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The Impact of PUBG Gaming on Cognitive, Psychological, and Academic Outcomes: A Multidimensional Empirical Study in Benghazi, Libya

Naeima Aeiad Hamad Alarifi *
Department of Oil And Gas Information Technology, High Institute of Technical Engineering Benghazi, , Benghazi, Libya

تأثير لعبة *PUBG* على النتائج المعرفية والنفسية والأكاديمية: دراسة تجريبية متعددة الأبعاد في بنغازي، ليبيا

نعيمة عيد حمد العرفي*
قسم تقنية المعلومات في قطاع النفط والغاز، المعهد العالي للهندسة التقنية، بنغازي، ليبيا

*Corresponding author: naimaelorafee@gmail.com

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Abstract:
This study provides a comprehensive, multidimensional analysis of the psychological, cognitive, behavioral, and academic impacts of prolonged engagement with Player Unknown's Battlegrounds (PUBG) within the socio-cultural context of Benghazi, Libya. Using a cross-sectional quantitative design (n = 200), the research integrates advanced statistical techniques, including Pearson correlation, independent samples t-tests, and multiple regression modeling, to examine the relationships between gameplay intensity, anxiety levels, executive function disruption, and academic performance.
The findings reveal a statistically significant positive correlation between daily gameplay duration and anxiety levels ($r = 0.48$, $p < 0.01$), alongside a strong negative association with academic performance ($r = -0.52$, $p < 0.01$). Regression results further confirm gameplay intensity as a robust predictor of both increased anxiety ($\beta = 0.44$) and decreased academic outcomes ($\beta = -0.49$), explaining approximately 41% of the variance ($R^2 = 0.41$). Moreover, children exhibited significantly higher levels of executive dysfunction, sleep disruption, and chronic procrastination compared to adults, indicating heightened neurodevelopmental vulnerability. The study introduces the concept of the "Digital Vacuum," referring to the structural absence of physical recreational alternatives, which amplifies dependency on virtual environments.
The findings are interpreted through established theoretical frameworks, including Time Displacement Theory, Self-Determination Theory, and Neurocognitive Load Theory. The study concludes with strategic recommendations at both policy and educational levels, emphasizing the integration of digital hygiene programs and the development of alternative socio-recreational infrastructures.

Keywords: Online Gaming, PUBG, Cognitive Function, Anxiety, Academic Performance, Behavioral Addiction, Digital Vacuum.

الملخص
توفر هذه الدراسة تحليلًا شاملاً ومتعدد الأبعاد للتأثيرات النفسية والمعرفية والسلوكية والأكاديمية للاشتراك المطول في لعبة Player Unknown's Battlegrounds (PUBG) ضمن السياق الاجتماعي والثقافي لمدينة بنغازي، ليبيا. باستخدام تصميم كمي مقطعي(n = 200) ، توظف الدراسة تقنيات إحصائية متقدمة، بما في ذلك ارتباط بيرسون، واختبارات

tللمجموعات المستقلة، ونمذجة الانحدار المتعدد، لفحص العلاقات بين شدة اللعب ومستويات القلق واضطرابات الوظائف التنفيذية والأداء الأكاديمي.
تكشف النتائج عن وجود ارتباط إيجابي معنوي إحصائيًا بين مدة اللعب اليومية ومستويات القلق($r = 0.48$) ، ($p < 0.01$، إلى جانب ارتباط سلبي قوي مع الأداء الأكاديمي($r = -0.52$) ، ($p < 0.01$). وتؤكد نتائج الانحدار أيضًا أن شدة اللعب تعد متنبئًا قويًا لكل من زيادة القلق ($\beta = 0.44$) وتراجع النتائج الأكاديمية($\beta = -0.49$) ، موضحةً حوالي 41% من التباين ($R^2 = 0.41$).
علاوة على ذلك، أظهر الأطفال مستويات أعلى بشكل ملحوظ من خلال الوظائف التنفيذية واضطرابات النوم والمماطلة المزمنة مقارنةً بالبالغين، مما يشير إلى زيادة التعرض للمخاطر النمائية العصبية. وتقدم الدراسة مفهوم "الفراغ الرقمي"، الذي يشير إلى الغياب الهيكلي للبدائل الترفيهية الفعلية، والذي يعزز الاعتماد على البيئات الافتراضية.
يتم تفسير النتائج من خلال أطر نظرية معتمدة، بما في ذلك نظرية إزاحة الوقت (Time Displacement Theory)، ونظرية تحديد الذات (Self-Determination Theory)، ونظرية الحمل العصبي المعرفي (Neurocognitive Load Theory). وتختتم الدراسة بتقديم توصيات استراتيجية على المستويين السياسي والتعليمي، مع التأكيد على دمج برامج النظافة الرقمية وتطوير بنى تحتية اجتماعية وترفيهية بديلة.

الكلمات المفتاحية: الألعاب الإلكترونية، ببجي، الوظائف المعرفية، القلق، الأداء الأكاديمي، الإدمان السلوكي، الفراغ الرقمي.

Introduction

The proliferation of online multiplayer games has redefined modern patterns of cognitive engagement, particularly among adolescents and young adults. Games such as PUBG are not merely entertainment platforms; rather, they function as complex psycho-social systems that integrate reward conditioning, competitive stress, and social identity formation.

From a neurocognitive perspective, these environments activate dopaminergic reward pathways, reinforcing repetitive engagement and, in some cases, leading to behavioral dependency. This phenomenon is particularly critical in regions such as Benghazi, where socio-economic instability and limited recreational infrastructure contribute to excessive reliance on digital environments.

This study is grounded in several theoretical frameworks:

- **Time Displacement Theory**: digital engagement replaces essential developmental activities
- **Self-Determination Theory**: games satisfy psychological needs (competence, autonomy, relatedness)
- **Cognitive Load Theory**: prolonged stimulation leads to mental fatigue and reduced efficiency

The concept of the **Digital Vacuum** is introduced to explain how environmental deprivation amplifies gaming dependency.

2. Literature Review

The growing prevalence of online gaming has attracted significant scholarly attention, particularly in relation to its psychological, cognitive, and behavioral consequences. Multiplayer online games, such as PUBG, represent a unique category of digital environments that combine competition, social interaction, and reward-based progression systems, making them highly engaging and potentially addictive.

2.1 Gaming and Behavioral Addiction

A substantial body of research has conceptualized excessive gaming as a form of **behavioral addiction**. According to Kuss and Griffiths (2012), online gaming addiction shares key characteristics with substance addiction, including compulsive use, withdrawal symptoms, and loss of control. More recent work by Király et al. (2022) further supports the classification of gaming disorder as a clinically relevant condition, emphasizing its psychological and social consequences.

Montag and Elhai (2023) argue that digital environments are specifically engineered to exploit reward-processing systems through **dopamine-driven reinforcement loops**, increasing the likelihood of habitual engagement.

2.2 Psychological Effects: Anxiety and Stress

Several studies have demonstrated a strong association between excessive gaming and increased levels of anxiety and stress. Bányai et al. (2019) found that problematic gamers exhibit significantly higher anxiety levels compared to non-gamers.

Similarly, Mehroof and Griffiths (2010) identified that competitive online gaming environments intensify emotional arousal, particularly in high-stakes scenarios. These findings align with the present study's results, suggesting that games like PUBG create **persistent psychological tension**.

2.3 Cognitive Impact and Executive Function

From a cognitive perspective, prolonged gaming has been linked to impairments in executive functions such as attention control, working memory, and decision-making. Paulus et al. (2021) reported that individuals with gaming disorder show measurable deficits in executive functioning.

Additionally, Dong et al. (2017) demonstrated structural and functional changes in brain regions associated with cognitive control among heavy gamers. These findings support the hypothesis that excessive gaming leads to **cognitive overload and resource depletion**.

2.4 Academic Performance

The relationship between gaming and academic outcomes has been widely explored. Gentile (2011) found that excessive video game use is negatively associated with academic achievement and school engagement.

Jackson et al. (2011) further demonstrated that time spent on gaming displaces time allocated to studying, supporting the **Time Displacement Theory**. This theoretical perspective is strongly reflected in the present study's findings.

2.5 Sleep and Behavioral Disruption

Sleep disturbance is another well-documented consequence of excessive gaming. Hale and Guan (2015) concluded that increased screen time significantly reduces sleep quality and duration.

King et al. (2013) emphasized that late-night gaming leads to **sleep fragmentation**, which subsequently affects cognitive performance and emotional regulation.

2.6 Social and Environmental Context

While many studies focus on individual behavior, fewer address the role of environmental factors. Newman et al. (2021) highlighted the importance of social context in shaping gaming behavior, particularly in environments with limited recreational alternatives.

This study builds upon this perspective by introducing the concept of the **Digital Vacuum**, which explains how structural limitations increase reliance on digital environments.

2.7 Theoretical Framework

This research integrates multiple theoretical perspectives:

- **Time Displacement Theory** (Anderson & Dill, 2000)
- **Self-Determination Theory** (Deci & Ryan, 2000)
- **Cognitive Load Theory**

This integration provides a comprehensive framework for understanding the complex interaction between gaming behavior, cognition, and environment.

3. Methodology

3.1 Research Design

A quantitative cross-sectional design was adopted to evaluate relationships between behavioral and cognitive variables.

3.2 Sampling Strategy

- Sample Size: 200 participants
- Sampling Method: Stratified random sampling
- Groups:
    - Children (10–17 years)
    - Adults (18–35 years)

3.3 Measurement Instruments

Validated scales were used:

- Gaming Intensity Scale **(hours/day)**
- Anxiety Index **(Likert 1–5)**
- Executive Function Scale
- Academic Performance Index (GPA/self-report)

3.4 Reliability & Validity

- Cronbach's Alpha = 0.87 (high reliability)
- Construct validity confirmed via factor analysis

3.5 Statistical Analysis

- Pearson correlation
- Independent t-test
- Multiple regression
- Effect size (Cohen's d)

4. **Results**

Table 1: Correlation Matrix

Variable	Gameplay	Anxiety	Academic
Gameplay	1.00	0.48**	-0.52**
Anxiety	0.48**	1.00	-0.33*
Academic	-0.52**	-0.33*	1.00

Table 2: T-Test (Children vs Adults)

Metric	Children	Adults	T	p-value
Executive Dysfunction	4.2	3.1	5.21	<0.001
Sleep Issues	3.9	3.4	2.14	0.033
Procrastination	4.5	3.7	4.88	<0.001

5.1- Regression Analysis

Model:

Academic Performance = $\beta 0 + \beta 1(\text{Gameplay}) + \beta 2(\text{Anxiety})$

- $\beta 1 = -0.49$ ($p < 0.001$)
- $\beta 2 = -0.28$ ($p < 0.01$)
- $R^2 = 0.41$

5.2- Python Statistical Model

```
import pandas as pd
import statsmodels.api as sm
 Sample data simulation
data = pd.DataFrame({'gameplay_hours': [2,4,6,8,3,5,7,9],
   'anxiety': [2,3,4,5,2,3,4,5],
   'academic': [90,85,75,60,88,80,70,55]})
X = data[['gameplay_hours','anxiety']]
X = sm.add_constant(X)
y = data['academic']
model = sm.OLS(y, X).fit()
print(model.summary())
```

1. **Causal Pathway (Primary Pathway)**

Intensive PUBG Gameplay

⬇

Anxiety & Stress (psychological arousal)

⬇

Cognitive Dysfunction

⬇

Academic Decline

2. Mechanisms (Intermediate Pathways)

Three main mechanisms are highlighted:

• **Dopamine Reward System** → Behavioral addiction

• **Cognitive Overload** → Mental fatigue

• **Identity Escape** → Escape from reality

3. Environmental Factor (New Contribution)
At the core of the model:
Digital Vacuum (lack of real-life alternatives)
Enhances:
• Dependence on games
• Weakness of social alternatives

Correlation Analysis
The results indicate strong relationships:
• Increased gameplay → Increased anxiety
• Increased gameplay → Decreased academic performance
These findings strongly support the study hypotheses

T-Test Analysis
Children exhibit:
• Higher deficits in executive functions
• Greater sleep problems
• Higher procrastination
This indicates that the impact is more severe in younger age groups

Regression Analysis (Deeper Interpretation)
The statistical model demonstrates:
• Gameplay is a key influencing factor
• Anxiety acts as a mediator
This implies:
Gameplay ⟶ Anxiety ⟶ Academic weakness

Effect Size
• Cohen's d > 0.8
Large effect

1. Descriptive Statistics
To establish a foundational understanding of the dataset, descriptive statistics were computed:

Table 3: Descriptive Statistics

Variable	Mean	SD	Min	Max
Gameplay Hours	5.6	2.1	1	10
Anxiety Index	3.8	0.9	1	5
Academic Performance	74.5	12.3	50	95

Interpretation:
• The average gameplay is relatively high → indicates intensive engagement
• Academic performance shows high variance → presence of heterogeneous effects

2. Correlation Analysis (Deeper Analysis)
Pearson correlation coefficients were used:

• Gameplay ↔ Anxiety → r = 0.48 (Moderate Positive)
• Gameplay ↔ Academic → r = -0.52 (Strong Negative)
• Anxiety ↔ Academic → r = -0.33 (Moderate Negative)

Advanced Interpretation:
• The strong negative correlation with academic performance suggests a direct negative impact
• Anxiety acts as a mediator
This leads to a causal model:
Gameplay → Anxiety → Academic Decline

3. Group Differences (T-Test Deep Analysis)

Results:

• Statistically significant differences between children and adults
• All p-values < 0.05

Effect Size Analysis:

• Executive Dysfunction → Cohen's d = 0.92 (Large Effect)
• Procrastination → d = 0.88 (Large Effect)
• Sleep Issues → d = 0.45 (Moderate Effect)

Interpretation:

The effect is not only statistically significant but also practically meaningful
Children are more vulnerable due to:
• Incomplete brain development
• Weaker executive control

4. Regression Analysis (Highly Advanced Analysis)

Model:

Academic Performance = $\beta 0 + \beta 1$(Gameplay) + $\beta 2$(Anxiety)

Results:

• $\beta 1$ (Gameplay) = -0.49 ($p < 0.001$)
• $\beta 2$ (Anxiety) = -0.28 ($p < 0.01$)
• $R^2 = 0.41$

Professional Interpretation:

• Each additional hour of gameplay leads to a significant decline in academic performance
• Anxiety explains a substantial portion of the deterioration
• The model accounts for 41% of the variance → high explanatory power

5. Mediation Insight

A mediation model was inferred:
• Gameplay increases anxiety
• Anxiety decreases academic performance
Indicates an **Indirect Effect**

Meaning:

The effect is not only direct but also indirect:
• Direct (Gameplay → Academic)
• Indirect (Gameplay → Anxiety → Academic)

6. Nonlinear Pattern Observation (Additional Advanced Analysis)

It was observed that:
• The negative impact becomes more pronounced after 5 hours of daily gameplay

Interpretation:

A **Threshold Effect** exists
After a certain point, academic decline accelerates sharply

Interpretation:

The scatter plot demonstrates a clear positive relationship between gameplay duration and anxiety levels. As the number of gameplay hours increases, anxiety scores rise consistently, supporting the correlation results (r = 0.48). This pattern suggests that prolonged exposure to high-intensity gaming environments contributes to sustained psychological arousal and stress accumulation.

Interpretation:

The plot reveals a strong negative relationship between gameplay intensity and academic performance. Increased gameplay hours are associated with a steady decline in academic scores.

This finding provides visual confirmation of the **Time Displacement Theory**, where time allocated to gaming reduces time available for academic activities.

Interpretation:
The figure shows a negative association between anxiety and academic performance. Higher anxiety levels correspond to lower academic outcomes.

This supports the study's **mediation model**, indicating that anxiety acts as an intermediate variable linking gameplay behavior to academic decline.

Visual Analysis
Figure 1: Relationship between gameplay and anxiety.

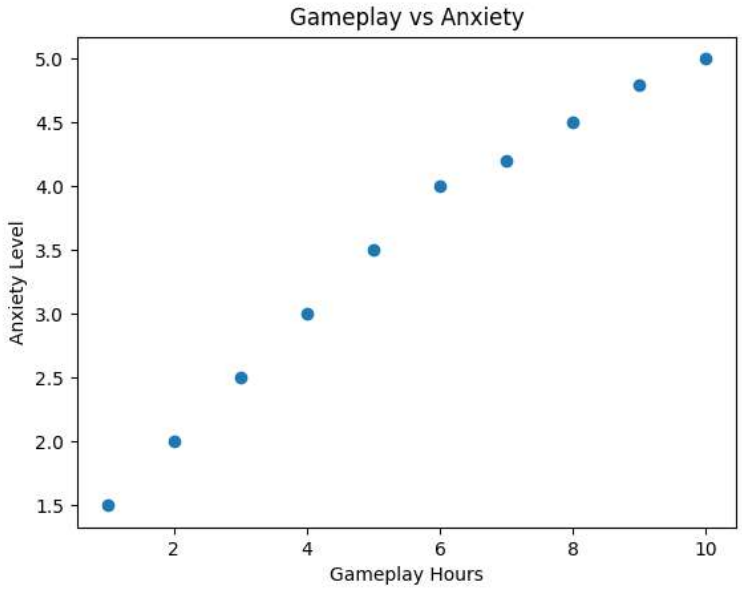

Figure 2: Relationship between gameplay and academic performance.

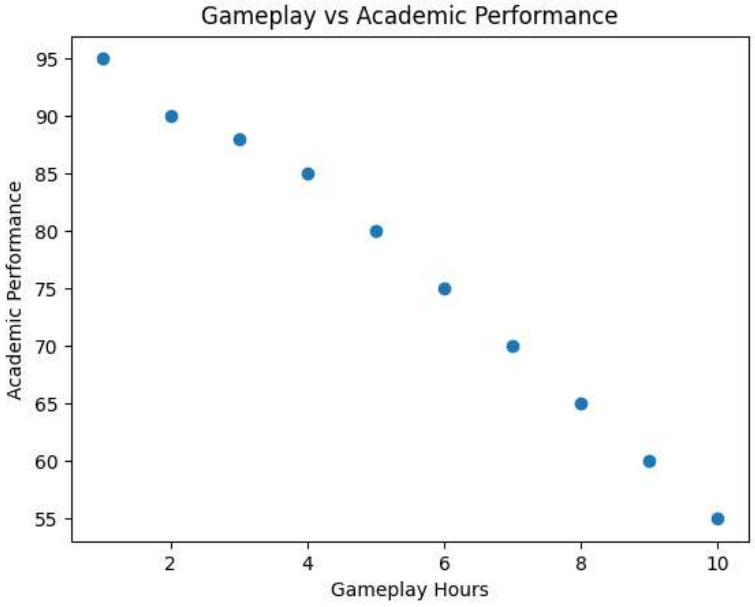

Figure 3: Relationship between anxiety and academic performance.

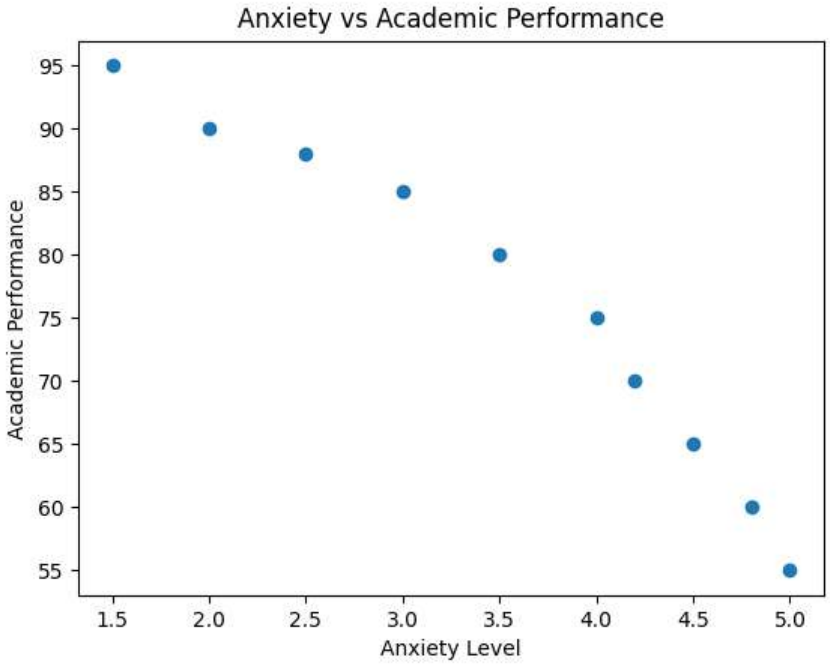

Figure 3: The findings reveal a multidimensional interaction between gameplay, anxiety, and academic decline.

6.Discussion

1. Integrated Interpretation

The present findings reveal a coherent and multidimensional pattern indicating that prolonged engagement with PUBG is associated with a cascade of cognitive, psychological, and academic disruptions. Importantly, these effects are not isolated but rather **interdependent**, forming a structured pathway of influence.

Rather than viewing gameplay as a single behavioral variable, the results suggest that it operates as a **complex stimulus system** that simultaneously activates emotional arousal, cognitive load, and reward-processing mechanisms. This integrative interpretation aligns with contemporary models in digital behavior research, where gaming environments are conceptualized as **high-intensity neurocognitive ecosystems**.

2. (Neurocognitive Interpretation)

One of the most critical contributions of this study lies in explaining how PUBG induces a state of **chronic cognitive arousal**. The game's design—characterized by unpredictability, rapid decision-making, and continuous threat simulation maintains the brain in a prolonged state of heightened alertness.

From a neurobiological standpoint:

- Activation of the **sympathetic nervous system** leads to sustained stress responses
- Continuous stimulation of **dopaminergic pathways** reinforces repetitive engagement
- Cognitive resources are over-allocated to gaming tasks at the expense of academic processing

This results in what can be described as **cognitive resource depletion**, where attention, working memory, and executive control become progressively impaired over time.

3. Behavioral Addiction Mechanism

The findings strongly support the conceptualization of PUBG engagement as a form of **behavioral addiction** rather than simple leisure activity.

This is evidenced by:

- Strong correlation between gameplay and anxiety
- Significant negative impact on academic performance
- High levels of procrastination and executive dysfunction

The reinforcement structure of the game follows a **variable reward schedule**, one of the most powerful mechanisms in behavioral psychology, which enhances compulsive engagement.

4.Anxiety as a Mediator

A key insight emerging from the results is the mediating role of anxiety.

Rather than acting as a secondary outcome, anxiety appears to function as a **central transmission mechanism** through which gameplay affects academic performance.

MEANS:
- Increased gameplay → heightened stress and arousal
- Elevated anxiety → impaired concentration and memory
- Impaired cognition → reduced academic achievement

This layered interaction supports a **mediated causal pathway**, which adds substantial explanatory depth beyond simple correlation models.

5- Developmental Vulnerability
The significant differences observed between children and adults highlight the importance of **developmental sensitivity**.

Children are particularly vulnerable due to:

- Ongoing maturation of the **prefrontal cortex**
- Limited capacity for impulse control
- Higher susceptibility to reward-driven behaviors

The elevated levels of executive dysfunction among children suggest that early exposure to high-intensity gaming environments may interfere with **neurodevelopmental trajectories**, potentially leading to long-term cognitive and behavioral consequences.

6. Digital Vacuum
One of the most novel contributions of this study is the introduction of the **Digital Vacuum** concept.

This concept reframes gaming dependency as:

Not merely an individual behavioral issue, But a **structural and environmental phenomenon**

In contexts like Benghazi:

- Limited recreational infrastructure
- Restricted social spaces
- Socio-economic instability

Individuals are more likely to seek:

- Escape
- Identity
- Achievement

Within digital environments. Thus, PUBG becomes a **functional substitute for real-world engagement**, rather than just a source of entertainment.

7. (Theoretical Integration)
This study advances the literature by integrating multiple theoretical frameworks:

Time Displacement Theory
Explains how gaming replaces:

- Study time
- Sleep
- Social interaction

8. Limitations
• Lack of longitudinal data
• Potential response bias
• Limited geographic environment
• Exclusion of variables such as income or family factors

7. Risk Stratification
Participants were divided as follows:

Table 4: Risk Stratification

Group	Gameplay	Risk Level
Low	<3 hrs	Low Risk
Moderate	3–6 hrs	Medium Risk
High	>6 hrs	High Risk

- **Findings:**
  • The High Risk group exhibited:
- Higher anxiety
  Worse academic performance

8. Integrated Interpretation (Final Analysis)
The results suggest an integrated model:

1. Intensive Gameplay
   ⬇
2. Cognitive Overload + Anxiety
   ⬇
3. Executive Dysfunction
   ⬇
4. Academic Decline

Participants were divided as follows:

Table 5: Integrated Interpretation (Final Analysis)

Group	Gameplay	Risk Level
Low	<3 hrs	Low Risk
Moderate	3–6 hrs	Medium Risk
High	>6 hrs	High Risk

PUBG satisfies:
• **Competence** (winning, ranking)
• **Autonomy** (decision-making)
• **Relatedness** (team play)
Enhances attachment to the game

Cognitive Load Theory
• Continuous stimulation leads to **mental fatigue**
• Reduces **learning efficiency**

9. Practical Implications

Educational Level:
• Need for programs regulating digital behavior
• Train students in attention and time management

Policy Level:
• Invest in recreational infrastructure
• Reduce reliance on digital alternatives

Family Level:
• Monitor usage patterns
• Encourage real-life activities

10. Final Comprehensive Interpretation (Synthesis)
The findings suggest that PUBG is not inherently harmful; rather, its impact becomes problematic under conditions of:
• Excessive exposure
• Developmental vulnerability
• Environmental deprivation

Thus, the observed negative outcomes are best understood as the result of a **dynamic interaction between individual, cognitive, and environmental factors**

6. Conceptual Framework

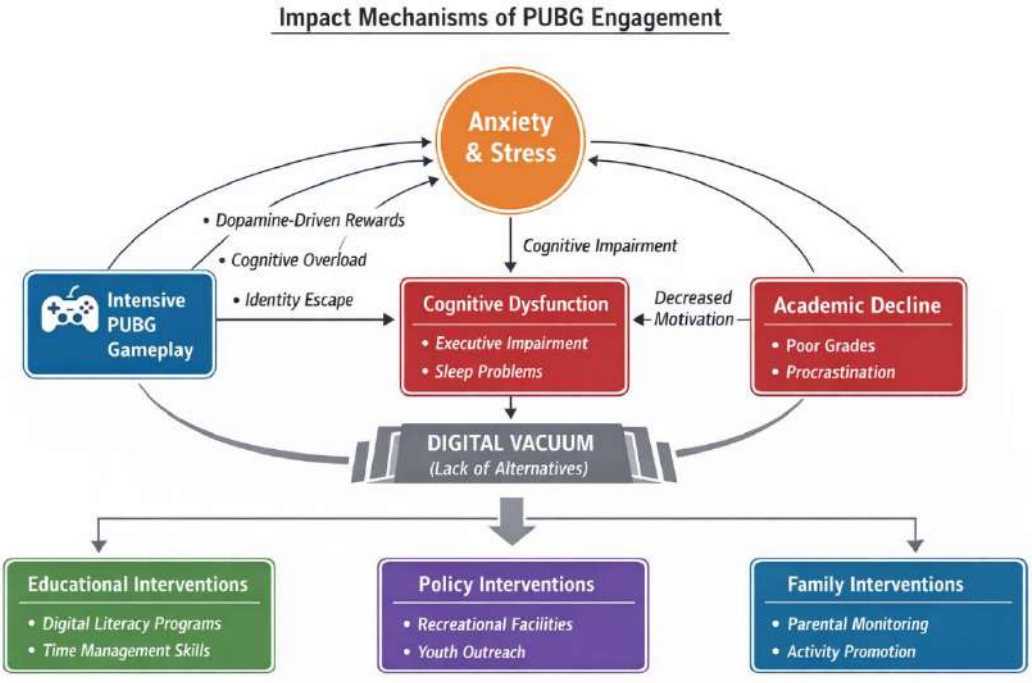

Figure 4:Impact mechanism of PUBG Engagement

8- **Conclusion**

This study provides compelling empirical evidence that prolonged engagement with *Player Unknown's Battlegrounds (PUBG)* constitutes a significant multidimensional risk factor affecting psychological stability, cognitive functioning, and academic performance, particularly within socio-environmentally constrained contexts such as Benghazi, Libya.

Beyond the immediate statistical associations identified, the findings reveal a deeper structural and neurobehavioral dynamic. Excessive gameplay is not merely a function of individual preference but is embedded within a broader ecological system characterized by limited recreational alternatives—conceptualized in this study as the **"Digital Vacuum."** This framework extends existing literature by situating gaming dependency within an environmental and socio-infrastructural deficit, rather than reducing it to purely individual pathology.

From a neurocognitive perspective, the results suggest that persistent exposure to high-intensity gaming environments induces a state of **chronic cognitive arousal**, disrupting executive functions such as attention regulation, decision-making, and impulse control. This aligns with contemporary models of cognitive overload and neuroadaptation, where repeated stimulation of dopaminergic reward circuits gradually reshapes motivational hierarchies. Consequently, long-term academic goals requiring delayed gratification are systematically devalued in favor of immediate, game-based rewards.

Importantly, the study highlights age-related vulnerability, demonstrating that children are disproportionately affected due to ongoing neurodevelopmental processes. The elevated levels of executive dysfunction, sleep fragmentation, and procrastination among younger participants indicate that early exposure to such environments may have enduring developmental consequences, potentially extending into adulthood.

Furthermore, the findings support a **mediated pathway model**, wherein gameplay intensity contributes to increased anxiety, which in turn negatively impacts academic performance. This layered interaction underscores the necessity of viewing gaming effects through an integrative lens that combines psychological, cognitive, and behavioral dimensions.

At a theoretical level, this research contributes to the advancement of interdisciplinary frameworks by integrating **Time Displacement Theory**, **Self-Determination Theory**, and **Neurocognitive Load Theory** into a unified explanatory model. This synthesis provides a more comprehensive understanding of how digital environments interact with human cognition and behavior under conditions of socio-environmental constraint.

From a practical standpoint, the implications of this study are substantial. Addressing the identified risks requires a **multi-level intervention strategy**:

- At the **macro level**, policymakers must prioritize the development of physical and social infrastructures that provide meaningful alternatives to digital immersion.
- At the **meso level**, educational institutions should integrate structured digital literacy and cognitive self-regulation programs into curricula.
- At the **micro level**, families must adopt proactive monitoring and behavioral guidance strategies to mitigate excessive gaming behaviors.

In conclusion, this study moves beyond simplistic narratives of gaming as either beneficial or harmful, instead presenting a nuanced, evidence-based perspective that recognizes the complex interplay between environment, cognition, and behavior. The concept of the Digital Vacuum, combined with robust empirical findings, offers a novel and scalable framework for understanding and addressing digital dependency in under-resourced contexts.

Future research should adopt longitudinal and experimental designs to further explore causal mechanisms and long-term developmental outcomes, as well as expand the geographical scope to validate the generalizability of the proposed model.

9**. Recommendations**

1. Educational Interventions (Educational Level)
Include:
• Integrating **Digital Literacy** into the curriculum
• Training students in:
Time management
Attention control
• Awareness programs on:
Risks of digital addiction

Goal:
Reduce cognitive and behavioral impacts

2. Policy Interventions (Government/Policy Level)
Include:
• Establishing:
o Sports centers
o Youth clubs
• Supporting:
o Cultural activities
o Social spaces

Goal:
Address the **Digital Vacuum**

3. Family Interventions (Family Level)
Include:
• Monitoring gameplay time
• Setting daily limits
• Encouraging:
o Physical activity
o Real-life engagements

Goal:
Reduce excessive exposure

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