hardship and distress.	1	2	3	4	5
6. There are people who will take you to the doctor if you need them.	1	2	3	4	5
7. Someone expresses their love and concern for you.	1	2	3	4	5
8. Someone spends time with you in a joyful way.	1	2	3	4	5
9. You are given some information to show that you understand the situation.	1	2	3	4	5
10. Someone you can trust to talk to about your own affairs or problems.	1	2	3	4	5
11. Someone will take good care of you.	1	2	3	4	5
12. Someone gets together with you to have some fun.	1	2	3	4	5
13. If you cannot cook for yourself, someone will do it for you.	1	2	3	4	5
14. Someone’s advice is what you really crave for.	1	2	3	4	5
15. Having someone to do something with enables you to let go of what's on your mind.	1	2	3	4	5
16. When you are unwell, someone will take care of your daily chores for you.	1	2	3	4	5
17. Someone can share your deepest fears and worries.	1	2	3	4	5
18. A number of people could be asked for advice on how to deal with personal problems.	1	2	3	4	5
19. You have someone who can do something happy with you.	1	2	3	4	5
20, Someone understands your problem.	1	2	3	4	5
21. You love some people and have the feeling of being needed.	1	2	3	4	5

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Annex B: Stakeholder Questionnaire

Stakeholder Questionnaire (Round 1)

Dear experts:

At this stage, the stakeholders of assisted reproduction treatment are complex and variable, and a multifaceted and collaborative social support system is yet to be constructed. In the construction of social support for patients undergoing ART, we will inevitably encounter resistance or motivation from stakeholders. Therefore, it is necessary to identify the stakeholders involved and analyze their interests. We would like to invite you as an expert on this topic and hope that you can provide the following information. We guarantee that the data you fill in will only be used for academic research and will never be publicized. We sincerely thank you for your support and cooperation.

Part I: Basic Information

Instructions for completing the form: Please fill in the blanks or tick as appropriate.

1.You work for ____________________

2.Your gender is: ____________________

3.Your age: ____________________

4.Your highest level of education: A. PhD. B. Master C. Bachelor D Junior college graduate E Others

5.Your professional title: A Senior B Associate senior C Intermediate D Junior E Other

6.Your current main area of expertise___________; years of experience________

7.Your familiarity with assisted reproduction:

A Very familiar B Familiar C Generally familiar D Unfamiliar E Unknown

8.The main basis for your judgement is (Check the extent to which you base your judgment):

Working experience			**Theoretical analysis**			**Peer understanding**			**Intuition**		
Large	Medium	Small	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small

9.Your e-mail address: _____________

Part II: Your Options

A stakeholder is any person or group of persons who can influence, or be influenced by, the process of achieving an organization's objectives. Any organizational or individual stakeholder should have the attributes of legitimacy, power and urgency.

Power: The status, ability, and degree of influence over decision-making and development of support for the assisted reproduction. (When assessing stakeholder power, we need to consider the ability of stakeholders to control organizational decisions and behaviors. This includes their ability to influence organizational decisions through resources, information, social status, or other channels. Stakeholders with high power scores tend to be able to influence the organization to a greater degree, and their opinions and demands are more likely to be accepted and adopted by the organization, such as government departments, large corporations, and powerful interest groups. On the contrary, stakeholders with lower power scores may be in a weaker position and their demands and expectations are less likely to be accepted and supported by the organization).

Legitimacy: Whether or not they are legally empowered to claim social support for assisted reproduction. (When assessing the legitimacy of stakeholders, we need to consider whether the basis of their claims or expectations is consistent with legal and ethical norms. If a stakeholder's claims or expectations are legitimate, it means that their claims are in line with generally accepted social norms and values that are recognized and accepted by the majority of people. For example, a consumer organization's criticism of product quality and safety and corporate counterfeiting is consistent with legal and ethical requirements and therefore has a high legitimacy score. On the other hand, a stakeholder whose demands violate legal or ethical norms, such as certain illegal assemblies asking for government privileges, will have a lower legitimacy score).

Urgency: The extent to which the group's demands can be brought to the attention of the decision-making body immediately. (Urgency scores are used to assess the degree to which a stakeholder's demands or expectations have a direct impact on the organization's goals and interests. Stakeholders with high urgency ratings have demands or expectations that have a significant and immediate impact on the organization and often need to be addressed as soon as possible, or else there may be a greater risk or adverse impact on the organization. For example, employees' wage demands and shareholders' concerns about the profitability of the organization are among the demands with high urgency. Conversely, some stakeholders whose claims have less impact and a lower degree of influence on the organization will have correspondingly lower urgency ratings).

Please make your choice as to whether the individuals, groups, and organizations listed in the table are stakeholders of assisted reproduction, and tick "√" if so. Please assign a 5-point scale to each of the three dimensions of power, legitimacy, and urgency for the stakeholders, with 5 being the strongest and 1 being the weakest.

Stakeholder candidates	**Whether or not belongs to stakeholder**		**Mitchell score-based approach**		
	Yes	No	Power	Legitimacy	Urgency
Health commission					
Provincial/municipal healthcare security bureaus					
Civil affairs department/foundations					
University experts on health insurance policy					
Reproductive clinicians					
Reproductive clinical nurse					
Embryologist					
Commercial insurance companies					
Patients					
Family members of patients					
Health group					
Ethics/law/demography specialists					
Managers of medical institutions					
The media					
Please fill in the blanks with the stakeholders you think should be added:					

Thank you for your support and cooperation. We will summarize and collate the expert comments to form a second round of stakeholder expert consultation form. We will invite you to conduct the second round of scoring after a week (via email).

Stakeholder Questionnaire (Round 2)

Dear experts:

Thank you for your choices and ratings in the Stakeholder Questionnaire (Round 1), and please continue the second round of questionnaire survey based on the results of the first round.

Part I: Basic Information

Instructions for completing the form: Please fill in the blanks or tick as appropriate.

1.You work for ____________________

2.Your gender is: ____________________

3.Your age: ____________________

4.Your highest level of education: A. PhD. B. Master C. Bachelor D Junior college graduate E Others

5.Your professional title: A Senior B Associate senior C Intermediate D Junior E Other

6.Your current main area of expertise___________; years of experience________

7.Your familiarity with assisted reproduction:

A Very familiar B Familiar C Generally familiar D Unfamiliar E Unknown

8.The main basis for your judgement is (Check the extent to which you base your judgment):

Working experience			**Theoretical analysis**			**Peer understanding**			**Intuition**		
Large	Medium	Small	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small

Part II: Your Options

A stakeholder is any person or group of persons who can influence, or be influenced by, the process of achieving an organization’s objectives. Any organizational or individual stakeholder should have the attributes of legitimacy, power and urgency.

Power: The status, ability, and degree of influence over decision-making and development of support for the assisted reproduction. (When assessing stakeholder power, we need to consider the ability of stakeholders to control organizational decisions and behaviors. This includes their ability to influence organizational decisions through resources, information, social status, or other channels. Stakeholders with high power scores tend to be able to influence the organization to a greater degree, and their opinions and demands are more likely to be accepted and adopted by the organization, such as government departments, large corporations, and powerful interest groups. On the contrary, stakeholders with lower power scores may be in a weaker position and their demands and expectations are less likely to be accepted and supported by the organization).

Legitimacy: Whether or not they are legally empowered to claim social support for assisted reproduction. (When assessing the legitimacy of stakeholders, we need to consider whether the basis of their claims or expectations is consistent with legal and ethical norms. If a stakeholder's claims or expectations are legitimate, it means that their claims are in line with generally accepted social norms and values that are recognized and accepted by the majority of people. For example, a consumer organization's criticism of product quality and safety and corporate counterfeiting is consistent with legal and ethical requirements and therefore has a high legitimacy score. On the other hand, a stakeholder whose demands violate legal or ethical norms, such as certain illegal assemblies asking for government privileges, will have a lower legitimacy score).

Urgency: The extent to which the group's demands can be brought to the attention of the decision-making body immediately. (Urgency scores are used to assess the degree to which a stakeholder's demands or expectations have a direct impact on the organization's goals and interests. Stakeholders with high urgency ratings have demands or expectations that have a significant and immediate impact on the organization and often need to be addressed as soon as possible, or else there may be a greater risk or adverse impact on the organization. For example, employees' wage demands and shareholders' concerns about the profitability of the organization are among the demands with high urgency. Conversely, some stakeholders whose claims have less impact and a lower degree of influence on the organization will have correspondingly lower urgency ratings).

Please make your choice as to whether the individuals, groups, and organizations listed in the table are stakeholders of assisted reproduction, and tick "√" if so. Please assign a 5-point scale to each of the three dimensions of power, legitimacy, and urgency for the stakeholders, with 5 being the strongest and 1 being the weakest.

Stakeholder candidate	**Support in Round 1**	**Stakeholder or not**	**Power in round 1**	**Power in round 2**	**Legitimacy in round1**	**Legitimacy in round 2**	**Urgency in round 1**	**Urgency in round 2**
Health commission	92.86%		4.92		4.69		4.62	
Provincial/municipal healthcare security bureaus	100.00%		4.36		4.21		4.00	
Civil affairs department/foundations	78.57%		3.00		3.36		2.91	
University experts on health insurance policy	100.00%		2.79		3.43		2.93	

Reproductive clinicians	100.00%		2.36		3.14		2.50	
Reproductive clinical nurse	92.86%		2.77		3.54		3.08	
Embryologist	92.86%		1.85		2.15		1.77	
Commercial insurance companies	100.00%		1.71		3.14		3.43	
Patients	100.00%		1.57		2.71		3.07	
Family members of patients	64.29%		0.89		1.22		1.22	
Health group	100.00%		3.14		3.29		2.57	
Ethics/law/demography specialists	92.86%		2.69		2.85		2.62	
Managers of medical institutions	78.57%		2.55		2.45		2.55	
Workplace or community	14.28%							
Pharmaceutical/medical apparatus companies	7.14%							
Mediation Committee for Medical Disputes	7.14%							
Your other comments:								

Annex C: Stakeholder Interview Outline

We are the staff of the research project Relationship Between Economic Burden of Disease, Financial Toxicity, and Social Support and the following information will help you understand the study. Please read it carefully and ask any questions you may have.

Purpose of the study: The results of this study will help us understand the current situation of the economic burden of disease and financial toxicity of patients treated with assisted reproduction and the factors affecting them, and at the same time, we will be able to investigate the attitudes of various stakeholders towards the provision of social support for assisted reproduction, the measures taken, the demands represented by each of them, as well as the problem of asymmetry of information and other contradictions, which will be conducive to constructing the mechanism for the provision of social support for patients with assisted reproduction.

Research process: Your participation in this study is voluntary, you can choose not to participate or notify the researcher at any time to withdraw from the study, your data will not be included in the results of the study, and any of your treatment and rights will not be affected.

If you agree to participate in this study, each subject will be numbered and a separate file will be created. During the course of the study, we will conduct an interview with you, which will be audio-recorded and later transcribed into a transcript for information extraction.

Risks and discomfort: This study does not pose any risks or harm to you or your family. Any information about you is confidential. The transcripts of your interviews will be identified by the study number and not by your name.

As a participant in this study, you have the following responsibilities: to be able to tell the researcher openly about your feelings and thoughts about the interview during the study. You will be able to keep up to date with information about this study and the progress of the research. If you have any questions about this study, or if you experience any discomfort during the study, or if you have questions about the rights of participants in this study, you may contact us at 0531-85651392.

I have read this informed consent form and voluntarily agree to participate in this study. This informed consent form is in duplicate, one for the researcher and one for the subject.

Signature of the respondent: __________ **Date**: _________

I have explained the study to the respondent and her/his understanding of informed consent has been obtained.

Signature of the researcher: __________ Date: _________

Interview Outline for Patients and their Family Members

I. Basic Information:

Gender: Educational level: Age: Household registration: Economic income: Residence: Occupation: Time of first visit: Number of cycles:

II. Interview outline:

1. Please describe the economic expenditures incurred in the process of assisted reproductive technology treatment, and what are the specific impacts of these expenditures on your quality of life, psychological status and treatment decisions? Have you relieved some of the financial pressure through reimbursement by medical or commercial insurance, policy subsidies, or other external support? How effective is the actual utilization of these resources?

2. What is your level of understanding of current assisted reproductive technology-related medical reimbursement, maternity allowance and other support policies? Have you received any financial assistance or services from the government, medical institutions or social organizations? Please give examples of their application process and actual effects.

3. What kind of emotional support (e.g., psychological counseling, companionship), information support (e.g., knowledge of diagnosis and treatment, interpretation of policies) or material support have you received during the treatment process? Have you ever refused to disclose your assisted reproduction treatment? What were the reasons? What support was most helpful to you? Which parts of the process were insufficient?

4. Was the social support you received from people around you during your visit helpful and how did you feel about it? Please describe these conflicts and how they affected you.

5. Have you ever purchased assisted reproduction services from an informal organization? What were the main considerations when choosing? What were the consequences?

Interview Outline for the Government (Health Commission and Healthcare Security Bureau)

I. Basic Information:

Age: Gender: Educational level: Work unit: Professional and technical position: Years of work:

II.Interview outline:

1. What targeted social support is currently provided to patients undergoing ART?

1) What is the advancement of work and actual effect? What is the response of the patients, what is the degree of utilization and why?

2) On what basis are government departments positioned to implement these programs (what are their interests)? What are the conflicts between providing social support and their own functions, and what are the solutions?

2. How do you evaluate the current policy on health insurance and other financial subsidies for assisted reproductive technology?

1) What are the reasons for formulating the policy and what factors have been taken into consideration? What is the impact on patients' financial burden?

2) After assisted reproduction is included in the health insurance, what is the impact on hospitals and other groups, what are the differences with other stakeholders, and how to promote the implementation process in concert with various stakeholders?

3) What is the main responsibility of public financing (e.g., health insurance funds) in the process of integrating assisted reproduction into health insurance? What are your views on the role of commercial insurance?

3) What have we done in terms of active reproductive support such as reproductive culture, etc.?

Interview Outline for the Hospital (Doctors, Nurses, and Administrators)

I. Basic Information:

Gender: Educational level: Age: Occupation: Grade:

Length of service: Employer:

II. Interview outline:

1. In the process of consultation and treatment, besides the introduction of assisted reproduction techniques and programs, what kind of services do you usually provide to patients?

2. What are the contradictions between the social support for assisted reproduction and your own functions, the difficulties and the next solutions?

3. Social support includes economic support, psychological support, and cultural support, etc. What kind of social support do you think patients need, and give a few examples in order of importance. What channels can be used to compensate for the social support that is not being met by the patients now? What do you think is the degree of utilization of social support for

patients?

4. What are the drawbacks and suggestions for health insurance coverage from your perspective and knowing the patient's perspective? Is there a divergence with other populations and how can social support be advanced in concert and precision with other groups?

Interview Outline for Commercial Insurance Companies

I. Basic Information:

Age: Gender: Educational level: Occupation: Grade:

Length of service: Employer:

II.Interview outline:

1. What role do you think commercial insurance for assisted reproduction plays in patients' financial support? How to promote the implementation process? What are the specific measures? What is the effect of the current implementation? What are the most critical needs on your side in the promotion process? How do you think patients utilize the social support of commercial insurance?

2. Where are the games and conflicts with different stakeholders such as the government and patients, and is there any information asymmetry?

3. How do the various stakeholders such as doctors, patients and commercial insurance work together to ensure social support for patients?

4. What do you think are the differences and advantages of commercial insurance versus health insurance and other financial subsidies? What are the disadvantages of health insurance coverage from your perspective and understanding of the patient's perspective, and suggestions?

5. Does commercial insurance add other social support items (e.g., psychological items) in addition to providing financial support?

Interview Outline for Think Tank Experts

I. Basic Information:

Age: Sex: Educational level: Occupation: Grade:

Length of service: Employer:

II.Interview outline:

1. What are the efforts of our professional field in support for assisted reproduction, and what are its roles and impacts? What are the core interests of college and university policy experts (and the academic community they may represent) in this area from a demographic sociology/humanistic nursing/ethics perspective? How might the interests of other stakeholders

intersect or conflict with ours?

2. What do you see as the biggest challenges in building a social support system for assisted reproduction patients? What are the current problems of emotional support, information support, and economic support? How to overcome the barriers in policy making, social cognition and resource allocation?

3. How to design a synergistic support mechanism that takes into account the needs of patients and effectively integrates the resources of the government, the market, social organizations and other parties? What role can we play in this mechanism?

4. How do you see the future development trend of assisted reproductive technology and social support system, and how will population sociology/humanistic nursing/ethics research continue to deepen and expand in this area?

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Annex D: Calculation of judgment of consulting experts

Table d.1 Calculation of judgment of consulting experts (N=14)

Basis of judgment	Large		Medium		Small		Score
	Number of experts	Assignment	Number of experts	Assignment	Number of experts	Assignment	
Work experience	9	0.5	2	0.4	3	0.3	0.44
Theoretical analysis	12	0.3	2	0.2	0	0.1	0.29
Peer understanding	13	0.1	1	0.1	0	0.1	0.1
Intuition	11	0.1	1	0.1	0	0.1	0.09
Score of basis of judgment							0.92

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Annex E: Consult the Statistical Results of the Coefficient of Variation of Power, Legitimacy and Urgency of Experts

Table e.1 Statistics on the coefficient of variation of the power indicators for the two rounds of expert consultation (N=14)

	Round 1			Round 2		
	Mean	SD	Coefficient of variation	Mean	SD	Coefficient of variation
Health commission	4.92	0.28	0.06	5.00	0	0
Healthcare security bureau	4.71	0.47	0.10	4.86	0.36	0.07
Civil affairs department/foundation	3.09	1.14	0.37	3.43	0.51	0.15
Reproductive clinicians	3.14	1.23	0.39	3.36	0.63	0.19
Reproductive clinical nurses	2.64	1.0	0.38	2.29	0.47	0.20
Embryologists	2.77	1.36	0.49	2.93	0.47	0.16
Commercial insurance companies	2.15	1.07	0.50	2.29	0.47	0.20
Patients	2.07	1.14	0.55	1.79	0.43	0.24
Patients’ family members	1.93	1.07	0.56	1.29	0.47	0.36
Health-promotion groups	1.60	0.89	0.56	1.17	0.41	0.34
Think-tank experts (psychological/ethical/ demographic/social)	3.43	1.22	0.36	3.50	0.65	0.19
Management staff of medical institutions	2.77	1.36	0.49	2.57	0.51	0.20
Publicity media	2.55	1.29	0.51	2.23	0.44	0.19
Workplace or community of patients				1.82	0.40	0.22
Pharmaceutical companies				1.22	0.44	0.36
People’s mediation committee for medical disputes				2.50	0.58	0.23

Table d.2 Statistics on the coefficient of variation of the legitimacy indicators for the two rounds of expert consultation (N=14)

		Round 1			Round 2	
	Mean	SD	Coefficient of variation	Mean	SD	Coefficient of variation
Health commission	4.69	0.85	0.18	4.86	0.53	0.11
Healthcare security bureau	4.57	0.78	0.17	4.93	0.27	0.05
Civil affairs department/foundation	3.64	0.95	0.26	3.86	0.77	0.20
Reproductive clinicians	3.79	1.38	0.36	4.00	0.68	0.17
Reproductive clinical nurses	3.43	1.26	0.37	3.29	0.61	0.19
Embryologists	3.54	1.33	0.38	3.71	0.73	0.20
Commercial insurance companies	2.46	1.07	0.44	3.00	0.68	0.23
Patients	3.50	1.50	0.43	4.50	0.76	0.17
Patients’ family members	3.07	1.50	0.49	3.43	0.94	0.27
Health-promotion groups	2.20	0.84	0.38	1.67	0.52	0.31
Think-tank experts (psychological/ethical/demographic/social)	3.64	1.33	0.37	3.43	0.76	0.22
Management staff of medical institutions	3.08	1.31	0.43	2.64	0.63	0.24
Publicity media	2.45	1.44	0.59	2.69	0.63	0.23
Workplace or community of patients				2.18	0.60	0.28
Pharmaceutical companies				1.22	0.44	0.36
People’s mediation committee for medical disputes				2.75	0.5	0.18

Table d.3 Statistics on the coefficient of variation of the urgency indicators for the two rounds of expert consultation (N=14)

		Round 1			Round 2	
	Mean	SD	Coefficient of variation	Mean	SD	Coefficient of variation
Health commission	4.62	0.77	0.17	4.86	0.36	0.07
Healthcare security bureau	4.36	0.93	0.21	4.71	0.47	0.10
Civil affairs department/foundation	3.09	0.94	0.31	3.00	0.56	0.18
Reproductive clinicians	3.29	1.44	0.44	3.79	0.70	0.18
Reproductive clinical nurses	2.86	1.46	0.51	2.71	0.73	0.27
Embryologists	3.08	1.19	0.39	3.14	0.53	0.17
Commercial insurance companies	2.08	1.26	0.60	2.29	0.47	0.21
Patients	3.79	1.53	0.40	4.14	0.78	0.19
Patients’ family	3.43	1.70	0.49	3.21	0.80	0.25

	Round 1			Round 2		
	Mean	SD	Coefficient of variation	Mean	SD	Coefficient of variation
members						
Health-promotion groups	2.20	1.30	0.59	1.17	0.41	0.35
Think-tank experts (psychological/ethical/ demographic/social)	2.86	1.35	0.47	3.07	0.47	0.15
Management staff of medical institutions	2.69	1.38	0.51	3.00	0.78	0.26
Publicity media	2.55	1.29	0.51	2.92	0.86	0.29
Workplace or community of patients				2.09	0.70	0.33
Pharmaceutical companies				1.78	0.83	0.47
People’s mediation committee for medical disputes				2.75	0.5	0.18

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Annex F: Results of the Stakeholder Questionnaire Survey

Table f.1 Results of the stakeholder questionnaire

	Round 1				Round 2			
Stakeholder	Approval rating	Power	Legitimacy	Urgency	Approval rating	Power	Legitimacy	Urgency
Health commission	92.86%	4.92	4.69	4.62	100.00%	5.00	4.86	4.86
Healthcare security bureau	100.00%	4.71	4.57	4.36	100.00%	4.86	4.93	4.71
Civil affairs department/foundation	78.57%	3.09	3.64	3.09	100.00%	3.43	3.86	3.00
Reproductive clinicians	100.00%	3.14	3.79	3.29	100.00%	3.36	4.00	3.79
Reproductive clinical nurses	100.00%	2.64	3.43	2.86	100.00%	2.29	3.29	2.71
Embryologists	92.86%	2.77	3.54	3.08	100.00%	2.93	3.71	3.14
Commercial insurance companies	92.86%	2.15	2.46	2.08	100.00%	2.29	3.01	2.29
Patients	100.00%	2.07	3.50	3.79	100.00%	1.79	4.50	4.14
Patients’ family members	100.00%	1.93	3.07	3.43	100.00%	1.29	3.43	3.21
Health-promotion groups	64.29%	1.60	2.20	2.20	42.86%	1.17	1.67	1.17
Think-tank experts (psychological/ ethical/demographic /social)	100.00%	3.43	3.64	2.86	100.00%	3.50	3.43	3.07
Management staff of medical institutions	92.86%	2.77	3.08	2.69	100.00%	2.57	2.64	3.00
Publicity media	78.57%	2.55	2.45	2.55	92.86%	2.23	2.69	2.92
Workplace or community of patients	14.28%				78.57%	1.82	2.18	2.09
Pharmaceutical companies	7.14%				64.29%	1.22	1.22	1.78
People’s mediation committee for medical disputes	7.14%				28.57%	2.50	2.75	2.75

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Annex G: Basic Information of the Interviewee

Table g.1 Basic information of interviewees (I)

No.	Gender	Educational background	Length of service	Workplace	Position/professional title	Type of stakeholder
A-01	F	Doctor	38 years	Provincial health commission	Full senior	Definitive
B-01	M	Master	25 years	Municipal healthcare security bureau	Full senior	Definitive
B-02	F	Master	15 years	Municipal healthcare security bureau	Associate senior	Definitive
C-01	F	Bachelor	20 years	Public welfare foundation	Council member	Definitive
D-01	F	Master	28 years	Hospital counseling room	Psychological counselor, associate senior	Definitive
D-02	F	Master	14 years	Hospital counseling room	Psychological counselor, Associate senior	Definitive
D-03	F	Doctor	22 years	Clinical department	Full senior	Definitive
D-04	F	Bachelor	15 years	Clinical department	Intermediate	Definitive
D-05	F	Master	15 years	Clinical department	Associate senior	Definitive
E-01	F	Doctor	10 years	Colleges and universities	Associate senior	Definitive
E-02	M	Doctor	5 years	Academy of social sciences	Associate senior	Definitive
E-03	F	Doctor	12 years	Colleges and universities	Associate senior	Definitive
E-04	M	Doctor	3 years	Colleges and universities	Intermediate	Definitive
F-01	M	Master	13 years	Hospital embryo laboratory	Intermediate	Expectant
F-02	M	Master	20 years	Hospital embryo laboratory	Associate senior	Expectant
I-01	F	Master	19 years	Hospital outpatient care	Chief nurse	Latent

No.	Gender	Educational background	Length of service	Workplace	Position/professional title	Type of stakeholder
I-02	F	Master	13 years	Hospital outpatient care	Intermediate	Latent
I-03	F	Bachelor	14 years	Hospital nursing department	Intermediate	Latent
I-04	F	Bachelor	12 years	Hospital operating room care	Intermediate	Latent
I-05	F	Bachelor	17 years	Hospital ward care	Chief nurse	Latent
J-01	F	Bachelor	13 years	Commercial insurance companies	Project manager	Latent
J-02	F	Master	12 years	Commercial insurance companies	Project manager	Latent
J-03	F	Master	25 years	Commercial insurance companies	Director	Latent
K-01	M	Master	15 years	Hospital management institution	Deputy director	Latent
K-02	F	Bachelor	12 years	Hospital management institution	Intermediate	Latent

Table g.2 Basic information of interviewees (II)

No.	Age	Educational background	Household registration	Marital status/relationship with patient	Household income	Occupation	Duration of infertility	Treatment plan	Treatment cycle	Type of stakeholder
G-01	44	Master	Urban	First marriage	200,000/year	Unemployed	6 years	PGT	14	Expectant
G-02	26	Junior high graduate	Rural	First marriage	Unemployed	Resigned	3 years	IVF	2	Expectant
G-03	38	Junior high graduate	Rural	Remarriage	100,000/year	Businessman	15 years	ICSI	6	Expectant
G-04	37	Junior high graduate	Urban	First marriage	200,000/year	Resigned	2 years	ICSI	3	Expectant
G-0	40	Junior high graduat	Rural	Remarriage	50,000/year	Unemployed	7 years	IVF	3	Expectant

5		e								
G-06	33	Bachelor	Urban	First marriage	200,000/year	Resigned	4 years	PGT	2	Expectant
G-07	39	Bachelor	Urban	Remarriage	100,000/year	Resigned	9 years	IVF	3	Expectant
H-01	39	Junior high graduate	Rural	Couple	50,000/year	Farmer				Expectant
H-02	55	Junior high graduate	Rural	Aunt and niece	100,000/year	Worker				Expectant
H-03	62	Senior high graduate	Rural	Mother-in-law and daughter-in-law	80,000/year	Retired teacher				Expectant

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Annex H: Overview of the Analysis of the Interview Topic

Table h.1 Overview of thematic analysis

Theme	Sub-theme	Coding
Stakeholder analysis	Role positioning (health commission, healthcare security bureau)	Policymaker, implementation supervisor
	Role positioning (civil affairs department/foundation)	Economic supporter, educational promoter
	Role positioning (hospital management staff, healthcare workers, embryologists)	Medical service provider, counseling supporter
	Role positioning (commercial insurance companies)	Business operator, healthcare insurance supplement
	Role positioning (patients)	High expectations, perceived stigma, forbearance and bigotry, poor mental adjustment and psychological resilience
	Role positioning (think-tank experts)	Knowledge disseminator, policy facilitator
	Interest demands (health commission, healthcare security bureau)	Protect basic livelihoods and achieve a win-win situation for all parties
	Interest demands (civil affairs department/foundation)	Technology R&D, policy advocacy
	Interest demands (hospital management staff, healthcare workers, embryologists)	Fulfill duties, focus on treatment outcomes, and enhance career achievement
	Interest demands (commercial insurance companies)	Profitability, fulfillment of social responsibility
	Interest demands (patients)	Pregnancy, financial support, emotional support, informational support
	Interest demands (think-tank experts)	Reference for clinical medicine, policy advocacy, research outputs
Stakeholder difference	Economic support conflict	Lack of integrated planning, existence of contradictions, limited health insurance coverage, operational difficulties, lack of feedback evaluation
	Emotional support contradiction	Lack of empathy, ineffective communication, cold violence, contradiction in consultation duration, lack of assessment
	Informational support asymmetry	Research limitations and discrepancy, lack of publicity, cumbersome channels, professional

Theme	Sub-theme	Coding
		gaps, moral hazard
Positive effects of social support	Effective economic support	Reduced direct economic burden, standardization and authority, improved accessibility of technology, release of pressure on doctors, full health coverage, flexible and easy operation
	Emotional support benefits	Improvement of pregnancy rate and relief of mental stress
Existing problems of social support	Low utilization of social support	Questioning, barrier to access, denial of support
	Excessive inappropriate social support	Inappropriate content of support, consistent source of stress and support, full accompaniment and excessive intervention

Annex I: Stakeholder Role Relationships and Interest Differences

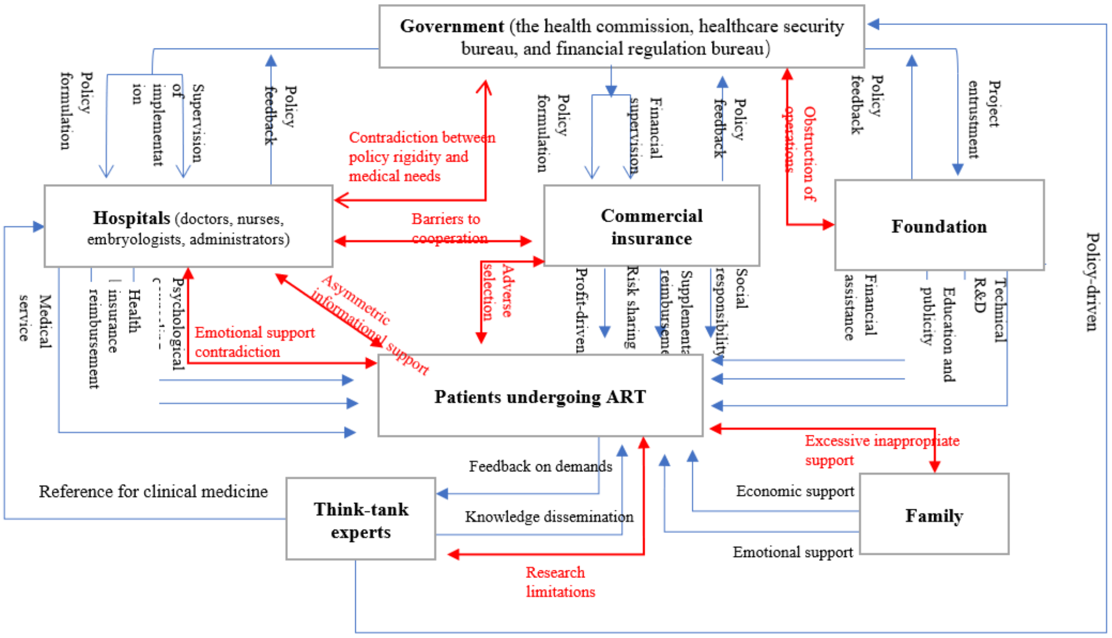

Figure i.1 Interest demands and divergence among stakeholders