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A Research Study on Cognitive Health Benefits of Nicotine to the Human Body

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Abstract

Background: Nicotine has been primarily known for its addictive properties and associated health risks, particularly in tobacco products. However, recent research has highlighted nicotine's potential cognitive health benefits, especially in neurodegenerative diseases like Alzheimer's and Parkinson's. This study investigates smoking prevalence across mental health conditions, and cognitive impairments in various psychiatric disorders, and explores the possible cognitive health benefits of nicotine. Methods: Data on age and gender distribution, smoking prevalence, and cognitive impairments were analyzed. The study also utilized meta-analyses to examine the effect sizes of cognitive deficits in different mental health conditions, including schizophrenia, bipolar disorder, major depressive disorder, PTSD, ADHD, and substance use disorders. Additionally, p-value calculations were conducted to evaluate the statistical significance of the observed differences. Results: Population distribution males represented 91.87% of the population, with the majority falling within the 18–30 age group. Females made up only 8.12%, predominantly in the 18–30 age group. Smoking Prevalence: The highest smoking prevalence was observed among individuals with substance use disorders (SUD), particularly opiate users (>98%) and cocaine users (80–90%). Schizophrenia showed smoking rates ranging from 54-89%, while bipolar disorder, major depressive disorder, PTSD, and ADHD exhibited substantial smoking rates (50–70%). Cognitive deficits schizophrenia displayed large deficits in executive functioning, working memory, attention/vigilance, episodic memory, and language. Bipolar disorder and major depressive disorder showed moderate deficits in working memory, attention, and processing speed. PTSD had severe deficits in verbal memory, while ADHD and substance use disorders exhibited moderate deficits in working memory, attention, language, and cognitive impulsivity. Nicotine's cognitive benefits, nicotine was found to enhance memory and cognitive function through modulation of key brain pathways, such as the phosphoinositide 3-kinase/Akt pathway and thyroid receptor signaling. It also promotes synaptic plasticity via chromatin modification and protein kinase activation. P-Value Analysis: The calculated p-value (0.1336) was greater than the significance level ($\alpha = 0.05$), indicating that the observed associations were not statistically significant. Conclusions: Nicotine has shown potential cognitive health benefits, particularly in individuals with neurodegenerative conditions. However, its cognitive-enhancing effects must be weighed against the risks associated with smoking and nicotine addiction. The study highlights the need for further research on controlled, non-addictive nicotine delivery methods to explore its therapeutic applications safely. Addressing research gaps related to long-term cognitive effects, nicotine delivery methods, and diverse population studies will contribute to a more nuanced understanding of nicotine's role in cognitive health.

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INTRODUCTION

Cognitive Enhancement

- *Attention and Memory:* Some studies suggest that nicotine may improve cognitive functions, such as attention, learning, and memory, particularly in individuals with cognitive impairments [1].

- *Neuroprotective Effects:* Research on diseases like Alzheimer's and Parkinson's suggests that nicotine might have neuroprotective properties, potentially delaying the onset of these conditions by affecting cholinergic pathways [2].

Potential Role in Parkinson's Disease

- *Motor Symptoms:* Some epidemiological studies have shown that nicotine might have a protective effect against Parkinson's disease. The mechanism is thought to involve nicotine's interaction with dopaminergic neurons, which are damaged in Parkinson's disease [3].

Nicotine and Weight Management

- *Appetite Suppression:* Nicotine has been shown to suppress appetite and increase metabolic rate, which is one reason some smokers report weight loss or reduced appetite when they start smoking [4, 5].

Nicotine as an Anti-Inflammatory

- *Inflammation:* Some research suggests that nicotine may have anti-inflammatory effects. This has led to interest in nicotine's role in treating inflammatory diseases like ulcerative colitis [5, 6].

Nicotine and Schizophrenia

- *Self-Medication Hypothesis:* Many individuals with schizophrenia smoke, and it's believed that nicotine may help alleviate some of the cognitive deficits and negative symptoms of the disorder by enhancing dopamine transmission [7].

Nicotine and ADHD

- *Attention:* Deficit/Hyperactivity Disorder (ADHD): There is ongoing research into whether nicotine or nicotinic receptor agonists can help improve attention and impulse control in individuals with ADHD [8–10].
- *Aim:* To conduct a research study on the cognitive health benefits of nicotine to the human body.
- *Objective:* To study the impact of nicotine on the cognitive health behavior of the population.

METHODOLOGY

Source of Data

Data will be collected through personal interviews and their reported outcomes.

Study Criteria

Inclusion Criteria

1. Patients who have the habit of smoking.
2. Patients with the age range of 18 years and above.

Exclusion Criteria

1. Patients who are not willing to participate in the study.
2. Patients below the age of 18 years.

Study Period

The study will be conducted over a period of 14 months from August 2023 to October 2024.

Sample Size: 9604

This means 9604 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within ±1% of the measured/surveyed value.

- *Study site:* Population residing in Kogilu, Yelahanka, Bangalore, Karnataka, India.
- *Study Type:* A prospective interventional study.
- *Study Design:* Case-control study.

Method of Data Collection

The present study involves in comparison of two groups as follows

- *Group A:* People with similar age group occupations and food habits are almost the same but they are non-smokers.
- *Group B:* People with similar age groups, occupations, and food habits are almost the same, but they are smokers.

Statistical Analysis

Microsoft Excel is used for recording and analyzing the data of recruited subjects and for calculating mean, standard deviation, etc. Prism Graph Pad software 10.2.0 (Windows and Mac) and Jamovi 2.3.26 software will be used for the determination of descriptive statistics and P value and another relevant statistical test will be calculated for the present study by the above software.

RESULTS AND DISCUSSION

Age Distributions Among Study Participants

The population distribution by age and gender reveals a significant difference between males and females. Among males, the age group 18–30 constitutes the largest proportion, with 51.01% (4502 individuals), followed by the 31–40 age group at 34.90% (3080 individuals). The remaining age groups have a much smaller representation: 11.35% in the 41–50 group, 1.427% in the 51–60 group, and less than 1% in the older age groups. For females, the majority, 85.89% (670 individuals), fall within the 18–30 age group, while only 8.717% are in the 31–40 group, 5.38% in the 41–50 group, and there are no females in the age groups above 50. In total, males make up 91.87% of the population, with females representing 8.121% (Table 1 and Figure 1) [11–16].

Table 1. Representing the age-wise distribution of the population.

Age (Males)	Number	Percentage	Age (Females)	Number	Percentage
18–30	4502	51.01	18–30	670	85.89
31–40	3080	34.90	31–40	68	8.717
41–50	1002	11.35	41–50	42	5.38
51–60	126	1.427	51–60	00	00
61–70	88	0.997	61–70	00	00
71–80	24	0.271	71–80	00	00
81–90	2	0.044	81–90	00	00
Total	8824	91.87	Total	780	8.121

Smoking Prevalence Across Mental Health Conditions, Cognitive Impairments in Mental Health and Substance Use Disorders

The prevalence of smoking varies significantly across different mental health conditions, with the highest rates observed in individuals with substance use disorders (SUD), particularly those using opiates (>98%) and cocaine (80–90%). Schizophrenia also shows a high smoking prevalence, ranging from 54–89%, while bipolar disorder (euthymic) and major depressive disorder (MDD, euthymic) have smoking rates between 50–70%. Conditions like PTSD and ADHD exhibit slightly lower smoking rates, at 50–60% and around 60%, respectively.

Regarding cognitive impairments, executive functioning is predominantly affected in schizophrenia, bipolar disorder, and substance use disorders, while working memory shows deficits across several conditions, including schizophrenia (low), ADHD (moderate), and substance use disorders (moderate). Attention/vigilance is notably impaired in schizophrenia and ADHD, while episodic memory is affected in schizophrenia. Visual memory shows moderate impairment in bipolar disorder and substance use disorders, while verbal memory is impaired in schizophrenia (low), bipolar disorder (moderate), and PTSD (severe). Language deficits are present in schizophrenia, ADHD, and substance use disorders. Additionally, cognitive impulsivity is a challenge for individuals with substance use disorders, and

impairments in sensory-perceptual functioning are noted in schizophrenia and substance use disorders. Finally, processing speed is moderately affected in bipolar disorder and major depressive disorder (Table 2 and Figure 2).

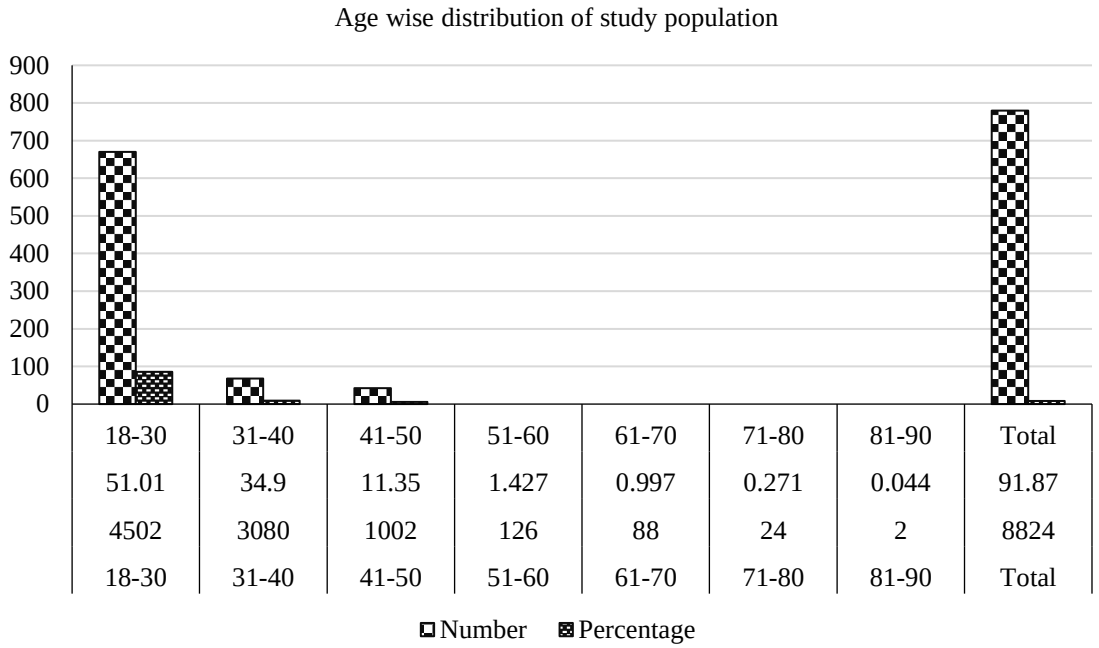

Figure 1. Representing the age-wise distribution of the study population.

Table 2. Representing the cognitive deficits identified in meta-analyses across major psychiatric disorders.

	Schizophrenia	**Bipolar (Euthymic)**	**MDD (Euthymic)**	**PTSD**	**ADHD**	**SUD-Cocaine**	**SUD-Opiate**
Smoking Prevalence	**54–89%**	**65–70%**	**50–70%**	**50–60%**	**~60%**	**80–90%**	**>98%**
Cognitive Domains							
Executive functioning	L	S	L		L		L
Working memory	L	S		M	M	M	M
Attention/vigilance	L				M	L	
Episodic memory	L						
Visual memory			M			M	
Verbal memory		L	M	S	M		
Language	L			M	M	L	
Cognitive impulsivity							M
Sensory-perceptual	M					M	
Processing speed		M		M			

Note: L = large effect size (d > 0.9), M = moderate effect size (0.78 > d ≥ 0.6), S = small effect size (0.4 > d ≥ 0.3).

P-Value Calculation

An interactive p-value calculator with solutions and graphs for Z-scores, T-scores, F-scores, and Chi-square scores.

$$P = P(Z < 1.5) = 0.9332$$

1 – P = P (Z > 1.5) = 0.06681
P-value = 2 * Min [P, 1–P]
P-value = 2 * Min [0.9332, 0.06681]
P-value = 2 * 0.06681 = 0.1336
P (Z < –1.5) + p (Z > 1.5) = 0.1336
Since the p-value (0.1336) is greater than α (0.05), H_0 is not rejected. (0.1336 > 0.05)

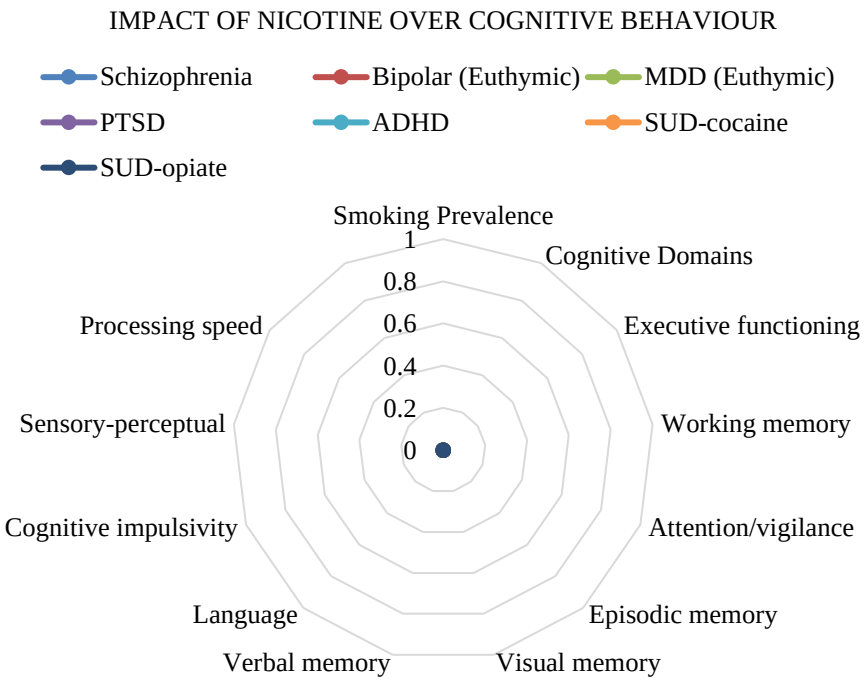

Figure. 2. Representing the cognitive deficits identified in meta-analyses across major psychiatric disorders.

DISCUSSION

The analysis of the population distribution by age and gender reveals a significant gender disparity in the study participants, with males representing 91.87% of the population and females only 8.12%. Among males, the majority (51.01%) fall within the 18–30 age group, followed by 34.90% in the 31–40 age group, indicating that most of the male participants are younger. In contrast, the female population is predominantly composed of individuals aged 18–30, accounting for 85.89%, while only a small percentage of females (8.717%) are in the 31–40 age group. This disproportionate representation of females across age groups, especially the absence of females in age groups over 50, suggests a gender bias in the sample or could indicate that fewer older females were included in or participated in the study. The smoking prevalence data highlights a strong correlation between mental health disorders and smoking habits, with the highest rates observed among individuals with substance use disorders (SUD), particularly for opiate use (>98%) and cocaine use (80–90%). Schizophrenia also has a notably high smoking prevalence, ranging from 54–89%, while other conditions like bipolar disorder (65–70%), major depressive disorder (50–70%), PTSD (50–60%), and ADHD (~60%) show substantial smoking rates. These findings suggest that smoking may serve as a coping mechanism or self-medication in these populations, aligning with previous studies showing a high prevalence of smoking among individuals with psychiatric disorders.

Cognitive impairments across mental health conditions reveal varying deficits in different cognitive domains. Schizophrenia shows large effect sizes in executive functioning, working memory, attention/vigilance, episodic memory, and language, indicating significant cognitive challenges in these

areas. Bipolar disorder (euthymic) and major depressive disorder (euthymic) show moderate to small deficits in working memory, attention, and verbal memory, with bipolar disorder also impacting processing speed. PTSD primarily affects verbal memory, with a severe effect size, while ADHD shows moderate deficits in working memory, attention, and language. Substance use disorders, particularly related to cocaine and opiate use, exhibit widespread cognitive impairments, including working memory, executive functioning, and sensory-perceptual functions, with moderate to large effect sizes. Cognitive impulsivity is notably observed in substance use disorders, suggesting difficulties in self-regulation. The results of the p-value calculation ($p = 0.1336$) indicate that there is insufficient statistical evidence to reject the null hypothesis (H0). Since the p-value is greater than the significance level ($\alpha = 0.05$), it suggests that the observed differences or associations are not statistically significant, implying that the study data may not support a strong relationship between certain variables analyzed. This emphasizes the need for further research with larger sample sizes or more robust statistical methods to explore the associations more comprehensively. Overall, the study underscores the high smoking prevalence among individuals with psychiatric disorders and highlights the cognitive deficits associated with various mental health conditions. These findings are crucial for developing targeted interventions aimed at addressing both the physical health concerns (such as smoking cessation) and cognitive impairments in these populations.

Recent investigations have illuminated the complex nature of nicotine, long recognized for its addictive properties and associated health risks, while also uncovering potential cognitive health benefits. Nicotine's ability to enhance cognitive function has gained attention, particularly in the context of neurodegenerative disorders like Alzheimer's and Parkinson's disease [17]. Research suggests that nicotine can improve memory and cognitive impairment by modulating key brain signaling pathways, including the phosphoinositide 3-kinase/Akt pathway and thyroid receptor signaling. Additionally, nicotine has been shown to promote synaptic plasticity and improve memory function through chromatin modifications and the activation of essential protein kinases [18]. However, these promising findings must be considered within the context of several important factors, such as dosage, method of delivery (e.g., e-cigarettes versus traditional smoking) [19], and the health status of the individual, all of which significantly influence nicotine's effects. Moreover, although some studies suggest cognitive improvements in healthy individuals under specific conditions, the long-term effects of nicotine use remain unclear, particularly regarding its addictive potential and associated health risks [20]. To fully understand nicotine's cognitive health benefits, several research gaps must be addressed. First, there is a need for longitudinal studies to examine the long-term cognitive effects of nicotine, especially in diverse populations with varying health conditions [21]. Second, while some mechanisms have been identified, a more comprehensive understanding of nicotine's interactions with neural pathways is required, necessitating further molecular studies. Third, comparative research on the cognitive effects of different nicotine delivery methods, such as e-cigarettes versus traditional smoking, is limited and could inform safer usage guidelines [22]. Additionally, broader studies involving various demographic groups are essential to determine which populations may benefit most from nicotine's cognitive-enhancing properties. Finally, thorough assessments of the potential negative health impacts of long-term nicotine use, such as addiction and cardiovascular risks, are crucial to weigh its cognitive benefits against its adverse effects. Addressing these research gaps will contribute to a more nuanced understanding of nicotine's role in cognitive health and its potential therapeutic applications [23].

CONCLUSIONS

Although nicotine is most often associated with various harmful effects on the human body, particularly due to its presence in tobacco products, this research suggests some potential benefits, particularly in specific contexts. It's essential to note that, however, any benefits do not outweigh the overall risks of nicotine use, while this study highlights the potential benefits of nicotine, it is important to understand that nicotine's delivery through smoking or vaping poses significant health risks, including addiction, cardiovascular issues, and respiratory diseases. Many researchers emphasize the need for controlled, non-addictive delivery methods to explore these potential therapeutic uses of nicotine.

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