

HARNESSING GRASSROOT WEARABLE HEALTH DATA ANALYTICS FOR STRENGTHENING NATIONAL HEALTH SYSTEM

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Abstract

This paper explores how wearable health data, or devices such as smart-watches, that can be strengthened on a grassroots scale, can support the national health system of Nigeria. Disease surveillance, resource allocation and early warning programs could be improved by analyzing real time measures like heart rate and sleep patterns. An investigation with primary data of a survey of 200 people at Osun State revealed that the majority of 72% of respondents believe that wearable can drastically enhance local healthcare monitoring. Nevertheless, affordability and digital literacy were named as some of the biggest obstacles by 65%. The statistical results revealed that there was a significant positive correlation ($r = 0.78$) between adoption of wearable data and effective community-based healthcare provision. The paper concludes that the combination of this information can transform preventive care and decrease health disparities on the national health care. Some of the recommendations to be adopted are government allocation towards digital infrastructure, subsidization of devices and creation of training programs to enhance data literacy among healthcare workers and communities.

Keywords: Wearable Health Devices, Data Analytics, National Health System, Digital Health, Public Health.

INTRODUCTION

The 21st century has brought forth a lot of opportunities of real-time health monitoring at both individual and population levels due to the proliferation of wearable health technologies. The wearable health device market in the world has been growing at an alarming rate with over one billion active gadgets registered by 2023 (Grand View Research, 2023). With their help, physiological indicators (heart rate, blood pressure, oxygen saturation, physical activity, sleep patterns, and glucose levels) can be continuously monitored, so these types of gadgets can

produce useful health data to support preventive and clinical decisions (Dunn et al., 2021; Iqbal et al., 2021). The development of miniaturization of sensors, analytics based on artificial intelligence, and lower cost of production has further streamlined adoption the world over.

Although this has happened, Nigeria, as well as most Sub-Saharan Africa nations, are still left behind in this technological revolution because of the ongoing health system challenges including poor infrastructure, the inability of the health workforce to meet the demands, and ineffective health information systems. As Nigeria has a population of more than 220 million, a dual burden of communicable and non-communicable diseases, and needs innovative data-driven measures to enhance surveillance and early detection as well as resource allocation (Olapade & Adebayo, 2023). The most vulnerable groups to the lack of access to diagnostic and monitoring technologies are grassroots communities, especially the rural and underserved communities, although they carry a considerable burden of the disease.

The recent trends in wearable technologies of low costs, the growing number of mobile phones, and the rising digital health programs can be used to fill such gaps. There is an indication that wearable technologies can reinforce the health systems by enhancing the production of health information, facilitating remote monitoring, and making preventive healthcare interventions possible (Alami et al., 2020; Nguyen et al., 2024). In developing nations, however, the barriers to adoption include financial barriers, low digital literacy, unreliable internet access, and data privacy concerns (Oyedepo and Ogunwuyi, 2024; Maha et al., 2024). As a result, the advantages of wearable health technologies are still limited to urban and more affluent communities, with grassroots communities still underserved digitally.

The health information system of Nigeria remains heavily reliant on facility-based reporting, which leads to underreporting of community health events, slow response to outbreaks, and ineffective targeting of responses (Oyedepo and Ogunwuyi, 2024). Despite potential benefits of wearable technologies to supplement the current systems (provision of health services on a community level), little is known empirically about awareness, adoption obstacles, and their numeric value in healthcare delivery efficiency, especially at the home care level. Moreover, the

majority of the research literature features urban or clinical settings, and little is done on the rural population and community-wide implementation.

The study consequently adds to the growing literature on digital health transformation in the low- and middle-income nations by giving empirical quantitative results in Osun State, Nigeria. In particular, the research focuses on the awareness rates, barriers to adoption, and statistical correlation between the use of wearable health data and healthcare delivery efficiency in adults. In contrast to most of the past studies, which involve clinical settings or urban population, this study dwells on the grassroots communities, where digital health adoption is still minimal. The findings will inform evidence-based policies on the usefulness of wearable health technology by policymakers, healthcare providers, and technology creators on the use of wearable health technologies in achieving equitable healthcare delivery and hastening the process of universal health coverage with data-based community health systems.

Aim and Objectives

The aim of this study is to examine the role of grassroots wearable health data analytics in strengthening Nigeria's national health system. The specific objectives are to:

1. Assess the level of awareness and adoption of wearable health devices among grassroots communities in Osun State.
2. Identify key challenges affecting the adoption of wearable health devices at the grassroots.
3. Determine the quantitative relationship between wearable health data adoption and efficiency in community-based healthcare delivery.
4. Recommend evidence-based strategies for integrating wearable data into public health decision-making in Nigeria.

Hypotheses

The following null hypotheses guided the quantitative analysis:

H₀₁: Wearable health data adoption and efficiency are not significantly related to community-based healthcare delivery.'

- H₁₁: Wearable health data adoption and efficiency are significantly related to community-based healthcare delivery.
- H₀₂: Affordability and digital literacy have no significant effect on community-level adoption of wearable health technologies.
- H₁₂: Affordability and digital literacy have significant effect on community-level adoption of wearable health technologies.

METHODOLOGY

In this study, cross-sectional quantitative survey was used to investigate the awareness, adoption, and barriers related to wearable health technologies and their impact on the efficiency of healthcare delivery. The study sample included adults and primary care providers in Osun State. A sample of 200 respondents was chosen through stratified random sampling of the selected communities that were spread across four senatorial districts in the Osun state. The sample size was greater than the minimum of 167 that was calculated with the help of the formula of calculating the sample size by Yamane (1967).

A structured questionnaire was used to collect data with demographic variables, indicators of awareness, adoption barriers, and perceived impact of healthcare on a five-point Likert scale. Cronbach alpha ($\alpha = 0.84$) was used to verify instrument reliability which is good internal consistency. IBM SPSS version 27 was used to undertake data analysis. The data were summarized using descriptive statistics (frequencies, percentages, means and standard deviations). The Pearson correlation analysis was used to determine the interrelationship between wearable adoption and healthcare efficiency and multiple regression analysis was conducted to predict the adoption predictors. The level of statistical significance was established at 5% ($p < 0.05$).

RESULTS AND DISCUSSION

Results

Socio-demographic Characteristics of Respondents

Two hundred questionnaires were given out, of which 194 were sent back with all the necessary details and a response rate of 97 was obtained. Table 2 shows the socio-demographic profile of the respondents.

Table 1: Socio-demographic Characteristics of Respondents (n = 194)

Characteristic	Frequency (n=194)	Percentage (%)
Gender: Male	108	55.7
Gender: Female	86	44.3
Age: 18–30 years	74	38.1
Age: 31–45 years	82	42.3
Age: 46+ years	38	19.6
Education: Secondary	61	31.4
Education: Tertiary	97	50
Education: Primary/None	36	18.6
Occupation: Healthcare Worker	58	29.9
Occupation: Non-Healthcare	136	70.1

Awareness and Adoption of Wearable Health Devices

Table 2: Awareness and Adoption of Wearable Health Devices

Item	Yes n (%)	No n (%)
Aware of wearable health devices	119 (61.3%)	75 (38.7%)
Currently owns/uses a wearable device	42 (21.6%)	152 (78.4%)
Believes wearables can improve local health monitoring	140 (72.2%)	54 (27.8%)
Willing to use wearables if affordable	168 (86.6%)	26 (13.4%)
Aware of wearable data use in healthcare	73 (37.6%)	121 (62.4%)

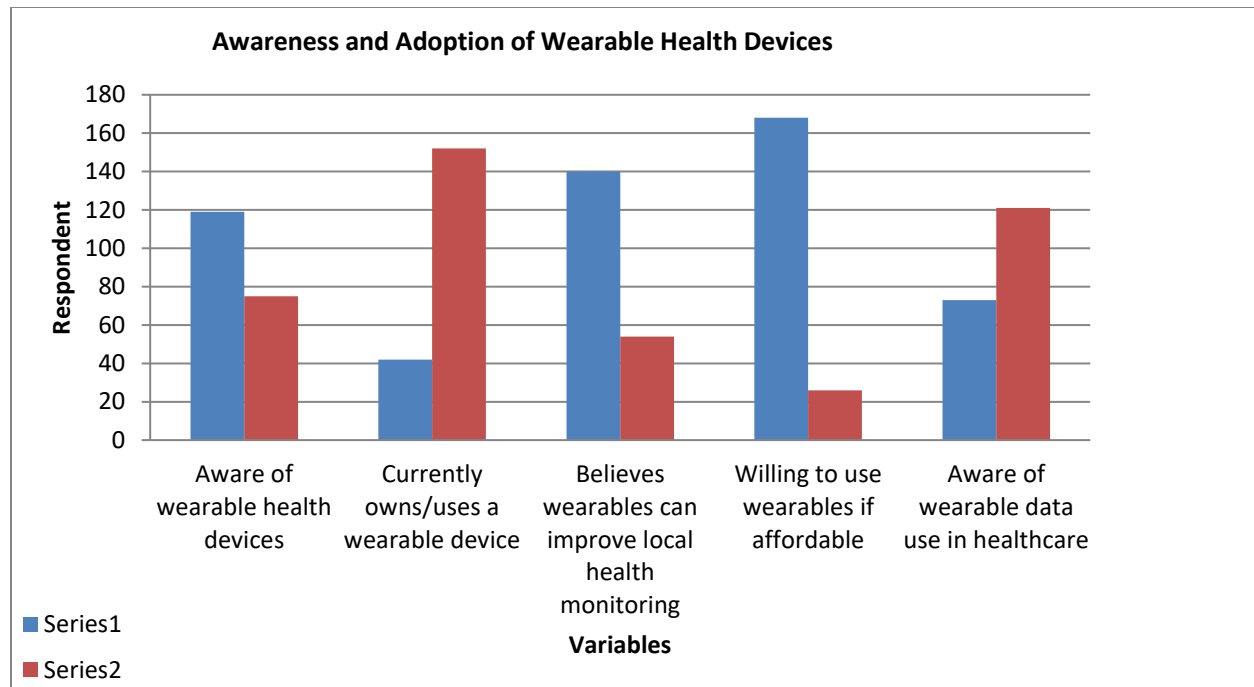


Figure 1: Awareness and Adoption of Wearable Health Devices

Table 2 shows the frequency distribution of the awareness and usage of wearable health devices by the respondents. Although the level of awareness was also decent (38.7% of respondents had heard about wearable health devices), the level of ownership and use was significantly lower (21.6%), which is in line with the data of similar LMICs (Maha et al., 2024). One of the main findings is that 72.2 percent of interviewed individuals indicated their belief that wearable health devices can positively influence the healthcare monitoring at the grassroots level. The high confidence with low current adoption indicates that there is high latent demand which is limited by structural constraints and not by lack of interest- a fact that is replicated in Oyedepo and Ogunwuyi (2024).

Problems that Influence the Wearable Technology Adoption.

The participants were requested to share the major obstacles to the use of wearable health technologies. Table 3 summarizes responses. The majority of the respondents (65.5%) referred to affordability and digital literacy as the most dominant barrier cluster.

Table 3: Challenges Affecting Wearable Technology Adoption (multiple responses allowed)

Challenge	Frequency	Percentage (%)
Affordability / High device cost	127	65.5
Digital literacy / skills gap	101	52.1
Insufficient electricity / charging	88	45.4
Poor internet/data connectivity	76	39.2
Privacy and data security concerns	54	27.8
Lack of awareness / information	49	25.3
Cultural/religious reservations	22	11.3

The percentages are greater than 100% since the respondents were allowed to choose various challenges. These results are consistent with the work by Maha et al. (2024) and Oyedepo and Ogunwuyi (2024) who have identified the same barriers profile in rural African populations.

Descriptive Statistics of Key Study Variables

Table 4: Descriptive Statistics of Key Study Variables

Variable	N	Mean	SD	Range
Wearable Data Adoption Score	194	3.14	0.87	1–5
Healthcare Delivery Efficiency Score	194	3.41	0.79	1–5
Affordability Barrier Score	194	4.02	0.91	1–5
Digital Literacy Score	194	2.87	1.03	1–5

That the mean affordability barrier score was ($M = 4.02$, $SD = .91$) indicates that the cost barrier is perceived as a pressing one among the respondents, and the comparatively low affordability score in digital literacy ($M = 2.87$, $SD = 1.03$) indicates that respondents have limited self-reported digital literacy- again in line with the challenge data presented in Table 4.

Test of hypotheses

Hypothesis 1

H₀₁: Wearable health data adoption and efficiency are not significantly related to community-based healthcare delivery.'

H₁₁: Wearable health data adoption and efficiency are significantly related to community-based healthcare delivery.

Correlation Analysis: Wearable Data Adoption and Efficiency of healthcare delivery.

Table 5: Pearson Correlation Matrix (n = 194)

Variables	r	p-value	Decision
Wearable Data Adoption × Healthcare Efficiency	0.78	< 0.001	Reject H01
Affordability × Adoption	-0.61	< 0.001	Significant
Digital Literacy × Adoption	0.55	< 0.001	Significant

Table 5 revealed that there is a strong, statistically significant positive correlation between wearable health data adoption and healthcare delivery efficiency (r = 0.78, p < 0.001). This result proves that H₀₁ should be rejected and that in communities where wearable data are more adopted, the score of healthcare delivery efficiency is significantly high. Also, affordability has a significant negative relationship with adoption (r = -0.61, p < 0.001), which proves cost barriers negatively influence wearable adoption, and digital literacy has a positive correlation with adoption (r = 0.55, p < 0.001).

Multiple Regression Analysis: Wearable Health Data Adoption Predictors.

Hypothesis 2

H₀₂: Affordability and digital literacy have no significant effect on community-level adoption of wearable health technologies.

H₁₂: Affordability and digital literacy have significant effect on community-level adoption of wearable health technologies.

Table 6: Multiple Regression Analysis- Predictors of Wearable Health Data Adoption.

Predictor	B	SE	β	p-value
(Constant)	1.24	0.31	—	< 0.001
Affordability Barrier	-0.43	0.08	-0.39	< 0.001
Digital Literacy	0.52	0.09	0.46	< 0.001
R² = 0.61; Adjusted R² = 0.60; F(2,191) = 149.2, p < 0.001				

The regression analysis (Table 6) indicated that the result was significant ($F(2,191) = 149.2, p < 0.001$) and explained 61 percent of the adoption of wearable health data ($R^2 = 0.61$). Both of the independent variables were identified as significant, affordability ($b = -0.39, p < 0.001$) and digital literacy ($b = 0.46, p < 0.001$). Therefore, the null hypothesis H02 is discarded. A stronger positive predictor was found in the digital literacy, which means that the improvement of the digital competencies might be more effective in augmenting the adoption than a simple reduction of costs, but both of these variables are still of critical importance as a policy intervention focus.

DISCUSSION

The results showed that there was a vast disparity between knowledge and the actual use of wearable health devices. Although 61.3% of the respondents knew of wearable devices, only 21.6% said they were using the devices. Nevertheless, 72.2% of the respondents felt that wearable devices would enhance grassroots healthcare monitoring. What this implies is that there is a latent demand that is not limited by the lack of interest but rather limited by the structural barriers. The greatest barriers to adoption were affordability (65.5%) and digital literacy (52.1%). The results are consistent with those of other sources that found the cost, lack of infrastructure, and digital skills gaps as primary obstacles in digital health uptake in the developing world.

The analysis of the correlation revealed that there is a strong positive relationship between the adoption of wearable health data and the efficiency of healthcare delivery ($r = 0.78, p < 0.001$), which proves that a higher level of adoption can influence the community healthcare performance in a significant way. In addition, affordability had a significant negative correlation with adoption ($r = -0.61$), whereas digital literacy was positively correlated ($r = 0.55$).

Multiple regression analysis also supported the claim that affordability ($\beta = -0.39$) and digital literacy ($\beta = 0.46$) are important predictors of wearable adoption. Digital literacy proved to be the predictor with the greatest significance and indicates that enhancing digital competencies may yield more improvements in adoption than cost reduction alone, but both are significant areas of interventions.

CONCLUSION

This study proves that grassroots wearable health data analytics has a great potential of enhancing the health system of Nigeria by providing better community health surveillance and making decisions based on data. The level of awareness is quite high but the level of adoption is low because of affordability factors and poor digital literacy. The strong positive correlation between the use of wearables and the efficiency of the healthcare sector demonstrates the opportunities of wearable technologies in the prevention of healthcare and enhancing the health of the community. Nevertheless, in order to attain this potential it is necessary to have co-ordinated policy interventions.

The study recommends:

- 1) Government subsidies to make the devices more affordable.
- 2) Infrastructure digital rural investment.
- 3) Digital health literacy education courses.
- 4) Wearable data in the National Health Management Information System.
- 5) Data governance and privacy policy development.

Although this has been added, the limitations of the study are that it is cross-sectional and it concentrates in one state. Longitudinal designs and larger national samples should be employed to prove these results in a future study to determine outcomes of long-term health.

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