The Combined Effects of Digital Health Interventions on Universal Health Coverage Equity in Kenya: An Integrated Approach

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Abstract

Achieving equitable Universal Health Coverage (UHC) is a fundamental goal for global health, especially in low-resource settings like Kenya. This study explores the integrated impact of digital health interventions - encompassing digital health tools and technologies, services, programmes, and information systems - on advancing UHC equity in Kenya, considering demographic factors of age, income, education, and digital literacy of the people. Several studies emphasised the promise of digital health, like telemedicine and mHealth applications, in overcoming geographic, financial, and infrastructural barriers to healthcare. However, challenges such as digital illiteracy, limited infrastructure, and socio-economic disparities persisted, inhibiting the widespread effectiveness of digital health interventions in achieving equity. Using a purely quantitative methodology, data was collected from 348 respondents drawn from Makueni County, and structural equation modelling (SEM) was used for data analysis. Findings revealed that while digital health platforms existed, and with 63.8% of respondents owning smartphones, digital literacy, income disparities, and gaps in awareness of advanced technologies, such as IoT, were significant barriers to equitable access to UHC. This shows that, while digital health was a powerful tool for advancing UHC, overcoming barriers related to technology access, education, and infrastructure was crucial to ensuring its success in promoting healthcare equity in resource-constrained environments like Kenya. The study recommends the implementation of digital literacy programmes, infrastructure improvements, and policies that promote equitable access to digital health innovations. The implications of this study are far-reaching, offering a roadmap for policymakers to enhance the inclusivity of healthcare systems through digital health.

Introduction

Achieving UHC is central to global health strategies, emphasising equity in access to quality healthcare services regardless of socio-economic status (World Health Organization, 2023). However, resource-limited settings like Kenya face significant challenges due to structural inequalities, geographic disparities, and limited healthcare infrastructure. Digital health interventions, including tools and technologies, services, programmes, and information systems, are increasingly recognised as transformative solutions for addressing these gaps (Ministry of Health, 2022). By leveraging telemedicine, mobile health applications, and health information systems, these innovations could bridge infrastructural divides, reduce operational inefficiencies, and expand healthcare access to

underserved populations. In Kenya, Makueni County, a semi-arid region with pronounced socio-economic disparities, presented a compelling case for evaluating the combined effects of these interventions on healthcare equity.

Digital health continued to capture global attention for its potential to revolutionise traditional healthcare systems and offer innovative solutions for underserved populations. Technologies such as telemedicine, mobile health applications, and electronic health records were transforming healthcare delivery by improving access, reducing costs, and optimising resource utilisation. Previous studies underscored their effectiveness in breaking down access barriers, particularly in low-income and resource-constrained settings (Pulimamidi, 2021). While these technologies held immense promise in addressing healthcare disparities, limited digital literacy, inadequate infrastructure, and socio-economic inequalities hindered widespread adoption. Makueni County, Kenya, exemplified these challenges, where rural populations faced compounded barriers to equitable healthcare access. This study, therefore, examined the contextual dynamics of digital health interventions in the region, exploring their inclusivity, scalability, and transformative potential, hence addressing the implementation gaps by providing actionable insights for advancing UHC through digital health innovation.

Digital Health Interventions in Kenya
Digital health interventions have been widely recognised for their transformative potential in improving healthcare access, particularly in underserved and resource-limited areas. In Kenya, digital health tools and technologies, such as mobile health applications (mHealth), telemedicine, and health information systems, have been deployed to tackle critical barriers like geographical distance, shortages in the healthcare workforce, and limited access to essential services. For instance, mobile health platforms have significantly enhanced healthcare access for rural populations, with initiatives such as mHealth connecting patients in remote locations to healthcare professionals (Pulimamidi, 2021). Similarly, telemedicine has been employed to provide specialist consultations, thereby reducing the need for patients to travel long distances, which constitutes a significant obstacle to accessing healthcare in rural Kenya (Nyatuka & De La Harpe, 2022). Integrating these digital health tools into Kenya's healthcare system has shown promise in improving accessibility and reaching marginalised populations, thus contributing to Universal Health Coverage (UHC). Internationally, comparable digital health interventions have demonstrated efficacy in expanding healthcare access. For example, studies in India and South Africa have underscored the role of mHealth and telemedicine in diminishing disparities in healthcare access by delivering timely medical care to rural communities (Pong et al., 2024; Chipps et al., 2012). These global examples reinforce the effectiveness of digital health technologies in overcoming barriers and promoting health equity, illustrating their potential for scalability across diverse healthcare systems, including Kenya's (Bitomsky et al., 2024).

Despite the potential of digital health interventions, several challenges hindered their effectiveness in promoting equitable Universal Health Coverage (UHC) in Kenya. Digital literacy remained a significant barrier, particularly in rural areas where traditional education and technology adoption are limited. Studies indicated that although digital health improved access, the impact was often constrained by low levels of digital literacy, especially among older adults and those with lower education levels (Mwangi & Muthoni, 2021). Furthermore, Kenya's digital health adoption was uneven across regions, with urban areas experiencing more widespread access and utilisation of digital health technologies than rural areas (Ministry of Health, 2022). This regional disparity in digital health adoption exacerbated healthcare inequities, as rural populations faced additional challenges such as limited internet connectivity, lack of digital devices, and poor infrastructure (Wambua & Oduor, 2024). Internationally, similar disparities were observed in other low- and middle-income countries. For instance, in India, rural populations encountered significant barriers to digital health

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adoption due to limited digital literacy and inadequate infrastructure (Sharma et al., 2024). Similarly, in sub-Saharan Africa, studies highlighted the digital divide that constrained the effectiveness of digital health interventions, with rural populations often left behind because of poor access to technology and digital skills (Owoyemi et al., 2022). These global examples further illustrated the need for targeted efforts to overcome the barriers mentioned above to ensure the equitable implementation of digital health solutions.

Recent literature suggests that an integrated approach, combining various digital health interventions, is crucial for enhancing healthcare delivery and achieving equitable access to UHC. Studies indicate that combining digital health tools and technologies, services, programmes, and information systems simultaneously addresses multiple facets of healthcare access. For example, integrating electronic health records (EHR) with telemedicine services allows for better care coordination, reducing fragmentation and improving healthcare delivery (Pulimamidi, 2021). Similarly, combining mobile health (mHealth) platforms with local health programmes and outreach services has been shown to enhance the effectiveness of interventions by ensuring continuous engagement with patients and healthcare providers (Nyatuka & De La Harpe, 2022). Such integration enables a holistic approach to healthcare delivery, considering the unique needs of underserved populations while promoting equity in health outcomes. International studies support these findings, with researchers in Brazil demonstrating how integrated digital health solutions improved patient outcomes by linking EHRs with telemedicine services in rural areas (Pimentel et al., 2023). Additionally, integrated mHealth programmes and community health outreach in the Philippines have successfully expanded access to essential health services in remote regions (Lu et al., 2021). These global examples underscore the effectiveness of integrated digital health interventions in achieving healthcare equity.

The role of policy and infrastructure in fostering digital health equity in Kenya cannot be overstated. The Kenyan government has made significant strides in embracing eHealth strategies at the policy level, aiming to integrate digital health solutions into the national health system (Ministry of Health, 2022). However, the successful implementation of these policies faces funding, infrastructure, and local capacity challenges. Studies have highlighted that infrastructural barriers, such as unreliable internet access and inadequate electricity supply in rural areas, limit the scalability and effectiveness of digital health solutions (Wambua & Oduor, 2024). Furthermore, policy gaps in ensuring the equitable distribution of digital health resources contribute to unequal access across socio-economic and geographic divides. Similar challenges have been observed internationally in other low- and middle-income countries. In India, for example, studies have shown that inadequate infrastructure and uneven policy implementation hinder the effective use of digital health technologies, especially in rural regions (Wambua, 2024; Sharma et al., 2024). Similarly, in sub-Saharan Africa, policymakers face difficulties ensuring the equitable distribution of digital health resources due to fragmented healthcare systems and limited funding (Owoyemi et al., 2022). Addressing these systemic barriers through targeted investments and policy interventions is essential for achieving equitable UHC in Kenya and similar contexts.

Equitable Access to Healthcare, including UHC
Empirical evidence supports the notion that digital health interventions significantly impact health equity by providing marginalised populations access to essential healthcare services. A study by Mwangi and Muthoni (2021) highlighted how digital health platforms, such as mobile applications for maternal and child health, improved health outcomes in rural Kenya by facilitating timely interventions and reducing barriers to care. Additionally, telemedicine has been shown to reduce wait times for consultations, thereby enhancing access to healthcare for patients in remote areas. However, the effectiveness of digital health interventions in achieving health equity depends on addressing

underlying socio-economic inequalities, such as income, education, and access to technology (Pulimamidi, 2021).

While Kenya has embraced eHealth strategies at the policy level, significant challenges remain in translating them into practical outcomes. Variations in healthcare access, infrastructure limitations, and uneven adoption of digital health technologies have revealed structural gaps between policy intent and on-the-ground realities (Nyatuka & De La Harpe, 2022; Ministry of Health, 2022). In rural areas like Makueni County, socio-economic disparities, digital illiteracy, and inadequate infrastructure have exacerbated these issues, hindering equitable healthcare delivery. This study examined these barriers, exploring how digital health frameworks could be adapted to the unique needs of underserved populations. By aligning technological solutions with local realities, the research offered actionable recommendations to enhance implementation effectiveness, bridge gaps in access, and advance UHC. Furthermore, it guided policymakers and healthcare providers in designing scalable, equitable strategies that address systemic and contextual digital health challenges.

The integration of digital health tools and technologies, services, programmes, and information systems has proven effective in enhancing healthcare delivery, particularly in regions with limited infrastructure. These innovations have improved access, optimised resource use, and addressed disparities, making them vital for advancing Universal Health Coverage (UHC) (Mathur et al., 2022). Despite their potential, the combined effects of these interventions on equitable UHC remain underexplored (Pong et al., 2024; Wambua & Oduor, 2024). This study examined how these digital health components collectively influenced healthcare equity in Makueni County, Kenya. By leveraging robust analytical frameworks, the research highlighted the synergies among these interventions, offering evidence-based insights into their transformative potential. The findings are intended to inform policies that promote inclusive and sustainable healthcare delivery.

Makueni County in Kenya offered a compelling case to explore the intersection of digital innovation and healthcare equity. As a semi-arid region characterised by limited infrastructure and socio-economic diversity, it exemplified the systemic challenges that hinder equitable healthcare access in resource-limited settings. Preliminary findings indicated that digital health interventions, such as telemedicine and mobile health applications, held significant potential for reducing disparities in healthcare access (Nyatuka & De La Harpe, 2022; Wambua, 2024). However, gaps in programme implementation, digital literacy, and public awareness remained critical barriers to achieving optimal outcomes. These challenges highlighted the need for a comprehensive and integrated approach that aligned digital health interventions with the specific needs of the target population. This study emphasised tailoring interventions to address context-specific barriers, ensuring digital health innovations fostered inclusive and sustainable progress towards UHC (Mwangi & Muthoni, 2021).

Demographic factors such as age, gender, income, education, and digital literacy have played a pivotal role in shaping the adoption and utilisation of digital health interventions (Hadjiat, 2023). These factors not only influence individual access to healthcare services but also determine the overall effectiveness and equity of digital health solutions (World Health Organization, 2023). For instance, higher income levels and digital literacy correlate with better utilisation of health technologies, while older age and lower education levels often present barriers (Ministry of Health, 2022; Mwangi & Muthoni, 2021). In regions like Makueni County, these disparities underscore the importance of context-specific strategies to bridge existing gaps in use and adoption, as well as in addressing inequalities and promoting inclusivity that advanced healthcare, including UHC.

This research, therefore, contributed to the growing discourse on the role of digital health in achieving equitable healthcare outcomes. Moreover, it highlighted the combined effects of digital health interventions on UHC equity in Kenya, which depended on the adoption of digital technologies and the socio-economic context in which they were implemented. By focusing on the combined effects of digital health interventions in Makueni County, the study underscored the importance of integrated approaches to addressing healthcare disparities in Kenya. It offered a roadmap for leveraging digital health innovations to achieve UHC in resource-constrained settings, emphasising inclusivity, scalability, and sustainability.

Methodology

A purely quantitative methodology was employed to assess the effectiveness and impact of digital health interventions on healthcare access and equity, focusing on Makueni County in Kenya. The methodology utilised a cross-sectional survey design. The population of Makueni County was estimated to be 987,653 people, according to the 2019 Kenya Population and Housing Census (KNBS, 2019). Furthermore, as stated in the 2022 Makueni County UHC policy (Bi & Cochran, 2014; Makueni County, 2022), 34.6% of the population in Makueni County was not covered by any prepayment plan and was likely to experience financial hardship. This informed the study's target population proportion, which was estimated to possess the measured characteristics. Consequently, following Cochran's sample size determination, the sample size for this study was set at 348 respondents, selected from across the sub-counties of Makueni County to ensure diversity in demographic characteristics.

The study primarily analysed the data using descriptive and inferential statistical techniques. Descriptive statistics, including frequencies, means, and standard deviations, summarised the demographic profile of the sample and the uptake of digital health. Inferential statistics, including SEM, tested hypotheses and examined the relationships between digital health interventions (tools and technologies, services, programmes, and information systems) and equitable access to UHC.

The SEM technique was specifically employed to model the relationships among various variables, including digital health tools, socio-demographic factors, and dimensions of UHC (availability, access, affordability, and coverage). The analysis also incorporated tests for multicollinearity, normality, and heteroscedasticity to ensure the reliability and validity of the data. The quantitative methodology offered a rigorous framework for assessing how digital health interventions affect healthcare access and equity.

This purely quantitative approach facilitated the establishment of statistically significant relationships. It yielded evidence-based insights into the combined effects of digital health interventions on UHC equity in a resource-constrained setting like Makueni County and much of Kenya.

Results and Findings

Age of the Respondents

The study gathered data from 348 respondents across the various Makueni County, Kenya sub-counties. The sample included diverse demographic groups, with a balanced representation of age and other demographic factors.

Table 1: Age of the Respondents

Age	Number of Respondents	Proportion (%)
18-25 years	30	9
26-35 years	67	19
36-45 years	108	31
46-55 years	86	25
Above 55 years	57	16
Target Sample Size, N	**348**	**100**

The age distribution of the respondents, as shown in Table 1, revealed vital insights into the adoption and utilisation of digital health interventions. The youngest age group, 18-25 years (9% of the sample), was the smallest, indicating lower digital health adoption among younger adults. This was likely due to several factors, including less frequent healthcare needs, limited awareness of digital health tools, or a preference for traditional healthcare options such as walk-in clinics or emergency services. However, this age group represents a potential area for growth, particularly with the introduction of digital health tools integrated into educational institutions or community programmes, which could enhance awareness and usage.

The 26-35 age group (19% of the sample) represented young professionals or individuals in the early stages of their careers. While this group would be more familiar with digital health tools, such as mobile health applications (mHealth) or telemedicine, their healthcare needs were typically lower than those of older adults. Engagement with digital health was likely influenced by factors such as the availability of smartphone apps or employer-sponsored insurance policies that promoted telehealth services.

The largest group of respondents fell within the age range of 36 to 45 years, comprising 31% of the sample. This group was often more engaged in healthcare decision-making, likely owing to family responsibilities, children, or managing chronic health conditions. Consequently, they were more inclined to adopt digital health interventions that addressed their healthcare needs and their families. This age group proved to be the most receptive to digital health services, as they prioritised healthcare access for themselves and their dependents, making them a key demographic for digital health initiatives.

The 46-55 age group (25% of the sample) also constituted a significant portion of the respondents. Individuals in this cohort likely experienced an increased need for healthcare services as they aged, particularly in managing chronic conditions or seeking preventive care. Digital health tools that enhance access to healthcare and reduce costs associated with frequent visits to healthcare facilities would be especially beneficial for this demographic. Therefore, they represent a crucial target for digital health interventions to improve healthcare outcomes and increase accessibility.

Finally, older adults aged 55 and above (16% of the sample) represented a smaller proportion of the respondents. This underrepresentation likely indicated that older individuals, particularly those in rural areas, faced barriers such as limited access to digital devices, lower digital literacy, and reduced engagement with technology. Since digital health solutions often require basic technological skills and internet access, this age group would thus be underrepresented in using these tools. This implies a need for targeted interventions, such as digital literacy programmes and affordable access to digital devices, to engage older adults more effectively in digital health solutions.

Descriptive Analysis

The descriptive statistics for the combined digital health variables, presented in Table 2, offer valuable insights into the overall adoption and perception of digital health tools, services, programmes, and information systems in Kenya.

The mean score for digital health tools and technologies stood at 2.42, with a standard deviation of 0.762, indicating a moderate level of adoption. This implies that, on average, respondents had access to or utilised digital health tools, although the variation was significant, as evidenced by the standard deviation. The skewness value of -0.034 suggested a relatively symmetrical distribution of responses, with most responses clustered around the mean. The kurtosis value of -0.377 was slightly negative, which signified a flatter distribution, indicating fewer extreme values compared to a normal distribution. This suggested that digital health tools and technologies were moderately utilised, yet likely required further efforts to enhance engagement and usage.

Table 2: Descriptive Statistics for Combined Variables

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Digital health tools and technologies (DHTT)	348	1	5	2.42	.762	-.034	.131	-.377	.261
Digital health services (DHS)	348	1	5	2.15	.769	.738	.131	.709	.261
Digital health programmes (DHP)	348	1	5	2.05	.836	.830	.131	.911	.261
Digital health information systems (DHIS)	348	1	5	2.12	.869	.738	.131	.451	.261

For digital health services, the mean score was slightly lower at 2.15, with a standard deviation of 0.769, again indicating moderate adoption. A skewness of 0.738 suggested a positive skew, meaning that more respondents rated digital health services on the lower end of the scale, potentially due to the limited availability or utilisation of such services. The kurtosis value of 0.709 indicated a slight peak, suggesting that most responses were concentrated around the middle range, although there was some variation. The lower mean score for digital health services likely reflected barriers to full integration and utilisation, such as infrastructure challenges or a lack of awareness.

The digital health programmes variable had the lowest mean score of 2.05 and a higher standard deviation of 0.836, indicating greater variability in responses. The skewness value of 0.830 suggested a positive skew, with most respondents likely rating the effectiveness or availability of these programmes towards the lower end of the scale. The kurtosis value of 0.911 was relatively high, indicating a concentration of responses around the mean, although some respondents rated the programmes at the extremes. The low mean scores and higher skewness imply that digital health programmes are underutilised or perceived as less effective within the community, necessitating further attention to improve engagement and outcomes.

For digital health information systems, the mean score was 2.12, slightly higher than that for digital health programmes, with a standard deviation of 0.869, indicating a moderate spread of responses. The skewness value of 0.738 again suggested a positive skew, indicating that a larger proportion of

respondents rated their access to or use of these systems lower. The kurtosis value of 0.451 indicated a distribution closer to normal, meaning the responses were more evenly spread across the scale. This relatively higher mean compared to digital health programmes suggested that digital health information systems were somewhat better received, although they still faced challenges in achieving widespread adoption.

The mean scores for all four variables—digital health tools and technologies, services, programmes, and information systems—ranged from 2.05 to 2.42, indicating that while digital health solutions were somewhat adopted, they were not fully integrated into healthcare practices. The high standard deviations for most variables implied significant variability in how respondents perceived and used digital health. While some individuals were highly engaged, others faced barriers to access, such as a lack of infrastructure, digital illiteracy, or limited awareness.

The positive skewness values across the variables indicated that a more significant proportion of respondents rated digital health services and tools lower, possibly due to infrastructural challenges, low awareness, or digital illiteracy. Kurtosis values closer to zero for digital health tools and technologies and higher values for digital health programmes suggested that responses for tools and technologies were more evenly distributed. In contrast, programmes and services tended to be concentrated around lower scores, highlighting the need for targeted improvements.

These findings highlighted several critical areas for intervention. First, there was a need to enhance the availability and accessibility of digital health services, particularly in rural areas where adoption rates were lower. Second, digital literacy programmes were essential, as the moderate scores across all variables suggested that many respondents were likely not fully equipped to engage in digital health. Programmes aimed at improving digital skills and raising awareness of the benefits of digital health would help to increase adoption rates. Finally, the variability in responses, particularly regarding digital health programmes and services, appeared to stem from infrastructure challenges such as unreliable internet access and a lack of digital devices. Targeted investments in infrastructure, including improved connectivity and access to devices, would likely enhance the effectiveness of digital health solutions in the region.

In summary, although digital health tools and technologies demonstrated potential, their adoption and effectiveness in Makueni County remained hindered by various factors. Tackling barriers such as digital illiteracy, infrastructure limitations, and inadequate awareness was essential for realising the full potential of digital health and achieving equitable access to digital healthcare, including UHC.

Inferential Analysis
The SEM evaluating the relationship between the "Digital Health Model" (DHM) and "Equitable Access to UHC" (EA), as shown in Figure 1, demonstrated a good fit with the data. DHM included DHTT, DHS, DHP, and DHIS, while EA consisted of the dimensions of availability (F1), access (F2), coverage (F3), and affordability (F4).

The non-significant chi-square (χ^2 = 32.344, p = 0.159) indicated no substantial discrepancy between the observed and modelled data, and the CMIN/DF value of 1.70 was within the acceptable range. The RMSEA value of 0.021 suggested an excellent fit with minimal error. Incremental fit indices (IFI = 0.891, CFI = 0.891, NFI = 0.885) were close to the recommended threshold of 0.9, while the GFI (0.934) and AGFI (0.915) surpassed it, confirming a good overall fit. The model revealed strong relationships between digital health components (e.g., DHP = 1.56, DHS = 1.44) and equitable access indicators (e.g., F2 = 0.97, F3 = 0.90), validating that the digital health model significantly influenced equitable access, providing a robust foundation for policy recommendations aimed at improving health equity through digital innovations.

Figure 1: SEM for Digital Health Model and Equitable Access
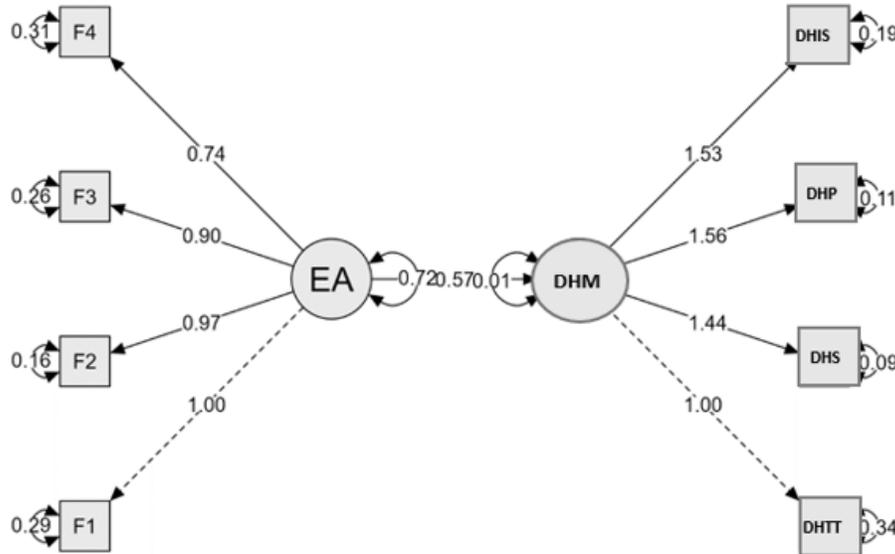
Chi-square ($\chi2$) = 32.344, DF = 19, p-Value = 0.159, CMIN/DF (x2 /df =1.70, RMSEA = 0.021, IFI= 0.891, CFI= 0.891, NFI= 0.885, GFI =0.934, AGFI=0.915

R-Square Values for Digital Health Model and Access to UHC as Dependent Variable

Table 3 presents the R-squared values for the Digital Health Model (DHM) and Equitable Access to UHC, which indicate the proportion of variance explained by the latent constructs.

Table 3: R-Square Values for Digital Health Model and Equitable Access to UHC

R-Squared

DHM	R²
DHTT	0.416
DHS	0.850
DHP	0.848
DHIS	0.747
F1	0.714
F2	0.809
F3	0.692
F4	0.563
Combine Variables (DHM)	0.966

Digital health services (DHS) and digital health programmes (DHP) exhibited the highest R-squared values of 0.850 and 0.848, respectively, indicating a strong explanation of their variance by the overall digital health model. Digital health tools and technologies (DHTT) had a moderate R-squared value of 0.416, while digital health information systems (DHIS) showed a strong value of 0.747, reflecting a solid relationship with the model. Regarding equitable access (EA), access (F2) possessed the highest R-squared value of 0.809, followed by availability (F1) at 0.714, with coverage (F3) and affordability (F4) at 0.692 and 0.563, respectively, demonstrating moderate relationships. The combined R-squared

value of 0.966 for EA and DHM illustrated that the latent variables and their components collectively accounted for a significant proportion of the variance in equitable access to UHC, underscoring the effectiveness of the digital health model in influencing UHC outcomes.

Relationship of Digital Health Model and Access to UHC using Path Analysis
The regression coefficients, presented in Table 4, for the digital health model and equitable access to UHC showed significant relationships between the latent constructs and their indicators.

Table 4: Regression Coefficients for Digital Health Model and Equitable Access to UHC

Factor Loadings

Latent	Indicator	Estimate	Std. Error	z-value	p	95% Confidence Interval Lower	Upper
DHM	DHTT	1.000	0.000			1.000	1.000
	DHS	1.441	0.100	14.474	< .001	1.246	1.636
	DHP	1.564	0.108	14.465	< .001	1.352	1.776
	DHIS	1.526	0.111	13.797	< .001	1.309	1.743
EA	F1	1.000	0.000			1.000	1.000
	F2	0.966	0.043	22.527	< .001	0.882	1.051
	F3	0.896	0.046	19.643	< .001	0.806	0.985
	F4	0.744	0.045	16.695	< .001	0.657	0.832

The DHTT, DHS, DHP, and DHIS coefficients had substantial estimates, with z-values ranging from 13.797 to 14.474 and p-values less than 0.001, indicating highly significant contributions to the DHM construct. Similarly, the equitable access (EA) indicators – F1, F2, F3, and F4 – demonstrated robust relationships with EA, with z-values ranging from 16.695 to 22.527 and p-values all below 0.001. The null hypothesis, which posited no significant relationship between the digital health model (DHM) and equitable access to UHC, could be rejected based on the statistical significance of these coefficients. The results affirmed that the digital health components significantly influence equitable access to UHC, with the path estimates for DHP, DHS, and DHIS being particularly strong. This validated the role of digital health interventions in promoting equitable access to UHC.

The path coefficient between the DHM and equitable access to UHC (EA) was 0.568, with a standard error of 0.043 and a z-value of 13.318, which was highly significant, with a p-value of less than 0.001. The 95% confidence interval for this path coefficient ranged from 0.483 to 0.652, indicating that the actual value of the path coefficient was likely to fall within this range with high confidence. These results provided strong evidence to reject the null hypothesis, which posited no significant relationship between the DHM and equitable access to UHC. The critical path estimate suggested that the digital health model had a noteworthy influence on equitable access to UHC, supporting the hypothesis that digital health interventions played a crucial role in enhancing access to healthcare and promoting equity in UHC outcomes.

Table 5: Path Coefficients for Digital Health Model and Equitable Access to UHC

Independent variable and indictors	Path	Dependent variable	Estimate	Std. Error	z-value	p	95% Confidence Interval	
							Lower	Upper
DHM	↔	EA	0.568	0.043	13.318	< .001	0.483	0.652

The results of the path analysis, presented in Table 5, confirmed that the findings of this study supported all five constructs and their associated hypotheses. The p-value of 0.000, which remained below the significance level of 0.05, indicated that the results were statistically significant.

Table 6: Hypothesis Testing Conclusion for DHM and EA to UHC

Hypothesis		p-value	Decision
H_0	There was no statistically significant influence of digital health model (combined variables) on equitable access to UHC in Kenya.	< .001	Rejected

The results of the hypothesis testing presented in Table 6 indicated that the model (DHM) and its combined components (DHTT, DHS, DHP, and DHIS) had a statistically significant impact on equitable access to UHC in Kenya, specifically in Makueni County. With p-values lower than 0.001, the null hypothesis, which posited no considerable relationship, was rejected. This finding strongly affirmed that DHM was a crucial factor in achieving equitable access to UHC, highlighting its essential role in addressing regional healthcare disparities. The structural equation model was $Y = \beta_0 + \beta_1 X_1 + \varepsilon$, where Equitable Access (EA) = Digital Health Model (DHM) + Error term = 0.568DHM + Error.

Conclusion

This study examined the impact of digital health interventions on achieving equitable access to UHC in Kenya. The findings from Makueni County suggested that integrating digital health tools, technologies, services, programmes, and information systems significantly influenced healthcare accessibility and equity. The digital health model (DHM), which encompassed these components, was found to have a strong, positive relationship with equitable access to UHC. The study highlighted that digital health interventions, such as telemedicine, mobile health applications, and electronic health records, held great potential for improving healthcare delivery. However, their adoption and effectiveness in Makueni County were constrained by digital literacy, infrastructure gaps, and socio-economic disparities. Despite these challenges, the results validated that digital health interventions were critical for addressing healthcare inequalities and advancing UHC, particularly in resource-limited settings.

Several key recommendations were proposed to enhance the effectiveness and equity of digital health interventions in Kenya. Firstly, targeted investments in digital literacy programmes were needed to equip communities, particularly older adults and those in rural areas, with the essential skills to effectively utilise digital health tools and technologies. Secondly, improving infrastructure, such as internet connectivity and access to digital devices, was crucial to ensure widespread adoption of these technologies. Furthermore, policies should focus on integrating digital health services with traditional

healthcare systems to ensure continuity of care and encourage greater engagement with underserved populations. Finally, future interventions should be designed to address the specific needs of marginalised groups, ensuring that digital health solutions are inclusive, accessible, and tailored to local contexts. These measures would help guarantee that digital health contributes to achieving equitable access to UHC and improving health outcomes for all.

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