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Exploring the Impacts of AI Tools on Human Health

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Abstract

With the rapid advancement in AI technology, the world has become more reliant on tools like Google, Alexa, Siri, and ChatGPT, and it has become an integral part of ones' life as it offers convenience and enhances productivity. Although with excessive reliance on such tools affects human health with disturbed sleeping patterns, increase in stress and decreased cognitive abilities which might diminish critical thinking, reduce creativity, and increase mental health issues such as depression and anxiety. This study investigates the impacts of AI tools on human health and ones' mental and emotional well-being. It explores the potential benefits and risks associated with the integration of these tools. Hence positioning to understand the impact of AI tools on daily routines and overall wellness. By analyzing empirical data and user experiences, this study aims to provide insights on a balanced perspective on how AI tools influence human health and mental well-being, with further guidelines for optimizing their use to promote beneficial outcomes while mitigating adverse effects. At last, this study paves the way for future innovations that support our well-being.

Keywords: Artificial Intelligence, Mental Health, Cognitive Abilities, Digital Well-being, Technology Dependence, Human–AI Interaction.

Introduction

Artificial Intelligence (AI) has rapidly transformed the way humans interact with technology, becoming an essential part of everyday life. AI-powered tools such as virtual assistants, search engines, and conversational systems have significantly enhanced convenience, efficiency, and productivity across personal and professional domains. From managing daily schedules to providing instant access to information, these technologies have reshaped human routines and decision-making processes. As AI continues to evolve, its integration into society is becoming increasingly unavoidable.

Despite the numerous advantages offered by AI tools, growing concerns have emerged regarding their impact on human health and mental well-being. Excessive dependence on AI-driven technologies may contribute to disrupted sleep patterns, heightened stress levels, reduced attention spans, and declining cognitive abilities. Over-reliance on automated systems can also affect critical thinking and creativity, as individuals may rely more on AI-generated outputs rather than independent reasoning. Furthermore, prolonged and uncontrolled usage of digital technologies has been associated with mental health challenges such as anxiety, depression, and emotional fatigue.

Understanding the balance between the benefits and risks of AI tools is essential for promoting healthy and sustainable technology use. While AI can support mental well-being through personalized assistance and stress management applications, improper usage may intensify psychological strain and reduce overall quality of life. Therefore, it is crucial to examine how AI tools influence daily routines, cognitive functions, and emotional health.

Problem Statement

This study examines the impact of AI tools on daily routines and overall well-being, focusing on their advantages and limitations in areas such as efficiency, problem-solving, innovation, and emotional health. It explores how AI technologies influence physical and mental health, including their role in healthcare applications like diagnostics and personalized treatments, as well as their psychological effects, such as privacy concerns and reduced human interaction. The study aims to provide insights for promoting a balanced and healthy integration of AI in society.

Objectives

- To analyze the impact of AI tools on privacy and data security concerns in the context of mental health.
- To visualize the sleeping patterns and stress levels based on extended screen time.
- To analyze the long-term effects of AI tools on cognitive abilities.
- To investigate the role of AI in shaping our learning experiences.

Materials and Methods Data Collection

We gathered primary data via a Google Forms questionnaire survey, shared across various online channels to gain insights into exploring the impact of AI tools on Human health.

Sample Size: A total of 205 individuals were included in the study's sample

Tools and Techniques: We used Python in Jupyter Notebook for our project, capitalizing on essential libraries like Pandas, NumPy, Scikit- -learn, SciPy, Matplotlib, and Seaborn for Data analysis, Visualization, and modeling.

Correlation: The relationship between two random variables X and Y is called correlation. There are two types of correlation a) Positive correlation: An increase in one variable leads to an increase in the other variable or a decrease in one variable leads to a decrease in the other variable is called a positive correlation. EX: heights and weights of a group of persons, Demand, and supply of a commodity b) Negative Correlation: An increase in one variable leads to a decrease in the other variable or a decrease in one variable leads to an increase in the other variable is called negative correlation.

$$r=r(x, y) = \frac{cov(x,y)}{\sigma_x \sigma_y}$$

$$cov(x, y) = \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})$$

$$cov(x,y) = \frac{1}{n} \sum_{i=}^{n} x_j y_i - \bar{x}\bar{y}$$

Correlation Coefficient: The correlation coefficient (r) is a statistical measure that calculates the strength and direction of the linear relationship between two continuous variables, X and Y. It ranges from -1 to 1, indicating: -1: perfect negative linear relationship (as X increases, Y decreases) 0: No linear relationship (X and Y are independent) 1: Perfect positive linear relationship (as X increases, Y increases)

Chi-Square Test (χ^2): A statistical test that compares the observed frequencies of a categorical dataset with the expected frequencies, assuming that the null hypothesis (no association between variables or that the data fits a certain distribution) is true.

Formula: The chi-square statistic is calculated using the formula

$$\chi 2=\sum(Oi-Ei)^2/E_i$$

Where:

- Oi = Observed frequency in each category
- Ei = Expected frequency in each category
- The summation is over all categories

Logistic Regression Analysis

Logistic regression is a supervised machine learning algorithm that accomplishes binary classification tasks by predicting the probability of an outcome, event, or observation. The logistic regression formula is:

The logistic regression formula is:

$$p = 1 / (1 + e^{(-z)})$$

Where:

- p is the probability of the positive outcome (1)
- e is the base of the natural logarithm (approximately 2.718)
- z is the logit, a linear combination of the predictor variables:
- z = β0 + β1x1 + β2x2 + … + βnxn
- β0 is the intercept or constant term
- β1, β2, …, βn are the coefficients of the predictor variables
- x1, x2, …, xn are the predictor variables

Metrics for Evaluating the Performance:

i). Confusion Matrix: The confusion matrix provides a detailed breakdown of the model's performance by showing the number of correct and incorrect predictions across different classes.

- **True Positives (TP):** Correctly predicted positive cases.
- **True Negatives (TN):** Correctly predicted negative cases.
- **False Positives (FP):** Incorrectly predicted positive cases.
- **False Negatives (FN):** Incorrectly predicted negative cases.

ii). Accuracy: Accuracy is the proportion of correctly predicted instances out of the total instances.

Accuracy= (TP+TN)/(TP+TN+FP+FN)

iii). Precision: Precision measures the accuracy of positive predictions. Precision=TP/(TP+FP)

iv). Recall (Sensitivity or True Positive Rate): Recall measures the ability of the model to identify all positive instances.

Recall=TP/(TP+FN)

v). F1 Score: The F1 Score is the harmonic mean of precision and recall, providing a single metric to balance the two.

F1 Score=2× [(Precision× Recall) / (Precision +Recall)

Cluster

Cluster is a statistical method for processing data. It works by organizing items into groups – or clusters – based on how closely associated they are.

The objective of the cluster is to find similar groups of subjects, where the "similarity" between each pair of subjects represents a unique characteristic of the group vs. the larger population/sample. Strong differentiation between groups is indicated through separate clusters; a single cluster indicates extremely homogeneous data.

A common clustering algorithm is K-Means Clustering. K-Means Clustering Algorithm

i). Initialization:

- Choose the number of clusters kkk.
- Randomly initialize k centroids (cluster centers) from the dataset.

ii). Assignment Step:

- For each data point, calculate the distance (often Euclidean distance) to each centroid.
- Assign each data point to the nearest centroid, forming kkk clusters.

iii). Update Step:

- Calculate the new centroids by taking the mean of all data points assigned to each cluster.

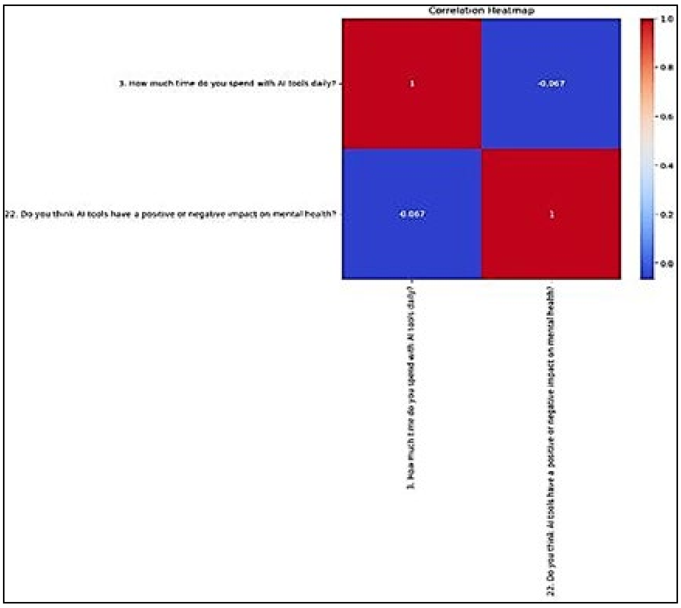
- Update the centroids' positions based on these mean values.

iv). Repeat: Repeat the assignment and update steps until convergence (i.e., the centroids no longer change significantly or the assignments of data points to clusters remain the same).

Results and Discussions

Correlation Analysis

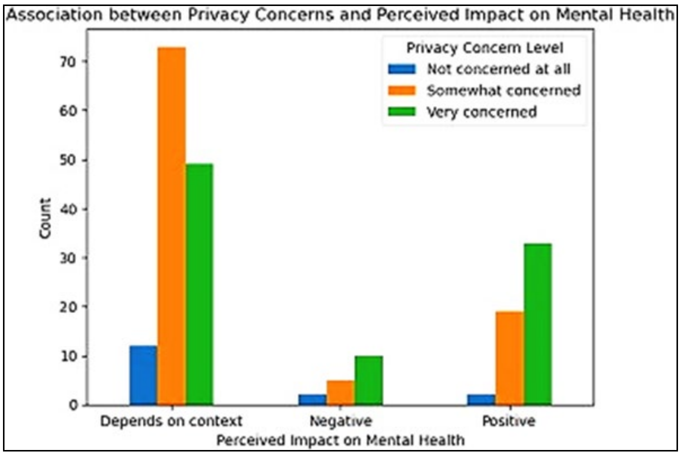
The correlation coefficient of -0.067 indicates a very weak negative correlation between the amount of time spent using AI tools daily and the perception of their impact on mental health. This suggests that as the time spent with AI tools increases, the perceived impact on mental health slightly tends towards being negative, though the effect is almost negligible.



The colors on the heatmap represent the strength and direction of the correlation between the variables:

- **Red:** Indicates a positive correlation. The stronger the red, the stronger the positive correlation.
- **Blue:** Indicates a negative correlation. The stronger the blue, the stronger the negative correlation. This indicates that there is a very weak negative correlation between the amount of time spent with AI tools daily and the perception of AI's impact on mental health.

Chi-Square Test



Chi-square Value: 46.44816169076725

Indicates the strength of the association between the variables (privacy concerns/experience and perceived impact on mental health)

P-value: 8.297982360072044e-05 (approximately 0.000083%)

Since the p-value is extremely low (less than 0.05), you can reject the null hypothesis and conclude that there is a statistically significant association between the variables.

Degree of freedom - Value: 16 Indicates the number of categories in the contingency table

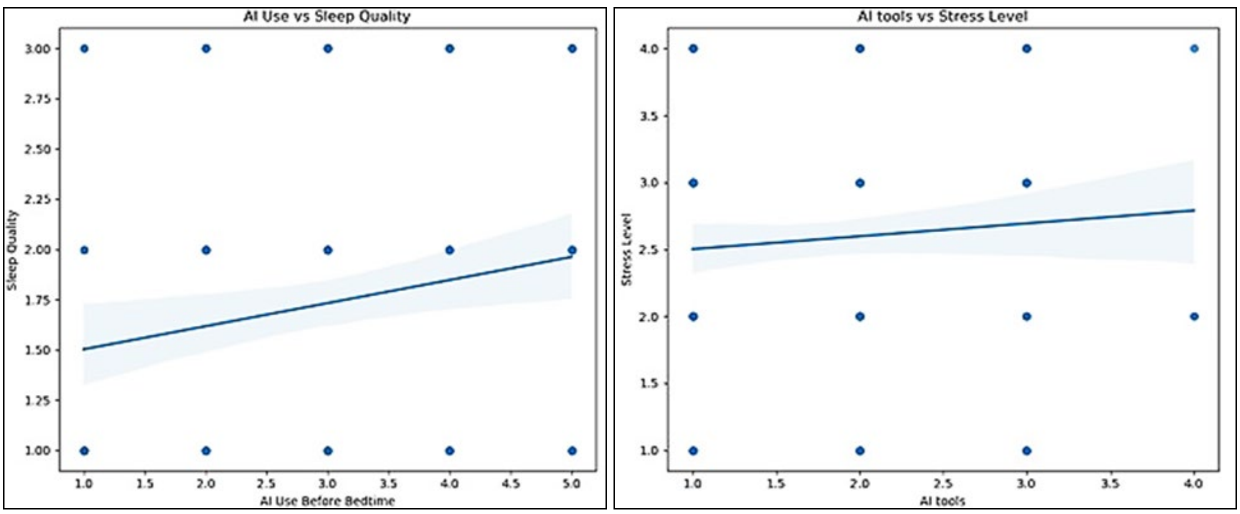
Phi Coefficient and Cramer's V:

Values: 0.16021370783019873

(Both) the values indicate a moderate association (around 0.16)

There is a statistically significant association between privacy concerns/experience and perceived impact on mental health. The association is moderate, indicating that individuals with higher privacy concerns/experiences are more likely to perceive a negative impact on their mental health. The results suggest that privacy concerns and experience play a role in shaping individuals' perceptions of the impact on their mental health.

Scatter Plot with Regression Line:



Left Plot: AI Use vs. Sleep Quality

- **X-Axis:** AI Use before Bedtime (on a scale, from 1 to 5, where 1 represents little to no use and 5 represents frequent use).
- **Y-Axis:** Sleep Quality (on a scale, from 1 to 3, where 1 represents poor sleep quality and 3 represents good sleep quality).

There is a slight positive relationship between AI use before bedtime and sleep quality. As AI use before bedtime increases, there is a minor increase in sleep quality, indicated by the upward slope of the regression line.

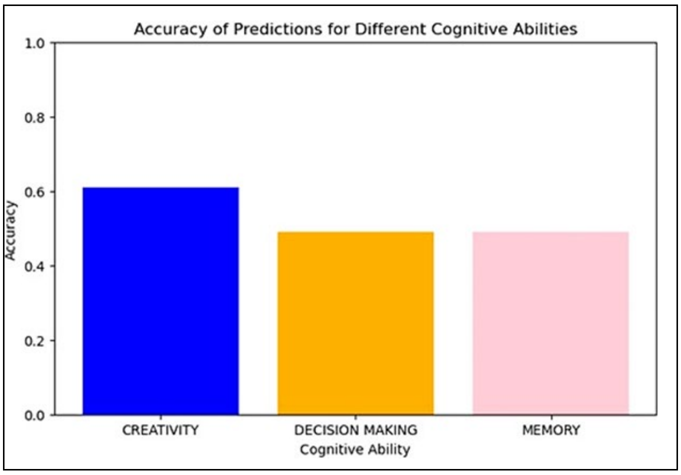
Right Plot: AI Tools vs Stress Level

- **X-axis (AI Tools):** This represents the general frequency of AI tool usage, also likely on a scale.
- **Y-axis (Stress Level):** This measures the level of frustration or stress experienced while using AI tools, on a scale of 1 to 4.

Trend: The regression line here is almost flat, indicating a very weak correlation between AI tool usage and stress level. This suggests that frequent usage of AI tools doesn't strongly affect stress levels. Overall Summary**:**

Sleep Quality: The data suggests that using AI tools before bedtime has a slight association with sleep quality, but the effect is minimal. Stress Level: The data shows a very weak relationship between AI tool usage and stress level, suggesting that users' stress levels are not significantly impacted by how often they use AI tools.

Accuracy of Predictions for Different Cognitive Abilities



The logistic regression analysis reveals that creativity is notably more influenced by AI tool usage, achieving an accuracy of 0.61, in contrast to decision-making and memory, which both recorded accuracies of 0.49. This finding implies that excessive engagement with AI tools may have a more significant effect on creative cognitive abilities.

Cluster Analysis

Each cluster demonstrates unique characteristics and preferences regarding the use of AI technology.

- Younger individuals exhibit a broad range of engagement levels, from minimal use in Cluster 0 to intensive multi-tool engagement in Cluster 1.
- The very young, in particular, concentrate their AI use on academic tools (Cluster 2), while slightly older individuals shift their focus towards healthcare applications (Cluster 3).
- Notably, older individuals demonstrate a comprehensive engagement with a variety of AI tools and report the highest levels of learning experiences (Cluster 4).

These patterns highlight a progression in AI tool utilization and learning experiences that correlate with age and specific interests. Thus, younger individuals being more inclined to AI tool usage the learning experiences are moderately affected.

Conclusion

The goal of this study is to reveal that AI tools have a significant impact on both physical and mental well-being. On the bright side, AI tools contribute to improving fitness and provide better management of health conditions. However, concerns about increased sedentary behavior, potential privacy issues, and psychological effects of AI tool algorithms also emerge. Given that, the downside of these tools affects human health with disturbed sleep and stress patterns, decreased cognitive abilities, and non-functionality of brain plasticity.

The findings of this study underscore the dual nature of AI's impact on human health. Centralizing over the following points:

To investigate the potential effects of AI tool dependency on mental health: Based on the analysis conducted, there has been a weak association between the amount of time spent with AI tools regularly and its impact on one's mental health. Therefore, the targeted sample shows no signs of disrupted mental health by the continued use of AI tools.

Visualizing sleep and stress patterns over screen time: The study centralizes on the usage of AI tools before bedtime influencing sleep quality and patterns, thus with less usage of tools before bedtime there is a betterment of sleep quality among respondents. To analyze the fluctuation of stress levels regarding AI tool usage, it proclaims no dominance of stress levels impacted by AI tools.

To study the long-term effects of AI tools on cognitive functionality: According to the analysis, the primary concerns of the cognitive abilities at risk are creativity, memory, and decision-making, amongst time management and productivity. The respondents opinionated that memory is most affected by AI tools.

To study the role of AI tools in shaping ones learning experience: By summarizing, it is evident that there are distinct clusters representing different age groups and levels of engagement with AI tools. This analysis sheds light on the varying degrees of engagement across different age groups and the specific areas of interest within AI tools.

Providing valuable insights into how different demographics interact with and benefit from AI tools. Thus, it suggests that the engagement with AI tools evolves as individuals grow older and their needs become more diverse.

To maximize the benefits of AI tools while mitigating their risks, users are encouraged to use these tools as a part of a balanced life rather than a sole focus. With future advancements in AI technologies, researchers should focus on long term impacts to refine the comprehensive understanding of AI tools. At last, it is crucial to safeguard our health and maintain healthy boundaries by limiting screen time, taking short breaks, and engaging in offline activities to ensure that these tools enhance rather than compromise our quality of life.

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