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Menstrual Health in the Digital Age: Association of Digital Media Use with Sleep-Wake Patterns and Psychological Well-Being Among Adolescent Girls—A Unani Perspective

Dr. Zeba AltafHusain Lalkot[1], Dr. Shahzadi Sultana[2], Dr. Amreen Begum[3]

[1]PG Scholar, Department of Ilmul Qabalat wa Amraz E Niswan,
[2]Principal and HOD, Department of Ilmul Qabalat wa Amraz E Niswan,
[3]Assistant Professor, Department of Ilmul Qabalat wa Amraz E Niswan,
[1,2,3]Government Nizamia Tibbi College, Hyderabad, Telangana, India

ABSTRACT

Background: The proliferation of digital media has fundamentally transformed adolescent lifestyle, profoundly affecting sleep-wake regulation and psychological well-being.Within the classical Unani framework, these two domains—Naum wa Yaqza (sleep and wakefulness) and Ahwal-e-Nafsaniyah (psychological states)—are recognised as two of the six indispensable regulators of health, collectively termed Asbab-e-Sittah Zaruriyyah. Emerging evidence indicates that excessive screen exposure, particularly nocturnal blue-light-mediated melatonin suppression and chronic social-media-induced psychoemotional arousal, disturbs both of these fundamental axes, with downstream consequences for hypothalamic-pituitary-ovarian (HPO) axis integrity and menstrual regularity in adolescent girls.

Objectives: This narrative review integrates contemporary biomedical evidence with classical Unani medical concepts to elucidate the mechanistic pathways by which digital media disrupts sleep-wake homeostasis and psychological equilibrium, and to delineate the consequent impact on menstrual health in adolescents.

Methods: A thematic narrative synthesis was conducted using peer-reviewed literature on digital media and sleep, psychological well-being, and menstrual health, supplemented by classical Unani texts addressing Naum wa Yaqza, Ahwal-e-Nafsaniyah, and Asbab-e-Sittah Zaruriyyah.

Results: Three converging pathways were identified: (1) nocturnal screen exposure suppresses melatonin via the ipRGC-SCN axis and disrupts HPO pulsatility, (2) social-media-associated psychosocial stress activates the HPA axis and suppresses GnRH pulsatility, and (3) these mutually reinforcing perturbations converge on menstrual irregularity via shared neuroendocrine and molecular mechanisms.

Conclusion: Digital media use constitutes a contemporary disturbance to Asbab-e-Sittah Zaruriyyah that classical Unani scholars recognised as indispensable for health maintenance. Integrating the Unani explanatory model with modern neuroscience and reproductive endocrinology offers a holistic framework for adolescent menstrual health research, clinical practice, and public health policy.

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KEYWORDS: *Digital media; Screen time; Sleep-wake cycle; Naum wa Yaqza; Ahwal-e-Nafsaniyah; Asbab-e-Sittah Zaruriyyah; Menstrual health; Adolescents; Melatonin; HPO axis; Blue light; Unani medicine; Circadian rhythm.*

1. INTRODUCTION

The twenty-first century has witnessed an unprecedented acceleration in digital media penetration, with smartphones, tablets, laptops, and social-media platforms becoming central to the daily lives of adolescents worldwide.[3,4] Global data indicate that over 80% of the world's population now resides in areas experiencing significant artificial light at night (ALAN), with urban ALAN expanding at an estimated annual rate of 2.2%.[2] Concurrently, more than two-thirds of internet users in India belong to the 12–29-year age cohort, making adolescent girls a population of particular epidemiological concern.[5]

Menstrual health is governed primarily by the finely tuned pulsatile dynamics of the HPO axis, which operates in precise synchrony with the circadian system.[2] Disturbances in sleep-wake regulation and psychological homeostasis—two of the most commonly reported consequences of excessive digital media use—have been mechanistically linked to HPO axis dysregulation, gonadotropin suppression, and menstrual irregularity.[1,7]

The classical Unani medical system anticipated these interconnections with remarkable conceptual sophistication.[8,10] The doctrine of Asbab-e-Sittah Zaruriyyah identifies Naum wa Yaqza (sleep and wakefulness) as its fifth pillar and Harkat-o-Sukun Nafsani (psychic movement and repose, encompassing Ahwal-e-Nafsaniyah) as its fourth.[8,9,10] Classical scholars recognised that derangement in these factors precipitates a cascade of constitutional imbalance, manifesting as disease in downstream systems, including the reproductive apparatus.[9]

Despite the growing burden of menstrual disorders among adolescent girls and the mounting evidence linking digital lifestyles to their determinants, an integrated framework bridging contemporary biomedical science with classical Unani conceptualisation remains conspicuously absent from the literature.[7,8] This review addresses that gap by constructing a unified explanatory model in which digital media functions as a contemporary perturbant of Asbab-e-Sittah Zaruriyyah, disrupting Naum wa Yaqza and Ahwal-e-Nafsaniyah, and thereby compromising menstrual health through shared neuroendocrine, molecular, and humoral mechanisms.[2,8,9]

2. Digital Media Use Among Adolescents: Epidemiological Landscape

Globally, compliance rates with recommended screen-time guidelines remain alarmingly low—only 19% of children and adolescents meet the World Health Organization's physical activity recommendations, while a mere 34–39% adhere to Canada's guideline of less than two hours of recreational screen time per day.[12] In China, a nationally representative survey of 52,503 children and adolescents conducted from 2017 to 2019 documented annual decreases in physical activity compliance of approximately 3.43% in primary school students and 5.23% in middle school students, with reciprocal increases in recreational screen time particularly among urban and older school-level populations.[12]

In India, 92.8% of households reported mobile ownership as of the UDAYA (2018) survey, with internet penetration concentrated in the 12–29-year age group.[5] Smartphone screen time exceeding two hours daily was associated with significantly higher odds of sleep problems among both adolescents (AOR 1.55; 95% CI: 1.21–1.99) and young adults (AOR 1.48; 95% CI: 1.24–1.75) in this nationally representative dataset.[5] Adolescent females who used smartphones for more than three hours daily demonstrated 2.94 times the odds of sleep problems compared with non-using males (AOR: 2.94; 95% CI: 1.97–4.38).[5]

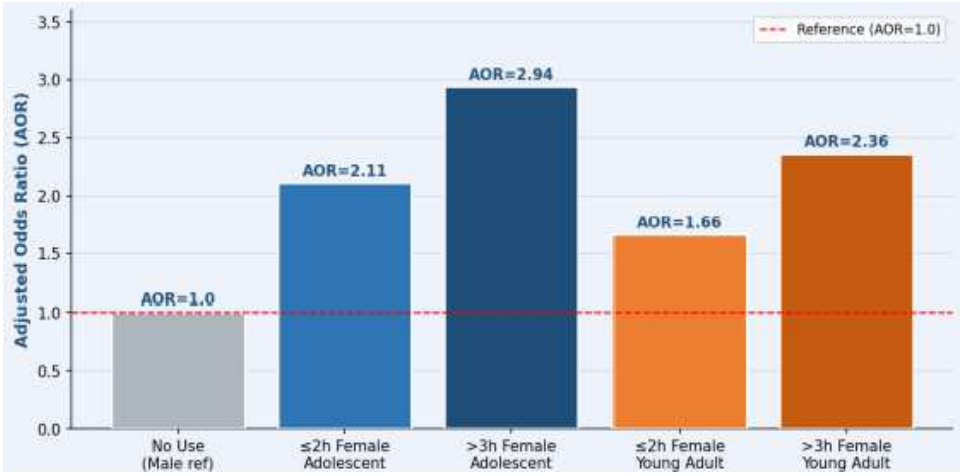

Figure 1: Adjusted Odds Ratios for Sleep Problems by Smartphone Use Duration Among Adolescents and Young Adults in India [5]

A particularly concerning pattern involves nocturnal smartphone use.[1] A Danish component of the SmartSleep Study reported that 41% of young adults occasionally used their smartphones during sleep hours, with night-time use objectively tracked across 1,068 women using high- resolution app-based monitoring.[1] The timing and continuity of screen exposure—not merely its aggregate daily duration—carries independent physiological significance for hormonal regulation and reproductive health.[1]

From the Unani perspective, excessive engagement with digital media constitutes a contemporary manifestation of Akhtayari Asbab (voluntary causes) of ill health—specifically, the use of stimulating activities and environments that prevent the body and mind from achieving the necessary restoration of Ratubat (moisture) and Barudat (coolness) that characterise physiological Naum.[8] Classical scholars identified exposure to excess light (Ziyada-e-Noor) and mental overstimulation among the voluntary causes predisposing to Sehar (insomnia).[9] The blue- light-emitting screen encountered on the scale now typical of adolescent life represents precisely the form of environmental perturbation that classical Unani physicians described as incompatible with the inward movement of Rooh-e-Nafsani that initiates Naum.[10]

3. Impact of Digital Media on Sleep-Wake Patterns: Biomedical and Unani Integration

3.1. Mechanisms of Screen-Induced Sleep Disruption

Three principal physiological mechanisms mediate the sleep-disrupting effects of night-time digital device use: (1) direct temporal displacement of sleep, (2) cognitive, emotional, and physiological arousal, and (3) blue-light-mediated circadian phase delay.[1] These mechanisms operate not in isolation but in synergy, producing a compounded disturbance of both sleep architecture and chronobiological regulation.[2,4]

3.1.1. Blue Light, the ipRGC-SCN Pathway, and Melatonin Suppression

Digital screens emit light predominantly in the 400–500 nm (blue) wavelength range.[2] This spectral signature is selectively captured by intrinsically photosensitive retinal ganglion cells (ipRGCs) in the retina, which transmit photic signals to the suprachiasmatic nucleus (SCN)—the master circadian pacemaker located in the hypothalamus.[2] The SCN interprets blue-range light as a daylight signal, regardless of clock time, thereby suppressing the nocturnal secretion of melatonin by the pineal gland through the ipRGC-SCN pathway.[2] Research indicates that 6.5 hours of blue-light exposure can suppress melatonin for approximately twice as long as green light of equal brightness and shift circadian rhythms by as much as three hours—a magnitude capable of substantially dysregulating the hormonal milieu of a 28-day menstrual cycle.[13]

The dose-response relationship between light intensity and melatonin suppression is well established.[2] Even exceedingly low nocturnal illuminances—0.1 to 5 lux, comparable to a dimly lit room or the glow of a standby screen—can measurably suppress melatonin secretion, establishing the principle that no truly safe threshold of nocturnal light exposure exists for the circadian system.[2] As illuminance escalates to the levels typical of indoor screen use (>500 lux), near-complete melatonin suppression may occur.[2] Critically, women may demonstrate stronger melatonin suppression and greater phase-shifting responses than men under equivalent lighting conditions, rendering adolescent girls particularly susceptible to digital-media-induced circadian disruption.[2]

3.1.2. Chronic Exposure and Molecular Clock Gene Disruption

Habitual, nightly screen use prevalent among adolescents represents a form of chronic exposure whose consequences operate at the molecular level.[2] Persistent nocturnal illumination progressively dampens the amplitude and precision of SCN output.[2] Core circadian clock genes—including Bmal1 and Per—lose coherent 24-hour oscillation patterns within reproductive tissues, including the hypothalamus, pituitary, and ovaries.[2] This molecular desynchrony constitutes a direct mechanistic contributor to impaired folliculogenesis, disrupted LH pulsatility, and compromised ovulatory function.[2]

Melatonin acts not only as a circadian signal but also as a direct regulator of reproductive neuroendocrinology, binding to MT1 and MT2 receptors on hypothalamic GnRH neurons, anterior pituitary gonadotrophs, and ovarian granulosa cells, thereby modulating pulsatile GnRH secretion, LH and FSH release, and ovarian steroidogenesis.[2] Experimental suppression of melatonin rhythms in animal models consistently produces oestrous cycle irregularities, ovulation disorders, and fertility impairment.[2]

3.1.3. Unani Interpretation: Naum wa Yaqza Disruption

According to Avicenna, sleep is defined as the inward movement of Rooh-e-Nafsani (neural pneuma), causing the cessation of external sensory and motor function, while the Quwwat-e- Haiwania (vital power) is restored and Ratubat (moisture) and Barudat (coolness) are replenished in the brain.[8,10] Conversely, Yaqza

(wakefulness) represents the outward activation of Rooh-e- Nafsani, consuming Hararat-e-Gharizia (innate heat) and Ratubat-e-Badania (body fluid), generating progressive fatigue and physiological dryness.[8]

The normative condition of sleep was understood as dependent on Ratoobat wa Baroodat (wetness and coolness) predominating in the brain; insomnia (Sehar or Bekhwabi) was characterised as a state of Yaboosat wa Hararat (dryness and heat).[8,9] The nocturnal blue-light stimulus—perceived by the retina as a daylight signal—maintains the brain in a state of Yaqza- like activation, preventing the physiological inward withdrawal of Rooh-e-Nafsani that constitutes Naum.[8] This mechanism maps directly onto the modern concept of blue-light-mediated SCN activation and melatonin suppression, translated into the Unani framework as a sustained excess of Hararat that obstructs the onset of Naum.[2,8]

Unani–Modern Integration: The blue-light-mediated suppression of melatonin via the ipRGC-SCN pathway [2] corresponds precisely to the Unani concept of Ziyada-e-Hararat (excess heat) in the brain preventing the inward movement of Rooh-e-Nafsani and thereby obstructing Naum [8]. Classical scholars also identified Sehar as a cause of secondary derangement in Harkat-o-Sukun Badani and Harkat-o-Sukun Nafsani [8]—precisely mirroring the modern finding that sleep deprivation activates the HPA axis and amplifies psychosocial stress reactivity [1,2].

3.2. Quantitative Impact on Adolescent Sleep

Among adolescent females in India, 23.5% reported sleep problems, rising to 33.24% among young adult females—substantially higher than male counterparts.[5] The SmartSleep Study documented that women sleeping fewer than seven hours per night demonstrated a 1.84 -fold increase in the odds of any menstrual disturbance and a 2.17-fold increase in the odds of cycle irregularity, with poor sleep quality independently predicting menstrual abnormality across multiple outcome definitions.[1]

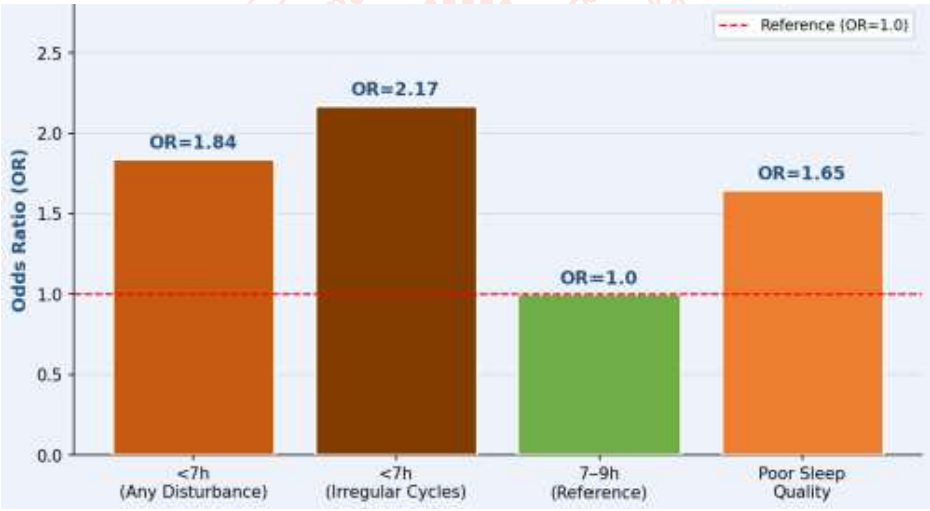

Figure 2: Menstrual Disturbance Risk by Sleep Duration and Quality— SmartSleep Study [1]

Lissak (2018) reported that children in 2011 slept approximately one hour less per night compared with early twentieth-century counterparts, with 20–30% of young British children experiencing sleep problems.[4] Higher sympathetic arousal was identified in adolescents with internet-addictive behaviour and hypothesised as a partial mediator of sleep disruption.[4] Sleep is required for adolescents aged 14–17 years to be 8–10 hours and for young adults aged 18–25 years to be 7–9 hours per night.[5,8]

4. Psychological Well-Being and Digital Media Use: Biomedical and Unani Integration

4.1. Screen Time and Adolescent Mental Health

Twenge et al. (2017), drawing on two nationally representative US surveys encompassing 506,820 adolescents in grades 8–12 and CDC suicide death statistics for ages 13–18, documented a significant increase in depressive symptoms, suicidal ideation, suicide plans, and suicide rates between 2010 and 2015, particularly among females.[3] Adolescents who spent more time on new media—including social media and electronic devices—were significantly more likely to report mental health issues.[3] Those spending more time on non-screen activities (in-person social interaction, sport, homework, print media, and religious services) were correspondingly less vulnerable.[3]

The temporal trends in adolescent screen time and mental health indicators paralleled each other between 2010 and 2015—the period during which smartphone penetration reached saturation—while cyclical economic

factors failed to predict depressive trends.[3] This temporal parallelism constitutes strong suggestive evidence for a causal role of excessive digital media use in adolescent psychological deterioration.[3]

In undergraduate females, Rizvi et al. (2026) demonstrated a statistically significant positive correlation between screen time and emotional distress ($r = 0.13$; $p = 0.039$) in a cross-sectional study of 252 university students.[6] Emotional distress was moderately correlated with menstrual distress ($r = 0.593$; $p < 0.001$) and weakly but significantly correlated with poorer sleep quality ($r = 0.126$; $p = 0.046$), positioning emotional well-being as the central integrating variable linking screen exposure, sleep disruption, and menstrual symptoms.[6]

4.2. 4.2 Neurobiological Mechanisms: Cortisol and HPA Activation

Social media notifications, fast-scrolling content, and competitive online environments trigger repeated small cortisol surges throughout the day and evening.[13,4] Over time, this pattern of chronic micro-stressor exposure desensitises the brain's reward pathways and reshapes baseline HPA reactivity.[13] A meta-analysis published in Frontiers in Endocrinology found that baseline cortisol is higher during the follicular phase, while research in the International Journal of Psychophysiology indicated heightened cortisol reactivity to stressors during the luteal phase—precisely the window of maximum vulnerability to premenstrual syndrome and PMDD.[13]

Elevated nocturnal cortisol—maintained by blue-light-mediated prevention of melatonin rise—directly suppresses GnRH pulsatility through HPA-HPG axis interaction.[13,7] When GnRH signalling is attenuated, downstream oestrogen and progesterone secretion, follicular development, and ovulation are progressively impaired, producing the spectrum of menstrual irregularities documented in screen-heavy populations.[7]

4.3. 4.3 Social Media and Interpersonal Harm

Twenge et al. (2017) situate their findings within the interpersonal theory of suicide, which proposes that suicidal desire arises from the combination of thwarted belongingness (social disconnection, loneliness) and perceived burdensomeness.[3] The shift from face-to-face social interaction—which provides more emotional closeness—to electronic communication was identified as a plausible driver of post-2010 increases in depression and suicide.[3] While males demonstrate higher rates of video game addiction, females' addictive digital behaviour centres predominantly on social networking—a pattern with direct implications for the psychological risk profiles of adolescent girls.[4]

4.4. 4.4 Unani Framework: Ahwal-e-Nafsaniyah and Mizaj Dysregulation

Unani physicians recognised that excessive psychic movement (Harkat-e-Nafsani), including sustained emotional arousal, anger, grief, fear, anxiety, and over-thinking, constitutes a pathological perturbant of constitutional equilibrium.[9,11] Depression was understood under the rubric of Amraz-e-Nafsaniyah (psychiatric disorders) as Malankhuliya (melancholia)—a condition arising from excess of Khilt-e-Sauda (black bile), characterised by aversion to food, hopelessness, sleep disturbance, irritability, and irrational ideation.[9] Razi's description of the initial stage of Malankhuliya—comprising worry, apprehension, sadness, and irrational thoughts—parallels the contemporary construct of sub-threshold depression and anxiety associated with problematic social media use.[9,11]

Azhar et al. (2025) demonstrated that among occupationally stressed workers assessed using Unani parameters of Mizaj-e-Dimagh (brain temperament), those with a Saudavi (melancholic) Mizaj exhibited the highest stress levels (95%), while Harr Yabis (bilious, hot-dry) temperament was most prevalent overall (34%).[11] This Unani temperamental classification finds a functional correlate in the modern concept of stress-reactive HPA phenotypes that confer heightened vulnerability to psychosocial stressors, including those emanating from digital media environments.[11]

Unani–Modern Integration: Social-media-induced psychosocial stress [3] corresponds in Unani medicine to excessive Harkat-e-Nafsani, leading to Ghalba-e-Sauda (dominance of black bile) [9], Su-e-Mizaj (temperamental imbalance) [11], and ultimately Malankhuliya [9]. Both frameworks identify psychic over-stimulation as a primary pathogenic force with downstream somatic consequences for reproductive physiology [7,9].

5. Menstrual Health in Adolescents: Contemporary Burden and Pathophysiology

5.1. Epidemiology of Menstrual Irregularities

In a hospital-based cross-sectional study conducted in South India among 105 women aged 18–40 years, menstrual irregularity was reported by 35.2% of participants, with delayed cycles constituting the most

frequent pattern (48.6%).[2] Screen exposure exceeding four hours per day was reported by 38.1% of participants and showed a statistically significant association with menstrual irregularity in multivariate logistic regression.[2]

The SmartSleep Study provided granular epidemiological characterisation of menstrual outcomes.[1] Women sleeping fewer than seven hours per night demonstrated a 1.84-fold increase in the odds of any menstrual disturbance (OR=1.84) and a 2.17-fold increase in the odds of cycle irregularity (OR=2.17), with poor sleep quality independently predicting menstrual abnormality across multiple FIGO-standardised outcome definitions.[1]

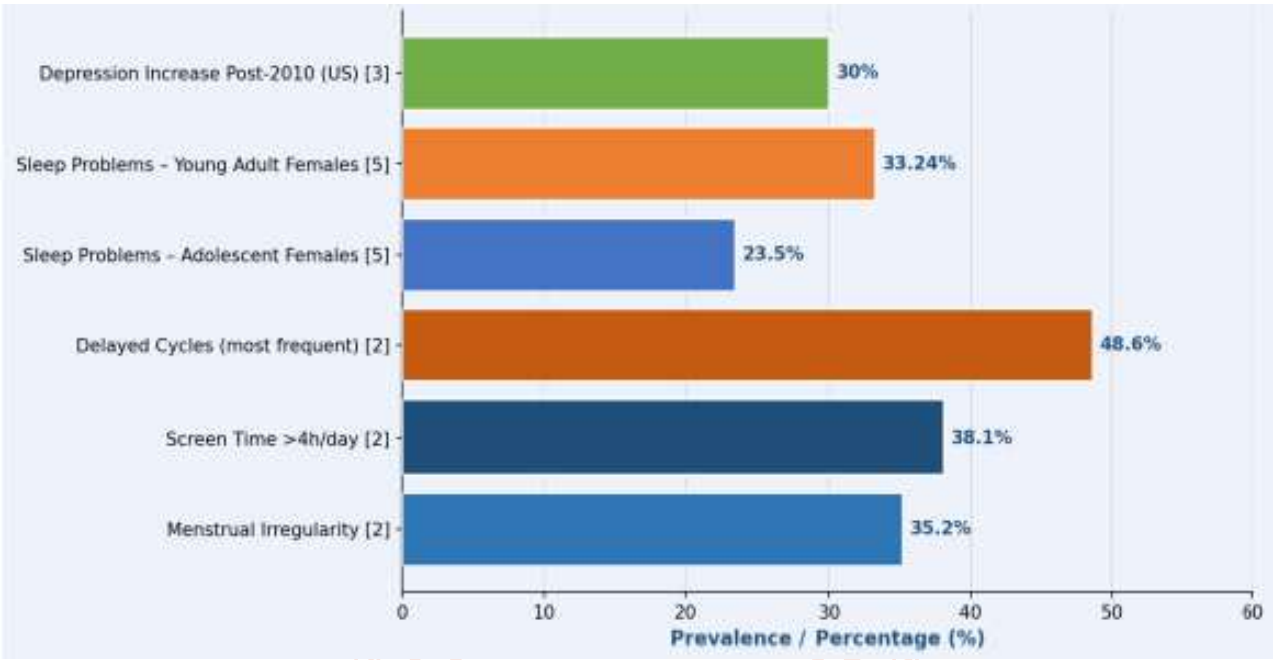

Figure 3: Key Prevalence Data Across Reviewed Studies— Menstrual Irregularity, Screen Time, and Sleep Problems [1,2,3,5]

Beyond cyclical irregularity, menstrual disorders carry systemic prognostic significance: irregularity has been associated with an elevated long-term risk of breast cancer, type 2 diabetes mellitus, cardiovascular disease, osteoporosis, and infertility.[7] Furthermore, menstrual cycle disorders in adolescents are frequently accompanied by anxiety, depression, insomnia, self-harm, and suicidal ideation, creating a bidirectional relationship between menstrual pathology and psychological morbidity.[2]

5.2. Hormonal and Neuroendocrine Pathophysiology

The menstrual cycle is orchestrated by the precise pulsatile secretion of GnRH from the hypothalamus, driving anterior pituitary gonadotroph secretion of LH and FSH, which regulate ovarian folliculogenesis, ovulation, and luteinisation.[2] This axis operates in obligatory coordination with the circadian system: LH pulsatility, FSH diurnal variation, and the mid-cycle LH surge are all temporally organised by circadian clock machinery expressed within the hypothalamus, pituitary, and ovaries.[2]

Melatonin participates in this reproductive endocrine orchestra through MT1/MT2 receptor binding on hypothalamic GnRH neurons and ovarian granulosa cells, modulating GnRH pulse frequency, FSH-induced follicular development, and the timing of the LH surge.[2] Disruption of nocturnal melatonin secretion—as produced by habitual night-time screen use—therefore disrupts each of these reproductive regulatory steps in sequence.[2,7] The hormonal cascade implicated additionally includes thyroid-stimulating hormone (TSH) and prolactin, both regulated in a sleep-dependent fashion and playing known roles in menstrual cycle regulation.[1]

6. Molecular-Level Changes: From Screen Exposure to Menstrual Dysfunction

6.1. Melatonin–MT1/MT2 Receptor Signalling and Ovarian Steroidogenesis

Melatonin exerts antioxidant effects within the follicular microenvironment, protecting oocytes from reactive oxygen species (ROS)-mediated damage during folliculogenesis.[2] Disruption of nocturnal melatonin secretion reduces intra-follicular melatonin concentrations, diminishing antioxidant protection, increasing oxidative stress within the granulosa cell layer, and impairing steroidogenic enzyme activity—including aromatase (CYP19A1), which catalyses oestrogen biosynthesis.[2] The resulting impairment of oestradiol

production attenuates positive feedback on the GnRH-LH system, delaying or preventing the mid-cycle LH surge and thereby disrupting ovulation.[2]

6.2. Circadian Clock Gene Dysregulation in Reproductive Tissues

Core circadian clock genes—including BMAL1, CLOCK, PER1, PER2, CRY1, and CRY2—are expressed throughout the reproductive axis, including hypothalamic GnRH neurons, pituitary gonadotrophs, and ovarian granulosa and theca cells.[2] Chronic nocturnal light exposure progressively desynchronises these peripheral clocks from the SCN master pacemaker; as Bmal1 and Per expression loses coherent oscillation in ovarian tissue, folliculogenesis becomes temporally disorganised and the precision of the LH surge timing is degraded.[2] Animal models of circadian disruption consistently reproduce polycystic ovary-like phenotypes, impaired ovulation, and reduced fertility—mechanistically consistent with the menstrual irregularities documented in screen-heavy human populations.[2]

6.3. HPA-HPG Crosstalk: CRH, GnRH, and Kisspeptin

CRH neurons in the paraventricular nucleus of the hypothalamus, activated by elevated cortisol and psychosocial stress, directly inhibit GnRH pulsatility through CRH receptor-mediated suppression of the GnRH pulse generator.[7] Additionally, glucocorticoid receptors expressed on kisspeptin neurons—which function as the primary upstream regulators of GnRH secretion—enable cortisol to downregulate kisspeptin synthesis, thereby attenuating GnRH drive at its proximal source.[7,13] This glucocorticoid-kisspeptin-GnRH suppressive cascade translates psychosocial stress from digital media into measurable reductions in LH pulse frequency and amplitude, predisposing to anovulation and menstrual irregularity.[7]

6.4. Oxidative Stress and Inflammatory Biomarkers

Chronic nocturnal light exposure and sleep deprivation independently generate systemic oxidative stress, characterised by increased production of ROS and reduced activity of endogenous antioxidant enzymes—superoxide dismutase (SOD), catalase, and glutathione peroxidase.[2] Oxidative stress within the ovarian follicular microenvironment impairs granulosa cell viability and steroidogenic function, activating pro-inflammatory signalling cascades (including NF-κB and IL- 6 pathways) that further disrupt follicular development and luteal function.[2] The animal literature on ALAN additionally documents polycystic ovary syndrome-like ovarian inflammatory responses following chronic blue-light exposure, with follicular apoptosis intensifying with duration of exposure, providing a molecular basis for the clinical spectrum of menstrual dysfunction.[2]

6.5. Unani Analogue: Fasad-e-Akhlat and Oxidative Dysregulation

The Unani concept of Fasad-e-Akhlat (corruption of humours) and Ghalba-e-Akhlat-e-Fasida (dominance of morbid humours) constitutes a functional analogue to the modern concept of systemic oxidative stress and inflammatory dysregulation.[9,10] Unani physicians recognised that disrupted sleep and psychoemotional disturbance impair Hazm (metabolic maturation), leading to the accumulation of Akhlat-e-Fasida (morbid humours) with deleterious effects on organ function.[10] The modern finding that melatonin functions as a mitochondrial antioxidant protecting granulosa cells from ROS-mediated damage can be interpreted within this Unani framework as the regulatory role of Naum in sustaining Hazm and preventing the accumulation of metabolic by- products that would corrupt the Akhlat governing reproductive tissue health.[2,10]

7. Interrelationship Between Digital Media, Sleep, Mental Health, and Menstrual Health

7.1. Convergent Evidence for a Multi-Pathway Model

The SmartSleep Study findings are instructive: night-time smartphone use per se was not directly associated with menstrual disturbances in multivariate analysis; rather, its impact was mediated through sleep quality and sleep duration, which independently and significantly predicted menstrual outcome.[1] However, a parallel and synergistic psychological pathway—screens→psychosocial stress→ HPA activation→ HPG suppression→ menstrual irregularity—operates simultaneously with the sleep pathway.[7,13] Rizvi et al. found emotional distress to be the strongest correlate of menstrual symptoms ($r=0.593$; $p<0.001$), with screen time as a distal predictor mediated through emotional distress.[6]

Excessive screen use can disrupt physiological functions including the regulation of menstrual cycles; emerging evidence suggests that lifestyle factors associated with prolonged screen exposure—increased stress, sedentary behaviour, and disrupted sleep—can negatively impact hormonal regulation, potentially leading to menstrual irregularities.[7] Additionally, the sedentary lifestyle often linked to extended screen use may exacerbate menstrual disturbances by impairing insulin sensitivity and disrupting overall hormonal balance.[7]

7.2. Integrated Conceptual Model

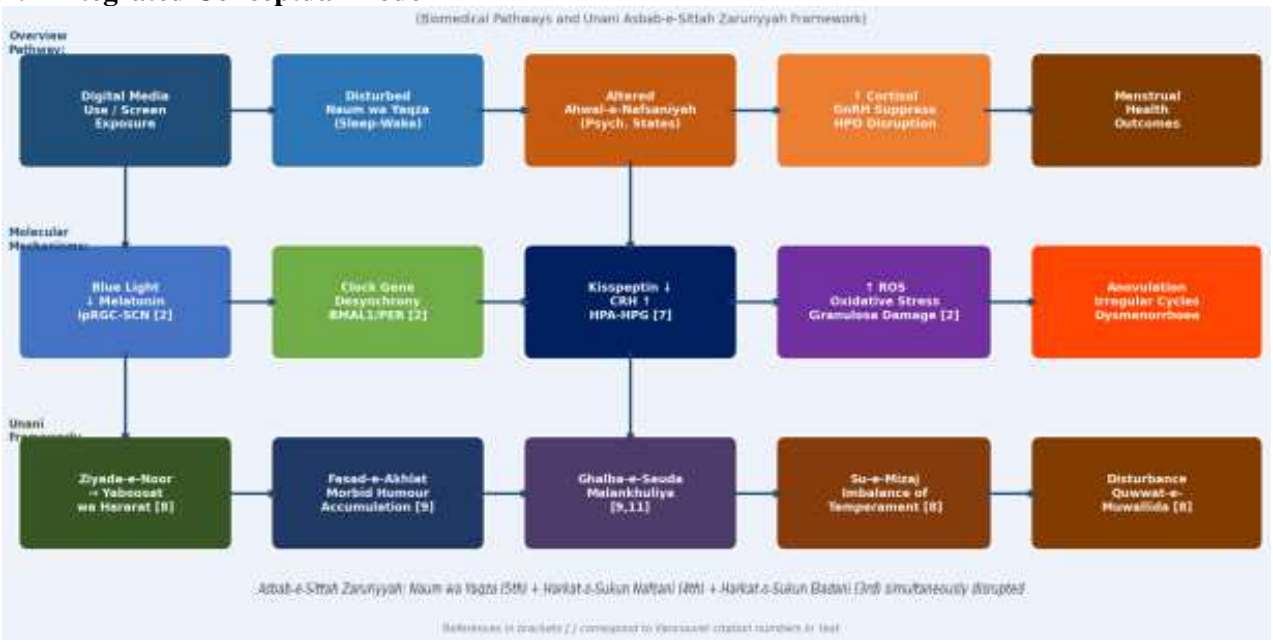

Figure 4: Integrated Conceptual Model— Digital Media Use to Menstrual Health Outcomes (Biomedical and Unani Asbab-e-Sittah Zaruriyyah Framework) [1,2,7,8,9,10,11,13]

This conceptual model illustrates the Asbab-e-Sittah Zaruriyyah framework as a systems-level explanatory architecture.[8] Digital media constitutes a single environmental perturbant, but its effects cascade across at least three of the six essential factors—Naum wa Yaqza, Harkat-o- Sukun Nafsani, and Hawa-e-Muheet (environmental quality, perturbed by artificial electromagnetic and light pollution)—producing cumulative derangement of the reproductive system.[8,9,10] The Unani insight that derangement in one pillar of Asbab-e-Sittah Zaruriyyah invariably destabilises adjacent factors anticipates the modern concept of bidirectional and mutually reinforcing pathways now emerging in the digital-health literature.[8,1]

7.3. Gender-Specific Vulnerability of Adolescent Girls

Adolescent girls represent a population of compounded vulnerability for at least three reasons. First, female adolescents demonstrate greater melatonin suppression and circadian phase - shifting in response to equivalent light exposure than males.[2] Second, female adolescents show disproportionately higher rates of social-media-associated depression and anxiety—the gender gap was consistently demonstrated across both US[3] and Indian population studies.[5] Third, the HPO axis, still undergoing developmental maturation during adolescence, is inherently more susceptible to perturbation by environmental stressors than the mature adult reproductive axis.[2]

8. The Unani Perspective: A Comprehensive Integrative Framework

8.1. Asbab-e-Sittah Zaruriyyah as a Systems Health Model

The doctrine of Asbab-e-Sittah Zaruriyyah represents one of the earliest frameworks of holistic preventive medicine.[8] The six factors are: Hawa-e-Muheet (ambient air and environment); Makul-o-Mashrub (food and drink); Harkat-o-Sukun Badani (physical movement and rest); Harkat-o- Sukun Nafsani (psychic movement and repose); Naum wa Yaqza (sleep and wakefulness); and Istifragh-o-Ihtibas (evacuation and retention).[8,9,10] Each factor is conceived not as an independent variable but as a node in an interconnected regulatory network; derangement in any single factor creates rippling perturbation across adjacent factors, ultimately disturbing the Mizaj and predisposing to Marazi (diseases).[8]

The digital lifestyle, assessed against this classical rubric, constitutes a simultaneous perturbant of multiple Asbab-e-Sittah Zaruriyyah: nocturnal screen use directly disrupts Naum wa Yaqza,[8] psychosocial stressors of social media disturb Harkat-o-Sukun Nafsani,[9] sedentary behaviour impairs Harkat-o-Sukun Badani,[12] and blue-light-rich artificial illumination constitutes an anthropogenic alteration of Hawa-e-Muheet.[2] This multiplicity of simultaneous disturbances explains why digital media's health consequences are so pervasive and systemic.

8.2. Naum wa Yaqza: Detailed Classical Conceptualisation

Avicenna defined sleep as the condition in which Rooh-e-Nafsani returns to the interior of the body, causing cessation of external sensory and motor

functions; during this inward withdrawal, free radicals produced during wakefulness are scavenged and Ratubat and Barudat are restored.[8] This classical description of sleep as a restorative anabolic state finds striking correspondence with modern understanding of sleep's role in glymphatic waste clearance, antioxidant enzyme restoration, and circadian hormone secretion.[2,8]

Avicenna specified that good sleep must be deep, continuous, of average duration, and initiated after adequate gastric digestion.[8] Unani physicians also described the impact of sleep on Akhlat (humours), stating that normal sleep induces the production of good Akhlat, and that Razi said normal sleep is responsible for Taskeen (relaxation) and Taqwiyat (strength) in the body.[10] These four criteria of good sleep map onto modern sleep quality constructs: sleep depth, continuity, duration, and the avoidance of pre-sleep stimulation—all factors perturbed by digital media engagement.[4,1]

8.3. Ahwal-e-Nafsaniyah: Classical Pathogenesis

The Unani aetiology of insomnia (Sehar) was classified as Akhtayari (voluntary: excessive work, stimulant drinks, excess light in the room, noise pollution), Aarzi (temporary: excess emotions including fear, sadness, happiness; over-thinking; nightmares), and Marzi (pathological: Su-e- Mizaj Yabis, Ghalba-e-Sauda, Ghalba-e-Safra, Fasad-e-Dam).[9] Digital media constitutes a uniquely powerful convergent cause—simultaneously producing Akhtayari Asbab (excess light, stimulant effect of screen engagement), Aarzi Asbab (emotional arousal from social media, overthinking, fear of social exclusion), and over time, Marzi Asbab.[9]

Unani management of Sehar and Amraz-e-Nafsaniyah is structured around three pillars: Ilaj-bil-Tadbeer (regimental therapy), Ilaj-bil-Ghiza (dietotherapy), and Ilaj-bil-Dawa (pharmacotherapy).[9] Within Ilaj-bil-Tadbeer, recommended interventions for insomnia include Hammam (warm bathing), Tadheen (application of cooling oils to the scalp), Dalk (massage of soles and lower limbs), and light Riyazat (physical exercise before sleep)—each promoting Tarteeb-e-Dimagh (moistening of the brain) and physiological cooling.[9] These interventions bear functional correspondence to modern sleep hygiene recommendations: pre-sleep temperature reduction, progressive muscle relaxation, and light physical activity.[9]

Unani–Modern Integration: The Unani classification of insomnia causes (Akhtayari, Aarzi, Marzi) [9] maps precisely onto the modern tripartite model of screen-induced sleep disruption: direct displacement, psychoemotional arousal, and blue-light-mediated circadian phase delay [1,2]. Digital media fulfils criteria across all three Unani aetiological categories simultaneously, explaining its disproportionate impact on adolescent sleep health.

9. Discussion

9.1. Synthesis and Critical Appraisal

The evidence reviewed converges on a coherent, multi-level account of how digital media use disturbs adolescent menstrual health through two principal pathways—circadian-hormonal and psychosocial-neuroendocrine—that operate in parallel and mutual reinforcement, with shared molecular endpoints in melatonin suppression, cortisol elevation, GnRH attenuation, and oxidative stress-mediated granulosa cell dysfunction.[1,2,7]

Several methodological limitations warrant acknowledgement. The SmartSleep Study—the most methodologically rigorous investigation—was conducted in a Danish adult population aged 18–40, limiting direct extrapolation to adolescents in South Asian settings.[1] The cross-sectional design of most other studies precludes causal inference; reverse causality cannot be excluded without longitudinal data.[6] Confounding by physical inactivity, dietary patterns, BMI, and socioeconomic status is inadequately controlled in most available studies.[2] Furthermore, direct evidence linking screen-emitted blue light to reproductive endocrinology in human populations remains limited to mechanistic inferences from animal models.[2]

9.2. Research Gaps and Future Directions

Longitudinal cohort studies specifically designed to investigate the temporal relationship between objective screen time, sleep parameters, and prospectively tracked menstrual cycle characteristics in Indian and South Asian adolescent girls are urgently needed.[2] Cycle-tracking applications provide a feasible methodology for high-resolution menstrual outcome data collection at population scale.[2]

Studies employing objective measures of light exposure (wearable photometers) to characterise both intensity and spectral composition of individual nocturnal light exposure, combined with actigraphy for objective sleep staging, would substantially advance mechanistic understanding.[2] Intervention studies testing the efficacy of structured screen curfews and Unani regimental sleep- hygiene interventions (Hammam, Tadheen, Dalk) on sleep quality and menstrual regularity in adolescent girls are also warranted.[9]

Biomarker studies measuring melatonin profiles (urinary 6-sulphatoxymelatonin), cortisol diurnal curves (salivary cortisol), LH pulsatility, and ovarian oxidative stress markers in screen-heavy versus screen-limited adolescent cohorts would provide direct molecular evidence for the pathways proposed in this review.[2,7] Studies incorporating Unani Mizaj assessment—using validated tools for temperament classification—to examine whether specific Mizaj profiles confer heightened vulnerability to screen-induced menstrual disruption would constitute a novel clinical contribution.[11]

10. Conclusion

This review has established that digital media use, particularly nocturnal smartphone and screen engagement, constitutes a clinically significant perturbant of adolescent menstrual health through two converging mechanistic pathways: the disruption of Naum wa Yaqza via blue-light-mediated melatonin suppression and circadian clock gene desynchrony,[1,2] and the derangement of Ahwal- e-Nafsaniyah via social-media-associated psychosocial stress, HPA axis activation, and GnRH- kisspeptin suppression.[3,7,13] At the molecular level, these pathways converge on oxidative stress-mediated granulosa cell dysfunction, impaired folliculogenesis, and disrupted ovulatory signalling.[2]

The classical Unani framework of Asbab-e-Sittah Zaruriyyah provides a systems-level explanatory architecture that integrates these modern findings with remarkable conceptual precision.[8,9,10] The classical understanding that Naum wa Yaqza and Harkat-o-Sukun Nafsani are indispensable regulators of constitutional health, and that their derangement cascades to disturb the Mizaj and impair downstream organ function, anticipates the modern multi-pathway model of screen- induced reproductive dysfunction.[8] Unani medicine's Asbab-e-Sittah Zaruriyyah offers an integrative explanatory and therapeutic framework that—combined with contemporary molecular neuroscience and reproductive endocrinology—provides a more comprehensive account of adolescent menstrual health in the digital age than either tradition offers in isolation.[8,9,10]

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