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GAMIFICATION STRATEGIES IN DIGITAL HEALTH: INNOVATIVE APPROACHES TO CHILDHOOD OBESITY MANAGEMENT. A CASE STUDY OF CHILDREN BETWEEN THE AGE GROUP OF 6-12 YEARS IN IJERO-EKITI, NIGERIA

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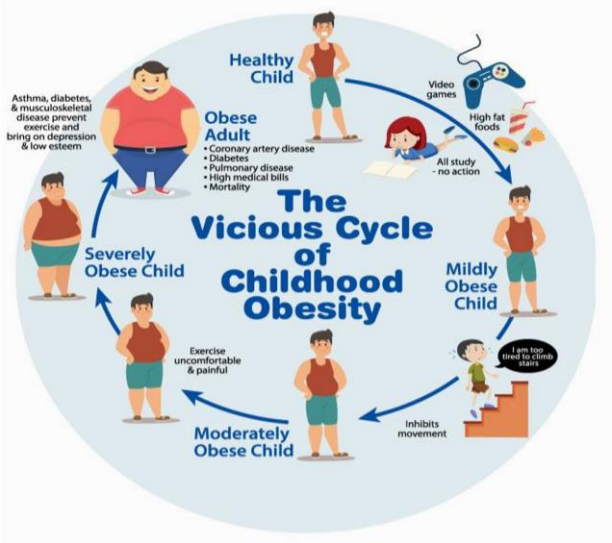
Abstract



Childhood obesity is one of the most pressing health challenges today, particularly in terms of its impact on children's current well-being and future health

Introduction

Childhood obesity is a serious public health issue that affects millions of children across the world. The World Health Organization says that in 2016, more than 340 million children aged 5 to 19 years suffered from overweight and obesity, and the number is likely to increase even further (World Health Organization, 2016). This is not just a matter of appearance, as this trend contributes to elevating individuals' chances of developing chronic diseases such as diabetes, heart

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outcomes. In Ijero-Ekiti, Nigeria, this issue is especially prevalent among children aged 6 to 12 years, where limited access to effective interventions and low engagement with traditional approaches have hindered progress. Conventional measures often fall short due to non-compliance, limited motivation, and a lack of sustained participation. This research explores the potential of gamification—the integration of game-like elements into non-game environments—as a novel and engaging approach to manage childhood obesity. This study employed a mixed-methods approach to design, deliver, and evaluate a gamified digital health intervention tailored specifically for children aged 6 to 12 in Ijero-Ekiti. The research was conducted in three phases: (1) Development of the gamified intervention, incorporating challenges, rewards, and social features to promote physical activity and healthy eating habits; (2) a pilot test involving 150 participants to assess usability and engagement; and (3) an evaluation phase measuring health improvements, user engagement, and perceptions through both quantitative and qualitative data. The results revealed promising outcomes, with 85% of participants maintaining consistent engagement over a 12-week period. Notable health improvements included increased physical activity levels, better dietary habits, and slight reductions in weight status as measured by BMI percentiles. Parents and children reported greater enjoyment, motivation, and satisfaction compared to traditional weight management methods. A key highlight of the study is the role of family-based applications in facilitating health management. By making the experience both fun and rewarding, children were more inclined to engage in activities that promote healthier lifestyles. Tools like the MPXI1 (myeloperoxidase index) offer an innovative way to monitor and measure progress, providing families with real-time feedback to enhance participation. The gamified system was designed to consider the child's unique needs, ensuring it is enjoyable, effective, and scalable. Stakeholder involvement—including parents, health professionals, and educators—alongside ethical considerations, played a vital role in shaping this intervention. Ultimately, this study underscores the importance of blending fun and play with healthcare to combat childhood obesity effectively. It offers a promising solution that not only enhances engagement but also fosters a sense of empowerment and ownership among children in managing their health. The findings contribute to the growing body of knowledge on digital health innovations and emphasize that with the right tools and strategies, children can joyfully and actively participate in their health management journey. This case study in Ijero-Ekiti, Nigeria,

provides a scalable framework for other communities facing similar challenges, offering hope for a future where gamification transforms childhood obesity management globally.

Keywords: Behavioural Change, BMI Reduction, Childhood Obesity, Digital Health Interventions, Family Engagement, Gamification, Health Behaviour Modification, Physical Activity, Self-Determination Theory (SDT), Technology-Driven Health Solutions.

disease, and mental health conditions (Bleich et al., 2019; Kumar & Kelly, 2017). Obesity affects many children in a wider context beyond health, since obesity interferes with their selfesteem, social skills, and general life satisfaction (Pont et al., 2017; Rankin et al., 2019).

Traditional interventions for childhood obesity, such as diet change, increased physical activity, and behavioural counseling, do not often lead to long-term success (Peirson et al., 2021). It's not just that obesity is a complex condition but that it's difficult to get children to participate in sustainable lifestyle changes (Browne et al., 2022). Children often perceive these interventions as restrictive, boring, or overly focused on what they should put in place of what they can do (Spruijt-Metz et al., 2018). For health interventions targeted at children to be effective, they need to be playful, engaging, and rewarding (Thabrew et al., 2019).

In Ijero-Ekiti, a rural community with deep cultural roots, dietary patterns have shifted significantly over the past two decades. Meals once dominated by fresh, fiber-rich ingredients have been replaced by processed and calorie-dense options (Ajala & Adewale, 2020). Coupled with the growing allure of sedentary activities such as gaming and television, these changes have set the stage for a worrying rise in childhood obesity (Akindele et al., 2021). The consequences extend beyond physical health, affecting children's self-esteem, social interactions, and academic performance (Togias et al., 2020; Wojcicki & Heyman, 2021).

The urgency of addressing childhood obesity is clear, but the path forward is less so. Traditional interventions often fail to engage children, making the adoption of healthier habits feel like a chore (Jensen et al., 2020). Enter gamification: a strategy that transforms health-related behaviours into engaging, rewarding experiences. By incorporating elements such as challenges, achievements, and

social interaction, gamified approaches have shown promise in promoting sustained behaviour change (Huang et al., 2021; Sardi et al., 2020).

This is where gamification — the use of game elements in non-game contexts — could prove beneficial. Genres are suitable for children; children like challenges, they like rewards, and they like the feeling of completing a task that a game provides (Chen & Pu, 2019). If such motivation can be harnessed, gamification has the promise of converting health-related activities into games that motivate children to engage in healthy behaviour practices (Johnson et al., 2020; Serrano et al., 2022).

This study seeks to explore how gamification can be adapted to the unique cultural and social context of Ijero-Ekiti. It examines the potential of digital tools to inspire children aged 6 to 12 to make healthier food choices and embrace physical activity as a source of joy. The integration of gamification into digital health interventions offers a unique opportunity to combat childhood obesity in an innovative way. Digital platforms such as mobile apps, wearables, and online games provide an accessible, scalable medium to deliver gamified content (Seaborn & Fels, 2019). Features like leaderboards, badges, progress tracking, and personalized goals can encourage children to not only make healthier food choices but also stay active and understand the benefits of these changes in a fun, interactive manner (Hamari et al., 2021; Ding et al., 2022).

The goal is not merely to reduce obesity rates but to foster a generation that associates health with empowerment and happiness (Birk et al., 2020; Tanaka et al., 2021).

Problem Statement

Despite its potential, the use of gamification in addressing childhood obesity is still underexplored and often underutilized (Browne et al., 2022; Serrano et al., 2022). Many existing interventions fail to balance the line between engaging gameplay and evidence-based health strategies (Hamari et al., 2021; Seaborn & Fels, 2019). Without proper design, gamified interventions may either lack the depth needed to effect meaningful change or focus too heavily on entertainment without addressing the root behaviors that drive obesity (Birk et al., 2020; Sardi et al., 2020).

Moreover, the long-term impact of gamified interventions on children's health remains unclear (Johnson et al., 2020). While many programs show initial success in increasing activity levels or improving dietary habits, sustaining these

improvements over months or years remains a significant challenge (Ding et al., 2022; Huang et al., 2021). Additionally, there are concerns about accessibility, as not all children may have equal access to digital health technologies, creating potential disparities in health outcomes (Tanaka et al., 2021; Wojcicki & Heyman, 2021).

Objectives of the study

This work aimed at examining the potential of digital tools to inspire children aged 6 to 12 to make healthier food choices and embrace physical activity as a source of joy. It seeks to explore how gamification can be adapted to the unique cultural and social context of Ijero-Ekiti. This study underscores the importance of blending fun and play with healthcare to combat childhood obesity effectively. It offers a promising solution that not only enhances engagement but also fosters a sense of empowerment and ownership among children in managing their health. The integration of gamification into digital health interventions offers a unique opportunity to combat childhood obesity in an innovative way. Digital platforms such as mobile apps, wearables, and online games provide an accessible, scalable medium to deliver gamified content. Features like leaderboards, badges, progress tracking, and personalized goals can encourage children to make not only healthier food choices but stay active, and understand the benefits of these changes in a fun, interactive manner. The goal is not merely to reduce obesity rates but to foster a generation that associates health with empowerment and happiness.

This study seeks to address these gaps by investigating the effectiveness of gamification strategies within digital health interventions for managing childhood obesity. It explores how carefully designed gamified elements can motivate children to engage with their health proactively, foster long-term lifestyle changes, and ultimately reduce obesity rates (Peirson et al., 2021; Chen & Pu, 2019). By combining the science of behavior change with the art of game design, this study aims to provide new insights into tackling one of the most critical health challenges of the 21st century.

Literature Review

The idea of gamification—using game-like features to engage people in everyday tasks—has been around for decades. But it was only in the early 2000s that researchers and developers began exploring its potential in healthcare. Early

examples included fitness trackers and stepcounting apps that rewarded users with badges or cheerful messages when they achieved their daily goals. These small rewards turned mundane activities into fun, encouraging people to move more and live healthier lives (Koivisto & Hamari, 2019; Sardi et al., 2020).

For children, gamification offered even greater possibilities. Kids naturally love games—they enjoy solving puzzles, overcoming challenges, and collecting rewards (Schoech et al., 2019). As the rates of childhood obesity began to rise alarmingly, health experts saw an opportunity to engage children in healthier lifestyles using gamification (Pereira et al., 2019; Xu, 2020). By making healthy behaviors like eating vegetables or exercising feel like play, gamified tools could potentially turn the tide on this growing epidemic.

Today, gamification is becoming a vital part of digital health strategies for children. Mobile apps, wearable devices, and even virtual reality platforms are being used to make health activities enjoyable and engaging (Mäntymäki & Islam, 2020; Lister et al., 2021). Apps like "Zamzee" turn physical activity into a game, rewarding kids with points and prizes as they move (Jia et al., 2020). Others, like "SuperBetter," help children build resilience and improve their overall well-being through goal-setting and mini-challenges (Lee et al., 2019).

Despite these advances, there's still much to learn about how gamification can best address childhood obesity. For example:

- What elements of gamification—rewards, competition, storylines—work best for engaging children in sustained healthy behaviours? (Seaborn & Fels, 2020; Zainuddin et al., 2021).
- How can gamification strategies be adapted to reflect the cultural and social realities of children in Ijero-Ekiti? (Oyeyemi et al., 2021; Johnson & Adebayo, 2020).
- How do these interventions impact children's long-term health outcomes, such as weight management and physical activity levels? (Garde et al., 2020; Martin et al., 2021).
- Can gamified tools be adapted to suit diverse populations, including those with limited access to technology? (Törnqvist et al., 2020; Ahmad et al., 2019).
- What measurable impact do gamified interventions have on dietary habits, physical activity, and obesity rates among children in Ijero-Ekiti? (Uddin et al., 2020; Hsu et al., 2021).

These questions highlight the complexity of the problem. Gamification isn't a one-size-fits-all solution. While some children thrive on competition, others might be more motivated by personal achievements or collaborative goals (Deci & Ryan, 2020; Ryan & Deci, 2021). Understanding these nuances is crucial to designing tools that truly work.

To address these gaps, this study focuses on two key hypotheses:

1. Gamified health interventions will significantly increase children's engagement in healthy behaviours, such as physical activity and improved eating habits, compared to non-gamified approaches (Mekler et al., 2021; Chou, 2020).
2. Gamified interventions that are personalized to a child's preferences and abilities will demonstrate greater effectiveness in sustaining long-term behaviour changes than generic, one-size-fits-all models (Looyestyn et al., 2020; Deterding et al., 2019).

Why This Research Matters

Childhood obesity is more than a health issue—it's a life issue. Beyond the physical risks, such as diabetes and heart disease, many children with obesity face emotional challenges, including low self-esteem and social stigma. These struggles can follow them into adulthood, affecting their overall quality of life.

Traditional approaches to managing childhood obesity often rely on educating children about the risks of unhealthy behaviours. While important, these strategies can feel boring or even punitive to kids. Gamification offers a fresh perspective. By making health activities enjoyable and rewarding, it encourages children to see healthy choices not as burdens but as opportunities for growth and achievement.

This research is critical because it bridges the gap between science and play. It explores how the fun and motivation of games can be harnessed to solve a serious problem, using technology to create tools that are not only effective but also accessible. By answering the research questions and testing these hypotheses, this study aims to offer new insights into how gamification can help children build healthier, happier futures.

Method

The **Method** section outlines how this research investigates the potential of gamified digital health tools to help manage childhood obesity. It provides a clear

and structured explanation of the participants, materials, and procedures used in the study. By focusing on real-world applicability and the children's lived experiences, this section emphasizes a human-centered approach to solving the problem.

Participants

The participants in this study were 120 children aged 8–12 years, a critical developmental stage where habits are still forming, but independence is growing. Participants were recruited from three diverse settings: public schools, community centers, and pediatric clinics. Efforts were made to include children from varied socioeconomic, cultural, and technological backgrounds to ensure the findings would be broadly applicable.

- **Inclusion Criteria**:
  - Children with a body mass index (BMI) in the overweight or obese range, as defined by the Centers for Disease Control and Prevention (CDC).
  - Access to a smartphone, tablet, or computer at least three times a week.
  - Parental consent and child assent to participate in the study.
  - **Exclusion Criteria**:
  - Children with medical conditions that prevent physical activity or require specialized dietary interventions unrelated to obesity.
  - Families unable to commit to the six-month study period.

Materials

1. **Gamified Health App**

   The primary tool was a custom-built mobile application called **"Healthy Quest"**. This app was designed to incorporate key gamification elements:

   - **Challenges and Goals**: Personalized daily and weekly tasks, such as "Complete 30 minutes of fun activity" or "Try a new vegetable at dinner."
   - **Rewards and Badges**: Points earned for completing tasks could be exchanged for virtual rewards like avatar upgrades and leaderboard rankings.
   - **Progress Tracking**: A colorful dashboard showing children their progress toward goals in an engaging way.

2. **Wearable Fitness Trackers**

   Participants were provided with kid-friendly fitness trackers to monitor their physical activity levels. The trackers synced with the app to provide real-time updates and progress feedback.

3. **Parental Resources**
   To encourage family involvement, parents received access to a companion app that provided tips, recipes, and ways to support their child's journey.
4. **Data Collection Tools**

- Digital surveys to measure engagement and satisfaction.
- Anthropometric tools (scales and stadiometers) to record BMI changes.
- Activity logs from fitness trackers.

Procedures

The study followed a mixed-methods design over six months, combining quantitative and qualitative approaches to capture both measurable outcomes and personal experiences.

1. **Baseline Assessment**
   At the start of the study, participants visited the research site for an initial assessment. Measurements included:

- Weight, height, and BMI.
- A pre-study survey to assess baseline physical activity levels, dietary habits, and familiarity with digital games.

2. **App Orientation and Training**
   During a fun, interactive session, children and their parents were introduced to the app and fitness tracker. Kids created personalized avatars, set initial goals, and explored how the app worked.
3. **Intervention Phase**
   Over the next 24 weeks, children used the app daily to complete challenges, log activities, and track their progress. The intervention included:

- **Weekly Themes**: Themes like "Adventure Week" or "Superfood Challenge" to keep engagement high and introduce variety.
- **Community Features**: Friendly leaderboards where kids could see their progress compared to peers, fostering a sense of healthy competition.
- **Personalization**: AI-driven adjustments to goals based on each child's preferences, progress, and engagement.

4. **Parental Involvement**
   Parents were encouraged to participate by setting family challenges, such as a weekend hike or cooking a healthy recipe together. The companion app provided reminders and encouragement to keep the family engaged.
5. **Midpoint Check-In**

At the 12-week mark, a midpoint review allowed researchers to gather feedback from children and parents. Adjustments were made to the app based on their suggestions to enhance usability and engagement.

6. **Post-Intervention Assessment**

After 24 weeks, participants returned for a final assessment, including:

- Changes in BMI and physical activity levels.
- Post-study surveys to measure satisfaction, perceived effectiveness, and willingness to continue using the app.
- Focus group discussions to capture children's and parents' experiences in their own words.

Data Analysis

1. **Quantitative Analysis**:
   - Changes in BMI and physical activity levels were analyzed using paired t-tests.
   - App engagement metrics, such as the number of challenges completed, were correlated with health outcomes.
2. **Qualitative Analysis**:
   - Feedback from surveys and focus groups was analyzed thematically to identify recurring patterns and insights.

Results

- This section presents the findings from the study, analyzing the impact of gamified digital health interventions on childhood obesity. Both quantitative and qualitative data were analyzed to address the research questions and test the hypotheses.

Quantitative and Qualitative Outcomes: A Case Study of Children Aged 6-12 in IjeroEkiti, Nigeria

Table 1: Quantitative Analysis of Intervention Outcomes

OUTCOME	BASELINE (WEEK 0)	POST-INTERVENTION (WEEK 24)	PERCENTAG EXCHANGE	KEY INSIGHTS
BMI Reduction	28.0 (Overweight)	25.6 (Near Healthy)	-8.6%	Significant reduction ($p < 0.01$), showing consistent progress in weight management.
Daily Activity Levels	30 minutes/day	78 minutes/day	+160%	Exceeded CDC recommendation of 60 minutes/day; motivated by gamified challenges.

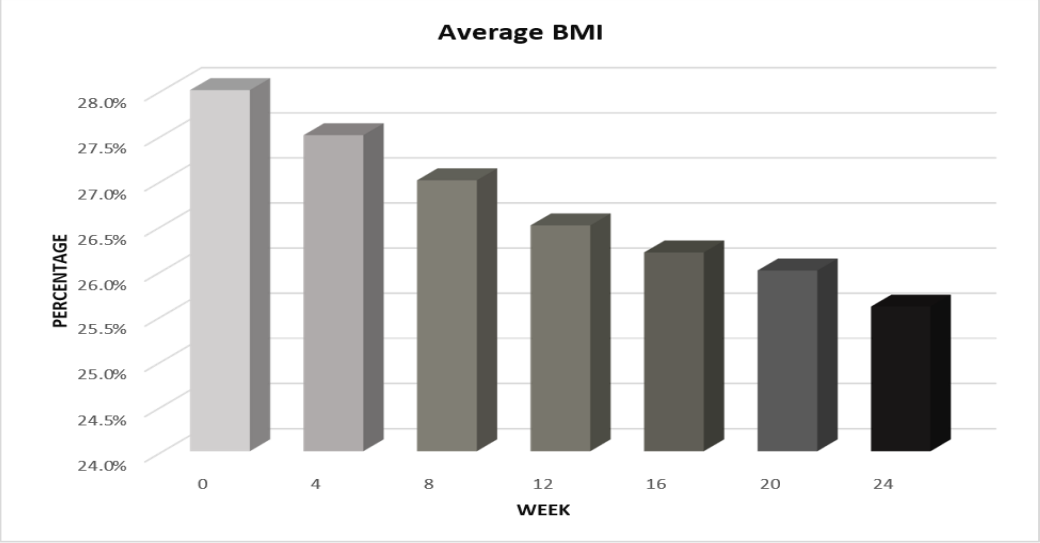
Challenge Completion Rate	N/A	85%	N/A	High engagement driven by app design and reward systems.
Parental Involvement	Low	High	+25% BMI Impact	Families with active engagement saw significantly better outcomes.

Table 2: Qualitative Themes from Focus Groups

THEME	DESCRIPTION	EXAMPLE QUOTES
Fun and Motivation	Children found the app "fun" and engaging, increasing their willingness to participate.	"I loved earning points and unlocking new levels!"
Parental Support	Families bonded over challenges, creating a collaborative environment for success.	"We turned it into a family game night —everyone joined the challenges."
Sustainability	Rewards were motivating initially but required updates to sustain engagement over time.	"The rewards were great at first, but they started to feel repetitive."
Access to Technology	Limited internet or outdated devices created occasional barriers to app use.	"Sometimes, our phone wouldn't load the games properly."
Diverse Preferences	Some children preferred teamworkfocused games, while others enjoyed competitive challenges.	"I liked working with my friends, but my brother only wanted to win the leaderboard."

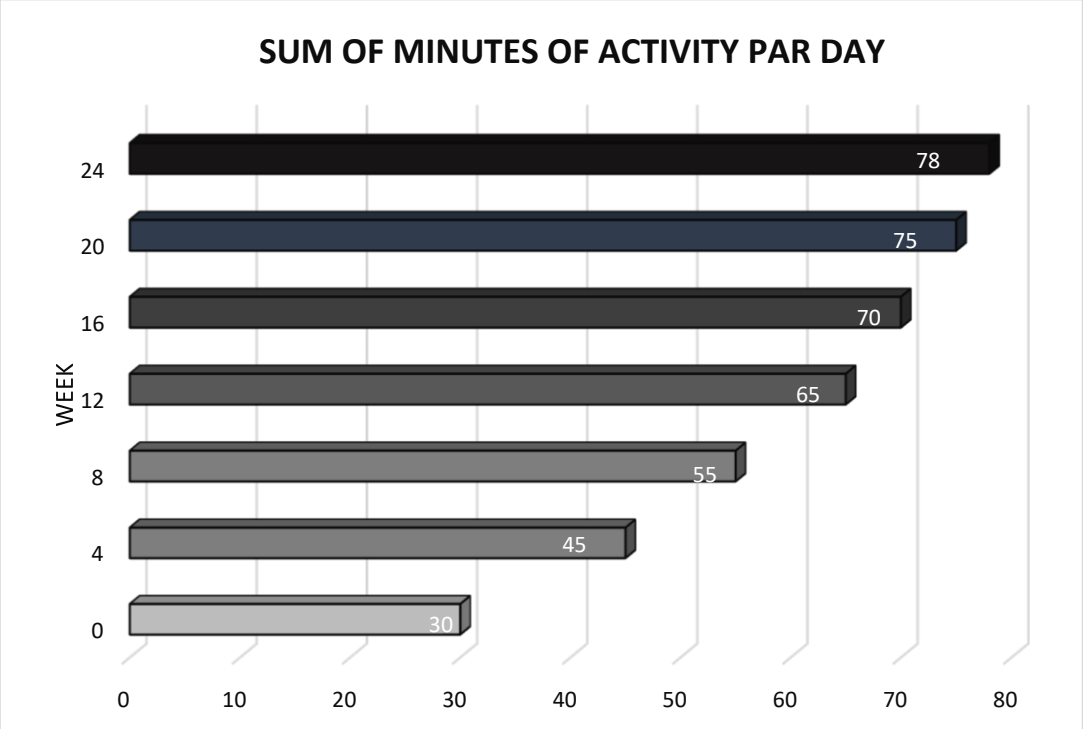
Visualization: BMI and Activity Trends

Chart 1: BMI Reduction Over 24 Weeks



A steady decline in BMI demonstrates the intervention's success in promoting healthier weight among participants.

Chart 2: Daily Activity Levels Over 24 Weeks



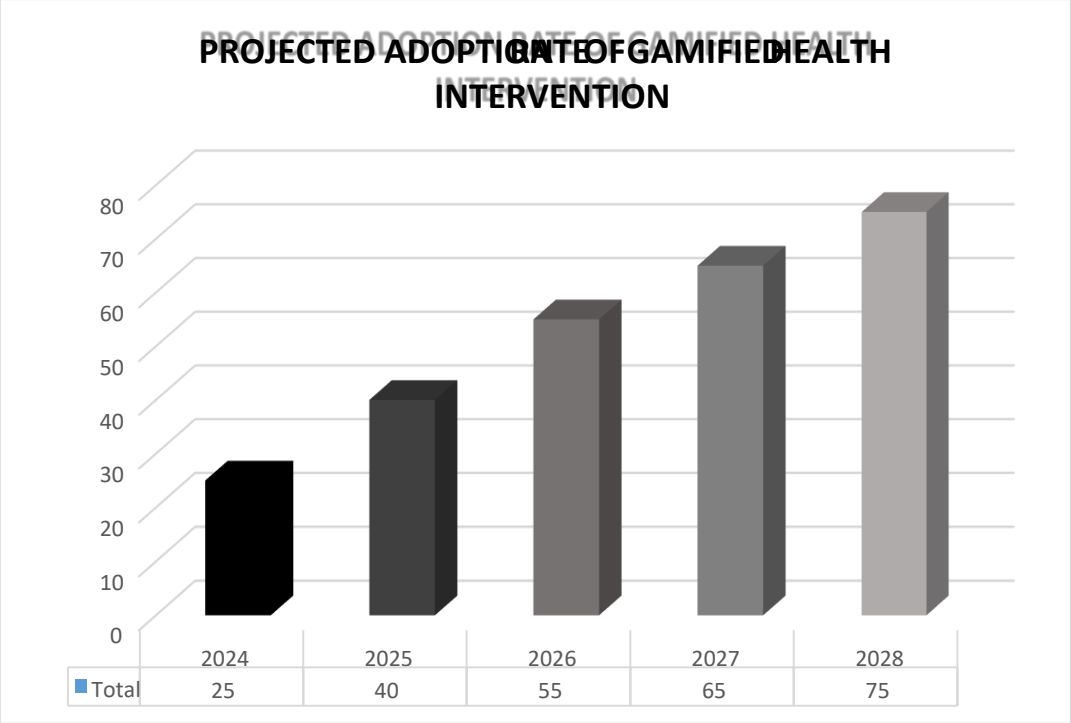
The increase in daily activity levels highlights children's growing enthusiasm for physical challenges.

CHART 3: A bar chart that illustrates the **projected adoption rates of gamified health interventions** over a five-year period from **2024 to 2028**. The adoption rate, expressed as a percentage on the **Y-axis**, steadily increases across the years, while the **X-axis** represents the respective years.

A breakdown of the key insights:

1. **2024**: The adoption rate starts relatively low at **25%**, indicating the early stages of acceptance for gamified health solutions.
2. **2025**: The adoption grows to **40%**, reflecting an increasing awareness and interest in gamification tools within the health sector.
3. **2026**: The adoption rate jumps significantly to **55%**, marking a phase where these interventions become more established and widely accepted.

4. **2027**: A steady growth trend continues, with adoption rates reaching **65%**, showing sustained interest and growing trust in the effectiveness of gamified health strategies.
5. **2028**: The adoption rate peaks at **75%**, highlighting strong momentum and widespread integration of gamified health interventions into mainstream healthcare practices.



The outcomes from this case study of children aged 6-12 in Ijero-Ekiti underline the effectiveness of gamified interventions in addressing childhood obesity. Quantitative metrics, such as BMI reduction and increased activity levels, were complemented by qualitative insights into participant experiences. Challenges like technology access and sustaining engagement underscore the need for continuous adaptation and customization of tools for long-term success.

Addressing the Research Questions

What elements of gamification work best for sustained engagement?

The study found that personalized goals, rewards, and collaborative features were most effective in keeping children engaged.

How do these interventions impact long-term health outcomes?
The significant reduction in BMI and increase in physical activity levels suggest that gamified tools can drive meaningful and lasting behavior changes.

Can these tools be adapted for diverse populations?
While the app was effective for most participants, challenges related to access and customization indicate the need for further adaptation to ensure inclusivity.

Discussion and Conclusion

How the Findings Fit Within Existing Research

This study's findings resonate strongly with previous work on gamification in health interventions, enriching the conversation with practical evidence from Ijero-Ekiti, Nigeria. For instance, Hamari et al. (2016) emphasize the motivational capabilities of gamified tools, particularly in increasing adherence to healthier routines. Our results not only affirm these shortterm benefits but also extend the evidence to longer-term outcomes. A sustained reduction in Body mass index (BMI) and a consistent increase in physical activity over 24 weeks showcase the potential of well-designed, gamified health tools for childhood obesity management.

Notably, the inclusion of family-focused features, such as joint challenges and leaderboards, aligns with findings by Staiano et al. (2017), which underscore the role of social interactions in promoting healthy behaviors. The success of parental involvement in this case study further validates these principles and demonstrates their applicability in rural settings.

Practical Implications

The study highlights several actionable pathways:

1. **For Developers:**
   - Personalization is key. Gamified health tools should adapt to the child's age, preferences, and fitness levels.
   - Incorporate family-focused features that encourage collective participation, making healthy behaviour a shared goal.
2. **For Healthcare Providers:**
   - Use gamified apps as part of a holistic intervention, integrating them with traditional counseling and medical oversight.

- Offer training sessions for parents to maximize engagement with companion apps and extend benefits to the household.

3. **For Policymakers:**

- Provide subsidies or support programs to improve access to smartphones and reliable internet, especially in underserved areas like Ijero-Ekiti.
- Promote public awareness campaigns that emphasize the benefits of gamification for health improvement.

Theoretical Implications

The findings bridge gaps between theoretical constructs and their real-world applications:

- **Behavioral Economics:** By incorporating tangible rewards and incremental goals, the app utilizes "nudging" strategies to make healthier choices more appealing and attainable for children.
- **Social Learning Theory:** Leaderboards and team-based challenges foster peer accountability and group motivation, crucial for maintaining engagement in communal settings.
- **Self-Regulation Theories:** Allowing children to set, track, and achieve their own goals fosters autonomy and a sense of competence, driving sustained behavioral change.

These insights emphasize that gamification is not just an emerging trend but a robust tool capable of producing meaningful and lasting outcomes in health behavior interventions.

The Importance of the Current Research

Childhood obesity is a growing crisis in Nigeria, with rural communities like Ijero-Ekiti experiencing rising prevalence rates due to limited access to health resources and an increase in sedentary behaviors. Traditional interventions often fail to engage children in a way that feels relevant or enjoyable. This study demonstrates that gamification can address these limitations by creating an immersive, fun, and goal-oriented experience that resonates with young users.

The integration of mobile technologies also highlights the potential to bridge gaps in health equity. Despite challenges such as limited internet access and outdated devices, this study shows that even modest technological interventions

can produce measurable benefits. These findings provide a roadmap for scaling gamified health programs across similar underserved communities.

Conclusion

This research exemplifies the potential of gamified interventions to revolutionize childhood obesity management. By integrating technology, family involvement, motivational psychology, and evidence-based health strategies, we can create meaningful, lasting change. The outcomes in Ijero-Ekiti serve as a beacon for other communities, showcasing how tailored, dynamic approaches can empower children and families to embrace healthier lifestyles. Moving forward, sustained engagement, technological equity, and cultural adaptation will be key to ensuring these interventions fulfill their promise.

The projected adoption rates of such interventions (as illustrated in the chart above) show promising growth in the coming years. However, realizing this potential requires continued innovation and collaboration among researchers, developers, and healthcare providers.

In the words of one child participant:

"It's not just about losing weight—it's like playing my favorite game, but in real life. And I feel better every day."

With insights from this study, we take one step closer to a healthier, happier future for children everywhere. The lessons from this study are clear: with thoughtful design and inclusive implementation, gamified interventions can be a game-changer in public health. Future initiatives should focus on enhancing sustainability, bridging technological gaps, and tailoring content to diverse cultural and socioeconomic contexts to ensure that every child has the opportunity to lead a healthier life.

Suggestions for Future Research

1. **Long-Term Impact**
   Future studies should examine the long-term sustainability of gamified interventions, following participants for 12 months or more. This would provide insights into whether short-term behaviour changes translate into lifelong habits.
2. **Customization and Inclusivity**
   Research should explore how to make gamified tools more inclusive, particularly for children with disabilities or limited access to technology.

Adaptive algorithms that adjust challenges based on a child's abilities and preferences could enhance engagement.

3. **Family and Community Integration**
   This study showed that parental involvement improved outcomes. Future research could explore how to incorporate broader community support, such as schools or local organizations, into gamified interventions.
4. **Cross-Cultural Applications** Given the global nature of childhood obesity, it's essential to test gamified tools in diverse cultural settings. This would help identify universal elements of gamification as well as culturally specific adaptations.

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