



Impact of Human Lifestyle and Androgen Antagonists on Reproductive Health: A Systematic Literature Review

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Abstract

Reproductive health disorders have become an increasing global public health concern, with growing evidence linking infertility and hormonal dysfunction to adverse lifestyle behaviours and exposure to endocrine-disrupting substances. Human lifestyle factors, such as poor nutrition, obesity, smoking, alcohol consumption, psychological stress, physical inactivity, and sleep disturbances have been associated with impaired reproductive outcomes. Similarly, androgen antagonists and environmental anti-androgenic compounds have been implicated in endocrine disruption and reproductive toxicity. This systematic literature review aimed to evaluate the impact of human lifestyle factors and androgen antagonists on reproductive health outcomes in both males and females, with emphasis on mechanisms of reproductive dysfunction and associated fertility challenges. A systematic literature search was conducted using electronic databases including PubMed, Scopus, Web of Science, ScienceDirect, and Google Scholar. Relevant peer-reviewed articles published between 2000 and 2025 were identified using predefined keywords and Boolean search strategies related to lifestyle factors, androgen antagonists, endocrine disruptors, fertility, and reproductive health. Eligible studies included observational studies, experimental studies, and review articles published in English. Data extraction, quality assessment, and narrative synthesis were performed in accordance with PRISMA guidelines. The reviewed studies demonstrated a strong association between unhealthy lifestyle behaviours and impaired reproductive health outcomes. Obesity, smoking, excessive alcohol consumption, poor dietary habits, chronic stress, physical inactivity, and sleep disturbances were consistently associated with hormonal imbalance, oxidative stress, reduced sperm quality, menstrual irregularities, ovulatory dysfunction, and infertility. In addition, androgen antagonists including pharmaceutical anti-androgens and environmental endocrine-disrupting chemicals such as phthalates and bisphenol A were found to adversely affect reproductive development, gonadal function, and fertility through endocrine disruption, androgen receptor blockade, oxidative stress induction, and DNA damage. Evidence further suggested that combined exposure to unhealthy lifestyle factors and androgen antagonists may exert synergistic adverse effects on reproductive health. The findings of this systematic review indicate that both modifiable lifestyle factors and exposure to androgen antagonists play critical roles in reproductive dysfunction and fertility impairment. The interaction between behavioural and environmental risk factors contributes significantly to declining reproductive health outcomes globally. Preventive strategies focusing on healthy lifestyle promotion, reduction of endocrine-disrupting chemical exposure, and improved public health awareness are essential for preserving reproductive wellbeing. Further longitudinal and mechanistic studies are required to strengthen understanding of the complex relationship between lifestyle, androgen antagonism, and reproductive health.

Keywords: Reproductive health; Lifestyle factors; Androgen antagonists; Endocrine disruptors; Fertility; Infertility; Oxidative stress

1. Introduction

Reproductive health is a fundamental component of human wellbeing and public health, encompassing the proper functioning of the reproductive system and the capacity to reproduce safely and effectively throughout life. According to the World Health Organization (WHO), reproductive health extends beyond the absence of disease and includes complete physical, mental, and social wellbeing in all matters relating to the reproductive system (WHO, 2022). In recent decades, there has been growing concern regarding the

increasing prevalence of reproductive health disorders, including infertility, hormonal imbalance, impaired gamete quality, menstrual irregularities, and reproductive cancers. These conditions have been associated with a complex interaction of environmental, behavioural, occupational, and physiological factors (Agarwal et al., 2021).

Human lifestyle behaviours play a significant role in influencing reproductive function and fertility outcomes. Lifestyle factors such as poor dietary habits, obesity, tobacco smoking, alcohol consumption, sedentary behaviour, chronic stress, substance abuse, and sleep disturbances have all been implicated in reproductive dysfunction in both males and females (Sharma et al., 2013). The increasing adoption of

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unhealthy lifestyles globally has contributed substantially to endocrine disruption and impaired reproductive capacity. Obesity, for example, is strongly associated with hormonal imbalance, reduced sperm quality in males, and ovulatory dysfunction in females (Craig et al., 2017). Similarly, cigarette smoking has been linked to oxidative stress, reduced semen quality, ovarian ageing, and increased risk of infertility (Practice Committee of the American Society for Reproductive Medicine, 2018).

In addition to lifestyle-related factors, exposure to androgen antagonists has emerged as a major concern in reproductive health research. Androgen antagonists are substances that inhibit the biological activity of androgens by blocking androgen receptors or suppressing androgen production. These compounds may be pharmaceutical agents used therapeutically or environmental endocrine-disrupting chemicals present in plastics, pesticides, industrial pollutants, and personal care products (Hotchkiss et al., 2008). Common pharmaceutical androgen antagonists include flutamide, spironolactone, and bicalutamide, which are widely used in the treatment of prostate cancer, acne, hirsutism, and androgen-related disorders (Furr, 2015). Environmental anti-androgenic compounds such as phthalates and bisphenol A have also attracted significant scientific attention due to their adverse effects on reproductive development and fertility (Skakkebaek et al., 2016).

The mechanisms through which androgen antagonists impair reproductive health involve endocrine disruption, interference with hormonal signalling pathways, oxidative stress induction, and gonadal toxicity. Studies have demonstrated that prolonged exposure to anti-androgenic substances may lead to reduced testosterone synthesis, impaired spermatogenesis, decreased sperm motility, altered ovarian function, and developmental abnormalities in reproductive organs (Diamanti-Kandarakis et al., 2009). Furthermore, combined exposure to unhealthy lifestyle factors and endocrine-disrupting agents may exert synergistic adverse effects on reproductive outcomes, thereby increasing the burden of infertility and reproductive disorders globally.

Globally, infertility affects approximately one in six individuals during their reproductive lifetime, representing a significant public health challenge with social, emotional, and economic implications (WHO, 2023). Although considerable research has been conducted on individual lifestyle factors and androgen antagonists, the available evidence remains fragmented, with variations in study design, population characteristics, and reported outcomes. Consequently, there is a need for a comprehensive synthesis of current scientific evidence examining the collective impact of human lifestyle behaviours and androgen antagonists on reproductive health.

This systematic literature review therefore aims to

critically evaluate existing evidence on the relationship between human lifestyle factors, androgen antagonists, and reproductive health outcomes. The review seeks to identify major lifestyle determinants associated with reproductive dysfunction, examine the mechanisms and effects of androgen antagonists, and synthesise current findings regarding their combined influence on male and female reproductive health. The findings of this review may contribute to improved public health awareness, clinical interventions, and policy development aimed at reducing reproductive health risks associated with lifestyle and environmental exposures.

2. Methodology

2.1 Study Design

This study employed a systematic literature review design to critically evaluate and synthesise existing evidence on the impact of human lifestyle factors and androgen antagonists on reproductive health outcomes. The systematic review approach was adopted to ensure a comprehensive, transparent, and reproducible method of identifying, selecting, appraising, and analysing relevant scientific literature. The review process was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to enhance methodological rigour and reporting quality (Page et al., 2021).

2.2 Search Strategy

A comprehensive electronic literature search was conducted using multiple scientific databases to identify relevant studies published on the relationship between lifestyle factors, androgen antagonists, and reproductive health. The databases searched included PubMed, Scopus, Web of Science, ScienceDirect, and Google Scholar.

Studies were considered eligible for inclusion in this review if they met the following criteria: peer-reviewed original research articles and review articles, studies examining the relationship between lifestyle factors and reproductive health, studies investigating the effects of androgen antagonists or endocrine-disrupting chemicals on reproductive outcomes, human studies and relevant animal experimental studies, articles published in the English language, and studies published between 2000 and 2025.

Studies were excluded from the review based on the following criteria: non-peer-reviewed articles, editorials, commentaries, and conference abstracts, articles not written in English, duplicate publications, studies lacking sufficient data on reproductive outcomes, studies unrelated to lifestyle factors or androgen antagonists, and publications outside the selected time frame.

2.3 Study Selection Process

The study selection process was conducted systematically in several stages. Initially, all identified articles from the database search were exported into a

reference management system, where duplicate studies were removed. The titles and abstracts of the remaining studies were screened independently to determine their relevance to the review objectives. Following the preliminary screening, full-text articles of potentially eligible studies were retrieved and assessed against the inclusion and exclusion criteria. Studies that met all eligibility requirements were included in the final review. The overall study selection procedure was documented using a PRISMA flow diagram illustrating the identification, screening, eligibility assessment, and inclusion stages.

2.4 Data Extraction

Relevant data were extracted systematically from the selected studies using a structured data extraction form developed for the purpose of this review. The extracted information included: Author(s) and year of publication, Country or region of study, Study design, Population characteristics, Sample size, Type of lifestyle factor investigated, Type of androgen antagonist or endocrine disruptor studied, Reproductive health outcomes measured, and Key findings and conclusions. The data extraction process ensured consistency and accuracy in the synthesis of evidence from the included studies.

2.5 Quality Assessment

The methodological quality and risk of bias of the included studies were evaluated using appropriate critical appraisal tools. Observational studies were assessed using the Newcastle–Ottawa Scale (NOS), while experimental studies were evaluated using standard quality assessment criteria relevant to their study designs.

The quality assessment focused on factors such as study design, sample representativeness, exposure assessment, outcome measurement, statistical analysis, and control of confounding variables. Studies were categorised as high, moderate, or low quality based on their appraisal scores.

2.6 Data Synthesis and Analysis

A narrative synthesis approach was employed to analyse and present the findings of the included studies due to the heterogeneity in study populations, exposure variables, methodologies, and reproductive health outcomes. The findings were organised thematically according to major lifestyle factors and categories of androgen antagonists.

Comparative analysis was performed to identify patterns, similarities, and differences across studies regarding the effects of lifestyle behaviours and androgen antagonists on male and female reproductive health. Emphasis was placed on identifying mechanisms of reproductive toxicity, endocrine disruption pathways, and reported fertility outcomes.

2.7 Ethical Considerations

As this study involved the review and analysis of

previously published literature, ethical approval was not required. Nevertheless, all sources of information used in the review were appropriately acknowledged and referenced in accordance with academic standards to maintain integrity and avoid plagiarism.

3. Results and Findings

3.1 Overview of Included Studies

The systematic search of electronic databases yielded a substantial number of studies examining the relationship between human lifestyle factors, androgen antagonists, and reproductive health outcomes. Following the removal of duplicate articles and application of the inclusion and exclusion criteria, eligible studies were selected for final review and synthesis. The incorporated studies comprised observational studies, cohort studies, case-control studies, cross-sectional studies, experimental animal studies, and review articles conducted across North America, Europe, Asia, and Africa.

Most of the reviewed studies reported a significant association between adverse lifestyle behaviours, exposure to androgen antagonists, and impaired reproductive function in both males and females. Commonly investigated reproductive outcomes included infertility, hormonal imbalance, reduced sperm quality, menstrual disorders, impaired ovulation, reproductive organ abnormalities, and pregnancy complications.

3.2 Lifestyle Factors and Reproductive Health

3.2.1 Diet and Nutrition

Several studies identified poor dietary patterns and nutritional imbalance as major contributors to reproductive dysfunction. Diets characterised by excessive intake of saturated fats, processed foods, and refined sugars were associated with obesity, oxidative stress, and hormonal imbalance, which negatively affected fertility outcomes (Agarwal et al., 2021). Conversely, diets rich in antioxidants, fruits, vegetables, omega-3 fatty acids, and micronutrients were associated with improved reproductive parameters and hormonal regulation.

Obesity was consistently reported as a significant risk factor for reproductive impairment. In males, obesity was associated with reduced testosterone levels, impaired spermatogenesis, and decreased sperm motility (Craig et al., 2017). In females, obesity contributed to ovulatory dysfunction, menstrual irregularities, polycystic ovarian syndrome (PCOS), and reduced pregnancy rates (Silvestris et al., 2018).

3.2.2 Smoking and Tobacco Use

Smoking was identified as one of the most detrimental lifestyle behaviours affecting reproductive health. Numerous studies demonstrated that cigarette smoke exposure increased oxidative stress and DNA damage in reproductive tissues, leading to reduced fertility potential in both sexes (Practice Committee of the American Society for Reproductive Medicine, 2018).

In males, smoking was associated with reduced sperm concentration, abnormal sperm morphology, impaired sperm motility, and increased sperm DNA fragmentation (Sharma et al., 2013). Female smokers were reported to experience diminished ovarian reserve, accelerated ovarian ageing, menstrual abnormalities, and increased risk of miscarriage and ectopic pregnancy (Soares & Melo, 2008).

3.2.3 Alcohol Consumption

Excessive alcohol consumption was linked to impaired reproductive hormone regulation and fertility disturbances. Chronic alcohol intake disrupted hypothalamic-pituitary-gonadal axis function, resulting in decreased testosterone production and impaired spermatogenesis in males (Emanuele & Emanuele, 2001). Studies also reported associations between alcohol abuse and erectile dysfunction, testicular atrophy, and reduced semen quality.

Among females, alcohol consumption was associated with menstrual disturbances, ovulatory dysfunction, reduced implantation success, and adverse pregnancy outcomes (Mamluk et al., 2017). The severity of reproductive impairment appeared to increase with prolonged and excessive alcohol exposure.

3.2.4 Physical Inactivity and Obesity

Physical inactivity and sedentary lifestyles were strongly associated with metabolic disorders that negatively affected reproductive health. Reduced physical activity contributed to obesity, insulin resistance, chronic inflammation, and endocrine dysfunction, all of which were linked to impaired fertility (Du Plessis et al., 2010).

Moderate physical activity was generally associated with improved hormonal balance and reproductive function. However, excessive physical exertion, particularly among elite athletes, was also linked to menstrual disturbances and reduced fertility in females due to alterations in energy balance and hormonal secretion (Nattiv et al., 2007).

3.2.5 Psychological Stress

Psychological stress emerged as an important factor influencing reproductive health. Chronic stress stimulated excessive cortisol production, which interfered with reproductive hormone secretion and gonadal function (Palomba et al., 2018). Several studies demonstrated that stress negatively affected ovulation, menstrual regularity, sperm production, and sexual function.

Stress-related infertility has been associated with occupational stress, emotional trauma, chronic psychological distress, anxiety, and depressive disorders, although the relationship is recognised to be complex and bidirectional (Karunyan et al., 2023; Bagade et al., 2023; Dehkordi et al., 2025). Elevated psychological stress and anxiety have also been associated with poorer outcomes during certain stages

of assisted reproductive procedures, particularly oocyte retrieval and fertilisation, although evidence regarding overall pregnancy and live birth rates remains inconsistent (Zanettoullis et al., 2024; Liu et al., 2025).

3.2.6 Sleep and Circadian Disruption

Sleep deprivation and circadian rhythm disturbances were increasingly recognised as contributors to reproductive dysfunction. Inadequate sleep altered melatonin secretion, disrupted hormonal regulation, and impaired reproductive endocrine function (Kloss et al., 2015; Qui et al., 2023).

Shift workers and individuals with chronic sleep disturbances have been associated with reduced fertility, menstrual irregularities, and impaired semen quality. Circadian disruption has also been linked to increased oxidative stress, metabolic dysfunction, and hormonal dysregulation that may adversely affect reproductive function (Zhang et al., 2022; Wang & Jiang, 2023; Kohn et al., 2025; Schettini et al., 2023; Makris et al., 2023).

3.3 Androgen Antagonists and Reproductive Health

3.3.1 Pharmaceutical Androgen Antagonists

Several studies examined the reproductive effects of pharmaceutical androgen antagonists such as flutamide, spironolactone, and bicalutamide. These drugs are commonly used in the treatment of prostate cancer, androgenic alopecia, acne, and hirsutism due to their ability to inhibit androgen receptor activity (Furr, 2015).

Although therapeutically beneficial, prolonged use of these agents was associated with reproductive side effects, including decreased libido, erectile dysfunction, reduced sperm production, gynecomastia, and hormonal imbalance in males (Narula & Carlson, 2014). In females, anti-androgenic medications occasionally altered menstrual cycles and ovulatory function.

3.3.2 Environmental Anti-Androgens

Environmental endocrine-disrupting chemicals with anti-androgenic activity were widely reported in the reviewed studies. Common environmental androgen antagonists included phthalates, bisphenol A (BPA), pesticides, dioxins, and industrial pollutants (Diamanti-Kandarakis et al., 2009).

Exposure to these compounds was associated with impaired reproductive development, testicular dysgenesis, reduced semen quality, altered ovarian function, and hormonal abnormalities. Prenatal and early-life exposure appeared particularly harmful, as developmental exposure to endocrine disruptors was linked to long-term reproductive abnormalities in adulthood (Skakkebaek et al., 2016).

Several animal studies demonstrated that phthalates disrupted testosterone synthesis and impaired male reproductive tract development. BPA exposure was

similarly associated with altered ovarian follicular development, impaired implantation, and reduced fertility in females (Peretz et al., 2014).

3.3.3 Mechanisms of Reproductive Toxicity

The reviewed studies identified multiple biological mechanisms through which androgen antagonists exert reproductive toxicity. These mechanisms included androgen receptor blockade, suppression of testosterone biosynthesis, oxidative stress induction, mitochondrial dysfunction, inflammation, and DNA damage (Hotchkiss et al., 2008).

Endocrine-disrupting chemicals interfered with hormonal signalling pathways responsible for reproductive development and gametogenesis. Oxidative stress was frequently implicated in sperm membrane damage, reduced sperm viability, and ovarian follicular degeneration.

3.3.4 Combined Effects of Lifestyle Factors and Androgen Antagonists

Several studies suggested that unhealthy lifestyle behaviours may amplify the harmful reproductive effects of androgen antagonists and endocrine-disrupting chemicals. Obesity, smoking, alcohol consumption, and poor dietary patterns were reported to increase susceptibility to hormonal disruption and oxidative damage caused by environmental toxicants (Sharma et al., 2013).

Combined exposure to endocrine-disrupting chemicals and adverse lifestyle factors, including smoking, obesity, poor diet, psychological stress, and occupational exposures, may exert additive or potentially synergistic effects on reproductive dysfunction, contributing to infertility, hormonal imbalance, and gonadal toxicity. Individuals with multiple concurrent risk factors generally demonstrate poorer reproductive outcomes than those exposed to a single environmental or lifestyle factor, although the magnitude of these combined effects varies across populations and study designs (Sharma et al., 2023; Pan et al., 2024; Shulhai et al., 2024; Rajamani et al., 2023).

3.4 Gender-Specific Reproductive Outcomes

3.4.1 Male Reproductive Effects

Male reproductive health was significantly affected by both lifestyle factors and androgen antagonists. Common findings included reduced sperm count, impaired sperm motility, abnormal sperm morphology, decreased testosterone levels, erectile dysfunction, and increased infertility rates (Agarwal et al., 2021).

Environmental anti-androgenic chemicals have been associated with testicular dysfunction and impaired spermatogenesis in experimental models and human epidemiological studies. Oxidative stress, endocrine disruption, impaired steroidogenesis, androgen receptor antagonism, inflammation, and epigenetic modifications have been identified as the principal mechanisms contributing to male reproductive

impairment (Gore et al., 2024; Virtanen & Adamsson, 2024; Wang et al., 2024; Wang et al., 2023).

3.4.2 Female Reproductive Effects

Among females, lifestyle factors and androgen antagonists were associated with menstrual irregularities, ovulatory disorders, reduced ovarian reserve, infertility, and adverse pregnancy outcomes. Obesity, smoking, stress, and endocrine-disrupting chemical exposure contributed significantly to hormonal imbalance and reproductive dysfunction (Silvestris et al., 2018).

Environmental toxicants such as BPA and phthalates were linked to impaired follicular maturation, altered oestrogen signalling, implantation failure, and increased risk of pregnancy complications.

3.5 Summary of Findings

The reviewed studies demonstrated strong evidence linking adverse lifestyle behaviours and androgen antagonist exposure to impaired reproductive health outcomes in both males and females. The evidence suggested that lifestyle-related endocrine dysfunction, oxidative stress, and environmental exposure to anti-androgenic compounds collectively contribute to declining fertility and increasing reproductive disorders globally.

The findings further highlighted the importance of preventive public health strategies aimed at promoting healthy lifestyle behaviours and reducing exposure to endocrine-disrupting chemicals in order to improve reproductive health outcomes.

4. Discussion

4.1 Interpretation of Major Findings

The findings of this systematic literature review demonstrate a substantial association between adverse human lifestyle behaviours, exposure to androgen antagonists, and impaired reproductive health outcomes in both males and females. The reviewed studies consistently revealed that lifestyle factors such as poor nutrition, obesity, smoking, excessive alcohol consumption, psychological stress, physical inactivity, and sleep disturbances contribute significantly to endocrine dysfunction, hormonal imbalance, oxidative stress, and fertility impairment.

The evidence reviewed indicates that reproductive health is highly sensitive to modifiable behavioural and environmental factors. Lifestyle-induced reproductive dysfunction appears to arise primarily through disturbances in hormonal regulation, metabolic imbalance, inflammatory responses, and oxidative damage to reproductive tissues (Sharma et al., 2013). Obesity, for example, was repeatedly identified as a major contributor to infertility due to its effects on insulin resistance, altered sex hormone metabolism, and chronic low-grade inflammation (Silvestris et al., 2018). In males, obesity was associated with impaired spermatogenesis, reduced testosterone levels, and decreased semen quality, while females experienced

ovulatory dysfunction and menstrual irregularities.

Smoking emerged as one of the most consistently reported lifestyle risk factors affecting reproductive health. The reviewed evidence demonstrated that tobacco smoke induces oxidative stress and DNA fragmentation in germ cells, thereby impairing sperm viability and ovarian function (Practice Committee of the American Society for Reproductive Medicine, 2018). Female smokers were also shown to experience accelerated ovarian ageing and reduced ovarian reserve. These findings support previous observations that smoking has both direct toxic effects on reproductive tissues and indirect endocrine-disrupting consequences.

Similarly, excessive alcohol consumption was associated with significant alterations in reproductive endocrine function. Chronic alcohol exposure interferes with the hypothalamic-pituitary-gonadal axis, leading to suppression of testosterone synthesis, impaired spermatogenesis, and sexual dysfunction in males (Emanuele & Emanuele, 2001). In females, alcohol-related reproductive dysfunction included menstrual disturbances, reduced implantation rates, and adverse pregnancy outcomes. The consistency of these findings across studies highlights the importance of alcohol moderation in preserving reproductive health.

Psychological stress and sleep disturbances were also identified as important contributors to reproductive dysfunction. Chronic stress increases cortisol secretion, which negatively affects gonadotropin release and reproductive hormone balance (Palomba et al., 2018). Furthermore, sleep deprivation and circadian rhythm disruption interfere with melatonin secretion and endocrine regulation, thereby impairing fertility outcomes (Kloss et al., 2015). These findings emphasise the multidimensional nature of reproductive health and the complex interactions between neuroendocrine and behavioural factors.

The review further demonstrated that androgen antagonists and endocrine-disrupting chemicals exert profound adverse effects on reproductive function. Pharmaceutical anti-androgens such as flutamide, spironolactone, and bicalutamide were shown to impair reproductive hormonal balance and sexual function, particularly following prolonged exposure (Furr, 2015). Although these agents are clinically useful in the management of androgen-related disorders, their reproductive side effects warrant careful monitoring, especially among individuals of reproductive age.

Environmental androgen antagonists and endocrine-disrupting chemicals emerged as major contributors to reproductive toxicity. Compounds such as phthalates, bisphenol A, pesticides, and industrial pollutants were consistently associated with impaired reproductive development, reduced semen quality, altered ovarian function, and infertility (Diamanti-Kandarakis et al.,

2009). Prenatal and early-life exposure appeared particularly harmful due to the vulnerability of developing reproductive tissues during critical developmental periods.

The mechanisms underlying reproductive toxicity were largely linked to endocrine disruption, androgen receptor blockade, oxidative stress induction, mitochondrial dysfunction, and DNA damage (Hotchkiss et al., 2008). These mechanisms interfere with hormonal signalling pathways necessary for normal reproductive development and gametogenesis. The reviewed evidence therefore supports growing concerns regarding the role of environmental toxicants in the global decline of reproductive health indicators. An important finding of this review is the potential synergistic interaction between unhealthy lifestyle factors and androgen antagonist exposure. Individuals exposed to multiple risk factors appeared more susceptible to reproductive dysfunction than those exposed to isolated factors. For example, obesity and smoking may exacerbate oxidative stress and inflammatory responses induced by endocrine-disrupting chemicals, thereby amplifying reproductive damage (Sharma et al., 2013). This suggests that reproductive impairment is often multifactorial and influenced by cumulative exposure patterns rather than single isolated determinants.

4.2 Public Health Implications

The findings of this review have important public health implications, particularly in light of increasing global infertility rates and widespread exposure to endocrine-disrupting chemicals. The growing prevalence of obesity, sedentary lifestyles, poor dietary patterns, and environmental pollution presents a significant threat to reproductive health across populations (WHO, 2023).

Public health interventions that promote healthy lifestyle behaviours have the potential to reduce the burden of reproductive disorders. Lifestyle modification strategies, including smoking cessation, balanced nutrition, regular physical activity, stress management, maintenance of a healthy body weight, and reduction of excessive alcohol consumption, have been associated with improved reproductive health and may improve fertility outcomes in selected populations (American Society for Reproductive Medicine [ASRM], 2023; Louis et al., 2024; Sharma et al., 2023; WHO, 2025a). Furthermore, increasing public awareness of environmental endocrine-disrupting chemicals and occupational exposure to reproductive toxicants is an important component of preventive reproductive healthcare. Regulatory measures aimed at limiting human exposure to harmful environmental anti-androgens are also necessary. The evidence reviewed suggests that stronger environmental protection policies and stricter regulation of industrial chemicals, plastics, and pesticides may help reduce reproductive toxicity risks (Zhou et al., 2023; Yadav et al., 2024; WHO, 2025b).

4.3 Strengths of the Review

One major strength of this systematic review is the comprehensive synthesis of evidence from diverse study designs and populations. The review incorporated findings from human epidemiological studies, clinical investigations, and experimental animal studies, thereby providing broad insight into the relationship between lifestyle factors, androgen antagonists, and reproductive health.

Additionally, the review adopted a systematic and transparent methodology guided by PRISMA principles, which enhanced the reliability and reproducibility of the findings. The inclusion of both male and female reproductive outcomes also allowed for a more holistic understanding of reproductive dysfunction.

4.4 Limitations of the Review

Despite its strengths, this review has several limitations. First, considerable heterogeneity existed among the included studies with respect to study design, population characteristics, exposure assessment methods, and outcome measures. This variability limited direct comparison across studies and prevented quantitative meta-analysis.

Secondly, many of the reviewed studies were observational in nature, making it difficult to establish definitive causal relationships between exposures and reproductive outcomes. Potential confounding variables such as socioeconomic status, genetic predisposition, occupational exposure, and pre-existing medical conditions may also have influenced the findings.

Another limitation relates to inconsistencies in exposure measurement and reporting, particularly for environmental endocrine disruptors. Variations in exposure duration, concentration, and assessment methods may have contributed to differences in reported reproductive outcomes.

Publication bias may also have influenced the review findings, as studies reporting significant associations are more likely to be published than studies with negative or inconclusive results.

4.5 Implications for Future Research

The findings of this review highlight the need for further high-quality longitudinal and mechanistic studies examining the combined effects of lifestyle factors and androgen antagonists on reproductive health. Future research should prioritise prospective cohort studies capable of establishing causal relationships and evaluating long-term reproductive outcomes.

There is also a need for improved biomonitoring techniques and standardised exposure assessment methods for endocrine-disrupting chemicals. Further molecular and genetic studies investigating oxidative stress pathways, epigenetic modifications, and endocrine signalling disruptions may provide deeper

understanding of reproductive toxicity mechanisms.

In addition, future studies should explore population-specific vulnerabilities, including age, sex, occupational exposure, and socioeconomic determinants of reproductive health. Greater emphasis should also be placed on preventive interventions and policy-oriented research aimed at reducing environmental and behavioural reproductive risk factors.

5. Conclusion

This systematic literature review critically examined the impact of human lifestyle factors and androgen antagonists on reproductive health outcomes in both males and females. The evidence synthesised from the reviewed studies demonstrates that reproductive health is significantly influenced by a complex interaction of behavioural, environmental, hormonal, and physiological factors.

The review identified unhealthy lifestyle behaviours including poor nutrition, obesity, smoking, excessive alcohol consumption, physical inactivity, chronic psychological stress, and sleep disturbances as major contributors to reproductive dysfunction. These factors were consistently associated with hormonal imbalance, oxidative stress, impaired gametogenesis, menstrual irregularities, reduced fertility, and adverse reproductive outcomes. The findings further revealed that many of these lifestyle-related reproductive disorders are potentially preventable through behavioural modification and improved health awareness.

In addition, the review established that androgen antagonists and endocrine-disrupting chemicals exert substantial adverse effects on reproductive health. Pharmaceutical anti-androgens such as flutamide, spironolactone, and bicalutamide, although clinically beneficial in the management of androgen-related conditions, may impair reproductive hormonal function and fertility following prolonged exposure. Environmental anti-androgenic compounds including phthalates, bisphenol A, pesticides, and industrial pollutants were also strongly associated with reproductive toxicity, endocrine disruption, impaired gonadal development, and infertility.

The evidence reviewed suggests that the mechanisms underlying reproductive impairment involve androgen receptor inhibition, endocrine disruption, oxidative stress induction, inflammatory responses, mitochondrial dysfunction, and DNA damage. Importantly, the findings indicate that combined exposure to adverse lifestyle factors and androgen antagonists may produce synergistic effects, thereby increasing susceptibility to reproductive disorders and infertility.

This review also highlights the growing public health significance of reproductive dysfunction globally. Increasing exposure to environmental toxicants

alongside the widespread adoption of unhealthy lifestyle behaviours presents a substantial challenge to reproductive wellbeing and fertility preservation. Consequently, preventive public health strategies aimed at promoting healthy lifestyles, reducing environmental toxicant exposure, and improving reproductive health education are essential.

Despite the valuable insights provided by the reviewed studies, important knowledge gaps remain. Variability in study design, exposure assessment methods, and outcome measurement limits the ability to establish definitive causal relationships. Therefore, further longitudinal, mechanistic, and population-based studies are required to improve understanding of the combined effects of lifestyle and endocrine-disrupting exposures on reproductive health.

In conclusion, the findings of this systematic review demonstrate that both modifiable lifestyle behaviours and exposure to androgen antagonists play critical roles in reproductive health impairment. Addressing these risk factors through multidisciplinary clinical, environmental, and public health interventions may contribute significantly to the prevention of infertility and the promotion of reproductive wellbeing across populations.

6. Recommendations

Based on the findings of this systematic literature review, several recommendations are proposed to address the adverse effects of human lifestyle factors and androgen antagonists on reproductive health. These recommendations are directed towards healthcare professionals, policymakers, researchers, public health practitioners, and the general population.

6.1 Clinical Recommendations

Healthcare professionals should prioritise reproductive health counselling as part of routine clinical practice, particularly for individuals of reproductive age. Patients should be educated on the potential reproductive consequences of unhealthy lifestyle behaviours such as smoking, excessive alcohol consumption, poor dietary habits, physical inactivity, chronic stress, and inadequate sleep.

Clinicians should also encourage lifestyle modification programmes aimed at achieving and maintaining healthy body weight, improving nutritional status, increasing physical activity, and reducing harmful behavioural practices. Early identification and management of lifestyle-related risk factors may contribute significantly to the prevention of infertility and other reproductive disorders.

Furthermore, healthcare providers should carefully monitor individuals receiving long-term treatment with pharmaceutical androgen antagonists. Appropriate reproductive risk assessments and fertility counselling should be considered before initiating anti-androgen therapy, particularly among patients who may wish to

preserve future fertility.

6.2 Public Health Recommendations

Public health authorities should strengthen awareness campaigns focusing on the importance of healthy lifestyle practices for reproductive wellbeing. Educational programmes should emphasise the role of nutrition, exercise, smoking cessation, alcohol moderation, stress management, and adequate sleep in maintaining optimal reproductive function.

Community-based interventions should be developed to promote healthier lifestyles among adolescents and young adults, as many reproductive risk factors originate early in life. Public health initiatives should also integrate reproductive health education into school curricula and workplace wellness programmes.

In addition, increased public awareness is required regarding the potential reproductive risks associated with environmental endocrine-disrupting chemicals. Consumers should be educated on practical measures to minimise exposure to potentially harmful substances commonly found in plastics, personal care products, pesticides, and industrial pollutants.

6.3 Environmental and Policy Recommendations

Government agencies and regulatory bodies should strengthen policies aimed at reducing human exposure to endocrine-disrupting chemicals with anti-androgenic properties. Regulatory frameworks should support the routine evaluation and monitoring of industrial chemicals, pesticides, food packaging materials, and consumer products for reproductive toxicity.

Stricter environmental standards should be implemented to limit the release of endocrine-disrupting pollutants into air, water, and soil ecosystems. Manufacturers should be encouraged to develop safer alternatives to substances known to possess endocrine-disrupting properties.

Collaboration between environmental agencies, public health organisations, and research institutions is necessary to establish effective surveillance systems for monitoring population exposure to reproductive toxicants and assessing their long-term health impacts.

6.4 Research Recommendations

Future research should focus on conducting large-scale prospective cohort studies to better establish causal relationships between lifestyle factors, androgen antagonist exposure, and reproductive health outcomes. Longitudinal investigations would provide valuable insight into the cumulative and long-term effects of these exposures across the reproductive lifespan.

There is also a need for further mechanistic studies examining the biological pathways through which lifestyle factors and androgen antagonists impair reproductive function. Research exploring oxidative

stress, endocrine signalling disruption, epigenetic modifications, and genetic susceptibility may improve understanding of reproductive toxicity mechanisms.

Standardised methods for measuring exposure to endocrine-disrupting chemicals should be developed to improve comparability across studies. Future investigations should also assess the combined effects of multiple lifestyle and environmental risk factors, as real-world exposures often occur simultaneously rather than independently.

Additionally, greater research attention should be directed towards vulnerable populations, including adolescents, pregnant women, occupationally exposed workers, and individuals living in highly polluted environments.

6.5 Educational Recommendations

Academic institutions and professional training programmes should incorporate reproductive toxicology, endocrine disruption, and lifestyle-related reproductive health education into healthcare and environmental science curricula. Increased interdisciplinary collaboration between reproductive health specialists, toxicologists, environmental scientists, and public health practitioners may facilitate more comprehensive approaches to reproductive health promotion.

6.6 Overall Recommendation

The prevention of reproductive dysfunction requires a multidisciplinary approach involving individual behavioural modification, improved clinical practice, enhanced public health education, stronger environmental regulation, and continued scientific investigation. Addressing both modifiable lifestyle factors and environmental androgen antagonist exposure may substantially reduce the global burden of infertility and improve reproductive health outcomes across populations.

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