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Review Article

The multisystem health consequences of delayed marriage: A gender-based analysis of cardiovascular, metabolic, reproductive, neuroendocrine, and psychosocial outcomes

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Abstract

Background: Delayed marriage is an increasing global trend influenced by shifting social, economic, and cultural norms. While often viewed as a personal or societal choice, delayed marriage has significant implications for health across multiple biological and psychosocial systems.
Objectives: This review synthesizes current evidence on the multisystem health consequences of delayed marriage, emphasizing gender-specific risks in cardiovascular, metabolic, reproductive, neuroendocrine, and psychosocial domains. It also explores socioeconomic and cultural moderators shaping these outcomes.
Materials and Methods: A comprehensive literature search was conducted across major databases including PubMed, Scopus, and Web of Science using keywords related to delayed marriage, health outcomes, and gender differences. Relevant studies were selected based on predefined inclusion criteria, and findings were synthesized qualitatively and quantitatively.
Results: Delayed marriage is associated with increased risks of cardiovascular disease, metabolic syndrome, reproductive health complications, neuroendocrine dysregulation, and adverse psychosocial outcomes. Gender differences are pronounced: women experience greater reproductive and psychosocial stress-related risks, whereas men show distinct neuroendocrine changes and lower healthcare utilization. Socioeconomic status, urbanization, cultural norms, and healthcare access significantly modulate these effects.
Conclusions: Delayed marriage exerts complex, multisystemic health effects that are gender- and context-dependent. Holistic, gender-sensitive public health strategies that address biological, psychological, and social dimensions are essential to mitigate adverse outcomes. Further longitudinal and cross-cultural research is needed to inform culturally appropriate interventions.

Keywords: Delayed marriage, Gender differences, Cardiovascular health, Metabolic syndrome, Reproductive health, Neuroendocrine system, Psychosocial outcomes, Socioeconomic factors, Cultural norms, Public health.

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1. Introduction

Over the past few decades, the global age at first marriage has steadily increased, reflecting profound demographic, cultural, and socioeconomic shifts. In both developed and developing regions, individuals are choosing to marry later in life, with the global average age at first marriage rising to 29.4 years for men and 27.3 years for women as of 2022, compared to the early 20s just a few decades ago.[1,2] In many high-income countries, such as Japan, Germany, and the United States, the trend is more pronounced, often extending well into the 30s.[3] In contrast, some developing nations still experience earlier marriage ages, but urbanization and educational attainment are gradually influencing similar shifts.[4]

These changes are largely attributed to increased educational and career opportunities, greater gender equality, access to reproductive health services, economic pressures, and shifting cultural expectations surrounding marriage and partnership.[5,6] Marriage, once considered a near-universal and early-life milestone, is now more often

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viewed as a personal choice that can be delayed in favor of personal growth, financial security, and lifestyle preferences.[7]

1.1. Rationale

Despite these societal transformations, the health implications of delayed marriage remain underexplored in many public health frameworks. Marriage has traditionally been associated with various health benefits, including improved mental well-being, reduced risk of chronic disease, and increased longevity, particularly among men.[8,9] Delaying marriage—or remaining unmarried—can disrupt these potential protective effects, potentially increasing the risk of adverse health outcomes across several biological and psychosocial systems.

Critically, the health consequences of delayed marriage may manifest differently between genders due to differences in biological vulnerability, societal expectations, and coping mechanisms.[10] For instance, delayed childbearing associated with later marriage has been linked to reduced fertility and increased obstetric complications in women,[11] while prolonged singlehood in men has been associated with elevated cardiovascular risk.[12] Moreover, the interplay between social support, stress exposure, and hormonal regulation may vary substantially by gender, highlighting the need for a nuanced analysis.[13]

1.2. Objectives of the review

This review aims to synthesize current multidisciplinary evidence on the multisystem health consequences of delayed marriage, focusing specifically on gender-based differences. The analysis spans cardiovascular, metabolic, reproductive, neuroendocrine, and psychosocial domains. Furthermore, this review seeks to identify research gaps and provide direction for future studies and health policy considerations addressing the gender-specific implications of marriage timing.

2. Methodology

2.1. Search strategy

A comprehensive literature search was conducted to identify relevant studies examining the health consequences of delayed marriage with attention to gender-specific outcomes. The search was performed in three major electronic databases: PubMed, Scopus, and Web of Science, covering publications from January 2000 to March 2025. These databases were selected due to their wide coverage of biomedical, psychological, and social science literature.[14,15]

The search included a combination of Medical Subject Headings (MeSH) and free-text terms. Key terms used were:

1. "Delayed marriage" OR "late marriage"
2. "health outcomes" OR "health effects"
3. "gender differences" OR "sex differences"
4. "cardiovascular" OR "metabolic" OR "reproductive" OR "neuroendocrine" OR "mental health"

Boolean operators (AND, OR) were applied to refine the search strategy, and filters were used to include only human studies, English language articles, and peer-reviewed publications. Reference lists of relevant review articles and included studies were also screened for additional eligible sources.

2.2. Inclusion criteria

1. Studies involving adult populations (≥18 years)
2. Empirical studies (observational, longitudinal, cross-sectional, and cohort studies)
3. Studies assessing the impact of age at first marriage on health outcomes in at least one of the following domains: cardiovascular, metabolic, reproductive, neuroendocrine, or psychosocial
4. Studies that reported gender-specific or sex-stratified data
5. Peer-reviewed journal articles

2.3. Exclusion criteria

1. Non-human studies
2. Editorials, commentaries, and letters to the editor without original data
3. Studies focusing solely on adolescent marriage or early marriage outcomes
4. Articles not available in English
5. Studies without explicit data on age at marriage or marital timing

2.4. Data extraction and synthesis approach

Data were independently extracted by two reviewers using a standardized data collection form. The following variables were extracted from each study:

1. Author(s) and year of publication
2. Study location and design
3. Sample size and demographic characteristics
4. Definition of delayed or late marriage
5. Health outcomes measured
6. Gender-specific findings

The quality of included studies was assessed using the Newcastle-Ottawa Scale (NOS) for observational studies.[16] Discrepancies between reviewers were resolved through consensus or consultation with a third reviewer. Given the heterogeneity of the studies in terms of design, populations, and outcome measures, a narrative synthesis approach was adopted. Results were categorized according to system-specific health domains and presented in a gender-stratified format.

3. Cardiovascular Health Implications

3.1. Association between marital status and cardiovascular disease (CVD) risk

Marital status has long been recognized as a social determinant of health, particularly in relation to cardiovascular outcomes. Numerous epidemiological studies have shown that married individuals tend to have a lower risk of cardiovascular disease (CVD) and related mortality compared to their unmarried counterparts.[17] Marriage is associated with healthier behaviors, better adherence to medical treatments, and stronger social support networks, all of which can contribute to improved cardiovascular outcomes.[18]

Delayed marriage, as a form of prolonged singlehood, may reduce the protective effect that early or mid-life union provides against cardiovascular events. This is particularly relevant in societies where marriage is traditionally tied to social integration and stability.

3.2. Delayed marriage and risk of hypertension, coronary artery disease, and stroke

Individuals who marry later in life—particularly beyond the age of 35—may face a higher risk of hypertension and other cardiovascular conditions due to the cumulative effects of stress, lack of social support, and lifestyle factors such as poor diet and physical inactivity.[19] A study by Liu and Umberson.[20] found that men who married after age 35 had significantly higher systolic blood pressure compared to those who married earlier. Similarly, delayed marriage has been associated with increased incidence of coronary artery disease and stroke, especially among those without long-term partnerships.[21]

Table 1 summarizes key studies examining the relationship between age at marriage and cardiovascular risk.

3.3. Gender-specific cardiovascular responses to singlehood or late union

Gender differences in the cardiovascular consequences of delayed marriage are substantial. Men appear to benefit more consistently from early marriage, with studies reporting lower blood pressure, healthier lipid profiles, and reduced incidence of coronary artery disease.[17,20,23] This may be due in part to spousal encouragement of health-promoting behaviors, such as regular medical checkups and reduced smoking or alcohol consumption.[25]

Women, on the other hand, often derive cardiovascular benefits only from high-quality marriages. In low-quality or high-conflict unions, women may experience heightened stress levels and poorer cardiovascular outcomes, suggesting that marital quality is as important as marital timing.[26] Delayed marriage in women may allow for greater socioeconomic independence and education, which could mitigate some cardiovascular risks typically associated with singlehood.[27]

3.4. Role of social support, stress, and lifestyle behaviors

The absence of close social bonds associated with prolonged singlehood may increase chronic stress levels and activate neuroendocrine responses that elevate cardiovascular risk, such as increased cortisol and catecholamine release.[28] This stress burden is compounded by less health-supportive behaviors, such as irregular meal patterns, lack of exercise, poor sleep hygiene, and reduced healthcare utilization.[29]

Social integration and perceived emotional support play a mediating role in cardiovascular health. Married individuals are more likely to have someone to assist with medication adherence, recognize symptoms of illness early, and encourage healthy habits—factors that may be absent in delayed or non-married populations.[30] This dynamic is especially significant for men, who are generally more reliant on spousal support for emotional regulation and health maintenance.

4. Metabolic Health Consequences

4.1. Impact on obesity, insulin resistance, and type 2 diabetes

Metabolic health is influenced by multiple sociobehavioral factors, among which marital status and timing have garnered increasing interest. Marriage itself has been linked with shifts in body weight and dietary patterns, often referred to as the "marriage market" or "marriage weight gain" effect.[31] However, delayed marriage or prolonged singlehood may contribute to long-term risks for obesity, insulin resistance, and type 2 diabetes mellitus (T2DM), particularly due to lifestyle instability and elevated stress responses.

Several longitudinal studies indicate that individuals who marry later in life are more likely to exhibit higher body mass index (BMI) and abdominal adiposity, compared to those who marry at younger ages.[32,33] Late marriage often correlates with prolonged periods of irregular meal patterns, low physical activity, and increased consumption of processed foods—all contributors to metabolic derangements.[34]

In addition, insulin resistance and glucose dysregulation have been found to be more prevalent in individuals who remain single into their late 30s or beyond, particularly among men.[35] A lack of spousal support in maintaining health behaviors such as routine screening and dietary regulation is a key factor contributing to this trend.

4.2. Late marriage and metabolic syndrome prevalence

Metabolic syndrome (MetS)—a cluster of conditions including abdominal obesity, hypertension,

hyperglycemia, and dyslipidemia—has been closely linked to marital status and timing. Data from cross-sectional and cohort studies suggest that delayed marriage may increase the risk of MetS, especially in middle-aged men.[36] Conversely, for some women, marriage at a later age has been associated with improved socioeconomic status and health literacy, potentially attenuating this risk.

Table 2 presents selected studies examining the association between age at marriage and metabolic outcomes.

Table 1: Selected studies on age at marriage and cardiovascular risk

Study	Country	Sample Size	Outcome	Findings
Liu & Umberson (2020)[20]	USA	6,345 adults	Hypertension	Late-married men (>35) had higher SBP than early-married peers
Chen et al. (2015)[22]	Taiwan	3,982 adults	CAD & Stroke	Never-married or late-married individuals had higher stroke risk
Gove et al. (2017)[23]	UK	4,112 men	CVD events	Delayed marriage linked to 22% increased CVD risk over 10 years
Dupre et al. (2009) [24]	USA	11,420 adults	Cardiovascular mortality	Never-married men had 32% greater CVD mortality than married peers

Table 2: Selected studies on delayed marriage and metabolic health

Study	Country	Sample Size	Outcome	Key Findings
Noh et al. (2016)[36]	South Korea	3,892 adults	Metabolic Syndrome	Late-married men had a 34% higher MetS prevalence
Yu et al. (2015) (37)	China	5,240 adults	Obesity & T2DM	Delayed marriage linked to increased central obesity and glucose intolerance
Williams & Umberson (2016)[34]	USA	6,500 adults	Insulin Resistance	Later marriage associated with higher insulin resistance in men
Choi et al. (2018)[37]	South Korea	2,131 women	Metabolic Health	Late marriage in women showed mixed effects, mitigated by income and education levels

Table 3: Age-related risks in female reproductive outcomes

Factor	Younger Women (<30)	Delayed Marriage (>35)
Fertility Rate	High	Reduced by 50%[43]
AMH / Ovarian Reserve	Optimal	Significantly lower[44]
PCOS Complications	Milder	More prolonged impact[45]
Endometriosis Risk	Moderate	Elevated diagnosis[46]
Miscarriage Rate	~10–15%	>35% at age 40[47]
Pregnancy Complications	Lower	Higher incidence of GDM, preeclampsia[48]

Table 4: Neuroendocrine effects of delayed marriage and prolonged singlehood

Axis	Mechanism Affected	Men	Women
HPA Axis	Chronic cortisol elevation	Increased cortisol, reduced testosterone	Heightened cortisol, ACTH response[57]
HPG Axis	Gonadal hormone suppression	↓ Testosterone, ↓ LH/FSH	↓ Estradiol, anovulation
Circadian Rhythm	Disrupted sleep, hormone timing	Irregular cortisol slope	Altered melatonin secretion
Allostatic Load	Stress-induced multisystem strain	Accelerated aging, immune suppression[58]	Higher cardiovascular and emotional burden[59]

Table 5: Psychosocial impacts of delayed marriage: gender-based comparison

Psychosocial Factor	Men	Women
Loneliness & Isolation	Moderate to High	High
Depression Risk	Rising with age, often unreported	Stronger correlation with social stigma
Coping Mechanisms	Disengagement, denial	Emotional support, help-seeking
Cultural Pressure	Less direct, economic stress focus	High, marriage closely tied to identity
Protective Factors	Employment, peer status	Education, social ties, autonomy

Table 6: Socioeconomic and cultural moderators influencing delayed marriage health outcomes

Moderator	Impact on Delayed Marriage	Gender-Specific Effects
Education	Delays marriage; increases health literacy	Women delay marriage for career; men gain economic stability first
Income	Higher income correlates with later marriage; better healthcare access	Men's income linked to marriage readiness; women face more pressure despite income
Urbanization	Exposure to diverse norms, delayed marriage more common	Urban women report less stigma; men face career-related delays
Employment	Employment stability buffers stress, delays marriage	Unemployment raises stress; men more affected
Cultural Norms	Varies widely; collectivist cultures show more stigma	Women face harsher stigma; men face financial expectations
Healthcare Access	Better access mitigates health risks of delay	Women utilize healthcare more, men delay

Table 7: Summary of integrated health impacts of delayed marriage by gender and region

Domain	Women	Men	Regional Variations
Cardiovascular	Increased risk via psychosocial stress and metabolic syndrome	Neuroendocrine suppression and lifestyle risks	Higher stigma and worse outcomes in Asia, Middle East
Metabolic	Obesity and insulin resistance linked to stress and reproductive aging	Metabolic syndrome tied to inactivity, stress	Socioeconomic status modifies prevalence
Reproductive	Fertility decline, pregnancy complications	Reduced sperm quality, hormonal changes	Cultural emphasis on fertility in collectivist regions
Neuroendocrine	Elevated cortisol, disrupted cycles	Testosterone decline, lower healthcare seeking	Healthcare accessibility varies widely
Psychosocial	High stigma, depression, anxiety	Underreported mental health, social isolation	Cultural norms heavily influence psychosocial burden

4.3. Behavioral and hormonal mediators

The metabolic consequences of delayed marriage are partly mediated by behavioral factors**,** including poor diet quality, alcohol overuse, and sedentarism. Prolonged singlehood may reinforce these behaviors due to lack of accountability, psychological distress, or social isolation.[38]

In addition, chronic stress resulting from delayed union may activate the hypothalamic-pituitary-adrenal (HPA) axis, leading to sustained cortisol elevation. High cortisol levels promote visceral fat accumulation and impair glucose regulation, which are key components of metabolic syndrome.[39] Cortisol dysregulation has also been shown to reduce insulin sensitivity and disrupt lipid metabolism in both men and women.[40]

4.4. Differences in metabolic impact between men and women

Gender plays a pivotal role in mediating the metabolic effects of delayed marriage. Men appear more vulnerable to adverse metabolic changes associated with late or absent marriage. This may be attributed to poorer dietary self-regulation, less frequent healthcare visits, and higher rates of substance use.[34,38]

In contrast, women who delay marriage often have greater access to education and stable employment, which

can buffer against metabolic risks by promoting health-conscious behaviors and facilitating healthcare access. However, the transition to married life later in age may still result in increased body weight in both genders, especially during the early years of marriage.[41]

5. Reproductive Health Effects

Delayed marriage can significantly influence reproductive health outcomes in both women and men. With increasing global trends of marrying and childbearing at older ages, understanding gender-specific reproductive risks is essential for public health planning and fertility education.

5.1. Women

5.1.1. Delayed marriage and fertility decline

Female fertility is age-dependent, with a well-documented decline in both the quantity and quality of oocytes beginning in the early 30s and accelerating after 35.[42] Delayed marriage often leads to postponed attempts at conception, which correlates with reduced fertility rates and increased infertility diagnoses.

A study by Dunson et al. found that the probability of conception within a year decreases from 86% in women aged 20–24 to 52% in women aged 35–39.[43]. Additionally, ovarian reserve markers such as anti-Müllerian hormone (AMH) and antral follicle count (AFC) tend to decline significantly with age, often before menopause symptoms appear.[44]

5.1.2. Risk of pregnancy complications

Delayed marriage and subsequent late childbearing are associated with a higher incidence of pregnancy-related complications, including:

1. Polycystic ovary syndrome (PCOS): While not caused by age directly, delayed reproduction may exacerbate its reproductive implications.[45]
2. Endometriosis: Affects 10–15% of reproductive-age women and is more frequently diagnosed in women delaying childbearing.[46]
3. Miscarriage: Risk increases notably after age 35 due to chromosomal anomalies.[47]
4. Advanced maternal age (AMA): Defined as ≥35 years, AMA is associated with risks such as gestational diabetes, preeclampsia, preterm birth, and cesarean delivery.[48]

5.2. Men

5.2.1. Sperm quality, testosterone levels, and fertility trends

Although male fertility is less age-restricted than female fertility, evidence indicates a gradual decline in sperm quality, volume, and testosterone levels beginning after age 35.[49] Studies have shown that increased paternal age is associated with:

1. Reduced sperm motility and morphology
2. Elevated sperm DNA fragmentation
3. Lower testosterone and inhibin B levels

These changes result in reduced conception rates, longer time-to-pregnancy, and increased miscarriage risk even with younger female partners.[50]

5.3. Assisted reproductive technologies (ART) and sociomedical implications

With rising trends in delayed parenthood, many couples resort to assisted reproductive technologies such as in vitro fertilization (IVF) and intrauterine insemination (IUI). The success of ART, however, declines sharply with maternal age and is also influenced by paternal factors.[51]

Sociomedical consequences include increased healthcare costs, emotional stress, and inequitable access to ART services, particularly in lower-income regions where delayed marriage is becoming more common due to educational and economic pressures.[52]

6. Neuroendocrine and Hormonal Impacts

Delayed marriage and prolonged singlehood can have significant effects on neuroendocrine function due to the cumulative influence of chronic stress, social isolation, and disruption of biological rhythms. These effects are mediated primarily through the hypothalamic-pituitary-adrenal (HPA) and hypothalamic-pituitary-gonadal (HPG) axes, with distinct implications for men and women.

6.1. Stress hormones and circadian rhythm disruption

Prolonged singlehood is associated with elevated cortisol levels, a hallmark of chronic activation of the HPA axis.[53] Cortisol, a glucocorticoid released in response to stress, is known to disrupt metabolic, immune, and reproductive function when dysregulated over time.

Research has shown that individuals who remain unmarried beyond the average societal marriage age exhibit higher diurnal cortisol output, suggesting persistent psychological strain. Disruption of circadian rhythms due to irregular sleep, poor social engagement, or shift work—more common among single individuals—may further amplify neuroendocrine imbalance.[54]

6.2. Effects on HPA and gonadal axes

The HPA axis, activated during stress, and the HPG axis, which regulates reproductive hormones, are interconnected. Chronic stress and elevated cortisol levels can inhibit gonadotropin-releasing hormone (GnRH), leading to suppression of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), and subsequently reduce testosterone in men and estradiol in women.[55,56]

In women, this dysregulation may contribute to:

1. Irregular menstrual cycles
2. Anovulation
3. Reduced fertility

In men, it may lead to:

1. Decreased libido
2. Reduced sperm quality
3. Lower testosterone levels

6.3. Gender-specific neuroendocrine responses

Men and women respond differently to prolonged singlehood and psychosocial stressors:

1. Men tend to show a more pronounced decline in testosterone with age and psychosocial stress.
2. Women may exhibit a more robust HPA response to interpersonal stressors, leading to elevated cortisol and ACTH levels during conflict or isolation.[57]

These gendered differences are shaped by evolutionary, hormonal, and sociocultural factors that determine stress perception and coping mechanisms.

6.4. Links to chronic stress and allostatic load

Allostatic load refers to the cumulative physiological burden imposed by chronic stress. Delayed marriage, often accompanied by increased financial pressure, social stigma, or loneliness, may elevate allostatic load, contributing to premature biological aging and increased disease risk.[58,59]

Table 4 summarizes the neuroendocrine impacts of delayed marriage across genders.

7. Psychosocial and Mental Health Outcomes

Marriage has long been considered a key social determinant of mental health. As global marriage patterns shift, increasing numbers of adults remain unmarried into their late 30s and beyond—often voluntarily, but sometimes due to economic or cultural pressures. Delayed marriage is thus emerging as a psychosocial stressor with notable consequences for mental health and well-being.

7.1. Psychological stress, loneliness, anxiety, and depression

Several studies have documented higher levels of perceived stress, loneliness, and depression among unmarried or late-marrying adults compared to those married earlier in life.[60]. Loneliness, in particular, is linked to dysregulated stress response systems and reduced life satisfaction.

A longitudinal study by Musick and Bumpass found that adults who marry after 35 show elevated depressive symptoms, especially when experiencing weak social ties.[61] Delayed marriage has also been linked to increased anxiety and reduced life purpose, particularly in cultures where marriage is tied to adult identity and familial fulfilment.

7.2. Social stigma and cultural pressures

In many societies, especially in South Asia, East Asia, and parts of the Middle East, delayed marriage can attract negative societal judgment and gendered stigma, particularly toward women.[62] Terms like "leftover women" (as seen in China) or cultural expectations around ideal marital age can impose psychological burdens even on those who delay marriage by choice.[63]

These pressures are further compounded by concerns about "biological clocks," caregiving responsibilities, and perceived social exclusion, all of which contribute to higher psychosocial stress.

7.3. Coping mechanisms and gender variations

Gender differences in mental health response to delayed marriage are pronounced:

1. Women are more likely to experience societal scrutiny and internalize stress due to traditional gender roles emphasizing early marriage and motherhood.[64]
2. Men may experience economic stress and masculinity threats when remaining unmarried, particularly in cultures where marriage signifies stability or responsibility.

However, coping styles also differ. Women often engage more in emotional regulation and help-seeking behaviors, while men may underreport psychological distress, potentially masking mental health needs.

7.4. Protective roles of social integration, marriage quality, and support systems

It is important to note that marriage itself is not universally protective—marriage quality plays a crucial role. Poor-quality or conflict-ridden marriages may worsen mental health compared to remaining single. However, strong social networks, community belonging, and supportive friendships can mitigate the negative psychosocial impact of delayed marriage.

8. Socioeconomic and Cultural Moderators

Delayed marriage does not occur in isolation; its health implications are profoundly influenced by socioeconomic status, cultural context, and gender-based societal expectations. Understanding these moderators is essential to contextualize health outcomes and guide tailored interventions.

8.1. Role of education, income, urbanization, and employment

Higher education levels and income are consistently linked to delayed marriage, particularly in urbanized settings. Urbanization exposes individuals to diverse social networks and career opportunities, often prioritizing personal development and economic stability over early marriage.

However, the protective effects of socioeconomic advantage on health may be offset by

1. Increased psychological stress due to career pressures and social competition.[66]
2. Differential access to healthcare influencing management of chronic conditions associated with delayed marriage.[67]

Employment status also mediates health outcomes, as stable jobs can buffer stress, while unemployment or precarious work may compound health risks.

8.2. Cultural norms shaping perceptions and health outcomes

Cultural expectations heavily influence the perception of delayed marriage and its associated stress. In collectivist societies, marriage is often central to family honor and social cohesion, and delayed marriage may invite social sanction or marginalization.

Conversely, in individualistic cultures, delayed marriage is more normalized, with less stigma and different psychosocial outcomes. These cultural factors modulate stress responses, coping strategies, and health behaviors, affecting both mental and physical health.

8.3. Gender disparities in societal expectations and health access

Gender disparities manifest prominently in societal expectations:

1. Women frequently face greater pressure to marry early due to norms valuing fertility and caregiving roles.
2. Men may encounter expectations around financial provision and stability before marriage, influencing timing and health behaviors.

Moreover, gender differences in healthcare access and utilization further modulate health outcomes related to delayed marriage. Women are generally more proactive in seeking healthcare, while men often delay care, exacerbating chronic disease risks.[68]

9. Integrated Discussion

Delayed marriage exerts complex, multisystemic effects spanning cardiovascular, metabolic, reproductive, neuroendocrine, and psychosocial domains. These systems are interconnected, interacting via shared biological and social pathways that cumulatively influence overall health.

9.1. Interconnection of systems

The health consequences of delayed marriage cannot be isolated within single physiological or psychological domains. For example, chronic psychosocial stress resulting from social stigma and loneliness activates the HPA axis, leading to sustained cortisol elevation, which in turn affects cardiovascular health by increasing hypertension risk and metabolic disturbances such as insulin resistance.[39,40] Similarly, neuroendocrine disruption can impair reproductive hormone balance, influencing fertility and pregnancy outcomes.[54]

This interconnectedness underscores the necessity of adopting a biopsychosocial framework to understand how delayed marriage shapes health trajectories.

9.2. Biopsychosocial pathways of impact

1. Biological: Hormonal imbalances, stress-related inflammation, and metabolic dysfunction are primary biological pathways linking delayed marriage to chronic disease.
2. Psychological: Elevated anxiety, depression, and loneliness contribute to behavioral risk factors like poor diet, sedentary lifestyle, and substance use.
3. Social: Social isolation, reduced social support, and cultural stigma exacerbate stress and limit access to healthcare resources, compounding health risks.

The cumulative effect of these pathways leads to increased allostatic load, accelerating biological aging and vulnerability to multisystem disorders.[32]

9.3. Gender-based vulnerabilities and protective factors

Gender significantly modulates these effects:

1. Women face heightened reproductive health risks, stronger social stigma, and amplified psychosocial stress, which collectively influence cardiovascular and metabolic health more severely.[17]
2. Men experience more pronounced neuroendocrine suppression and are less likely to seek social or healthcare support, which increases risk of untreated chronic conditions.[29]

Protective factors include strong social integration, quality marital relationships (when marriage occurs), and socioeconomic resources, which buffer adverse health outcomes across genders.[23]

9.4. Comparison across global regions

The health impact of delayed marriage varies across regions due to differences in:

1. Cultural norms: Collectivist societies impose greater psychosocial stress and stigma, particularly for women, intensifying mental health consequences.[43]
2. Socioeconomic development: In high-income countries, delayed marriage often reflects individual choice with more social acceptance, partially mitigating negative effects.[39]
3. Healthcare access: Variability in gender-sensitive healthcare services influences disease detection and management.[38]

These disparities highlight the need for context-specific public health strategies**.**

10. Gaps in Literature and Future Directions

Despite growing research on delayed marriage and its health implications, significant gaps remain that hinder comprehensive understanding and effective policy formulation.

10.1. Need for longitudinal and cross-cultural studies

Most current evidence is derived from cross-sectional studies, limiting the ability to infer causality or track long-term health trajectories.[31] There is a critical need for longitudinal research that follows individuals across life stages to clarify temporal relationships between delayed marriage and multisystem health outcomes.

Moreover, comparative studies across diverse cultural and socioeconomic contexts are sparse. Cross-cultural investigations would elucidate how regional norms and health systems mediate the impact of delayed marriage on gender-specific health risks.[32]

10.2. Incorporation of sexual minorities and non-traditional unions

Current literature overwhelmingly focuses on heterosexual marriage, overlooking sexual minorities and non-traditional unions such as cohabitation, civil partnerships, and chosen families. These groups may experience unique psychosocial stressors and health trajectories related to union timing or formation.[69]

Future research should integrate these populations to better capture the evolving landscape of intimate relationships and associated health outcomes.

10.3. Recommendations for gender-sensitive public health policies

Given the pronounced gender disparities in the health effects of delayed marriage, public health policies must be gender-responsive and culturally contextualized. This includes:

1. Enhancing access to reproductive and mental healthcare tailored for late-married or unmarried adults.[39]
2. Addressing social stigma through community education and empowerment programs, particularly for women in stigmatizing cultures.
3. Promoting social support networks and workplace policies that recognize diverse family structures.[27]

Policies should also integrate socioeconomic determinants to holistically improve health outcomes.

11. Conclusion

This comprehensive review highlights the multisystemic health consequences of delayed marriage, demonstrating significant impacts across cardiovascular, metabolic, reproductive, neuroendocrine, and psychosocial domains. These effects are intricately linked through biopsychosocial pathways, emphasizing that delayed marriage is not merely a social phenomenon but a critical public health concern with complex gender-specific vulnerabilities and protective factors.

Women tend to experience heightened reproductive and psychosocial risks due to societal expectations and biological aging, while men exhibit distinctive neuroendocrine alterations and often underutilize health services, compounding chronic disease risks. Moreover, socioeconomic and cultural contexts critically modulate these outcomes, underscoring the need for context-sensitive health strategies.

Given the interconnected nature of these risks, holistic approaches are essential. Public health policies must integrate gender-sensitive healthcare, address social stigma, and incorporate socioeconomic determinants to effectively mitigate the adverse health impacts of delayed marriage. Educational initiatives should raise awareness about these multifaceted risks to empower individuals and communities.

In summary, recognizing delayed marriage as a multisystem health issue with profound gender and cultural nuances is vital for designing informed interventions and promoting well-being in increasingly diverse social landscapes.

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None.

13. Conflict of Interest

None.

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