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The Relationship Between Digital Literacy and Internet Penetration on the Risk of Anxiety Disorders: A Big Data Analysis of Province-Based Social Media Usage

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ABSTRACT

The rapid surge in internet infrastructure in Indonesia has redefined social interaction, yet the psychological implications of this digital expansion remain insufficiently explored within regional contexts. This study examines the relationship between digital literacy, internet penetration, and anxiety disorder risks using big data analysis across 38 Indonesian provinces. The research aims to evaluate whether digital literacy serves as a critical moderator for technology-induced psychological distress. Adopting a quantitative secondary data design, the study synthesized metrics from 221,563,479 users using 2023–2024 reports from APJII, Kemenkominfo, and the Ministry of Health. Multiple linear regression and spatial analysis revealed that high internet penetration significantly correlates with increased anxiety ($p = 0.001$), especially in regions with deficient digital literacy. However, digital literacy demonstrated a robust buffering effect ($t = -3.124$), where proficiency in digital ethics and safety significantly reduced anxiety prevalence. These findings suggest that public health strategies must integrate digital hygiene into national mental health frameworks. The study concludes that fostering cognitive digital competence is vital for a resilient society, suggesting that future policies prioritize educational scaffolding over mere infrastructure expansion to bridge the emerging psychological digital divide.

Keywords: *Digital Literacy, Internet Penetration, Anxiety Disorders, Big Data, Cyber-psychology*

INTRODUCTION

The exponential surge in internet penetration across Indonesia, currently reaching over 220 million individuals based on the latest 2024 APJII report which shows a significant climb from previous years, has fundamentally restructured the landscape of social engagement and information consumption (Asosiasi Penyelenggara Jasa Internet Indonesia (APJII), 2024). Nevertheless, this massive technological integration does not always align with the mental and cognitive preparedness of its users (Effendi, 2023). A concerning practical issue has emerged where provinces characterized by high technological access simultaneously report a significant spike in the prevalence of anxiety disorders. National health surveys indicate fluctuating but rising trends in Emotional Mental Disorders (EMD), with prevalence rates reaching an average of 7.40% across various regional clusters (Kementerian Kesehatan Republik Indonesia, 2023). The core problem lies in how an unregulated digital ecosystem, devoid of adequate literacy, acts as a catalyst for emotional mental disturbances, necessitating an urgent mapping of mental health risks within the framework of national digital transformation (Xie, 2024).

The disparity between technical accessibility and the capacity for critical evaluation of digital content creates a profound psychological vulnerability (Yu, 2024). At the provincial level, variances in infrastructure and educational attainment result in diverse individual responses to digital stressors, including disinformation, cyberbullying, and the distorted social standards prevalent on social media platforms (Genobiagon, 2024). Theoretically, incessant exposure to massive data streams without sufficient cognitive filters can trigger persistent stress response mechanisms, which eventually manifest as generalized anxiety disorders among the productive-age population (Merzlyakov, 2024). This study empirically tests this concept by examining the interaction between digital literacy scores currently averaging 3.54 out of 5.00 and high-density social media exposure within a big data framework to determine if cognitive filters effectively mitigate stress.

Contemporary scholarship regarding the impact of digitalization on mental health has extensively investigated individual social media usage but frequently overlooks macro-level geospatial contexts and regional penetration variables. Several studies indicate that intensive internet utilization correlates positively with heightened levels of depression and anxiety, particularly among Generation Z (Sao, 2024). However, current literature remains constrained by a lack of cross-sectoral data integration between telecommunications infrastructure penetration and official government mental health statistics at the provincial level. Most existing research relies on restricted sample sizes within academic settings, unlike national-scale assessments that capture the aggregate dynamics of over 221 million users, thereby failing to capture the broad population dynamics influenced by regional digital literacy policies.

Furthermore, analysis concerning the role of digital literacy as a moderating variable remains remarkably scarce within the field of Indonesian cyber-psychology. Although the Ministry of Communication and Informatics (Kemenkominfo) regularly publishes the Digital Literacy Index, these metrics are seldom correlated with national mental health survey data to determine the extent to which digital proficiency can mitigate the risk of anxiety induced by internet penetration

(Ministry of Communication and Informatics, 2023). This oversight results in a "blind spot" within mental health promotion strategies, where clinical interventions are often disconnected from digital educational initiatives. The primary challenge is the deficiency of empirical evidence utilizing a big data approach to link social media user behavior with spatial anxiety prevalence rates. This oversight results in a "blind spot" within mental health promotion strategies, where clinical interventions are often disconnected from digital educational initiatives. Operationalizing this link requires integrating "digital hygiene" protocols into public health screenings, ensuring that mental health practitioners address the digital ethics and safety pillars as part of therapeutic recovery. The primary challenge is the deficiency of empirical evidence utilizing a big data approach to link social media user behavior with spatial anxiety prevalence rates.

A palpable gap exists between the rapid adoption of internet services and the understanding of psychological protective mechanisms afforded by digital literacy. Previous inquiries have largely remained descriptive and have yet to employ predictive analysis based on official secondary data, such as the internet penetration profiles from the Indonesian Internet Service Providers Association (APJII) and anxiety prevalence data from the Ministry of Health (Kemenkes). This study utilizes predictive multiple linear regression to move beyond simple descriptions, allowing for the quantification of how much digital literacy can statistically "buffer" or reduce the risk (reflected in a t-value of -3.124) compared to the risk increases caused by penetration alone. This study seeks to bridge this divide by evaluating whether provinces with high internet penetration but deficient digital literacy face a greater risk of anxiety disorders compared to regions with more mature digital competencies.

Building upon this gap analysis, the present research aims to examine the correlation between digital literacy, internet penetration, and the risk of anxiety disorders through a big data analysis of provincial-based social media usage in Indonesia. The novelty of this research lies in the integration of multi-sectoral data encompassing telecommunications, digital literacy, and mental health to construct a comprehensive digital psychosocial risk model. Through this methodology, the study is expected to provide an empirical foundation for policymakers to design digital literacy programs that prioritize the mental well-being of the citizenry.

METHODS

This section delineates the methodological framework, encompassing the research design, participants, procedural steps, and analytical tools employed to investigate the intersection of digital infrastructure and mental health. This study adopts a quantitative approach utilizing spatial correlation analysis of secondary datasets. Such a methodology is specifically selected to evaluate mental health phenomena at a macro scale by synthesizing vast data arrays from the telecommunications and public health sectors (Zhou, 2024).The research subjects consist of aggregate data from the general population across 38 Indonesian provinces, including the newly established administrative regions in Papua, with data localized to the 2023–2024 reporting period.

The research population comprises the collective data of 221,563,479 internet users in Indonesia, as documented by the Indonesian Internet Service Providers Association (APJII) in 2024. Given the big data nature of this study, a total sampling technique was applied at the administrative level, where each of the 38 provinces serves as a distinct unit of observation, thereby bypassing individual sample size calculations in favor of a comprehensive population-wide spatial census. The inclusion criteria required provinces to have complete datasets across all three primary variables for 2023–2024, while exclusion criteria applied to regions with fragmented mental health reporting to ensure statistical validity. The use of aggregate provincial data is justified as it aligns with national policy frameworks and allows for the identification of geospatial "hotspots" that are often obscured in smaller, localized samples . The inclusion of these samples was contingent upon the availability of metrics across three primary instruments:

1. The Indonesian Internet Penetration Survey Report (APJII) for penetration variables.
2. The Indonesian Digital Literacy Index (Kemenkominfo) for cognitive digital capacity variables.
3. The Indonesia Health Survey (SKI) and Ministry of Health Routine Data for anxiety disorder prevalence variables.

The investigative process initiated with data extraction from official open-access government portals and authorized organizational repositories. Internet penetration metrics were retrieved as percentage-based access per region, while digital literacy was quantified through a composite score of four pillars: digital skills, digital ethics, digital safety, and digital culture. Regarding mental health indicators, the researchers extracted the prevalence of Emotional Mental Disorders (EMD). EMD is utilized as a robust proxy for anxiety risk because it encompasses the spectrum of clinically verified psychological distress and non-psychotic disturbances that characterize the early stages of anxiety in digital environments . All data collection protocols adhered to ethical standards for the use of anonymous secondary data, which does not require individual informed consent as the information is aggregated at the provincial level.

The primary instruments utilized include statistical analysis software and Geographic Information System (GIS) mapping to visualize spatial distributions. The core materials integrated into this study are: Table 1: A provincial-based secondary data matrix (Variables X_1, X_2, and Y). Datasets: Official digital and health profile documents accessible via public ministerial repositories.

Table 1. Description of Variables and Official Secondary Data Sources

Variable	Key Indicators	Official Source	Data Year
Internet Penetration (X_1)	Percentage of population with internet access	APJII	2023/2024

Variable	Key Indicators	Official Source	Data Year
Digital Literacy (X_2)	Composite score of literacy pillars (Scale 0-5)	Kemenkominfo	2023
Anxiety Risk (Y)	Prevalence of Emotional Mental Disorders (EMD)	Kemenkes RI	2023

The dataset was subjected to multiple linear regression analysis to determine the correlation strength between the independent and dependent variables. The regression model is specifically designed to measure the moderating effect of digital literacy on the relationship between network expansion and psychological health. Furthermore, Spatial Autocorrelation was performed to detect whether anxiety risk clusters geographically in provinces sharing similar internet penetration profiles. In alignment with transparency principles, all analytical protocols and raw datasets are available to readers via research data repositories upon reasonable request following publication. This methodological description is presented concisely to ensure replicability by future researchers seeking to conduct cross-regional comparative studies (Griffith, 2023).

RESULTS

1. Spatial Distribution of Digital Metrics and Mental Health Prevalence

The extensive data analysis across 38 provinces uncovers a varied landscape regarding digital assimilation and its psychological repercussions. According to figures from the Indonesian Internet Service Providers Association (APJII, 2024), the country's internet penetration has reached an average of 79.50%. Nevertheless, this physical connectivity does not consistently align with the cognitive preparedness of the population, as evaluated by the Digital Literacy Index.

a. Regional Disparities in Internet Penetration

In highly urbanized provinces such as DKI Jakarta and West Java, the rate of internet penetration exceeds 85.00%. These specific regions also demonstrate a higher frequency of psychological stressors linked to social media consumption. In contrast, the newly established provinces in the Papua region report lower penetration figures, ranging between 50.00% and 60.00%, yet they face different catalysts for emotional distress, primarily stemming from information deficits rather than digital saturation (Kemenkominfo, 2023).

b. Digital Literacy as a Protective Factor

Empirical observations indicate that the Digital Literacy Index—which maintains a national average of 3.54 on a 5.00 scale functions as a critical determinant in how different populations manage digital stimuli. Provinces demonstrating superior scores in the "Digital Safety" and "Digital

Ethics" categories report a lower prevalence of cyber-victimization, a major precursor to clinical anxiety symptoms within digital spaces (Valkenburg, 2022).

2. Statistical Correlation and Mathematical Components

A multiple linear regression analysis was executed to quantify the relationship between the identified variables. The interaction between Internet Penetration (X_1), Digital Literacy (X_2), and the Risk of Anxiety (Y) is represented by the following econometric equation:

$$Y = \beta_0 + \beta_1 X_1 - \beta_2 X_2 + \epsilon$$
$$R^2 = 0.426; \text{Adj. } R^2 = 0.401$$

Statistical assessments regarding the impact of internet penetration on anxiety risk revealed a significant positive correlation, whereas digital literacy exhibited a significant negative correlation, suggesting a buffering effect. Hypothesis testing yielded the following results: $F(2,35) = 12.456; p = 0.001$. The effect size, calculated via partial eta squared (η_p^2), was 0.42, signifying a substantial impact. The individual t-test for digital literacy as a primary predictor resulted in $t(35) = -3.124; p = 0.003; d = 0.65$.

3. Data Visualization and Tabulation

Table 1. Correlation Matrix of Digital Profiles and Anxiety Prevalence by Regional Cluster

Regional Cluster	Internet Penetration (%)	Digital Literacy Index	Anxiety Prevalence (%)
High Access - High Literacy	88.20	3.92	6.10
High Access - Low Literacy	84.50	3.10	11.40
Low Access - High Literacy	62.10	3.65	4.80
Low Access - Low Literacy	58.40	2.80	7.20
National Total/Average	79.50	3.54	7.40

The statistics in Table 1 reveal that the highest prevalence of anxiety (11.40%) is concentrated in clusters where elevated internet penetration (84.50%) is not supported by sufficient digital literacy (3.10). This evidence supports the hypothesis that "Connectivity without Competency" serves as a primary risk factor for digital-related psychological disorders. It is increasingly clear that the "Digital Anxiety Gap" is most acute in rapidly developing suburban areas where infrastructure has outpaced formal digital training (Kementerian Kesehatan Republik Indonesia, 2023).

DISCUSSION

The outcomes of this large-scale data synthesis indicate that the intersection of technological proliferation and psychological health is not defined merely by the presence of infrastructure, but by the cognitive maturity of the user base. The evidence supports the "Digital Vulnerability Hypothesis," suggesting that high-speed connectivity correlates with psychological strain when it is not counterbalanced by digital literacy. The data highlights a critical disparity: regions characterized by high internet penetration but lagging digital literacy indices display the most acute risk of clinical anxiety, suggesting that rapid digitalization without educational scaffolding is associated with a "social media toxicity" trap.

The statistical reality of an 11.40% anxiety prevalence in regions with high access but low literacy underscores the detrimental effects of unregulated information flows. As theorized by Kuss and Griffiths (2020), when users lack the critical capacity to filter digital stimuli, they may become susceptible to "maladaptive cognitions" where the digital world is perceived as a primary source of social threat rather than a tool for utility. In the Indonesian provincial context, this manifests as a heightened sensitivity to cyber-harassment and news-induced stress, particularly in areas where the arrival of broad-spectrum internet has outpaced the development of critical thinking programs (Kuss, 2020).

A pivotal revelation in this research is the inverse relationship between literacy scores and anxiety levels ($t = -3.124$). This positioning of digital literacy as a "cognitive shield" suggests that the ability to navigate digital ethics and safety protocols provides users with a sense of agency that is linked to reduced feelings of helplessness and paranoia. This finding expands upon the work of Twenge (2020), who emphasized that the psychological burden of constant connectivity is most severe for those who internalize the superficial metrics of social media success. In provinces where literacy is robust, users demonstrate higher "digital hygiene," enabling them to disconnect from anxiety-inducing content and maintain a boundary between virtual interactions and real-world self-esteem (Twenge, 2020).

Beyond individual behavior, the macro-data provided by APJII and Kemenkes reveals a systemic public health challenge. The concentration of anxiety in developing urban hubs suggests that "digital stress" is a localized phenomenon influenced by regional policy. The data implies that psychological resilience in the digital age is as much a matter of educational infrastructure as it is of clinical intervention. These findings align with the framework proposed by Zuo (2022), which posits

that in a post-pandemic society, mental health stability is inextricably linked to one's ability to critically engage with digital platforms (Zuo, 2022).

Furthermore, the study suggests that the "Digital Anxiety Gap" is not permanent but can be mitigated through targeted literacy interventions that emphasize emotional intelligence within digital spaces. Future research should prioritize longitudinal tracking of provincial literacy scores to determine the long-term effectiveness of such educational policies on reducing national mental health expenditures.

Primack and Shensa (2021) posit that persistent engagement with these synthesized digital spheres, in the absence of analytical filters, results in a marked decline in psychological welfare (Shensa, 2021). This research identifies that in regional clusters where digital ethics scores are deficient, individuals show a higher propensity for accepting algorithmic biases as absolute truths, a process that subsequently associates with chronic stress and manifestations of generalized anxiety. Statistics from the Ministry of Health (Kemenkes, 2023) suggest that the fiscal strain associated with anxiety disorders is significantly more pronounced in digital epicenters where internet accessibility has achieved total saturation. As observed by Verduyn et al. (2020), the transition from passive observation to active social appraisal constitutes a pathway through which digital platforms compromise emotional stability (Verduyn, 2020).

Moreover, the evidence indicates that Indonesia is confronting an emerging dimension of disparity: the Psychological Digital Divide. Although state initiatives have effectively minimized the chasm in physical network connectivity (APJII, 2024), the discrepancy in "emotional-digital intelligence" persists. This study illustrates that provinces which have integrated advanced digital safety protocols into their regional pedagogical frameworks exhibit superior psychological endurance. This observation resonates with the discourse provided by Orben (2020), who argued that societal anxieties regarding technological shifts are often misdirected; the genuine peril resides in the insufficiency of adaptive mechanisms to regulate the impact of technology on the human mind.

CONCLUSIONS

This inquiry establishes that the preliminary projections detailed in the introduction—concerning the psychological ramifications of accelerated digital expansion—are empirically sustained through a rigorous big data synthesis. The observations confirm a definitive alignment between rising internet penetration and an intensified risk of anxiety disorders, yet they simultaneously reveal that this correlation is profoundly moderated by high levels of digital literacy. The essence of our findings indicates that while technological connectivity serves as a potent engine for socio-economic advancement, it functions as a dual-edged sword for mental well-being when the user base lacks the cognitive sophistication required to navigate intricate digital environments.

The fundamental contribution of this research lies in the spatial identification of the "Digital Anxiety Gap," particularly within regional clusters where elevated access is coupled with deficient literacy. This evidence demonstrates that infrastructural growth, in isolation, is insufficient for

safeguarding public mental health; it must be synchronized with psychological and ethical digital training. By consolidating secondary datasets from APJII, Kemenkominfo, and Kemenkes, this study offers a robust geospatial framework that emphasizes the necessity of treating digital literacy as a core public health intervention rather than a peripheral educational competency.

The prospects for expanding upon these research outcomes are significant. Future investigations should transition toward longitudinal monitoring of regional digital health to ascertain if literacy-driven policies result in a quantifiable reduction in clinical anxiety rates. Furthermore, there is a clear application prospect for developing AI-integrated "Digital Resilience Dashboards" at the provincial level, enabling health authorities to receive real-time indicators when digital stressors in specific jurisdictions escalate. Ultimately, this research provides an empirical cornerstone for a more integrated national digital transformation strategy one that prioritizes the "human software" with the same urgency as telecommunications hardware to foster a mentally resilient digital society.

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