MERIT RESEARCH JOURNALS
www.meritresearchjournals.org

Merit Research Journal of Medicine and Medical Sciences (ISSN: 2354-323X) Vol. 13(2) pp. 022-035, April, 2025
Available online http://www.meritresearchjournals.org/mms/index.htm

DOI 10.5281/zenodo.15224685

*Review*

# Neuman Systems Model and Quality of Life in Individuals with Infertility: An Objective Review

**Joy Oluwabosede Esan[1], Adeyinka Ganiyat Ishola[2], Aloysius Obinna Ikwuka[3*], Babatunde Ayodeji Esan[4], Olugbenga Oluseun Saanu[5]**

[1]Department of Nursing, University College Hospital, Ibadan, Nigeria

[2]Faculty of Nursing, University of Ibadan, Ibadan, Nigeria

[3]College of Medicine and Health Sciences, American International University West Africa, Banjul, The Gambia

[4,5]Department of Obstetrics and Gynecology, University College Hospital, Ibadan, Nigeria

***Corresponding Author's E-mail: aloysiussweet@yahoo.com**

**Abstract**

**Globally, most previous studies revealed low quality of life (QoL) in individuals with infertility which is seriously worsened in females, and in individuals with lower educational status, younger age, and idiopathic cause of infertility. This study aimed to objectively review the Neuman Systems Model (NSM) and QoL in individuals with infertility. Current literatures from different databases including Scopus, Web of Science, JSTOR, MEDLINE, PubMed, EMBASE, CINAHL, Google Scholar, etc. on the topic were searched online and reviewed. This objective review centered on the physical health, psychological health, social health, and environmental health of individuals with infertility. The Neuman Systems Model revealed that individuals (clients) are exposed to different stressors. Clients have flexible lines of defense, normal lines of defense, lines of resistance, and a basic structure (central core) – all of which serve to protect the individual (client) from stressors e.g. infertility. Healthcare providers should create more awareness on infertility at the local community levels. This will help correct cultures, and beliefs that stigmatize individuals with infertility. In addition, men with infertility should be encouraged to attend fertility clinics.**

**Keywords:** Individuals with Infertility, Infertility, Neuman Systems Model, Quality of Life

## INTRODUCTION

Gametes are ova and sperm cells which are haploid and have one copy of each type of chromosome i.e. 1–22 X or 1–22 Y (Ikwuka, 2023a). Reproduction is such an essential human desire, that infertility may cause a great deal of psychosocial impairment thus reducing the quality of life. In recent times, infertility is one of the public health issues gaining global attention (Bakhtiyar, 2019). In fact, it has been reported that approximately 48.5 million individuals were estimated to be infertile globally (SingleCare, 2021). In many developing countries, childbearing is very important and infertility can have a huge negative impact on social and marital lives of the individuals which as a result affect their quality of life (QoL).

However, it has been noted that the female gender is more affected by the impact – with a report of women suffering from a wide range of psychological challenges and having reduced QoL. Hence, most studies focus on women with infertility (Cusatis, 2019), but infertility is a problem between two partners. So, there is a need to also assess the impact of infertility on the QoL of husbands of these women. In 2019, it was reported that globally 20-30% of infertility are from male and 20-35% are female infertility, but 25-40% are from both sexes (Murtaza, 2019).

In Nigeria, 10-30% of individuals are infertile (Mohammed-Durosinlorun, 2019). Hence, infertility affects both sexes. Therefore, the impact of infertility on

the QoL of both sexes needs to be assessed although the physical integrity of individuals with infertility seems to be intact. However, there is a need to have a critical assessment of the impact of infertility on the physical, psychological, social, and environmental health – the four domains of QoL in individuals with infertility. These can affect the decision of individuals with infertility to undertake and complete fertility treatment.

Several studies have been conducted on the effects of infertility on the quality of life in developed countries, with the majority of the studies reporting poor quality of life (Aduloju, 2017). Meanwhile, there is a paucity of data on the subject in developing countries. In Ibadan, some individuals with infertility fall into depression while some partners of individuals with infertility quit their marriages. Hence, there is a need to assess the quality of life in individuals with infertility in a developing country such as Nigeria.

Infertility has been defined as the inability to get pregnant or nurture pregnancy to complete term (Murtaza, 2019) while the American College of Obstetricians and Gynecologists (ACOG) defined infertility as failure to achieve pregnancy within 365 days of uninterrupted intercourse or therapeutic donor insemination in females younger than 35 years or within 6 months in females older than 35 years (ACOG, 2019). Infertility is divided into primary and secondary infertility. Primary infertility means that the individual has never achieved conception while secondary infertility means the individual has achieved pregnancy either full-term or non full-term earlier and failed to conceive later (AIMU, 2018).

Globally, 3-7% of all heterosexual couples have infertility problem that is unresolvable, 12-28% individual experience involuntary childlessness while 20-30% of infertility are from male and 20-50% are due to female infertility, 25-40% are from both sexes (Shreffler, 2018). The cause of 10-20% cases of infertility is idiopathic (Murtaza, 2019) while (Adelosoye, 2020) reported that in Nigeria almost 59.0% cases of infertility among couples are caused by male partners which are either undiagnosed or untreated because of the assumptive role of women being the only cause of infertility in the family.

Autoimmune antibodies produced by the female partner against sperm cells from the male partner have been implicated as a cause of female infertility. Other immune reactions include antibodies to clotting factors, which result in both thrombosis and hemorrhage; and hemolytic reactions during transfusion of blood products (Ikwuka, 2023e). It is believed that most infertility cases of women are caused by infectious disease while that of men are as a result of untreated or poorly treated sexually transmitted diseases (Abebe, 2020). Oxidative stress has also been associated with infertility. Linked to the induction of oxidative stress are major free radicals. Among these major free radicals, superoxide anions, hydroxyl radicals, and hydroperoxyl radicals are of physiological significance. A non-radical of physiological significance is hydrogen peroxide (Ikwuka, 2023b).

In addition, the links, roles and effects of metabolic syndrome diseases on fertility in both sexes are still being investigated. Chronic diabetes mellitus has been linked with erectile dysfunction in men. Hormonal disorders e.g. diabetes mellitus and arterial hypertension remain two of the most common diseases in the world. Today, diabetes mellitus ranks third in the overall structure of morbidity and mortality after cardiovascular diseases and oncological diseases (Virstyuk, 2021a). Metabolic disorders, e.g. hypertension, adiposity (obesity), diabetes mellitus and dyslipidemia, collectively known as Metabolic Syndrome Diseases (MSDs) are interrelated diseases (Ikwuka, 2015; Ikwuka, 2017a; Ikwuka, 2017c; Ikwuka, 2023c; Ikwuka, 2023f; Ikwuka, 2024; Virstyuk, 2016).

Infertility is no more a mere disorder of the reproductive system, but also a menace that eats up the quality of lives among couples with infertility (Rooney, 2018; Namdar, 2017). It has been reported that infertility can cause social and psychological challenges such as anxiety, depression, social withdrawal among others because it is seen as a silent struggle. Hence, the affected persons bottle it up thus increasing their vulnerabilities to these psychological disorders (Rooney, 2018).

Different studies have shown that MSDs are associated with asymptomatic hyperuricemia, systemic immune inflammatory processes, and fibrogenesis all of which can lead to kidney damage (Ikwuka, 2017d; Ikwuka, 2017e; Ikwuka, 2018c; Ikwuka, 2018d; Ikwuka, 2019a; Ikwuka, 2019c; Ikwuka, 2022; Ikwuka, 2023d; Virstyuk, 2017a; Virstyuk, 2018a; Virstyuk, 2019; Virstyuk, 2021a; Virstyuk, 2021b). According to (Sun, 2019), it is nearly impossible to estimate the actual population of individuals with infertility because of the differences in the criteria used to define infertility. Some schools of thought define infertility as the inability to conceive within 1 year or 2 years or 5 years. In addition, estimates of infertility are either done on large-scale populations or epidemiological findings. Some researchers even defined infertility based on its location in individuals, people, men, women, or couples and there are disparities in the unit of analysis.

Nonetheless, (Obajimi, 2017) revealed that worldwide, 50-80 million individuals are infertile and up to 2 million new couples are involved yearly, rounding it up to 8-15% (Odunvbun, 2018). About 50.0% of these individuals with infertility seek medical treatment (Hubens, 2018). The prevalence of infertility in sub-developed and developing regions like sub-Saharan Africa, North Africa, Middle East, South Asia, Central Asia, Central and Eastern Europe tend to be higher than developed regions like North America (United Nations, 2020). The prevalence of infertility in developed countries varies from 3.5-16.7%

while that of developing countries varies from 6.9-9.3% (Luk, 2018). It was made known that infertility prevalence in Eastern Europe and Central Asia ranged from 16.0–25.0% due to high incidence of unsafe abortions (Ezeh, 2016).

In sub-Saharan Africa, 14 out of 23 countries have between 25.0-30.0% secondary infertility rate of which Zimbabwe singlehandedly has 62.0% (Abebe, 2020), although this seems to be reducing due to the drastic decline in the rate of sexually transmitted infections and unsafe abortions. Nevertheless, sub-Saharan Africa remains the highlight of secondary infertility in the world despite its high fertility rate (Atake, 2019). Nigeria has its total prevalence rate of infertility to be 23.0% with prevalence rates of secondary infertility as 18.0% and that of primary infertility as 5.0% (Fehintola, 2017). The prevalence rates of infertility from some institution-based studies in 3 out of the 6 geopolitical regions in Nigeria were 4.0% for Ilorin (North-Central), 11.2% for Abakaliki (South-East) and 48.1% for Osogbo (South-West) (Odunvbun, 2018).

## METHODS

### Study Design

This study is an objective review.

### Study Methodology

Current literatures from different databases including Scopus, Web of Science, JSTOR, MEDLINE, PubMed, EMBASE, CINAHL, Google Scholar, etc. on the topic were searched online and reviewed.

### Study Selection

### Inclusion Criteria

Reliable publications (which included every type of study, which involves both initial and subsequent studies), demographic accounts (which included both females and males seeking medical care from infertility), and concept reports (which included predictors of quality of life in individuals with infertility) were included in this study. The search was limited to studies that were accessible in the English language.

### Exclusion Criteria

Published articles which did not undergo peer review due to concerns about the reliability of their sources were excluded from this objective review. Bias may be introduced by including data from unpublished studies and thus unpublished studies were excluded. Literatures (in other languages apart from the English language) that would be difficult to translate due to linguistic problems can also add bias to this objective review and were excluded.

## DISCUSSION

### Quality of Life (QoL)

The World Health Organization (WHO) as cited by (Bakhtiyar, 2019) also defined QoL as a concept that describes the well-being, growth and development which expresses people's perceived position in the society including their desires, priorities and standards while (Song, 2021) believed that quality of life is what the individual call it after putting into consideration his culture and values. QoL is complex, subjective and may involve both positive and negative emotions. Thus, it is influenced by different factors, some of which are individual and environmental factors (Palomba, 2018). QoL can be viewed in three unique ways: welfare and tranquility of life; physical symptoms, finance and social; and, disability and disease (Celestine, 2021). However, WHO divided quality of life into four domains: physical health, psychological health, social health, and environmental health (WHOQOL, 1998; WHOQOL, 2012).

Infertility is a life crisis or a chronic illness or a combination of the two and the results showed that infertility reduces the QoL (Abebe, 2020). It was expatiated that infertility is an unsolvable life challenge that threatens being a parent. It affects men and women. Individuals with infertility will pass through some stages just as if they were mourning, even though there is no loss of life in infertility cases (McBain, 2019). The first stage is the shock stage, at this stage the individual newly diagnosed of infertility, may choose not to agree. The second stage is the denial stage, at which affected individuals with infertility may decide to ignore their state and get engrossed with other things. The third stage is the fury and anxiety stage, at which the affected individuals are overwhelmed with the fear of the unknown, whether to leave the childless marriage or the other partner might leave at any time. The fourth stage is the anger stage - affected individuals become provocative and irritable to everyone around them and this can make them become so lonely (Hocaoglu, 2018).

In addition, the 5th stage is the stage of loss of control. At this stage, the sexual lives of the individuals are no more private to them in the sense that the society wants to know what is causing their infertility and the treatments they are undergoing. At this stage, they will become withdrawn to themselves, they will be avoiding people especially their fertile friends. The 6th stage is the stage

of guilt feeling. At this stage, the individuals with infertility feel guilty of their state. They recall all the abortions they did in the past, the contraceptive pills they used and put all the blame on themselves. Coupled with the pressure from family and friends, they may feel they are being punished and gradually become depressed. The 7th stage is the stage of acceptance. At this stage, individuals with infertility accept reality and try to make decisive steps. They may either continue with their childless unions or get a divorce, or go back to their neglected families and friends to seek alternative treatments for their infertility (Hocaoglu, 2018).

Some researchers who have assessed the quality of life in individuals with infertility have reaffirmed that infertility is related to low scores of QoL and affects the physical, psychological, social, and environmental domains of QoL (Namdar, 2017).

**Physical Health**

Physical health entails pain, energy, sleep, mobility, activities, medication, and work. It was discovered that couples with infertility have positive physical quality of life because of their independent lifestyle caused by infertility when compared to their fertile counterparts (Xiaoli, 2016). However, (Hubens, 2018) submitted that infertility affects the QoL of individuals in terms of physical function, and role limitations, as a result of the physical challenge.

Depending on the cause of infertility in the individuals, intense pain can disrupt activities of daily living of individuals with infertility. Healthy sexual function can also be disrupted, thus leading to reduction in quality of life of individuals with infertility (Youseflu, 2020). Some women with infertility experience dyspareunia and this may affect the quality of sexual intercourse of individuals with infertility, which can eventually cause frustration thus reducing their quality of life. History of childhood health challenges such as illnesses, injuries, hospitalizations, congenital malformations, etc are frequently reported in individuals with infertility (Zurlo, 2019). Despite the fact that individuals with infertility who have underlying illness will have low quality of life, pain may have an impact on the way individuals with infertility perceive and define their current state of infertility (Bakhtiyar, 2019).

Individuals with infertility that need medical treatment to function in their activities of daily living may have poor quality of life because some of the drugs used to treat infertility actually have some adverse effects that can alter the quality of life in individuals with infertility using the drugs (Johnson, 2021). The side effects of some of the medications individuals with infertility use for infertility treatment such as clomiphene, leuprolide, and gonadotrophins have been said to have psychological effects e.g. anxiety, and depression which might eventually lead to reduction in their quality of life (Rooney, 2018).

Anxiety and depression can make individuals with infertility disrupt their infertility treatment and influence the type of treatment they opt for (Crawford, 2017). The quality of life in individuals with infertility reduces with fertility treatment regardless of age (Asazawa, 2020). Policy-makers of most countries do not take infertility as serious as other diseases because infertility treatment is not catered for in the national health insurance scheme which means that individuals with infertility have to pay for their fertility treatment from their pockets despite the fact that fertility treatment is expensive, thus increasing the burden of infertility which might eventually affect their quality of life (Hubens, 2018).

It is an established fact that infertility and fertility treatment are stressful. Hence, due to the stress of fertility treatment, it may be difficult for individuals with infertility to combine the stress of their jobs with the stress of fertility treatment; as a result this burden may lead to reduced quality of life in individuals with infertility. Therefore, there is a need for support at the workplace of individuals with infertility (Asazawa, 2018). It is no gainsaying that stress affects the outcome of pregnancy or treatment outcome because (Terzioglu, 2016; Xu, 2017) revealed this in their studies. However, (Rooney, 2018) said stress does not affect the outcome of infertility treatment.

Most individuals with infertility do not create time for leisure as they are busy finding solutions to their infertility while some indulge in some harmful habits such as smoking, drinking spirits in order to forget their states of infertility which could affect their quality of life (Collins, 2019). Some individuals with infertility due to stigmatization from family and friends decide to restrict their movements. The sleeping patterns of the majority of individuals with infertility are distorted. Hence, their quality of life might be affected, because some individuals with infertility have to be hospitalized due to infertility treatment, thus restricting the movement of the individual which might impact their quality of life (Arc, 2021).

Nevertheless, it has been reported in different studies that treatments in MSD patients can be improved upon by using a combination of HMG-CoA inhibitors, SGLT-2 inhibitors, and A2RB (AT1) because these medicines have proven resultant clinical effectiveness as indicated by marked improvements in metabolic functions of the heart, liver, pancreas, and kidney (Ikwuka, 2017b; Ikwuka, 2018a; Ikwuka, 2018b; Ikwuka, 2021; Virstyuk, 2017b; Virstyuk, 2018b; Virstyuk, 2018c; Ikwuka, 2024). In addition, Glucagon-like Peptide 1 Receptor Agonists (GLP-1 RAs) e.g. Liraglutide have been found to also improve the efficacy of treatment and clinical course of type 2 diabetes mellitus and hypertension in patients with such comorbidities (Ikwuka, 2019b).

## Psychological Health

Psychological health entails the normal emotional, mental, and social well-being of a person. It involves how people cope and find life interesting. It involves positive feelings, cognitions, self-esteem, body image, negative feelings, and spirituality.

Fertility is seen as a great achievement in this part of the world. As a result, inability to be fertile is associated with negative feelings (Mohammed-Durosinlorun, 2019). Infertility comes with mixed feelings, mostly negative feelings. Despite the huge negative feelings, some individuals with infertility prevent these negative feelings (Royani, 2019). The researches done in the Netherlands, Belgium, and France revealed that 24.9% of individuals with infertility met the diagnostic pre-requisite of depressive disorder (Xiaoli, 2016). A study showed that individuals with infertility are at risk of depression, low self-esteem, and emotional disorders (Alimohamadi, 2020).

The rate of depression and anxiety among individuals with infertility are the same as in individuals with cardiac or cancer or human immunodeficiency (Bamawi, 2020). Most individuals with infertility have psychological challenges like depression, stress and anxiety which affect their cognition (Shahraki, 2019). Quite a few researches had shown that individuals with infertility are either depressed on their own or influenced by their spouse's depression (Sarafraz, 2020). Depression is the commonest psychological disorder of infertility. Hence, any person with infertility whose partner is depressed might have low quality of life likewise the depressed spouse, although the female partner feels the heat of her male's partner depression more (Maroufizadeh, 2018).

The depression may be as a result of failed fertility treatment. For instance, some individuals with infertility may not be depressed initially but can become depressed after the infertility treatment is not successful or pressure from their partners (Shahraki, 2019). The higher the rate of failure of infertility treatment, the higher the level of anxiety and depression in individuals with infertility (Karaca, 2016). Too much anxiety can affect the outcome of pregnancy in individuals with infertility. It is still a mystery how some couples with infertility experience anxiety and depression more than the others (Shahraki, 2019). Individuals that had higher scores in quality of life, had lower scores in anxiety and depression (Shahraki, 2019).

Infertility is a distressing occurrence which significantly affects perceived levels of quality of life (Karaca, 2016). Although pregnancy is the most desirable thing a woman wants, the woman may still have some fears about getting pregnant like losing body shape, fear of losing life during gestation period, delivery and journey to motherhood (Hocaoglu, 2018). Most individuals with infertility feel that they have dented body image. However, this is not so. In a study, approximately 93.0% of the sampled women with infertility scored higher body image marks which show that body image is not a trivial issue like self-esteem (Bradley University, 2021).

Psychological QoL was highest in individuals with infertility who had university degrees and were gainfully employed (Namdar, 2017), although infertility and its treatment are stressful and considered as a negative event which drains individuals with infertility emotionally, financially, and psychologically (Yazdani, 2016). Individuals with infertility actually experience low self-esteem. However, the females experience lower self-esteem than the males (Cavdar, 2018). In this part of the world, most individuals with infertility seek spiritual help for their infertility having at the back of their minds that their infertility state is as a result of curses from the ancestors. Due to this belief, some individuals with infertility in this part of the world combine both orthodox medical and spiritual treatment for infertility (Hiadzi, 2020).

## Social Health

Social health is the ability to relate and form a healthy rapport with others and it involves personal relationships, social support, and sexual intercourse. Insufficient knowledge among individuals with infertility concerning infertility and their personalities may be responsible for their inability to cope with infertility, thus leading to social isolation, depression, and anxiety. However, their counterparts who have adequate knowledge of their personalities and infertility develop a coping mechanism to help pull through (Kiani, 2020).

Social support is the strongest determinant of quality of life (Song, 2021). Hence, individuals with infertility that have adequate social support from their significant others have a higher quality of life than others who do not have social support. However, social support is diminishing in recent times because of the way the society is structured. (Bakhtiyar, 2019) compared the social health of fertile individuals and individuals with infertility and discovered that individuals with infertility have better social health because of the social support they get from their significant others. (Bamawi, 2020) added that individuals who have adequate social support have reduced mental tension and seek infertility treatment and insist on being treated.

(Rooney, 2018) buttressed that individuals with infertility who have the support of their spouses will seek for treatment and adhere strictly to treatment regimen of infertility. (Asazawa, 2020) reported that there is a need for partners of individuals with infertility to support each other in order to improve their qualities of life. According to (Yazdani, 2016), social support does not influence marital satisfaction of women with infertility. However, social acceptance might influence their marital satisfaction but in an environment where infertility is seen

as the fault of the women, there might be reduced social acceptance leading to reduced marital satisfaction which can eventually reduce the quality of life in women with infertility. But for men with infertility, both social support and social acceptance influence their marital satisfaction, thus increasing their quality of life (Yazdani, 2016).

Sexual intercourse is a normal and natural expression of closeness. However, if it is for the purpose of conception, it generates undue pressure on the individuals with infertility and this may cause frustration because their sexual life will be a routine and will be done on schedule which can reduce their sexual and marital bonding (Luk, 2018). Sexual function is one of the major factors in social health, but it is also very important in reproductive health. Dysfunctional sexual intercourse reduces the quality of life and can also cause infertility and prolong the duration of infertility (Youseflu, 2020). There is sexual dysfunction among individuals with infertility (Shahraki, 2019). Vaginal dryness and low libido are higher in women with infertility (Direkvand-Moghadam, 2016). Some individuals with infertility come down with sexual dysfunction like lower orgasm and suicidal attempt, which is more common in women than men (Fehintola, 2017). The effects of anxiety and depression have been linked to sexual dysfunction (Shahraki, 2019).

It has been pointed out that some young couples actually desire to delay conception in order for them to explore their sexual function together (Luk, 2018). However, they should be properly counseled on the consequences in delaying conception during family planning sessions because this may lead to infertility later. (Asazawa, 2020) findings revealed that self-esteem, social support, sexual satisfaction, and marital satisfaction are major factors affecting the quality of life in individuals with infertility.

Ethnic and cultural values have an impact on how individuals with infertility are being treated. Some communities automatically expect women to play the roles of mothers. So, if these women do not achieve pregnancy, psychosocial issues may arise (Bakhtiyar, 2019). In fact, infertility is culturally unacceptable (Masoumi, 2016). It was emphasized that psychological distress may occur when this desired social role is not met and this might lead to reduced quality of life (Cusatis, 2019).

In this part of the world, infertility is socially not acceptable thus making individuals with infertility to be on endless search for infertility treatment because children are highly desirous and parenthood is a must (Fehintola, 2017). In their work, (Bakhtiyar, 2019) showed that a good social support for individuals with infertility will improve their physical and mental health which in turn will improve their quality of life. Unfortunately, the reverse is the case in this part of the world. It was reported that most people believed individuals with infertility are suffering from their past sins and should be stigmatized so that they would not transfer their curses to others (Fehintola, 2017).

**Environmental Health**

Environmental health is the healthy interaction between the individual and his or her surroundings. According to (WHOQOL, 2012), environmental health involves the home, finance, health services, information, leisure, environment, transport, safety and security of individuals with infertility (Bakhtiyar, 2019). The environment the individuals with infertility find themselves determine their quality of life because in developing countries, fertile individuals are addressed with the names of their children which can make individuals with infertility feel unwanted in the society, unlike in developed countries where infertility are taken as personal issues (Bradley University, 2021). It was made known that individuals with infertility living in rural areas have lower QoL compared to their counterparts living in urban areas because those in the rural areas were not exposed to information and comprehensive health services, thus they were restricted in getting adequate care for their state of infertility (Namdar, 2017).

In developed countries, infertility may not be easily discovered by the individual because childlessness is a voluntary decision and divorce is no big deal unlike in developing countries where childbearing is a must and divorce is a grave offence such that divorcees find it difficult to remarry (Kiani, 2020). The environment of the couple with infertility determines their quality of life. In some cultures, a woman with infertility is called ‘a woman made of rock’ and such a woman is banned from social gatherings (Royani, 2019).

Fertility treatment is expensive. So, there is a need to be financially capable in order to cater for the expenses of fertility treatment. Individuals with infertility who cannot afford fertility treatment may feel dejected thinking that they are a failure, thus leading to a poor quality of life (Strosberg, 2021). Moreover, it has been advocated that there is a need for the government to subsidize fertility treatment for individuals with infertility so that fertility treatments can become more accessible (Connolly, 2021), as practiced in some developed countries e.g. United Kingdom (HFEA, 2021).

Most of the causes of infertility are from environmental toxins and they can be described in four ways which are endocrine interruption, impairment to the female reproductive system, impairment to the male reproductive system, and impaired fetal viability (Pizzorno, 2018). These impairments not only affect natural fertility, but also reduce the success rate of infertility treatment.

Individuals with infertility feel socially insecure because of the lack of children that will take care of them when they are old or incapacitated, hence reducing their quality of life (Kiani, 2020). The state of health services in

developing countries is actually appalling and it needs reviving in order for it to cater for the health needs of its citizens (Aregbeshola, 2019). Also, most of the health facilities that treat infertility are in the urban areas thus making it difficult for individuals with infertility living in the rural areas to access fertility treatment (Harzif, 2019). Some chemicals emitted from the air have been associated with infertility thus exposing individuals living in the urban areas to more infertility (Carre, 2017). It was found in a study that most of the respondents with infertility sought medical treatment, thus causing more pressure on the health sector although some also patronized traditional health systems (Fehintola, 2017). Individuals with infertility exhibit impaired quality of life compared to fertile individuals (Masoumi, 2016).

Infertility can cause financial problems which can lead to severe distress thus causing poor quality of life (Sarafraz, 2020). Different studies have revealed that individuals with infertility who were highly educated, gainfully employed, and a homeowner, have a better physical, environmental and mental health thus leading to high quality of life whereas low educational level can be associated with poverty, poor health, poor quality of life and probably high mortality rate (Bakhtiyar, 2019; Cusatis, 2019).

**Relationships between socio-demographic characteristics and quality of life in individuals with infertility**

This includes the demographic data which are gender, age, education, duration of infertility, employment status, family type, personality characteristics like defense mechanisms, etc - all these can influence the quality of life in individuals with infertility. However, (Kiani, 2020) made it known that customarily, infertility is a feminine challenge i.e. womanhood means motherhood meaning for a woman to be called a real woman, she has to be a mother. Inability to achieve this is seen as a huge blemish, so there is so much pressure on the women with infertility to get treated. This was further proven by (Cavdar, 2018) study which used a sample size of 150 infertile individuals attending a particular infertility clinic and 100 were females with infertility while they got only 50 males with infertility attending the clinic.

Psychosocial challenges affect female gender more negatively than their male counterparts because of the way women are wired (Bakhtiyar, 2019). Both men and women with infertility have reduced quality of life (Cusatis, 2019). However, women are more emotional than men because they spend more time ruminating and reflecting about their problem. Thus, they have reduced quality of life compared to men. It was discovered that a couple's quality of life was higher when the cause of infertility is the man which means men hardly put the issues of infertility to heart (Jahromi, 2018). Hence, the quality of life of men with infertility is normally higher than that of women with infertility. It was observed that there is a great difference in the quality of life of men with infertility and women with infertility. It was reported that men with infertility have higher quality of life compared to women with infertility (Grube, 2019).

Aging causes a decrease in the quality of life in individuals with infertility, probably because younger individuals with infertility have higher self-esteem, and energy to work thus having little medical and physical problems (Bamawi, 2020). However, (Cusatis, 2019) believed that the more the individuals with infertility age, they get used to their life condition hence their quality of life improves. Another researcher opined that age has an impact on the physical and mental health of individuals with infertility (Bakhtiyar, 2019). Individuals with infertility younger than 35 years are found to be physically and mentally healthier than older couples of more than 35 years. Individuals with infertility are not usually bothered with their state of infertility when they are younger but are bothered when they are older, thus they start fertility treatment at older age (Vaghar, 2019).

Lower academic qualification, lower income, and longer duration of infertility are associated with lower quality of life (Jahromi, 2018). On the contrary, (Cavdar, 2018) revealed that the duration of infertility does not have an effect on the quality of life in individuals with infertility because the longer the duration of infertility, the more the individuals with infertility get used to their state and accept their fate. Infertility can lead to marital dispute which can affect marital satisfaction, and also cause divorce thus affecting the quality of life (Sarafraz, 2020).

Based on (Bakhtiyar, 2019)'s findings, the duration of marriage has an impact on the quality of life in individuals with infertility. Marriage satisfaction in a marriage of more than 10 years can be lower because of poor physical appearance when compared to marriage of less than 10 years. It is also believed that individuals with infertility have more money at their disposal because they do not have too much responsibility (Xiaoli, 2016). The physical QoL was lowest in individuals with infertility who earn low income (Namdar, 2017). The major factors affecting the quality of life in individuals with infertility are gender, age, and education (Royani, 2019). In addition, (Asazawa, 2018) also identified age, education, income, home environment, and duration of infertility as major factors influencing the quality of life in individuals with infertility.

**Neuman Systems Model (NSM): Theoretical Framework**

The Neuman Systems Model (NSM) was developed by Betty Neuman in 1970 to "offer unity, or a pivotal point, for student learning" at the School of Nursing, University of California, Los Angeles (UCLA). She observed that it is necessary for nurses generally to have a context to view

nursing broadly within different contexts (Smith, 2015). The ideological base of NSM covers holism, a wellness angle, client perception and motivation, and a dynamic systems perspective of energy and variable interaction with the environment to mitigate possible harm from internal and external stressors, while caregivers and clients form a partnership relationship to negotiated desired outcomes or goals for optimal health retention, restoration, and maintenance. This ideological base pervades all aspects of the model (Smith, 2015).

The NSM illustrates a client–client system, and presents nursing as a discipline concerned primarily with defining appropriate nursing actions in stressor-related situations or in possible reactions of the client–client system. The client and environment may be positively or negatively affected by each other. There is a tendency within any system to maintain a steady state or balance among the various disruptive forces operating within or upon it (Smith, 2015). Neuman identified these forces as stressors and suggested that possible reactions and actual reactions with identifiable signs or symptoms may be mitigated through appropriate early interventions (Smith, 2015).

Neuman identified 10 exclusive perspectives inherent within her model. However, for the purpose of this objective review, only 7 will be discussed. They describe, define, and connect concepts (Dike, 2016).

- Every client, either individual or group is seen as a client system and it is exceptional as each system is a composite of commonly known factors or innate characteristics within a normal or given range of response contained within a basic structure.
- The client as a system is in a dynamic, constant energy exchange with the environment.
- There are so many environmental stressors - known or unknown. They operate differently in the way they destabilize the normal line of defense of the client. The particular interrelationships of client variables — physiological, psychological, socio-cultural, developmental, and spiritual — at any point in time can affect the degree to which a client is protected by the flexible line of defense against possible reaction to a single stressor, or a combination of stressors.
- Each individual client–client system has evolved a normal range of response to the environment that is referred to as a normal line of defense, or usual wellness/stability state. It represents change over time through coping with diverse stress encounters. The normal line of defense can be used as a standard from which to measure health deviation.
- When the cushioning effect of the flexible line of defense is no longer capable of protecting the client–client system against an environmental stressor, the stressor breaks through the normal line of defense. The interrelationships of variables — physiological, psychological, socio-cultural, developmental, and spiritual — determine the nature and degree of system reaction or possible reaction to the stressor.
- The individual's variables — physiological, psychological, socio-cultural, developmental, and spiritual are interrelated and are dynamic in either state of health. Wellness is on a continuum of available energy to support the system in an optimal state of system stability.
- Implicit within each client system are internal resistance factors known as lines of resistance, which function to stabilize and return the client to the usual wellness state (normal line of defense) or possibly to a higher level of stability after an environmental stressor reaction.

## Theoretical Construct

The conceptual model was developed to explain the client–client system as an individual person for the discipline of nursing. The word "client" was used instead of "patient" to express the respect for joint relationship that is in existence between the caregiver and the clients in NSM, as well as the wellness perspective of the model. The model can be applied to an individual, a group, a community, or a social issue, and is appropriate for nursing and other health disciplines. The NSM provides a way of looking at the domains of nursing: humans, environment, health, and nursing proper (Montano, 2021).

## Client–Client System

The client–client system consists of a flexible line of defense, the normal line of defense, lines of resistance, and the basic structure energy resources which is the core of the concentric circle. Five client variables — physiological, psychological, socio-cultural, developmental, and spiritual — occur and are considered simultaneously in each concentric circle that makes up the client–client system (Montano, 2021).

## Flexible Line of Defense

Stressors must penetrate the flexible line of defense before they are capable of penetrating the rest of the client system. Neuman described this line of defense as accordion-like in function. The flexible line of defense acts like a protective buffer system to help prevent stressor invasion of the client system and protects the normal line of defense. The client has more protection from stressors when the flexible line expands away from the normal line of defense. The opposite is true when the flexible line moves closer to the normal line of defense (Smith, 2015).

**Normal Line of Defense**

The normal line of defense represents what the client has become over time, or the usual state of wellness. The nurse should determine the client's usual level of wellness to recognize a change. The normal line of defense is considered dynamic because it can expand or contract over time. The usual wellness level or system stability can decrease, remain the same, or improve after treatment of a stressor reaction. The normal line of defense is dynamic because of its ability to become and remain stabilized with life stressors over time, protecting the basic structure and system integrity (Smith, 2015).

**Lines of Resistance**

Neuman identified the series of concentric broken circles that surround the basic structure as lines of resistance for the client. When the normal line of defense is penetrated by environmental stressors, a degree of reaction, or signs and/or symptoms, will occur. Each line of resistance contains known and unknown internal and external resource factors. These factors support the client's basic structure and the normal line of defense, resulting in protection of system integrity (Smith, 2015).

**Basic Structure or Central Core**

The basic structure or central core consists of factors that are common to the human species. Neuman offered the following examples of basic survival factors: temperature range, genetic structure, response pattern, organ strength or weakness, ego structure, and knowns or commonalities (Smith, 2015).

**Five Client Variables**

Neuman identified five client variables that are contained in all client systems: physiological, psychological, socio-cultural, developmental, and spiritual. These five variables are considered simultaneously in each client concentric circle. They are present in varying degrees of development and in a wide range of interactive styles and potential. Neuman offers the following definitions for each variable:
Physiological: Denotes bodily structure and function
Psychological: Denotes mental processes and relationships
Socio-cultural: Denotes combined social and cultural functions
Developmental: Denotes life-developmental progressions
Spiritual: Denotes spiritual beliefs and influence
Neuman elaborated that the spiritual variable is an innate component of the basic structure or central core. Although it may or may not be acknowledged or developed by the client or client's system, Neuman views the spiritual variable as being on a continuum of development that penetrates all other client system variables and supports the client's optimal wellness. The client–client system can have a complete lack of awareness of the spiritual variable's presence and potential, deny its presence, or have a conscious and highly developed spiritual understanding that supports the client's optimal wellness (Smith, 2015).

**Environment**

A second concept identified by Neuman is the environment. She defined environment broadly as "all internal and external factors or influences surrounding the identified client or client system" including:
•Internal environment: intrapersonal factors
•External environment: Inter- and extrapersonal factors
•Created environment: Intra-, inter-, and extrapersonal factors (Smith, 2015).

**Internal Environment**

The internal environment consists of all forces or interactive influences contained within the boundaries of the client–client system. Examples of intrapersonal forces are presented for each variable.
•Physiological variable: autoimmune response, degree of mobility, range of body function
•Psychological and socio-cultural variables: attitudes, values, expectations, behavior patterns, coping patterns, conditioned responses
•Developmental variable: age, degree of normalcy, factors related to the present situation
•Spiritual variable: hope, sustaining force (Smith, 2015).

**External Environment**

The external environment consists of all forces or interactive influences existing outside the client–client system. Interpersonal factors in the environment are forces between people or client systems. These factors include the relationships and resources of family, friends, or caregivers. Extrapersonal factors include education, finances, employment, and other resources (Smith, 2015).

**Created Environment**

Neuman identified a third environment as the "created environment". The client unconsciously mobilizes all system variables, including the basic structure or central

**Conceptual Model**

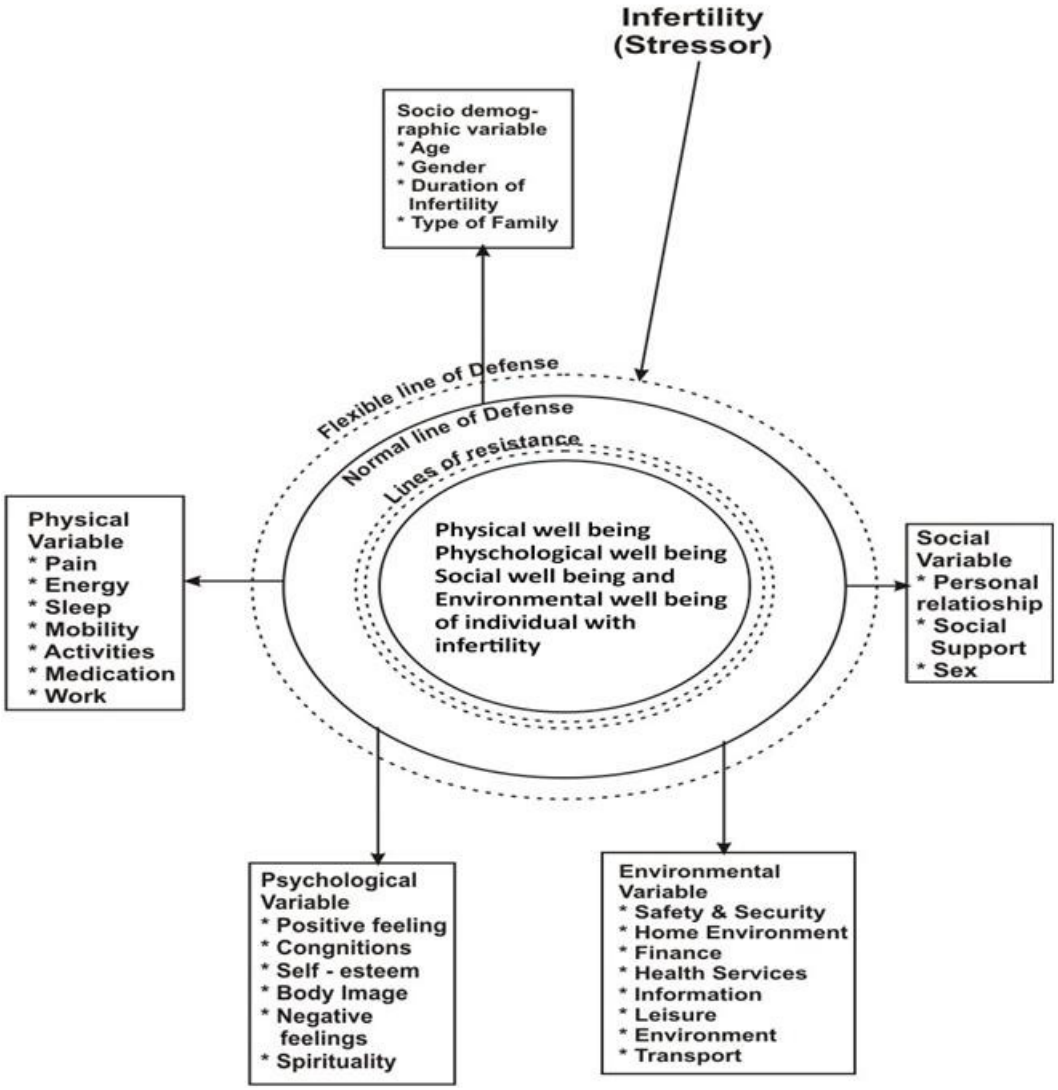


**Figure 1.** Adapted Neuman Systems Model (Smith, 2015)

core of energy factors, toward system integration, stability, and integrity to create a safe environment. This safe, created environment offers a protective, perceptive coping shield that helps the client to function. A major objective of this environment is to stimulate the client's health. Neuman pointed out that what was originally created to safeguard the health of the system may have a negative effect because of the binding of available energy (Smith, 2015).

## Health

Health is a third concept in Neuman's model. She believes that health (or wellness) and illness are on opposite ends of the continuum. Health is equated with optimal system stability (the best possible wellness state at any given time). Client movement toward wellness exists when more energy is built and stored than expended. Client's movement toward illness and death exists when more energy is needed than is available to support life. The degree of wellness depends on the amount of energy required to return to and maintain system stability. The system is stable when more energy is available than is being used. Health is seen as varying levels within a normal range, rising and falling throughout the lifespan. These changes are in response to basic structure or central core factors and reflect satisfactory or unsatisfactory adjustment by the client system to environmental stressors (Dike, 2016). Figure 1

## RECOMMENDATIONS

The recommendations based on the finding are as follows:

- Government should include infertility as part of the diseases under the National Health Insurance Scheme (NHIS) in order to reduce the financial burden on individuals with infertility.
- Healthcare providers who prescribe drugs for infertility should prescribe drugs with lesser side effects.
- Fertility clinics for individuals with infertility should be less cumbersome - the waiting time in the clinics should be reduced so that individuals with infertility can easily walk in and out of the clinics and still be able to attend to other things in their daily lives.
- There should be support groups supervised by healthcare providers to improve the psychological, social, and environmental health of individuals with infertility.

## CONCLUSION

Based on published studies, the effects of infertility on individuals with infertility are still being investigated, with genuine causes not fully understood. There are existent knowledge gaps that must be filled in order to comprehend fully the real causes of infertility. A thorough understanding of the effects of infertility on individuals with infertility may result in the recognition of more efficient initial prevention and intervention strategies for infertility. Healthcare providers should create more awareness on infertility at the local community levels. This will help correct cultures, and beliefs that stigmatize individuals with infertility. In addition, men with infertility should be encouraged to attend fertility clinics.

## ACKNOWLEDGMENT

Special thanks to everyone who contributed in one way or the other to make this research a reality. Your assistance in conducting this research can never be denied.

### Authors' Contributions

All authors contributed to different aspects of the research.

### Conflict of Interest

All the authors hereby declare that they do not have any possible conflicts of interest.

## REFERENCES

Abebe MS, Afework M, Abaynew Y (2020). Primary and secondary infertility in Africa: systematic review with meta-analysis. *Fertility Research and Practice, 6*, 20. DOI: 10.1186/s40738-020-00090-3.

Adelosoye AA, Fasipe OJ, Medunoye EI, Adelosoye OC, Sunday EO (2020). Assessment of family function impact on depression severity among infertile women attending a teaching hospital in South-South Nigeria. *Future Science Open Access, 6*(8), FSO595. DOI: 10.2144/fsoa-2020-0033.

Aduloju OP., Olaogun, O. D., Aduloju, T. (2017). Quality of life in women of reproductive age: a comparative study of infertile and fertile women in a Nigerian tertiary centre. *J. Obstetrics and Gynaecol. 13*(16), 1-5. DOI: 10.1080 /0144 3615.2017.1347916.

Alimohamadi, Y., Mehri, A., Sepandi, M., Esmaeilzadeh, F., & Rashti, R. (2020). The prevalence of depression among Iranian infertile couples: an updated systematic review and meta-analysis. *Middle East Fertility Soc. J.* ***25***(16), 1-12. DOI: 10.1186/s43043-020-00026-3.

American College of Obstetricians and Gynecologists (ACOG). (2019). Infertility workup for the women's health specialist. *Obstetrics and Gynecology,* ***133***(6), e377-384.

American International Medical University (AIMU). (2018). Infertility: Symptoms, Causes, Diagnosis, Management and Prevention. Available online: https://www.aimu.us

Arc Fertility Blog. (2021). Problem with sleep? You might have problem with fertility, too. Available online: https://www.arcfertility.com/problems-with-sleep-you-might-have-problems-with-fertility-too/

Aregbeshola, B. (2019). Health care in Nigeria: Challenges and recommendations. Available online: https://www.social-protection.org/discover

Asazawa, K., Jitsuzaki, M., Mori, A., Ichikawa, T., & Shinozaki, K. (2020). Effectiveness of a Spousal Support Program in Improving the Quality of Life of Male Patients Undergoing Infertility Treatment: A Pilot Study. *IJCBNM*, ***8***(1), 23-33. DOI: 10.30476/IJCBNM.2019.81329.0.

Asazawa, K., Jitsuzaki, M., Mori, A., Ichikawa, T., Shinozaki, K., & Porter, S. E. (2018). Quality of Life predictors for men undergoing Infertility Treatment. *Japan Journal of Nursing Science,* ***16***(3), 329-341. DOI: 10.1111/jjns.12248.

Atake, E., & Gnakou, A. P. (2019). Women's empowerment and fertility preferences in high fertility countries in Sub-Saharan Africa. *BMC Women's Health,* ***19***, 54. DOI: 10.1186/s12905-019-0747-9.

Bakhtiyar, K., Beiranvand, R., Ardalan, A., Changaee, F., Almasian, M., Badrizadeh, A., Bastami, F., & Ebrahimzadeh, F. (2019). An investigation of the effects of infertility on women's quality of life: a case-control study. *BMC Women's Health*, ***19***(1), 114. DOI: 10.1186/s12905-019-0805-3.

Bamawi, Y., Adetunji, H., Edris, F., BinHassan, R., & Fairaq, B. (2020). Quality of life among women with primary and secondary infertility attending a private fertility center in Jeddah, Saudi Arabia: A Cross - Sectional Study. *Medical Science J. 24*(105), 3061-3069.

Bradley University. (2021). Infertility and body image. Available online: https://www.bradley.edu/sites/bodyproject/sexuality /infertility/

Carré, J., Gatimel, N., Moreau, J., Parinaud, J., Leandri, R. (2017). Does air pollution play a role in infertility? A systematic review. *Environmental Health Journal,* ***16***, 82. DOI: 10.1186/s12940-017-0291-8.

Çavdar, N. K., Coşkun, A. M. (2018). The effect of infertility upon quality of life and self-esteem. *MOJ Women's Health*, ***7***(3), 89–94. DOI: 10.15406/mojwh.2018.07.00176.

Celestine, N. (2021). 5 Quality of Life Questionnaires and Assessment. Available online: www.positivepsychology.com

Collins, M. E. (2019). The Impact of Infertility on Daily Occupations and Roles. *J. Reprod. Infertility*, ***20***(1), 24-34.

Connolly, M. P., Panda, S., Mburu, G., Matsaseng, T., Kiarie, J. (2021). Estimating the government public economic benefits attributed to investing in assisted reproductive technology: A South African case study. *Reproductive BioMedicine and Society Online, **12***, 14-21.

Crawford NM, Hoff HS, Mersereau JE (2017). Infertile women who screen positive for depression is less likely to initiate fertility treatments. *Human Reproduction*, ***32***(3), 582–7.

Cusatis, R., Fergestrom, N., Cooper, A., Schoyer, K. D., Kruper, A., Sandlow, J., Strawn, E., & Flynn, K. E. (2019). Too much time? Time use and fertility-specific quality of life among men and women seeking specialty care for infertility. *BMC Psychology, **7***, 45. DOI: 10.1186/s40359-019-0312-1.

Dike K, Joseph V (2016). Betty Neuman Conceptual Framework - Effect of Acupressure on Anxiety and Fertility among women with Unexplained Infertility subjected to Intrauterine Insemination. *Paripex-Indian J. Res. 5*(2), 191-193.

Direkvand-Moghadam, A., Delpiseh, A., Montazeri, A., & Sayehmiri, K. (2016). Quality of life among Iranian infertile women in menopausal period: A cross-sectional study. *J. Menopausal Med. **22***, 108-113. DOI: 10.6118/jmm. 2016.222.108.

Ezeh, A., Bankole, A., Cleland, J., Garcia-Moreno, C., Temmerman, M., & Ziraba, A. K. (2016). Burden of Reproductive Ill Health. In: *Reproductive, Maternal, Newborn, and Child Health. Disease Control Priorities,* 3rd Edition, Vol. 2.

Fehintola, A. O., Fehintola, F. O., Ogunlaja, O. A., Awotunde, T. O., Ogunlaja, I. P., & Onwudiegwu, U. (2017). Social Meaning and Consequences of Infertility in Ogbomoso, Nigeria. *Sudan Journal of Medical Sciences, **12***(2), 63-77. DOI: 10.18502/sjmsv12i2.917.

Grube, T. (2019). A grounded theory approach to explore the experience of involuntary childlessness in couples with infertility. A Dissertation presented to the Faculty of Nursing, Widener University, Chester, Pennsylvania, USA.

Harzif, A. K., Santawi, V. P. A., & Wijaja, S. (2019). Discrepancy in perception of infertility and attitude towards treatment options: Indonesian urban and rural area. *Reproductive Health, **16***, 129. DOI: 10.1186/s12978-019-0792-8.

Hiadzi, R. A., & Boafo, I. M. (2020). Quest for Conception: Exploring Treatment Patterns Associated with Infertility in Ghana. *African Journal of Reproductive Health, **24***(2), 27. DOI: 10.29063/ajrh2020/v24i2.3.

Hocaoglu, C. (2018). The psychosocial aspect of infertility. *Intech Open, **3***, 2-9. DOI: 10.5772/intechopen.80713.

Hubens, K., Arons, A. M. M., & Krol, M. (2018). Measurement and evaluation of quality of life and well-being in individuals having or having had fertility problems: a systematic review. *The European Journal of Contraception and Reproductive Health Care, **23***(6), 1-10. DOI: 10.1080/ 1362 518 7.2018.1539161.

Human Fertilisation & Embryology Authority (HFEA). (2021). Available online: https://www.hfea.gov.uk/treatments/

Ikwuka, A. O. (2015). Risk factors for the pathogenesis of diabetes mellitus type 2. *Materials of 84th Scientific and Practical Conference of Students and Young Scientists with International Participation "Innovations in medicine"*, p. 19. Available online: http://www.ifnmu.edu.ua/images/snt/files/konferenciya/Tezu_2015.pdf

Ikwuka, A. O. (2017)a. Dyslipidemia risk severity in patients with diabetes mellitus type 2 and essential hypertension. *Journal of the 21st International Medical Congress of Students and Young Scientists*, p. 59.

Ikwuka, A. O. (2017)b. Effectiveness of dapagliflozin in patients with diabetes mellitus type 2 and essential hypertension. *Book of abstracts of the 7th International Students' Scientific Conference of Young Medical Researchers*, p. 102. Available online: http://www.stn.umed.wroc.pl/files/lm/ Accepted_papers.16113.pdf

Ikwuka, A. O. (2017)c. Influence of dyslipidemia in patients with diabetes mellitus type 2 and essential hypertension. *The Pharma Innovation Journal*, ***6***(3), 101-103. Available online: http://www.thepharmajournal.com/archives/?year=2017&vol=6&issue=3&part=B

Ikwuka, A. O. (2018)a. Clinical dynamics in patients with diabetes mellitus type 2 and concomitant essential hypertensive disease treated with dapagliflozin. *Journal of the 22nd International Medical Congress of Students and Young Scientists,* p. 32.

Ikwuka, A. O. (2018)b. Clinical effectiveness of SGLT-2 inhibitors in patients with diabetes mellitus type 2 and essential hypertensive disease. *Endocrine Practice*, *24*(1), 74. DOI: 10.1016/S1530-891X(20)47129-0.

Ikwuka, A. O. (2018)c. Features of kidney damage in patients with arterial hypertension and type 2 diabetes mellitus and optimization of treatment. *Specialized Academic Council IFNMU*, Available online: http://www.ifnmu.edu.ua/images/zagalna_informacia/spec_vcheni_radi/20172019/%D0%942 0.601.01/Ikvuka/Avtoreferat.pdf

Ikwuka, A. O. (2019)a. Clinical dynamics of nephropathy in patients with diabetes mellitus type 2 and concomitant essential hypertensive disease. *Clinical Medicine*, ***19***(2), s39. DOI: 10.7861/clinmedicine.19-2-s39.

Ikwuka, A. O. (2019)b. Clinical effectiveness of GLP-1 RAs in patients with metabolic syndrome diseases. *Endocrine Practice*, ***25***(1), 104-105. DOI: 10.1016/S1530-891X (20) 46611-X.

Ikwuka, A. O. (2023)a. *Dr. Aloy's Core Essential Series (DACES) Medical Genetics*. 1st Edition. Science and Education Publishing, USA, p. 9. ISBN: 978-1-958293-02-7.

Ikwuka, A. O. (2023)b. *Dr. Aloy's Core Essential Series (DACES) Immunology*. 1st Edition. Science and Education Publishing, USA, p. 30. ISBN: 978-978-795-866-7.

Ikwuka, A. O. (2023)e. *Dr. Aloy's Core Essential Series (DACES) Hematology*. 1st Edition. Science and Education Publishing, USA, p. 95. ISBN: 978-1-958293-09-6.

Ikwuka, A. O., & Haman, I. O. (2017)d. Features of kidney damage in patients with diabetes mellitus type 2 and essential hypertension. *Journal of 86th Scientific and Practical Conference of Students and Young Scientists with International Participation "Innovations in medicine"*, p. 144. Available online: http://www.ifnmu.edu.ua/images/snt/86-konf-tezi%20(1).pdf

Ikwuka, A. O., Paliy, Yu. (2018)d. Structural changes of the left ventricular myocardium in patients with essential arterial hypertension and diabetes mellitus type 2. *Abstracts of the 87th Scientific Conference of Students and Young Scientists with International Participation "Innovations in medicine"*, p. 25-26. Available online: https://www.ifnmu.edu.ua/ images /snt/zaproshennia_eng.pdf

Ikwuka, A. O., Virstyuk, N. (2022). Prognostic markers of nephropathy in patients with dual metabolic syndrome diseases (essential hypertensive disease and concomitant type 2 diabetes mellitus). *Endocrine Practice*, ***28***(5), S65-S66. DOI: 10.1016/j.eprac.2022.03.164.

Ikwuka, A. O., & Virstyuk, N. (2023)c. Patterns and Influence of Cardio-Metabolic Insufficiency in Patients with Essential Hypertensive Disease and Concomitant Type 2 Diabetes Mellitus. *Endocrine Practice*, ***29***(5), S32-S33. DOI: 10.1016/j.eprac.2023.03.076.

Ikwuka, A. O., & Virstyuk, N. G. (2019)c. Pattern of cardiac remodelling of the left ventricle in patients with essential hypertensive disease and concomitant type 2 diabetes mellitus. *Clinical Medicine*, ***19***(3), s92. DOI: 10.7861/clinmedicine.19-3-s92.

Ikwuka, A. O., & Virstyuk, N. G. (2021). Influence of SGLT2 inhibitor and A2RB (AT1) on fibrogenesis and heart failure in patients with essential hypertensive disease combined with diabetes mellitus type 2. *E-Poster No. 143 of the 44th & 45th Annual General and Scientific Meeting of the West African College of Physicians (WACP), 1 - 3 November, 2021*. DOI: 10.13140/RG.2.2.26912.87047.

Ikwuka, A. O., Omoju, D. I., & Mahanera, O. K. (2023)f. Profiling of Clinical Dynamics of Type 2 Diabetes Mellitus in Patients: A Perspective Review. *World Journal of Current Medical and Pharmaceutical Research*, ***5***(5), 210-218. DOI: 10.37022/wjcmpr.v5i5.294.

Ikwuka, A. O., Virstyuk, N. G., & Luchko, O. R. (2017)e. Features of the functional state of kidneys in patients with diabetes mellitus type 2 and essential arterial hypertension. *Materials of scientific-practical conference with international participation "Babenkivski reading"*, p. 48.

Ikwuka, A. O., Virstyuk, N. G., Luchko, O. R., & Kobitovych, I. (2023)d. Heterogeneity Of Renal Pathogenicity On The Background Of Asymptomatic Hyperuricemia In Patients With Dual Metabolic Syndrome Diseases (Essential Hypertensive Disease and Type 2 Diabetes Mellitus). *British Journal of Medical and Health Research*, ***10***(2), 1-9. DOI: 10.5281/zenodo.7690636.

Ikwuka, A. O., Virstyuk, N., Luchko, O., & Kobitovych, I. (2024). Optimization of treatment in MSD patients using a combination of HMG-CoA reductase inhibitor, SGLT-2 inhibitor and A2RB (AT1): Resultant clinical effectiveness. *Endocrine Practice*, ***30***(5), S60-S61. DOI: 10.1016/j.eprac.2024.03.243.

Jahromi, B. N., Mansouri, M., Forouhari, S., Poordast, T., & Salehi, A. (2018). *Royan Institute International Journal of Fertility and Sterility, **11***(4), 293-297.

Johnson, T. C. (2021). Fertility drugs. Available online: https://www.webmd.com/infertility-and-reproduction/guide/fertility-drugs

Karaca, N., Karabulutb, A., Ozkanc, S., Aktund, H., Orengule, F., Yilmaza, R., Atesa, S., & Batmaz, G. (2016). Effect of IVF failure on quality of life and emotional status in infertile couples. *European Journal of Obstetrics & Gynecology and Reproductive Biology, **206***, 156-163.

Kiani, Z., Simbar, M., Hajian, S., & Zayeri, F. (2020). Development and psychometric evaluation of a quality of life questionnaire for infertile women: a mixed method study. *Reproductive Health, **17***, 140.

Luk, B. H. K., & Loke, A. Y. (2018). Sexual satisfaction, intimacy and relationship of couples undergoing infertility treatment. *J. Reprod. Infant Psychol. 37*(2), 1-15. DOI: 10.1080/02646838.2018.1529407.

Maroufizadeh, S., Hosseini, M., Foroushani, A. R., Omani-Samani R, Amini, P. (2018). The effect of depression on quality of life in infertile couples: an actor-partner inter-dependence model approach. *Health and Quality of Life Outcomes*, ***16***, 73. DOI: 10.1186/s12955-018-0904-0.

Masoumi, S. Z., Garousian, M., Khani, S., Oliaei, S. R., & Shayan, A. (2016). Comparison of Quality of Life, Sexual Satisfaction and Marital Satisfaction between Fertile and Infertile Couples. *Int. J. Fertility & Sterility, **10***(3), 290–296. DOI: 10.22074/ijfs.2016.5045.

McBain, T. D. (2019). The invisibility of infertility grief. *Counseling Today*. Available online: www.ct.counseling.org

Mohammed-Durosinlorun, A., Adze, J., Bature, S., Abubakar, A., Mohammed, C., Taingson, M., & Airede, L. (2019). Use and pattern of previous care received by infertile Nigerian women. *Fertility Research and Practice Journal*, ***5***, 14. DOI: 10.1186/s40738-019-0068-6.

Montano, A. (2021). Neuman Systems Model with Nurse-Led Interprofessional Collaborative Practice. *Nursing Science Quarterly, **34***(1), 45-53. DOI: 10.1177/0894318420965219.

Murtaza, M. (2019). Male and female infertility: Causes and management. *IOSR Journal of Dental and Medical Sciences*, ***18***(9), 27-32.

Namdar, A., Naghizadeh, M., Zamani, M., Yaghmaei, F., & Sameni, M. (2017). Quality of life and general health of infertile women. *Health and Quality of Life Outcomes*, ***15***(139), 1-7. DOI: 10.1186/s12955-017-0712-y.

Obajimi, G. O., Ogunbode, O. O., Adetayo, C. O., & Ilesanmi, A. D. (2017). Acceptability of artificial insemination by donor among infertile women attending the Gynaecological Clinic of the University College Hospital, Ibadan. *Tropical Journal of Obstetrics and Gynaecology, **34***(3), 207-211.

Odunvbun, W. O., Oziga, D. V., Oyeye, L. O., & Ojeogwu, C. L. (2018). Pattern of infertility among infertile couple in a secondary health facility in Delta State, South-South Nigeria. *Tropical Journal of Obstetrics and Gynaecology, **35***(3), 244-248.

Palomba, S., Daolio, J., Romeo, S., Battaglia, F. A., Marci, R., & La Sala, G. B. (2018). Lifestyle and fertility: the influence of stress and quality of life on female infertility. *Reproductive Biology and Endocrinology Journal, **16***, 113. DOI: 10.1186/s12958-0180434-y.

Pizzorno, J. (2018). The path ahead: environmental toxins and infertility. *Integrative Medicine*, ***17***, 2.

Rooney, K. L., & Domar, A. D. (2018). The relationship between stress and infertility. *Dialogues in Clinical Neuroscience, **20***(1), 4147.DOI: 10. 318 87/ DCN S.2 018. 20. 1/klrooney.

Royani, Z., Heidari, M., Vatanparast, M., Yaghmaei, F., Sarcheshme, A., & Majomerd, J. (2019). Predictors of Quality of Life in Infertile Couples. *Journal of Menopausal Medicine*, ***25***, 35-40. DOI: 10.6118/jmm.2019.25.1.35.

Sarafraz, Y. M., Nasiri, R., Gharaei, J. M., & Sarafraz, Y. S. (2020). Quality of life and general health in pregnant women conceived with assisted reproductive technology: a case-control study. *International Journal of Fertility and Sterilization*, ***13***(4), 271-276. DOI: 10.22074/ijfs.2020.5684.

Shahraki, Z., Ghajarzadeh, M., & Ganjali, M. (2019). Depression, anxiety, quality of life and sexual dysfunction in Zabol women with infertility. *Maedica-a Journal of Clinical Medicine*, *14*(2), 131-134. DOI: 10.26574/maedica.2019.14.2.131.

Shreffler, K. M., Greil, A. L., & McQuillan, J. (2018). Responding to Infertility: Lessons from a Growing Body of Research and Suggested Guidelines for Practice. *FamRelat*, ***66***(4), 644–658. DOI: 10.1111/fare.1228.

SingleCare Team. (2021). Infertility statistics 2021: How many couples are affected by Infertility? Available online: https://www.singlecare.com/blog/news/infertility-statistics/

Smith, M. C., & Parker, M. E. (2015). Ed.: *Nursing Theories and Nursing Practice.* pp. 165-171. 4th Edition. Philadelphia, PA 19103. F. A. Davis Company.

Song, D., Li, X., Yang, M., Wang, N., Zhao, Y., Diao, S., Zhang, X., Gou, X., Zhu, X. (2021). Fertility quality of life (FertiQoL) among Chinese women undergoing frozen embryo transfer. *BMC Women's Health, **21***, 177. DOI: 10.1186/s12905-021-01325-1.

Strosberg, S. (2021). Fertility treatment was too expensive so I had sex with a friend instead. *Parents Magazine*. Available online: https://www.parents.com/parenting/money/family-finances/starting-out/ways-to-pay-for-ivf/

Sun, H., Gong, T., Jiang, Y., Zhang, S., Zhao, Y., & Wu, Q. (2019). Global, regional and national prevalence and disability-adjusted life-years for infertility in 195 countries and territories, 1990-2017: results from a global burden of disease study, 2017. *Impact Journals on Aging*, ***11***, 23. DOI: 10.18632/aging.102497.

Terzioglu, F., Turk, R., Yucel, C., Dilbaz, S., Cinar, O., & Karahalil, B. (2016). The effect of anxiety and depression scores of couples who underwent assisted reproductive techniques on the pregnancy outcomes. *African Health Sciences, **16***(2), 441–450.

United Nations. (2020). World fertility and family planning. Available online: http://creativecommons.org/licenses/by/3.0/igo/

Vaghar, M. I. (2019). Evaluation of lifestyle and endometriosis in infertile women referred to the selected hospital of Tehran University Medical Sciences. *Journal of Family Medicine and Primary Care, **8***(11), 3574-3577. DOI: 10.4103/jfmpc.jfmpc_496_19.

Virstyuk, N. H., & Ikwuka, A. O. (2018)c. Dapagliflozin influence on the clinical course of diabetes mellitus type 2 and essential hypertension in patients. *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions*, p. 2007-2008. DOI: 10.1007/978-3-319-70548-4_582.

Virstyuk, N. G., & Ikwuka, A. O. (2017)a. Diagnostic and prognostic markers of the diabetes mellitus type 2 course in connection with essential arterial hypertension taking into account the kidney function. *Precarpathian Journal Pulse*, ***8***(44), 53-62.

Virstyuk, N. G., Ikwuka, A. O. (2018)a. Features of asymptomatic hyperuricemia in patients with diabetes mellitus type 2 and concomitant essential arterial hypertension. *Clinical and Experimental Pathology*, ***1***(63), 22-26. DOI: 10.24061/1727-4338.XVII.1.63.2018.5.

Virstyuk, N. G., Ikwuka, A. O. (2019). Nephropathic characteristics in patients with diabetes mellitus type 2 and essential hypertensive disease. *Art of Medicine*, ***1***(5), 44-47. DOI: 10.21802/artm.2019.1.9.44.

Virstyuk NG, Ikwuka AO. (2021)a. Asymptomatic hyperuricemia and functional state of the kidneys in patients with essential arterial hypertension and concomitant diabetes mellitus type 2. *European Journal of Clinical Medicine*, ***2***(3), 100-104. DOI: 10.24018/clinicmed.2021.2.3.65.

Virstyuk, N. G., Ikwuka, A. O., & Didushko, O. M. (2018)b. Effect of dapagliflozin on the level of uric acid during asymptomatic hyperuricemia in patients with diabetes mellitus type 2 and concomitant arterial hypertension. *Art of Medicine*, ***1***(5), 21-26. Available online: https://art-of-medicine.ifnmu.edu.ua/index.php/aom/article/view/179/150

Virstyuk, N. G., Ikwuka, A. O., Haman, I. O., & Adebomi, M. S. (2016). Diabetes mellitus type 2, arterial hypertension and dyslipidemia. *Materials of 2nd International Scientific and Practical Conference "Therapeutic readings: modern aspects of diagnosis and treatment of diseases of internal organs"*, p. 46-47.

Virstyuk, N. H., Ikwuka, A. O., Losyuk, L. V., Kobrynska, O. Ya., & Markiv, H. D. (2017)b. Dapagliflozin utility in patients with diabetes mellitus type 2 and essential hypertensive disease. *Actual Problems of Modern Medicine*, ***4***(60)1, 76-79. Available online: http://www.umsa.edu.ua/journal2stat4_2017_eng.html

Virstyuk, N. H., Ikwuka, A. O., Luchko, O. R., & Kocherzhat, O. I. (2021)b. Peculiarities of renal insufficiency in patients with diabetes mellitus type 2 and arterial hypertension. *Materials of scientific-practical conference with international participation "Achievements and prospects of experimental and clinical endocrinology" Twentieth Danilevsky readings*, p. 86-87.

WHOQOL Group. (1998). Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychological Medicine*, ***28***, 551-558.

WHOQOL. (2012). WHOQOL User Manual.1-106. Available online: https://www.who/his/hsi#

Xiaoli, S., Mei, L., Junjun, B., Shu, D., Zhaolian, W, Jin, W., Ju, Q., Wanli, S., Huali, Z., Li, J., Dong, L., Li, P., & Xiaojin, H. (2016). Assessing the quality of life of infertile Chinese women: a cross-sectional study. *Taiwanese Journal of Obstetrics & Gynaecology*, ***55***, 244-250.

Xu, H., Ouyang, N., Li, R., Tuo, P., Mai, M., & Wang, W. (2017). The effects of anxiety and depression on *in vitro* fertilization outcomes of Chinese women. *Psychol Health Med, **22***, 37–43.

Yazdani, F., Kazemi, A., Fooladi, M. M., & Samani, H. R. (2016). The relations between marital quality, social support, social acceptance and coping strategies among the infertile Iranian couples. *European Journal of Obstetrics, Gynecology and Reproductive Biology*, ***200***, 58-62. DOI: 10.1016/j.ejogrb.2016.02.034.

Youseflu, S., Sadatmahalleh, S. J., Khomami, M. B., & Nasiri, M. (2020). Influential factors on sexual function in infertile women with endometriosis: a path analysis. *BMC Women's Health*, ***20***, 92. DOI: 10.1186/s12905-020-00941-7.

Zurlo MC, Cattaneo D, Volta MF, Vallone F (2019). The association between stressful life events and perceived quality of life among women attending infertility treatments: The moderating role of coping strategies and perceived couple's dyadic adjustment. *BMC Public Health, 19*(1548), 1-8. DOI: 10.1186/s12889-019-7925-4.