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Original Research Article

Influence of lifestyle factors-sleep patterns and stress on skin health and ageing amongst the general population in India

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ABSTRACT

Background: This study examines the impact of lifestyle factors, particularly sleep patterns and stress, on skin health and aging in the Indian population. The findings provide valuable information for health professionals, policy makers and individuals to develop targeted interventions and recommendations to promote healthy skin and combat premature aging.
Methods: The study utilized SPSS Software (by IBM) for descriptive and inferential statistical tests, calculating frequencies and percentages of categorical variables. Descriptive statistics summarized participants' characteristics, while the chi-square test was used to investigate associations between socio demographic factors and acne. The total of 510 participants was included in the analysis.
Results: To investigate categorical factors associated with skin finding (acne), Chi-square test was used to find the association and where the expected count in cells was less than 5, Fisher Exact test was applied. Statistical significance determined at $p<0.05$. There was a total of 510 individuals but 7 did not consent to participate so 503 individuals were included in analysis.
Conclusions: The use of smartphones has had a big impact on sleep patterns, which are crucial for preserving physiological balance. Sleep disturbances can cause dryness and irritation of skin. A diet high in fruits and vegetables like tomatoes, red grapes are directly linked to promoting skin health. Blue light exposure from smartphones and other electronics can cause hyperpigmentation, premature wrinkles, tanning, and other skin problems. Nomophobia is a phenomenon that we see in this age of reliance on technology, especially cell phones.

Keywords: Acne, Ageing, Lifestyle factors, Skin health, Sleep patterns, Stress

INTRODUCTION

The largest organ in the body, the skin, acts as a vital protective barrier and has a big impact on our physical health. Research has recently revealed the intricate connections between our everyday routines and the complex realm of skin health and the ageing process. We delve through an avalanche of research, concentrating on three crucial lifestyle factors that have all been extensively explored for their profound impact on the skin: stress, sleep, and dietary habits. Even just a single night of poor sleep habits can cause dark circles and a

fatigued appearance, while chronic sleep insufficiency is linked to weakened skin barrier function, increased ageing indicators, and decreased self-esteem with regard to one's appearance.[1-2] Several things can have an adverse effect on how well a person sleeps, which includes diet (proteins, fats, carbohydrates), as well as increased calorie intake, obesity, low vitamin D levels, alcohol, nicotine, caffeine and obstructive sleep apnea syndrome.[3-4] Another modern constant, stress, causes hormonal changes and inflammation that have an immediate impact on the skin. These changes speed up ageing, exacerbate chronic skin problems, and decrease barrier function.[1] Conversely, dietary practices emphasise the adage "you are what you eat," with a balanced diet supporting ideal skin integrity and an excess of sugar and unhealthy fats causing skin problems.[1]

Additionally, a comprehensive skincare routine used over an extended period of time is beneficial, and a variety of plant-derived substances, such as carotenoids and polyphenols, have shown promise in improving skin health.[2-3] We explore this topic and reveal the intricate network of relationships between these lifestyle factors and their effects on skin health and the ageing process, highlighting the significance of making educated decisions for healthy, youthful skin.

This study aimed to study impact of lifestyle factors such as sleep patterns, stress levels and dietary factors on overall skin health. Also, to find association between sleep patterns, stress, skin health. Additionally, to contribute knowledge to the existing body by providing evidence-based insights that can guide both individuals and healthcare professionals in promoting skin health through lifestyle modifications.

METHODS

Study area

An observational cross-sectional study conducted in general population across India.

Study period

Study was conducted for the period of seven months i.e. June to December 2023 and individuals age from 20-40 years were included in the study.

Study subjects

All individuals age from 20-40 years were included in to the study.

Inclusion criteria

Participants aged between 18 and 60 years including both males and females, individuals with good physical health, consistent sleeping patterns and regular bedtimes and wakeup times, participants experiencing varying levels of stress, including both high and moderate stress, participants who give consent and are willing to participate in the study were included.

Exclusion criteria

Individuals below 18 or above 60 years old, participants with chronic skin conditions or other chronic health issues affecting skin health and also those who underwent recent dermatological procedures affecting skin health, individuals with inconsistent sleep patterns or significant sleep disorders and also who are on medication known significantly impacting sleep or skin health, pregnant individuals, as pregnancy can impact both sleep patterns and stress levels, those engaged in shift work, as it can disrupt normal sleep-wake cycles, people who do not give consent were excluded from this study.

Sampling type

The convenient sampling technique was used.

Sample size

Total 510 individuals were included into the study.

Tools used

Self-made questionnaire including questions which assess: Demographic data, sleep patterns and difficulties faced during sleep, skin changes, about common stressors in life

Statistical analysis

Statistical analysis was performed using the SPSS software version. After obtaining consent as per Helsinki Declaration 2013, we conducted our study among 510 individuals who are between 18-60 years of age fulfilling our inclusion criteria and exclusion criteria in India.

The purpose of the study was explained in their local language to the study population and their consent was taken regarding this. Data was continuously collected, observed, and analysed. Furthermore, there was daily supervision of data collected in the data collection process. Finally, it was checked for accuracy, reliability, completeness, and consistency.

The analysis involved descriptive and inferential statistical tests. Simple frequencies and percentages of the categorical variables were calculated and tabulated.

The Descriptive statistics were used to summarize and describe the characteristics of the study participants and their responses. To investigate categorical factors (sociodemographic, sleep patterns and stress) associated with the Skin finding (Acne), chi-square test was used to find the association and where the expected count in cells

was less than 5, Fisher Exact test was applied. All analyses were performed using SPSS Software (by IBM) version 27.0.1, with statistical significance determined at $p<0.05$. There was a total of 510 individuals but 7 did not consent to participate so 503 individuals were included in analysis.

RESULTS

Table 1 presents the sociodemographic characteristics of the participants involved in the study. The age distribution reveals that the majority of participants (71.6%) fall within the 20-26 age range, with a significant portion (22.3%) aged between 12-19 years. Smaller percentages are distributed across older age groups, including 27-33 years, 34-45 years, and only 1 individual between 45-60 years. In terms of gender, the study population is almost evenly split between females (49.9%) and males (49.7%).

Regarding occupation, the largest proportion of participants are students (72.6%), followed by healthcare professionals (8.0%), self-employed individuals (6.6%) and IT professionals (5.8%). Finally, the distribution of participants across different states and union territories (UTs) indicates that the majority are from Telangana (51.3%), followed by Tamil Nadu (13.3%) and Maharashtra (13.1%). Smaller percentages of participants are from Andhra Pradesh, Karnataka, Kerala, New Delhi, and other regions.

Table 2 provides insights into the responses of participants regarding their sleep patterns and stress levels. Participants were asked to rate the quality of their sleep, with responses ranging from "Excellent" (20.7%) to "Poor" (1.6%), with the majority rating their sleep as "Good" (44.7%). Regarding the duration of sleep, most participants reported sleeping for 6-8 hours per night (74.0%). Additionally, participants were asked about the difficulty of falling back asleep once awakened, with responses varying from "Never" (7.4%) to "Almost always" (17.9%).

Various symptoms experienced during sleep were also reported with majority experiencing waking up tired and sleepy despite adequate sleep duration (25.8%), headache (17.5%) sudden episodes of micro sleep during the day (13.7%), and midnight cravings for food (13.7%).

In terms of stress, participants reported experiencing stress levels ranging from "Never" (5.6%) to "Sometimes" (56.5%), with the majority falling in the latter category. Common stressors in life included work-related stress (60.4%), family/relationship issues (41.4%), financial stress (30.8%), and health-related stress (23.9%). Furthermore, participants were asked about their methods for stress relief, with popular choices including listening to music (55.7%), talking with a friend (47.5%), and using their phone (52.7%).

Table 3 presents the responses of participants regarding their food habits and skincare routines, as well as their perception of their skin condition and changes. Participants were asked about their consumption of caffeinated beverages or stimulants within 6 hours of bedtime, with responses ranging from "Never" (19.1%) to "Daily" (26.8%).

Similarly, their consumption of processed foods, bakery items, and chocolates varied from "Very rare" (10.5%) to "Few times a week" (41.7%). Regarding their overall skin condition, responses ranged from "Excellent" (8.0%) to "Poor" (2.2%), with the majority rating it as "Good" (47.3%). Participants also reported various skin changes, including acne (34.0%), oiliness (45.1%), dark circles (41.4%), and premature loss of hair (24.9%). Participants' frequency of dermatologist visits varied, with responses ranging from "Never" (61.2%) to "Every month" (5.4%). 41.7% individuals never applied any self-medication. The majority (57.7%) indicated that they had an idea about the UV spectrum and its effects, a significant portion (42.3%) reported not having such knowledge.

Table 4 explores the association between sociodemographic factors and the presence of acne among the participants. Gender shows a significant association with acne prevalence ($p<0.001$), with females exhibiting a higher percentage (41.4%) compared to males (26.8%). Moreover, occupation also demonstrates a significant relationship with acne ($p=0.045$), with healthcare professionals having the highest percentage (42.5%), followed by students (35.9%). Conversely, no significant association is found between the Age, state/UT of residence and acne prevalence.

Table 5 illustrates the association between sleep patterns, stress levels, and the presence of acne among the participants. Significant associations are observed between certain symptoms during sleep and acne prevalence. For instance, participants who reported waking up tired and sleepy despite adequate sleep (50%) were significantly more likely to have acne ($p<0.001$) than those who didn't have this symptom (28.4%).

Similarly, participants experiencing sudden episodes of micro sleep during the day exhibited a significant association with acne prevalence (52.2% vs 31.1%). Regarding common stressors, those who have a work related stressor has significantly higher percentage of acne (40.1%) than those who do not have this stressor (24.6%). Participants currently on antidepressant medications were significantly less likely to have acne (21.3%) than those who are not on any antidepressants (35.3%).

Moreover, various stress-busting methods such as watching TV, talking with a friend, using the phone, and listening to music show significant associations with acne prevalence and participants with these stress busting methods were more likely to have acne.

Table 1: Sociodemographic characteristics of participants.

Characteristics		N (%)
Age (in years)	12-19	112 (22.3)
	20-26	360 (71.6)
	27-33	19 (3.8)
	34-45	11 (2.2)
	45-60	1 (0.2)
Gender	Female	251 (49.9)
	Male	250 (49.7)
	Prefer not to say	2 (0.4)
Occupation	Healthcare professional	40 (8.0)
	Home maker	11 (2.2)
	IT professional	29 (5.8)
	Self employed	33 (6.6)
	Student	365 (72.6)
	Others	25 (5.0)
State /UT where you're studying/ working currently	Andhra Pradesh	27 (5.4)
	Karnataka	27 (5.4)
	Kerala	13 (2.6)
	Maharashtra	66 (13.1)
	New Delhi	13 (2.6)
	Tamil Nadu	67 (13.3)
	Telangana	258 (51.3)
	Others	32 (6.4)

Table 2: Response of participants regarding sleep patterns and stress.

		N (%)
How would you rate the quality of your sleep?	Average	147 (29.2)
	Bad	19 (3.8)
	Excellent	104 (20.7)
	Good	225 (44.7)
	Poor	8 (1.6)
On an average, how many hours do you sleep every night?	3-5 hours	45 (8.9)
	6-8 hours	372 (74.0)
	9-10 hours	65 (12.9)
	Less than 3 hours	3 (0.6)
	More than 10 hours	18 (3.6)
How hard is it for you to fall back asleep once you wake up or was awakened?	Almost always	90 (17.9)
	Never	37 (7.4)
	Rarely	140 (27.8)
	Sometimes	236 (46.9)
Symptoms present while sleeping		
Breathlessness		24 (4.8)
Frequent thirst		54 (10.7)
Headache		88 (17.5)
Waking up tired and sleepy in spite of having a solid 7-8 hours of sleep		130 (25.8)
Frequent urination at night		31 (6.2)
Sudden episodes of Micro sleep during the day		69 (13.7)
Midnight craving for food		69 (13.7)
Snoring loudly such that bed partner is disturbed		30 (6.0)
Do You feel stressed?	Almost always	77 (15.3)
	Never	28 (5.6)
	Rarely	114 (22.7)
	Sometimes	284 (56.5)

Continued.

		N (%)
Do you have a hard time feeling really relaxed?	Almost always	83 (16.5)
	Never	40 (8.0)
	Rarely	117 (23.3)
	Sometimes	263 (52.3)
Common stressors in life		
Family/relationship		208 (41.4)
Work-related		304 (60.4)
Financial		155 (30.8)
Health		120 (23.9)
Are you currently on any antidepressant medications?		47 (9.3)
Source of stress buster		
Gym workout		65 (12.9)
Yoga		57 (11.3)
Watch TV		100 (19.9)
Book Reading		86 (17.1)
Talk with a friend		239 (47.5)
Phone		265 (52.7)
Listen to music		280 (55.7)
Walk in garden or park		112 (22.3)

N: Frequency, %; Percentage

Table 3: Response of participants regarding food habits and skin care.

		N (%)
How often do you consume caffeinated beverages or stimulants (e.g., coffee, energy drinks) within 6 hours of bedtime?	Daily	135 (26.8)
	Never	96 (19.1)
	Once in a week	105 (20.9)
	Rarely	167 (33.2)
How often do you consume processed food (instant, ready to eat meals), Bakery items and Chocolates?	Few times a week	210 (41.7)
	Few times in a month	141 (28.0)
	Occasionally	99 (19.7)
	Very rare	53 (10.5)
Your overall skin condition is (Left-normal skin, Right- wrinkles, dark circles due to sleep deprivation)	Average	195 (38.8)
	Bad	19 (3.8)
	Excellent	40 (8.0)
	Good	238 (47.3)
	Poor	11 (2.2)
Skin changes		
Acne		171 (34.0)
Wrinkles/ fine lines		44 (8.7)
Dryness/ scaly skin		101 (20.1)
Oiliness		227 (45.1)
Sensitivity/ redness		55 (10.9)
Increased facial pores		104 (20.7)
Dark circles		208 (41.4)
Premature greying of hair		73 (14.5)
Premature loss of hair		125 (24.9)
How often do you visit dermatologist ?	Every month	27 (5.4)
	Never	308 (61.2)
	Rarely	168 (33.4)
How many times do you apply self medication like application of serum, moisturizer and sunscreen or any other equivalent home remedies?	2-3 times a week	43 (8.5)
	I don't use all 3 products at same time, but use it time to time	52 (10.3)
	Twice a day	39 (7.8)
	Once a day	110 (21.9)
	Once a week	49 (9.7)

Continued.

		N (%)
	I don't use any products	210 (41.7)
Do you have an idea about UV spectrum and its effect on skin health?	No	213 (42.3)
	Yes	290 (57.7)

N: Frequency, %; Percentage

Table 4: Association of sociodemographic factors and acne.

		Acne		P value
		Yes	No	
		N (%)	N (%)	
Age (in years)	12-19	44 (39.3)	68 (60.7)	0.188
	20-26	118 (32.8)	242 (67.2)	
	27-33	8 (42.1)	11 (57.9)	
	34-45	1 (9.1)	10 (90.9)	
	45-60	0 (0.0)	1 (100.0)	
Gender	Female	104 (41.4)	147 (58.6)	<0.001*
	Male	67 (26.8)	183 (73.2)	
	Prefer not to say	0 (0.0)	2 (100.0)	
Occupation	Healthcare professional	17 (42.5)	23 (57.5)	0.045*
	Home maker	2 (18.2)	9 (81.8)	
	IT professional	6 (20.7)	23 (79.3)	
	Self employed	5 (15.2)	28 (84.8)	
	Student	131 (35.9)	234 (64.1)	
	Others	10 (40.0)	15 (60.0)	
State/UT where you're studying/ working currently	Andhra Pradesh	8 (29.6)	19 (70.4)	0.901
	Karnataka	11 (40.7)	16 (59.3)	
	Kerala	6 (46.2)	7 (53.8)	
	Maharashtra	24 (36.4)	42 (63.6)	
	New Delhi	3 (23.1)	10 (76.9)	
	Tamil Nadu	24 (35.8)	43 (64.2)	
	Telangana	84 (32.6)	174 (67.4)	
	Others	11 (34.4)	21 (65.6)	

N: Frequency, %; Percentage, *p<0.05, significant

Table 5: Association of sleep patterns and stress and acne.

		Acne		P value
		Yes	No	
		N (%)	N (%)	
How would you rate the quality of your sleep?	Average	63 (42.9)	84 (57.1)	0.095
	Bad	6 (31.6)	13 (68.4)	
	Excellent	29 (27.9)	75 (72.1)	
	Good	70 (31.1)	155 (68.9)	
	Poor	3 (37.5)	5 (62.5)	
On an average, how many hours do you sleep every night	3-5 hours	17 (37.8)	28 (62.2)	0.111
	6-8 hours	135 (36.3)	237 (63.7)	
	9-10 hours	15 (23.1)	50 (76.9)	
	Less than 3 hours	1 (33.3)	2 (66.7)	
	More than 10 hours	3 (16.7)	15 (83.3)	
How hard is it for you to fall back asleep once you wake up or was awakened?	Almost always	32 (35.6)	58 (64.4)	0.618
	Never	16 (43.2)	21 (56.8)	
	Rarely	46 (32.9)	94 (67.1)	
	Sometimes	77 (32.6)	159 (67.4)	
Symptoms present while Breathlessness	Yes	8 (33.3)	16 (66.7)	0.944
	No	163 (34.0)	316 (66.0)	

Continued.

			Acne		P value
			Yes	No	
			N (%)	N (%)	
sleeping	Frequent thirst	Yes	20 (37.0)	34 (63.0)	0.620
		No	151 (33.6)	298 (66.4)	
	Headache	Yes	26 (29.5)	62 (70.5)	0.327
		No	145 (34.9)	270 (65.1)	
	Waking up tired and sleepy in spite of having a solid 7-8 hours of sleep	Yes	65 (50.0)	65 (50.0)	<0.001*
		No	106 (28.4)	267 (71.6)	
	Frequent urination at night	Yes	8 (25.8)	23 (74.2)	0.310
		No	163 (34.5)	309 (65.5)	
	Sudden episodes of Micro sleep during the day	Yes	36 (52.2)	33 (47.8)	<0.001*
		No	135 (31.1)	299 (68.9)	
	Midnight craving for food	Yes	29 (42.0)	40 (58.0)	0.135
		No	142 (32.7)	292 (67.3)	
	Snoring loudly such that bed partner is disturbed	Yes	8 (26.7)	22 (73.3)	0.373
		No	163 (34.5)	310 (65.5)	
You feel stressed		Almost always	32 (41.6)	45 (58.4)	0.126
		Never	8 (28.6)	20 (71.4)	
		Rarely	30 (26.3)	84 (73.7)	
		Sometimes	101 (35.6)	183 (64.4)	
Do you have a hard time feeling really relaxed		Almost always	27 (32.5)	56 (67.5)	0.570
		Never	12 (30.0)	28 (70.0)	
		Rarely	46 (39.3)	71 (60.7)	
		Sometimes	86 (32.7)	177 (67.3)	
Common stressors in life	Family / Relationship	Yes	70 (33.7)	138 (66.3)	0.892
		No	101 (34.2)	194 (65.8)	
	Work-related	Yes	122 (40.1)	182 (59.9)	<0.001*
		No	49 (24.6)	150 (75.4)	
	Financial	Yes	53 (34.2)	102 (65.8)	0.950
		No	118 (33.9)	230 (66.1)	
	Health	Yes	43 (35.8)	77 (64.2)	0.627
		No	128 (33.4)	255 (66.6)	
Are you currently on any antidepressant medications?		Yes	10 (21.3)	37 (78.7)	0.045*
		No	161 (35.3)	295 (64.7)	
Source of stress buster	Gym workout	Yes	18 (27.7)	47 (72.3)	0.243
		No	153 (34.9)	285 (65.1)	
	Yoga	Yes	20 (35.1)	37 (64.9)	0.854
		No	151 (33.9)	295 (66.1)	
	Watch TV	Yes	43 (43.0)	57 (57.0)	0.036*
		No	128 (31.8)	275 (68.2)	
	Book Reading	Yes	29 (33.7)	57 (66.3)	0.953
		No	142 (34.1)	275 (65.9)	
	Talk with a friend	Yes	93 (38.9)	146 (61.1)	0.027*
		No	78 (29.5)	186 (70.5)	
	Phone	Yes	101 (38.1)	164 (61.9)	0.039*
		No	70 (29.4)	168 (70.6)	
	Listen to music	Yes	108 (38.6)	172 (61.4)	0.015*
		No	63 (28.3)	160 (71.7)	
	Walk in garden or park	Yes	43 (38.4)	69 (61.6)	0.268
		No	128 (32.7)	263 (67.3)	

N: Frequency, %; Percentage, *p<0.05, significant

DISCUSSION

The relationship between sleep patterns and skin health is a multifaceted one. Quality sleep plays a significant part in promoting the repair and rejuvenation of the skin. During deep sleep, the body releases growth hormones that are essential for the rejuvenescence of skin cells and the production of collagen, a critical protein responsible for skin elasticity and firmness. This connection underscores the significance of a good night's sleep in maintaining youthful and healthy skin. Conversely, sleep deprivation disrupts these pivotal processes, resulting in adverse effects on the skin. Impaired skin barrier function, increased dryness, and the formation of wrinkles are common consequences of inadequate sleep.[6] Likewise, sleep deprivation may worsen pre-existing skin conditions such as acne and psoriasis. It's apparent that maintaining regular and sufficient sleep patterns is imperative for conserving skin health and decelerating the ageing process. The influence of chronic stress on skin health is equally profound. Stress triggers the release of hormones like cortisol, which can negatively affect the skin. Increased cortisol levels have been associated with heightened sebum production, potentially contributing to the development of acne.[9] This hormonal imbalance is just one aspect of how stress can lead to skin problems. Inflammation is a key mechanism through which stress accelerates the ageing of the skin.[8] Chronic stress can induce a state of chronic inflammation, which is detrimental to the skin. Inflammation leads to the breakdown of collagen and elastin, critical components of the skin's structure. Over time, this can result in sagging skin, fine lines, and wrinkles. likewise, stress has been implicated in the exacerbation of various skin diseases, including eczema, psoriasis, and rosacea. Stress management techniques, along with conventional treatments, are often recommended for individuals with these conditions. Understanding the relationship between life factors, such as sleep patterns and stress, and their impact on skin health and ageing has profound implications. It offers insights into how individuals can take proactive way to maintain and enhance their skin's health and appearance. Incorporating strategies for improving sleep quality and stress management into daily routines and skincare regimens can be vital for achieving these goals.[5]

To further advance our knowledge in this field, future exploration should delve into the molecular and cellular mechanisms through which sleep and stress affect skin health. Identifying specific pathways and targets can lead to the development of further tailored interventions and skincare products.[10] This will enable individuals to alleviate the detrimental effects of poor sleep and habitual stress on their skin effectively.[6] In conclusion, this research highlights the intimate connection between lifestyle factors, sleep patterns, and stress, and their profound impact on skin health and ageing. Recognizing and addressing these influences can empower individuals to make informed choices for hale skin and delay the signs of ageing. Eventually, this research contributes to the growing body of knowledge that underscores the importance of holistic well- being in preserving the skin's youth and vitality.

The limitation of our study includes inability to represent the country as a whole due to lack of survey conducted in the northern parts of India. This is a pilot study conducted on a small scale and we encourage epidemiologists to conduct further survey analysing inputs received.

CONCLUSION

In this study, the relation between sleep patterns and ageing has been well understood where sleep constitutes a typical physiological function, encompassing roughly a third of an individual’s lifespan. Any disturbance in this regular pattern, which in turn is essential for maintaining physiological equilibrium, may potentially result in health issues, particularly affecting overall skin health. The precise causal relationship between sleep disturbances and skin conditions remains uncertain, with suspicions of a bidirectional influence. The primary role of the skin is to serve as a protective barrier against water loss and the penetration of external substances. Any disruption in the skin’s natural balance can result in issues like dryness, itching, and potentially even the development of pathological conditions. Mental stress can negatively impact the integrity of the skin barrier by causing disturbances in sleep and inducing heightened anxiety levels. Various food items such as red grapes, tomatoes, salmon (omega-3 fatty acids), avocados, walnuts, sweet potatoes (beta carotene), broccoli (sulforaphane) and soy (isoflavones). Pollutants include particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), cigarette smoke, UV light, volatile organic compounds (VOCs), and ground-level ozone can infiltrate the skin through direct accumulation, inducing oxidative stress with nanoparticles generating quinones. Epidemiological evidence links traffic-related air pollution to pigment spots and wrinkles. The skin’s vulnerability to pollution is more pronounced in older age, possibly due to age-related molecular processes. The blue light emitted by smartphones and electronic devices can result in tanning, hyperpigmentation, premature wrinkles, sagging caused by collagen breakdown, and various other skin concerns. In this era of technology dependence, particularly on smartphones, we observe a phenomenon referred to as nomophobia.

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