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Applying Data Science to Assess Postpartum Depression in Women from Rural Bihar in India

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Abstract: ***Postpartum Depression (PPD) affects women during pregnancy or within a year of giving birth. This paper uses data science principles to study the prevalence of PPD in women from the state of Bihar in India. Data was obtained by trained surveyors for a random sample of 531 women, aged 15 to 41 years old, who had been pregnant or recently given birth. Our results show a significant occurrence of PPD in the population with 24% ± 4% of women showing symptoms based on a 95% confidence interval. We analyze the impact of age, number of children and sex of the last child on PPD. PPD was found to be 70% more prevalent in women between the ages of 30 and 39, correlated with them having more children. Women in this age group had on an average 4.6 children compared to the overall sample average of 2.1 children per mother.***
Keywords: postpartum depression, rural women, data science

I. INTRODUCTION

According to the American Psychiatric Association, depression is a common mental health illness that affects the way one thinks and feels leading to a loss of interest in pleasurable activities, increased fatigue, feeling worthless or sad, and thoughts of suicide or death. Postpartum Depression (PPD) affects 10-15% of new mothers [1] and is characterized by minor or major episodes of depression during pregnancy or within a year of giving birth [2]. During this phase of a woman's life, they become more susceptible to depressive symptoms due to rapid hormonal and life changes [3]. Not only does PPD have long term effects on the mood and mental health of a mother, but it also affects the child as this is when the foundation of optimal growth across the lifespan is established [4]. A meta-analysis of 9 studies revealed that PPD adversely affects the interactions between a mother and her child as she may have difficulties with breastfeeding, soothing, and enjoying the baby [5]. As a result, a young infant can be drowsier, fussier, and developing insecure attachment patterns [6]. This may also have a detrimental effect on long-term fetal and child development, resulting in stunted growth, delayed cognitive abilities, and impaired social skills [7].

It is estimated that around 22% of new mothers in India suffer from PPD and need medical attention to protect themselves and their babies [8]. However, the scarcity of mental health professionals, the unequal distribution of resources, and inefficient use of programs and supplies limit the advancement of mental health across the nation [9]. This is partially because less than 1% of the national healthcare budget is dedicated to mental health spending [10]. Furthermore, widespread social stigma in the form of ignorance, prejudice, and discrimination impedes timely diagnosis and rehabilitation and reduces the overall quality of life for the mentally ill [11]. As a result, many mothers remain undiagnosed because shame, fear, and guilt prevent them from reaching out for help [6]. In rural and low-income communities in India, PPD is further amplified due to contextual factors including unemployment, low education, poverty, domestic violence, and inadequate social services [7].

Following the launch of India's national mental health program in 1982, new policies and services attempted to provide aid, but the program lacked funding for maternal mental health [9]. In 2005, the National Rural Health Mission (NRHM) was created to address the health needs of villages, but it also failed to address maternal mental health in its statement [12]. PPD is a significant health problem in India, especially in rural areas. The goal of this study is to apply data science principles to quantify the prevalence of PPD in rural Bihar, analyze factors that increase likelihood, and shed light on ways in which local community-based healthcare organizations can play an important role in diagnoses and intervention.

II. DATA COLLECTION

A. Demographics of Bihar

Bihar is the third largest state in India, with an overall literacy rate and health index rank that is amongst the lowest across states in India [13]. It has one of the highest rates of maternal, neonatal, and infant mortality. Poor health outcomes are further exacerbated by social inequality, low literacy rates, and extreme poverty. A variety of languages are spoken including Hindi, Bhojpuri, Maithili, and Magahi.

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The language used to communicate for this study was Thethi, a dialect of the Maithili language. Bihar is broken up into 38 administrative districts. This study was conducted in the Samastipur District of Bihar. This district is further split into 20 blocks, which includes 381 *panchayats* (village councils). Data was collected from 15 randomly selected wards across 10 panchayats of Dalsinghsarai block, providing a representative sample of the population.

B. Background of Participants

Over the course of seven months, 531 women were selected for this study. The study was conducted on women between the ages of 15 and 41. Each ward typically had between 20 and 25 pregnant women or new mothers who consented to participating in the study. These women live in very poor circumstances. Nearly 70% of them live in households that make less than INR 5,000 monthly, which is equivalent to USD 1.6/person/day based on purchasing power parity. Their lives are shaped by social factors which often includes domestic violence, little to no education, and abandonment by their husbands due to male-only migration for a living. Furthermore, health factors like poor nutrition and anemia put them and their babies at risk. We found that a staggering 80-90% of women in these communities are anemic. This leads to fatigue, weakness, and dizziness which also impacts their mental well-being. Despite the poor circumstances, the fertility rates in these communities are much higher and women often have more children, due to lack of access to birth control and social pressure to have more children, with a preference for a male child.

C. Field Workers

Data for this study was collected by Innovators in Health (IIH). IIH is a nonprofit organization that provides multiple forms of healthcare interventions to rural communities in Bihar. Their maternal mental health programs offer remote and on-site screenings for PPD, psychological and social support at the mother's doorstep, and free psychiatric treatments through professionals when required. A team of 15 Community Health Workers (CHWs) collected data for this study by directly engaging with participants in the field.

Of the 15, 8 were IIH full time staff members. IIH workers were trained from the National Institute of Mental Health and Neurosciences (NIMHANS), a medical institution and research center located in Bangalore, India. All staff members completed a mandatory training in community mental health. They were further trained to learn the foundations of Cognitive Behavioral Therapy (CBT) from the "Thinking Healthy" manual [14]. They implemented 6 of the interventions in this manual (ventilation, coping, problem-solving, mindfulness, breathing and relaxation, and healthy living) to help women build resilience against PPD.

The remaining 7 CHWs were Accredited Social Health Activists (ASHAs). ASHAs are frontline health workers employed by the government to help extend healthcare systems to rural populations. One ASHA is typically responsible for each ward. ASHAs help treat basic illnesses, improve sanitation and nutrition, and keep track of health and family demographics. They also conduct government mandated surveys once a month. An ASHA can visit around 200 households over the course of three days to checkup on residents for the survey. During this survey, they ask couples if they are expecting or planning to have a child soon. Pregnancy is a sensitive topic in these communities, and many couples are reluctant to discuss it openly due to social conventions and superstitions. The ASHAs are trained to approach the topic delicately. They may ask a subtle question such as, "*Kuch khush khabari aane wali hai kya*?" which translates to "Are you expecting any good news sometime soon?". Residents are familiar with this question and are more comfortable answering in a non-direct way. Based on their response, the ASHAs record basic information such as their name, age, and family details.

The ASHAs worked very closely with IIH staff members. They would meet with IIH *panchayat* coordinators to share information about recently reported pregnancies. The IIH workers then followed up with these families to gather more data and screen for depression. The community welcomes IIH members as the agency has been offering a wide array of services to plug gaps in the maternal health program for past several years.

D. EPDS Scoring Methodology

The Edinburgh Postnatal Depression Scale (EPDS) was used to assess depression levels during this study [15]. EPDS responders are asked to answer 10 questions about their mood, thoughts, and feelings from the last 7 days. The 10 question prompts are as follows:

1) I have been able to laugh and see the funny side of things
2) I have looked forward with enjoyment to things
3) I have blamed myself unnecessarily when things went wrong
4) I have been anxious or worried for no good reason
5) I have felt scared or panicky for no very good reason
6) Things have been getting on top of me

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7) I have been so unhappy that I have had difficulty sleeping
8) I have felt sad or miserable
9) I have been so unhappy that I have been crying
10) The thought of harming myself has occurred to me

Each question prompt is followed by four answer choices that map to a numerical score of 0-3. Responders are asked to select the option that most accurately reflects how often a particular circumstance has affected them. A higher score for each question implies higher tendency towards PPD. The final EPDS score is calculated by adding scores from each question based on the selected response. Since there are 10 questions with a score of 0-3 per question, the EPDS score can range from 0 to 30. A larger EPDS score indicates higher chances of depression. A score of 10 or above is widely used as a threshold to diagnose a positive case of PPD. The EPDS survey was translated to Hindi for this study and was administered after due validation and approval from the Internal Ethics Committee (IEC).

III. ANALYSIS AND RESULTS

A. *Dataset Analysis*

This study collected data from n = 531 total female participants, aged 15 to 41 years old. The average age of the participants was 23.6 years, the average number of children per participant was 2.1, and 15% of the participants were pregnant for the first time. Table 1 shows a summary of the dataset.

Table 1: Summary of dataset

	Sample Count	Sample Percent	Average Age	Average Children	First Pregnancy
No PPD	401	76%	23.4	2.0	15%
PPD	130	24%	24.2	2.3	14%
Total	531	100%	23.6	2.1	15%

We used a confidence interval metric that is based on approximating the distribution of error for binomially distributed observations, to a normal distribution [16].

$$CI = \hat{p} + z\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

In the equation above, $\hat{p}$ represents the proportion of true outcomes, n is the sample size, and z is the appropriate quantile of the normal distribution. For 95% Confidence Interval (CI), z is approximately equal to 1.96.

Based on the EPDS score threshold of greater than or equal to 10, a total of 130 participants or 24% of the sample were diagnosed with PPD. Using the CI estimation above, the margin of error is ±4% in the population. The average age as well as the average number of children for women with PPD was slightly higher than women without PPD, as shown in Table 1.

The dataset includes attributes such as age, number of children, first time pregnancy, sex of last child, weeks since delivery, and weeks to due date as independent variables, along with EPDS scores and PPD diagnoses derived from it. Cross correlation analysis did not reveal any significant correlation between independent variables and depression scores. Regression analysis also did not reveal any significant predictors based on P-value tests. We did notice that older women had a higher tendency to show PPD. We used this as a starting point to segment the dataset in age bands to perform further analysis.

B. *Key Results*

We analyzed the impact of age, number of children and sex of the last child on PPD. Fig. 1 shows prevalence of PPD across different age bands and sex of last child. Overall, prevalence of PPD remains flat for women under 30 and starts to rise sharply for women over the age of 30. As noted earlier, 24% of women show PPD in the sample. However, 42% of women aged 30-39 had PPD symptoms. PPD was 70% more prevalent for women in their 30s in the sample. Sex of the last child did not have a significant bearing on PPD.

Fig. 2 shows a distribution of women and number of children in the sample: 40% had less than 2 children, 47% had 2 to 3 children, and 10% had 4 to 5 children. PPD is more prevalent in women with more children: 22% of women with 3 or less children had PPD, compared to 38% of women with 4 or more children. Older women tend to have more children. Women in the 30-39 age bracket had on average 4.6 children compared to the overall sample average of 2.1 children per mother.

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Fig. 3 shows the average score as well as the total score for the ten EPDS survey questions across different age groups in the sample. We can see that average EPDS score rises with age, consistent with the observation that PPD is more prevalent in older women. The score contribution from questions 3, 4 and 6 were almost twice as much as contributions from other EPDS questions across all age bands, indicating that participants often blamed themselves unnecessarily when things went wrong, had been anxious or worried for no good reason, and felt things have been getting on top of them.

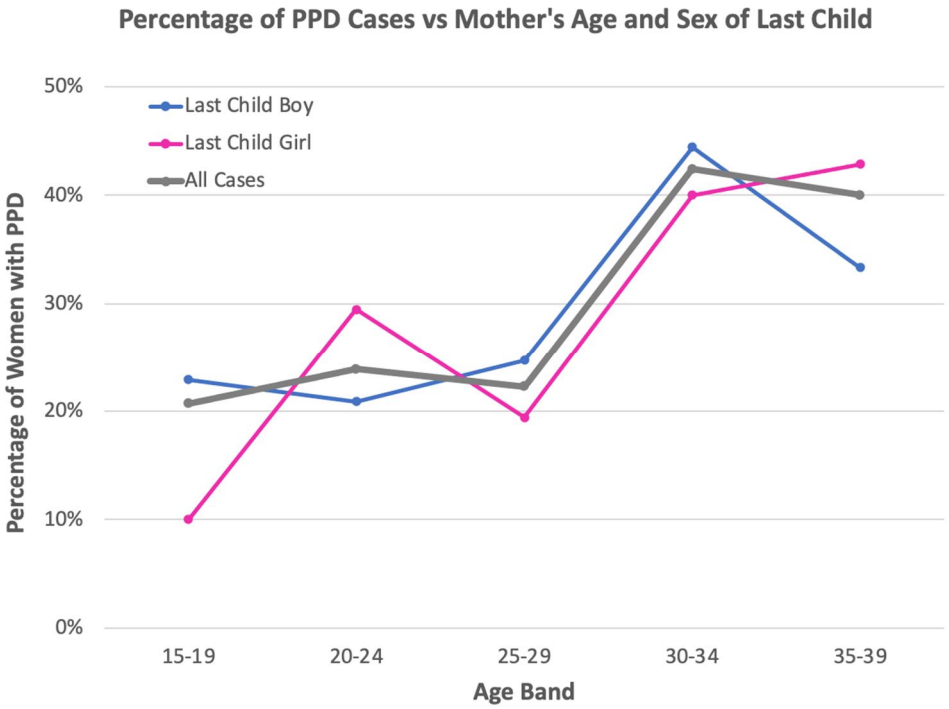


Fig. 1 Prevalence of PPD across different age bands and sex of last child

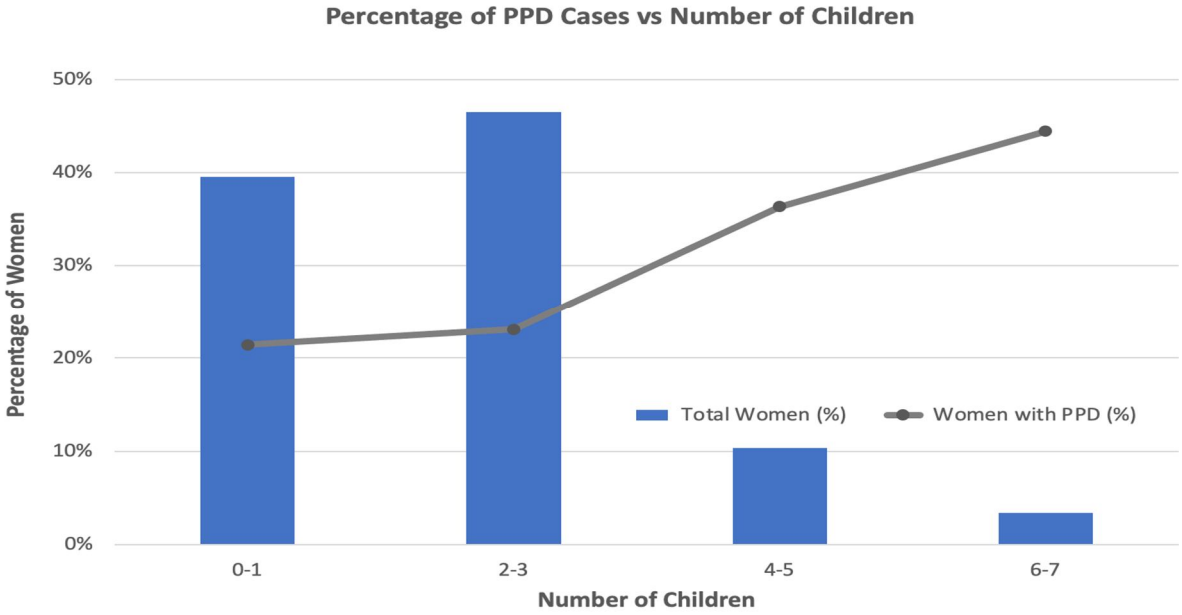


Fig. 2 Prevalence of PPD with number of children

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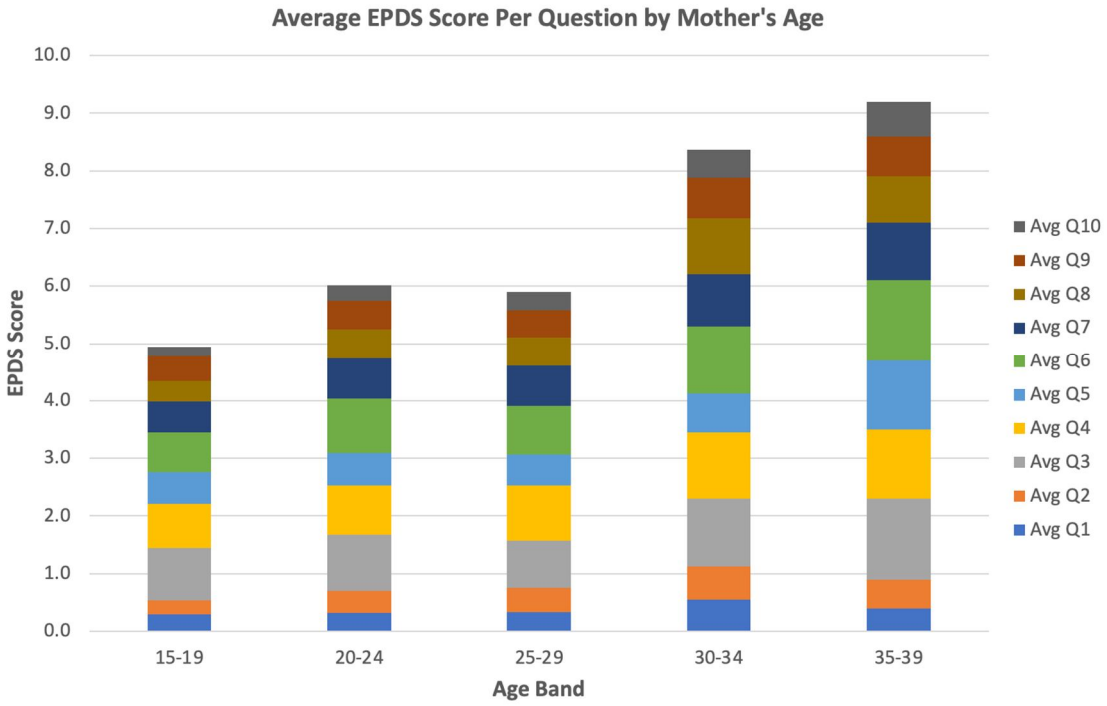


Fig. 3 Average EPDS scores across age bands

Question 10 is of particular importance in the EPDS survey as it relates to self-harm or suicidal tendencies and should always be looked at carefully. Table 2 shows the distribution of responses from the sample for question 10. Overall, 12% (± 3%) indicated that the thought of harming themselves had occurred to them sometimes or quite often in the past 7 days.

Table 2. Risk of self-harm in sample

The thought of harming myself has occurred to me	Sample Count	Sample Percent
Never	450	85%
Hardly	15	3%
Sometimes	58	11%
Quite Often	8	1%
Total	531	100%

IV. CONCLUSIONS

Our results corroborate findings that 22% of Indian mothers have PPD (Ghosh, 2020). In our rural Bihar population, 24% (± 4%) of women had PPD. Our results also show that mothers in specific age groups can be more prone to PPD. A key finding in our study was that PPD is 70% more prevalent for women in their thirties, compared to the population average. We hypothesize that younger women have more energy, may require less sleep and are physically and socially more flexible, making it easier to raise a child. Younger women's bodies can recover faster after giving birth. On the other hand, older women have higher risk for complications during and after pregnancy including gestational diabetes, high blood pressure, and premature birth. These health issues can lead to more depressive symptoms in older mothers.

Older women tend to have more children which also correlates with higher levels of PPD, a second key finding in our study. Mothers with more children must adapt to the needs of an infant while catering to the needs of older siblings that still require significant time and attention. They are unable to get some downtime from taking care of multiple children. Siblings may also have a difficult time coping with the arrival of a new baby, often seeking more attention from the mother, which can make her feel overwhelmed and helpless. We did not see any significant correlation between sex of the last child and PPD. Our dataset did not have a full history of the sex of all children from the participants. Further work is needed to establish if the social bias to have male children leads to higher prevalence of PPD.

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Analysis of EPDS score patterns suggests that women in the population suffer more from self-blame, anxiety, and feeling overwhelmed. Lack of awareness and social stigma around mental health issues can result in rural women often being scared to share their thoughts and struggles with family members, as they fear being shunned and labelled as a "bad mother". The fact that 12% (± 3%) of mothers indicated that the thought of harming themselves had occurred to them is of significant concern.

Raising awareness and reducing the social stigma in rural communities around mental health and PPD will enable women to openly discuss their condition and seek help. By making this a comfortable topic within families, husbands and relatives will be better suited to help women suffering from PPD. Social programs that provide childcare support, quality school education, and engagement activities for young children can help mothers focus on their pregnancy or newborn child and reduce the stress of having to deal with multiple children simultaneously. Programs that provide meals and supplements for pregnant and lactating mothers can help them gain strength and stamina.

CHWs play a vital role in PPD diagnosis and treatment in rural communities. They can effectively administer at-home screening and counselling sessions and facilitate referrals for severe cases. Public health initiatives should invest more in CHWs and PPD interventions to assist rural women who are often disenfranchised and suffer silently from misogyny, neglect, and abuse

V. ACKNOWLEDGMENTS

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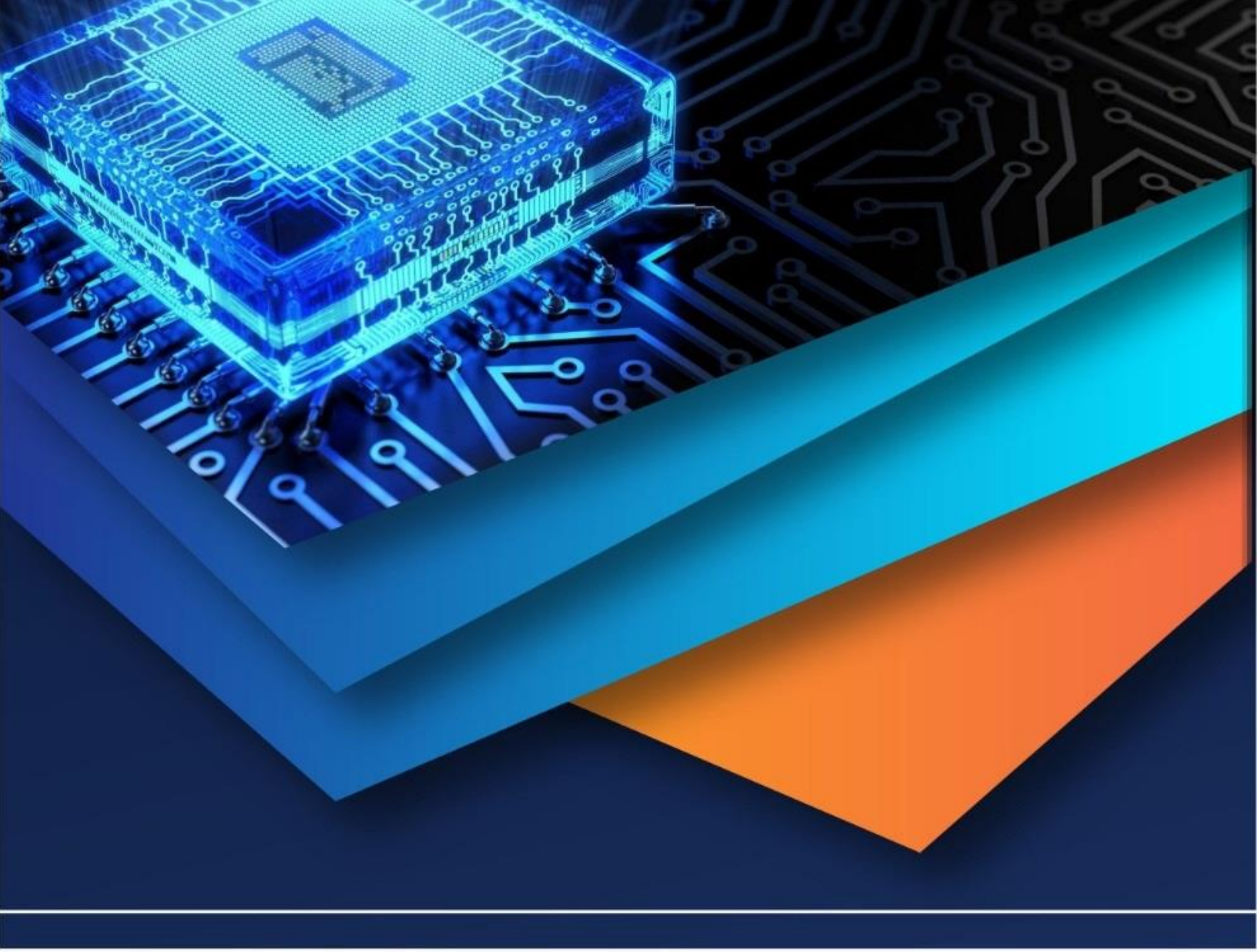
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