Coverage, Utilisation and Users of a Chat-Based Digital Primary Care Clinic in Publicly Funded Healthcare: A Registry-Based Observational Study in Finland

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Abstract

Background: Chat-based digital clinics are increasingly integrated into public primary care. This study evaluates a 24/7 chat-based digital clinic integrated into Harjun terveys, Päijät-Häme, Finland.

Methods: Data from 2,796,976 primary care encounters recorded between 2019 and 2025 were used to examine care patterns following the digital clinic's introduction.

Results: Coverage fell from 36.5% in 2019 to 32.1% in 2020, consistent with pandemic-related suppression, before stabilising between 40% and 43% from 2022 onwards (40.7% in 2025). Utilisation rose from 972 encounters per 1,000 residents in 2020 to 1,568 by 2025. Digital encounters grew from 19.6% of all primary care contacts in 2021 to 29.8% in 2025. Digital users were substantially younger (mean age 33.5 vs. 52.5 years; *P*<.001) and had lower unadjusted comorbidity prevalence (CCI ≥1: 12.8%

vs. 25.6%). Within each year (2023-2025), digital users had lower adjusted odds of comorbidity than traditional users (OR range 0.87-0.90; all *P*<.001). Common physician-level diagnoses included conjunctivitis, acute cystitis, and prescription renewals. Following a nurse consultation, 18.0% were escalated to a same-day physician consultation; excluding pre-scheduled visits, 16.8% had a subsequent contact within 14 days and 23.4% within 30 days.

Conclusions: Over the study period, primary care coverage and the digital share of encounters both rose alongside the introduction of the digital clinic. Most minor acute presentations were managed at nurse level without recorded follow-up: approximately 60% of pathways ended within the digital channel, the remainder going on to in-person, telephone, or other encounters.

Keywords: Digital health; Telemedicine; eHealth; Primary Health Care; Health Services Accessibility; Service Coverage; Nordic; Finland

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Introduction

Digital technologies are reshaping the delivery of primary care. Asynchronous messaging, live chat, video consultations, remote monitoring, patient portals, and structured digital care pathways can improve accessibility, timeliness, and operational efficiency [1-3]. In the Nordic context, digital primary care has been promoted both as a service innovation and as a response to rising demand, workforce shortages, and access problems in publicly funded systems. In many countries, the COVID-19 pandemic accelerated the adoption of digital care models [4,5], though interest in digital-first approaches predated the crisis [6]. In Finland, digital transformation has similarly been framed as a system-level priority, with the expectation that digital modalities can support timely access to care and alleviate pressure on outpatient services.

Chat-based digital clinics are often organised around nurse-led triage, with the aim of resolving a substantial share of care needs without physician involvement and escalating cases to physician consultations or in-person care when clinically indicated. Early implementation studies and economic evaluations suggest that such digital-first pathways can be cost-effective and may enhance system responsiveness in real-world settings [7-9].

Evidence from European settings indicates that patients in digital primary care tend to be younger and more often female than those accessing only traditional (non-digital) services, and unadjusted comorbidity prevalence is typically lower in digital user populations. Whether this reflects genuinely lower disease burden or is an artefact of the younger age profile of digital users has not been systematically examined [9-11]. These patterns raise concerns about differential uptake and the potential for a digital divide, whereby patients with greater health needs or barriers to care may be less likely to benefit from digital channels. Despite these concerns, longitudinal evidence from publicly funded systems on how integrated digital clinics affect overall coverage, utilisation, and patient pathways over time remains limited, particularly in Nordic settings.

In this study, we examine the integration of a centralised, 24/7 chat-based digital clinic into Harjun terveys, a publicly funded primary care provider serving approximately 130,000 residents in the Päijät-Häme region of Finland. Using registry-based data from 2019 to 2025, the study had four aims: (1) to describe system-level trends in primary care coverage and utilisation across a seven-year period spanning pre-implementation, early implementation, and mature implementation phases; (2) to characterise the demographic and clinical profile of digital users; (3) to describe the clinical scope of digital encounters; and (4) to examine care pathway patterns following nurse-led digital consultations.

Methods

Study Design, Setting and Data

Finland provides universal healthcare coverage primarily through publicly funded services, with private providers in a complementary role. Three components operate in parallel: public, private, and occupational healthcare [12]. In some municipalities, parts of public service delivery are outsourced to private healthcare providers.

Harjun terveys is a joint venture that delivers publicly funded primary health care, including outpatient medical and dental services, to approximately 130,000 residents in the Päijät-Häme region of Finland. Established in January 2021 as a partnership between the regional wellbeing authority and a private healthcare company, the venture was created to address sustained shortfalls in local service capacity relative to patient demand. Harjun terveys introduced a multidisciplinary, team-based care model alongside a "digi-physical" service pathway. The catchment population is urban-rural mixed, with an age distribution slightly older than the Finnish national average [13].

All primary care encounters, whether a face-to-face appointment at a health centre, a telephone triage call, or an asynchronous chat consultation via the regional mobile application, are documented in the national unified electronic health record (EHR) system. All registered residents can access a 24/7 digital clinic via the Päijät-Sote application, which provides chat-based consultations alongside traditional telephone and in-person appointments. The model is intended to reduce appointment delays and improve access to same-day or rapid assessment.

This study is a retrospective observational study using routinely collected health service data. The observation window spans 1 January 2019 to 31 December 2025, providing two pre-implementation years (2019-2020) and five years during which digital services and broader organisational reforms were introduced and scaled (2021-2025). System-wide digital services were introduced in January 2021, followed by the launch of a centralised digital clinic operating under a new standardised model in January 2023. The observation period encompasses the COVID-19 pandemic, during which care-seeking behaviour and service delivery were substantially disrupted across 2020, and this should be considered when interpreting pre- to post-implementation comparisons.

The dataset comprises pseudonymised encounter-level records totalling 2,796,976 primary care encounters. Extracted variables include patient identifier, encounter date, encounter modality, service unit, provider profession, booking status, and diagnostic codes (ICPC-2 and ICD-10). Patient characteristics, including sex, date of birth, municipality, and residence start and end dates, were obtained from a corresponding population registry extract and used to define annual eligible populations and derive age at encounter. Comorbidity burden was measured using the Charlson Comorbidity Index (CCI), calculated from ICD-10 diagnostic history using an established mapping algorithm [14].

Coverage and Utilisation

This analysis examines trends in primary care coverage and service utilisation in Päijät-Häme between 2019 and 2025, encompassing distinct phases of organisational and digital reform: two pre-implementation years (2019-2020), the establishment of the joint venture and introduction of digital services (2021-2022), and the operation of the centralised digital clinic under a standardised model (2023-2025). Observed trends must be interpreted in context: the COVID-19 pandemic substantially suppressed care-seeking in 2020, and subsequent recovery likely contributed independently to increases in coverage and utilisation from 2021 onwards. Additionally, primary care provision in the region had experienced prolonged capacity challenges prior to the joint venture's establishment, and system-level improvements may have contributed to observed trends alongside the digital clinic.

Service coverage was defined as the proportion of registered residents with at least one primary care encounter during a calendar year; digital coverage as the proportion with at least one digital clinic encounter. Service utilisation was measured as encounters per 1,000 registered residents per year. Mean annual encounters per patient and mean annual digital encounters per patient were calculated by dividing total and digital encounter counts by the number of unique patients with at least one primary care encounter during that year. Population denominators were derived from national population registry data [13]. A primary care encounter was defined as any encounter with a nurse or general practitioner through either the digital clinic or a physical health centre, excluding health promotion and preventive services such as vaccinations and maternity or child health clinic visits.

For 2021-2022 and evening encounters in January-April 2023, digital clinic records were held in a separate administrative system with distinct patient identifiers that could not be linked to the primary EHR. This introduced a methodological distinction between encounter-level and patient-level metrics. Encounter-level metrics, including total encounters per 1,000 residents, digital share, and mean encounters per patient, were computed by summing counts across both systems and are exact for all years. Patient-level coverage estimates required correction, as direct addition of unique patient counts across systems would risk double-counting individuals who used both modalities within the same year.

An empirical overlap fraction φ was derived from the fully linked 2024-2025 data, in which digital and traditional encounter records share a common patient identifier. For each linked year, φ was defined as the proportion of unique digital users who also had at least one traditional encounter during that calendar year; the mean across both years was applied to the unlinked period. Corrected coverage was estimated as:

$$N_{covered} = N_{EHR} + N_{digital} \times (1 - \varphi)$$

where N_{EHR} is the number of unique patients in the primary EHR, $N_{digital}$ is the number of unique patients in the separate digital system, and $N_{digital} \times (1 - \varphi)$ represents the expected number of digital patients not already captured in the EHR. Digital coverage for 2021-2023 was derived directly from the unique patient count in the separate digital system, as this metric is unaffected by cross-system linkage.

This approach assumes that the propensity for overlap between digital and traditional service use was similar in 2021-2023 to that observed in 2024-2025. This assumption may not hold fully given that the digital clinic was in early rollout in 2021-2022, with a potentially narrower user base. If early adopters were more likely to use digital services exclusively, φ would be overestimated for those years, leading to underestimation of coverage; if they were predominantly existing EHR-registered patients, coverage would be overestimated. To characterise this uncertainty, sensitivity analyses across the full range of plausible φ values (0 to 1) are presented in Supplementary Table S2.

The separate digital system contributed 3,823 evening encounters from 2,877 unique patients in January-April 2023, representing a small fraction of total annual volume. Given this limited scope and the absence of linkable identifiers in pre-2023 digital data, all patient-level analyses were restricted to the fully linked EHR data spanning 2023-2025.

Patient Characteristics

Patient-level digital clinic encounter data were unavailable prior to the centralised model's launch in January 2023; accordingly, all patient-level analyses were restricted to 2023-2025. By this point, the joint venture had been operational for several years and pandemic-related disruptions to care-seeking behaviour had largely resolved, so observed patterns are likely to reflect routine use rather than implementation or pandemic artefacts.

A digital user was defined as a patient with at least one digital clinic encounter during a calendar year; traditional users were defined as those without any digital clinic encounter in that year. We reported the annual number and proportion of digital users and compared demographic and clinical characteristics between the two groups. Comparisons were stratified by age group, sex, municipality, and comorbidity burden (CCI categories), with age derived from date of birth. Characteristics were examined annually to assess whether pooling across 2023-2025 was justified; year-specific distributions are provided in the supplementary material (Supplementary Table S1).

Clinical Content of Digital Encounters

To characterise the clinical scope of digital care, we examined diagnoses recorded in digital clinic encounters from 2023 to 2025. Presenting symptoms and primary care-level assessments were described using ICPC-2 codes, and physician-level digital consultations were characterised using ICD-10 diagnoses. Diagnoses were summarised both as the most frequent individual codes and as aggregated categories (ICPC-2 chapters and ICD-10 chapters) to support clinical interpretability and reduce fragmentation across rare codes.

Follow-up Analysis

To evaluate care pathways and potential downstream utilisation following digital care, we analysed follow-up encounters occurring after nurse-led digital clinic contacts from 2023 to 2025. The index event was defined as a digital clinic encounter with a nurse. Follow-up was defined as any subsequent primary care encounter by the same patient within pre-specified windows of 48 hours, 14 days, and 30 days after the index encounter. The modality of each follow-up encounter was classified as one of: digital clinic, telephone consultation, digital physician consultation, in-person appointment, or other recorded encounter type. Encounters already booked at the time of the index digital nurse contact were identified using booking status information and analysed separately, allowing planned follow-up to be distinguished from new, unplanned care contacts.

Statistical Analysis

Differences in demographic characteristics between digital users and traditional users were tested using χ^2 tests for categorical variables. Age was compared using a two-sided Mann-Whitney U test, given the non-normal distribution of age in both groups.

To examine the independent association between digital clinic use and comorbidity burden, separate logistic regression models were fitted for each calendar year (2023, 2024, 2025) and a pooled model was fitted across all three years with calendar year included as a covariate. The models were fitted with CCI ≥1 as the binary outcome and digital versus traditional user status as the exposure, adjusted for age (continuous) and sex. Results are reported as adjusted odds ratios (ORs) with 95% confidence intervals. All statistical tests were two-tailed with a significance level of $P<.05$. Data analyses were performed using Python (version 3.12.10) [15-19].

Ethics and Approval

The study was approved by the Päijät-Häme Wellbeing Services County for secondary use of health data (decision number HA/187/07.01.04.05/2025). This study was based on secondary use of pseudonymised administrative data. In accordance with the Finnish Act on the Secondary Use of Health and Social Data (552/2019) [20] and the research permit, individual patient consent or separate ethical review was not required.

Results

Results are presented in four subsections corresponding to the study aims: system-level trends in coverage and utilisation (2019-2025); demographic and clinical characteristics of digital users (2023-2025); clinical content of digital encounters; and care pathway patterns following nurse-led digital consultations.

The initial extract comprised 2,902,707 primary care encounters recorded between 1 January 2019 and 31 December 2025 (inclusive). After deduplication, exclusion of encounters with unknown or out-of-scope profession codes, and removal of records with missing date of birth, 2,796,976 encounters remained for analysis. This represents a net reduction of 105,731 records (3.6% of the original entries).

Growth of Digital Care, 2019-2025

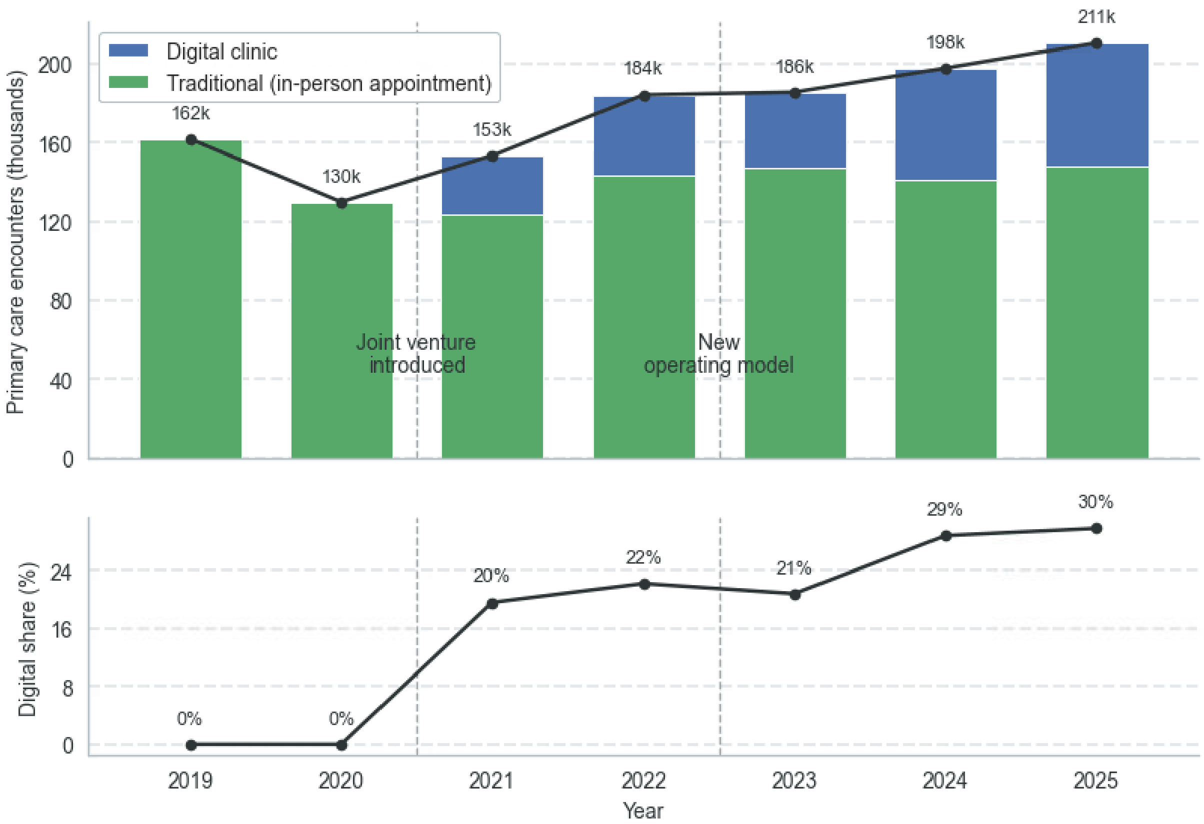
Service coverage declined from 36.5% in 2019 to 32.1% in 2020, and total encounters per 1,000 residents fell from 1,211 to 972 over the same period, consistent with the widespread suppression of non-urgent primary care contacts observed during the COVID-19 pandemic. Recovery began in 2021 coinciding with the establishment of Harjun terveys and the introduction of digital services, with coverage and utilisation subsequently exceeding pre-pandemic levels from 2022 onwards. The digital share of all primary care contacts rose from 19.6% in 2021 to 29.8% in 2025 (Table 1, Figure 1). Both the proportion of the population reached by digital services and the mean number of digital encounters per patient increased consistently across 2023-2025.

Table 1. Annual primary care coverage (%) and encounters per 1,000 population, 2019-2025. *Coverage represents the proportion of the registered population with at least one primary care encounter during the year. Encounters include digital clinic encounters (chat-based) and traditional in-person and telephone appointments. Population denominators derived from national population registry data [13]; 2024 population data used for 2025 as 2025 figures were not yet available at time of analysis. For 2021-2022 and evening encounters in January-April 2023, digital clinic records were held in a separate administrative system with distinct patient identifiers. Encounter-level metrics (encounters per 1,000, digital share, mean encounters per patient) are exact for all years, derived by summing counts across both systems. Overall coverage estimates for 2021-2023 incorporate an empirical correction for expected cross-system patient overlap, derived from fully linked 2024-2025 data; see Methods for details. Sensitivity analyses under the full range of plausible overlap assumptions are presented in Supplementary Table S2.*

Year	Overall coverage (%)	Digital coverage (%)	Encounters per 1,000	Digital share (%)	Mean encounters per patient	Mean digital encounters per patient
2019	36.5	-	1,211.3	0.0	3.32	-
2020	32.1	-	972.2	0.0	3.03	-
2021	35.6	9.7	1,149.6	19.6	3.23	0.63
2022	40.9	11.8	1,380.4	22.2	3.37	0.75
2023	42.8	14.1	1,387.3	20.8	3.24	0.68
2024	42.9	16.6	1,472.7	28.8	3.44	0.99
2025	40.7	18.5	1,567.8	29.8	3.85	1.15

Figure 1 Total primary care encounters by modality, Harjun terveys, 2019-2025. *The stacked bar chart shows annual encounters (in thousands) stratified by traditional encounters (in-person appointments, green) and digital clinic encounters (blue). The line graph indicates total encounter volume. The lower panel displays the digital share*

(%) of total encounters for each year. The digital clinic was introduced in 2021, with the centralised model implemented in 2023.



Demographic Profile of Digital Users

The following patient-level analyses are restricted to 2023-2025, reflecting the availability of fully linked patient-level data from the centralised digital clinic system; this restriction is described in detail in the Methods section. The year-specific distributions were sufficiently consistent to justify pooling, see Supplementary Table S1.

Digital users were substantially younger (mean age 33.5 vs. 52.5 years; *P*<.001), more often female (60.7% vs. 52.1%; *P*<.001), and less likely to have documented comorbidity (CCI ≥ 1: 12.8% vs. 25.6%; *P*<.001) than those using only traditional services (Table 2). After adjustment for age and sex, the association between digital use and comorbidity varied by year. Within each individual year, digital users had consistently lower odds of CCI ≥1 (2023: adjusted OR 0.90, 95% CI 0.85-0.95; 2024:

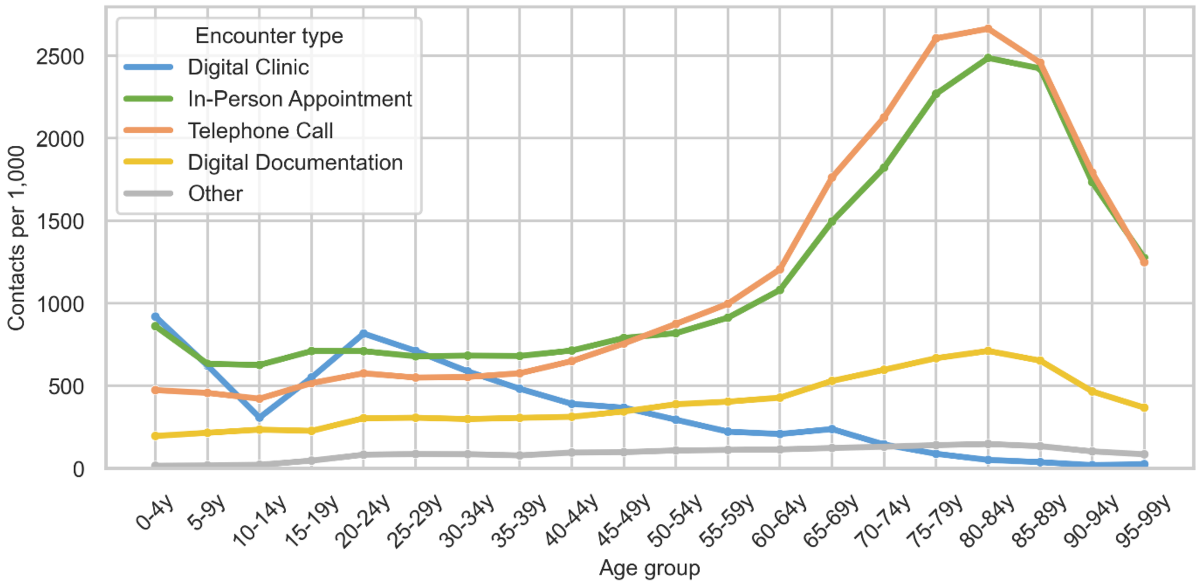
adjusted OR 0.87, 95% CI 0.83-0.91; 2025: adjusted OR 0.90, 95% CI 0.86-0.95; all *P*<.001). When pooling across all three years with year included as a covariate, however, the direction reversed (adjusted OR 1.04, 95% CI 1.00-1.08; *P*=.047), illustrating Simpson's Paradox driven by temporal trends in both digital adoption and patient case mix.

Table 2 Demographic characteristics of those using healthcare services in Harjun terveys 2023-2025. *Comparison of age, sex distribution, and comorbidity burden between users of digital clinic services and those utilising only traditional care modalities. Year-stratified demographic data are in Supplementary Table S1. CCI = Charlson Comorbidity Index. Age compared using Mann-Whitney U test; categorical variables compared using chi-square test. Year-stratified adjusted ORs derived from logistic regression models fitted separately for each year, with age (continuous) and sex as covariates, and traditional users as the reference category.*

	2023-2025		
	Digital user	Traditional user	*P*-value
Patients (n)	41,788	63,209	-
Patients (% of total)	39.8%	60.2%	-
Mean age (SD)	33.5 (21.7)	52.5 (24.4)	<.001
Median age (IQR)	31.0 (33.0)	59.0 (40.0)	<.001
Female (%)	60.7%	52.1%	<.001
Male (%)	39.3%	47.9%	<.001
CCI ≥ 1 (%): Unadjusted	12.8%	25.6%	<.001
CCI ≥ 1 Adjusted OR (95% CI)	1.04 (1.00-1.08)	ref	.047
CCI ≥ 1: Year-stratified adjusted OR (95% CI)			
- 2023	0.90 (0.85-0.95)	ref	<.001
- 2024	0.87 (0.83-0.91)	ref	<.001
- 2025	0.90 (0.86-0.95)	ref	<.001

Digital utilisation peaked in adolescents and young adults aged 15-29 years and declined steeply after age 30, whereas telephone and in-person utilisation increased markedly from age 65 onwards (Figure 2).

Figure 2 Annualised primary care encounters per 1,000 population by age group and encounter type, 2023-2025. *Encounter types include digital clinic (blue), in-person appointments (green), telephone calls (orange), digital documentation (yellow), and other (grey).*



Digital Consultation Characteristics: Diagnoses and Conditions Managed

The 20 most common ICPC-2 codes collectively accounted for 46.2% of all digital encounters, as shown in Figure 3. The most common reasons for encounters were respiratory infections (R74 and R83, 13.0%). Other frequent codes included general symptom consultations such as health maintenance or preventive advice (-45 and A98, 7.1%), various skin symptoms (S29 and S21, 5.2%), and throat or eye-related symptoms (R21, F03, and F29, 6.4%). Notably, administrative interactions related to prescription renewal were also featured (-50, 1.9%).

Figure 3. Most common ICPC-2 diagnosis categories in the digital clinic (2023-2025). *The 20 most frequent ICPC-2 codes recorded in digital clinic consultations, shown as the percentage of all digital clinic encounters.*

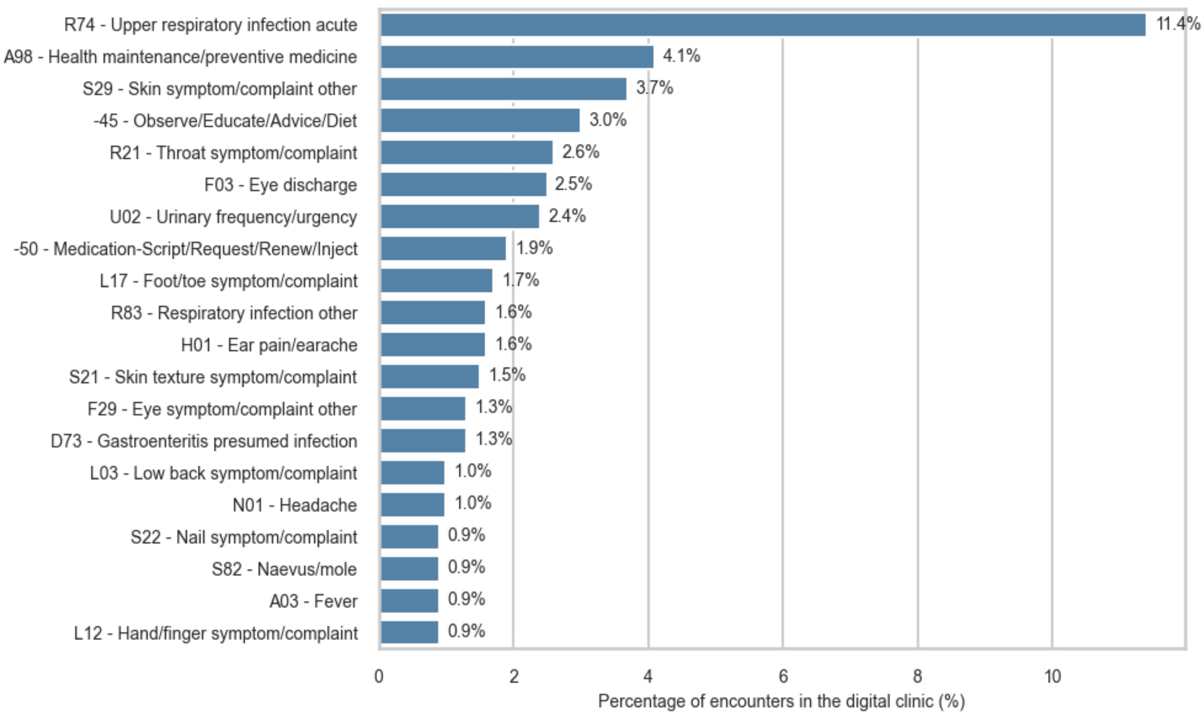
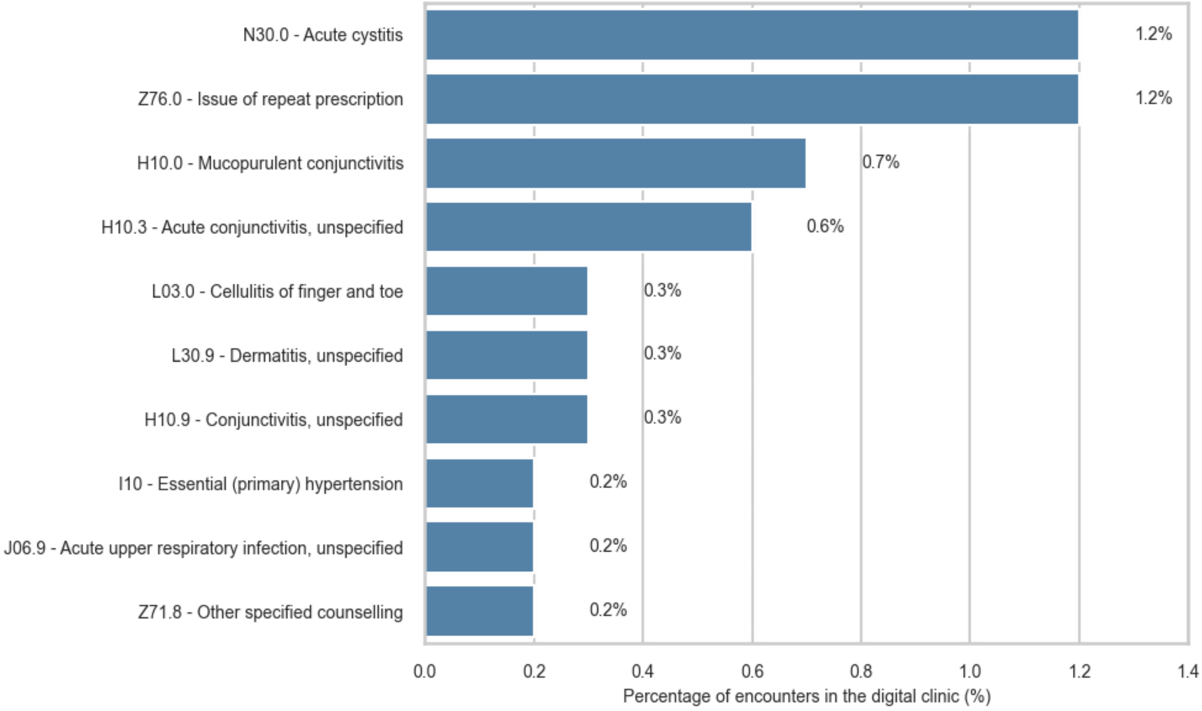


Figure 4 shows the 10 most frequent ICD-10 diagnoses recorded in physician-level digital consultations, expressed as a percentage of all digital clinic encounters. The most common were conjunctival infections (H10.x combined, 1.6%), acute cystitis (N30.0, 1.2%), and prescription renewals (Z76.0, 1.2%). Additional diagnoses reflected a typical profile of low-complexity primary care issues, including cellulitis, dermatitis, and streptococcal pharyngitis.

Figure 4. Most common ICD-10 diagnosis categories in the digital clinic (2023-2025). *Top 10 ICD-10 codes recorded during digital consultations with a physician, following escalation from the nurse encounter at the digital clinic. Percentages represent the share of all digital clinic encounters.*

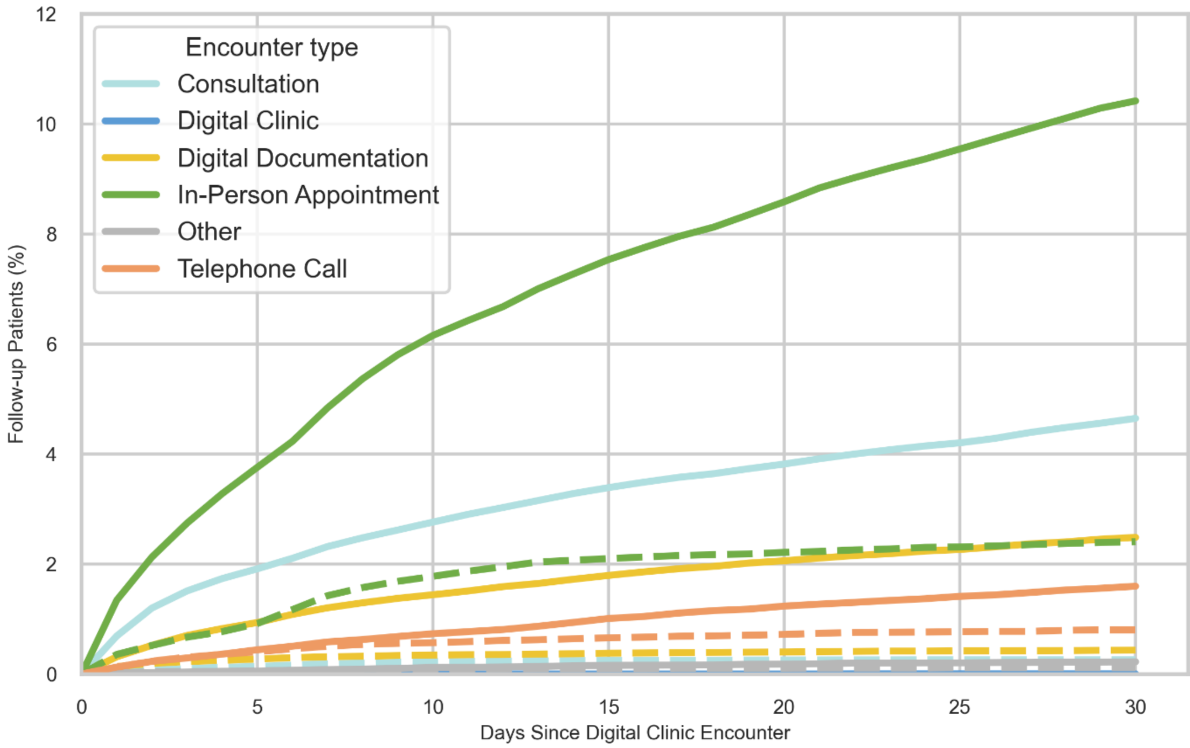


Follow-up Analysis

To evaluate care continuity following nurse-led digital encounters, we analysed subsequent primary care encounters over a 30-day window for the period 2023-2025. The cohort comprised 154,695 index digital nurse encounters. On the same day as the digital encounter, 18.0% (n = 27,820) involved direct escalation to a physician consultation, and 14.0% (n = 21,591) resulted in a new subsequent encounter being booked for a later date.

To focus on unplanned care needs, we excluded encounters already booked at the time of the index digital encounter and restricted the analysis to new encounters arising more than 24 hours afterwards. Across all modalities, 5.2% of patients had a new unplanned encounter within 48 hours, 16.8% within 14 days, and 23.4% within 30 days. Figure 5 presents the cumulative incidence stratified by encounter type. In-person appointments were the most common follow-up modality, with telephone consultations, new digital, and administrative encounters accounting for the remainder.

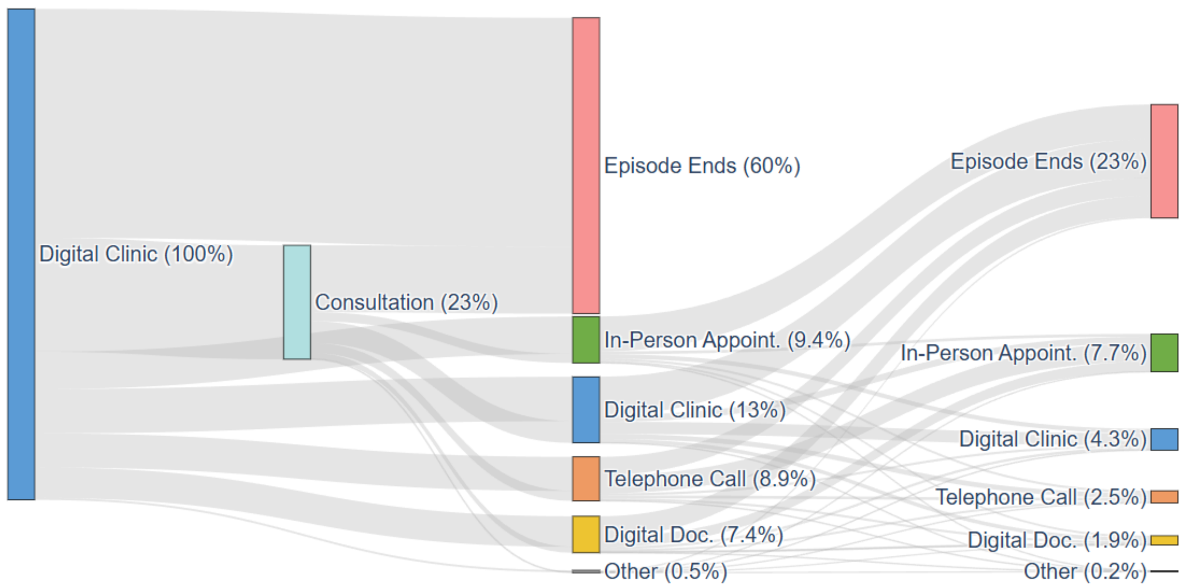
Figure 5 Cumulative follow-up by encounter type over 30 days following an encounter with the digital clinic. *Follow-ups that had been booked prior to the encounter with the digital clinic are excluded. Dashed lines indicate follow-up encounters that were scheduled on the same day as the digital clinic encounter.*



We also examined encounters booked on the same day as the digital nurse consultation but scheduled for a later date, as a measure of planned care coordination. The likelihood of same-day booking varied by modality: among patients with any follow-up within 30 days, 33.4% of telephone consultations and 18.8% of in-person appointments were arranged at the time of the index encounter. The most common presenting reasons for these pre-booked follow-ups were skin lesions (naevus/mole), lacerations, acute upper respiratory tract infections, diabetes, and sleep disturbances.

To illustrate care pathways over a shorter horizon, Figure 6 presents a Sankey diagram restricted to the first 14 days after a digital clinic encounter. Flow widths correspond to the share of patients at each step. For readability, paths are limited to three steps, and the observation window is 14 days. The diagram takes into account all healthcare utilisation, both planned and unplanned. Approximately 60% of patient trajectories ended within the digital channel, either directly following the nurse encounter or after a physician consultation. A physician consultation was involved as an intermediate step in 23% of all encounters, after which patients either concluded the episode or went on to in-person, new digital encounter, telephone, or other follow-up encounters.

Figure 6 Sankey diagram of healthcare utilisation after a digital clinic encounter, 2023-2025. *Flow widths correspond to the proportion of patients at each step. The diagram covers the first 14 days after the encounter, and sequences are truncated at three steps to aid interpretation.*



Discussion

This study characterised the utilisation, patient profile, clinical scope, and care pathways of a 24/7 chat-based digital clinic integrated into publicly funded primary care in Finland. Digital encounters grew from 19.6% of all primary care encounters at launch to approximately 30% by 2025, and were predominantly used for acute, low-complexity presentations, most of which were managed within the digital channel without a recorded subsequent contact. Because the digital clinic was introduced concurrently with broader joint-venture organisational reforms, its independent contribution to system-level changes in coverage cannot be established with the present design. Furthermore, 2019 represents a pre-pandemic baseline in which care-seeking patterns were substantially different from those observed after 2020. The sharp contraction in utilisation during 2020 and subsequent recovery make it difficult to disentangle the effects of the digital clinic from broader post-pandemic normalisation of care-seeking behaviour.

Patterns of digital clinic adoption were consistent with those reported in prior European studies, with higher uptake among younger adults and women [9-11]. Older adults and patients with a higher burden of chronic disease continued to rely primarily on traditional, non-digital care. The digital channel appears to attract patients with acute, episodic care needs rather than those with substantial chronic disease burden, consistent with the predominance of minor acute diagnostic codes in the clinical content analysis.

Within each calendar year, age- and sex-adjusted comorbidity odds were consistently lower among digital users than traditional users (OR range 0.87-0.90), but pooling across 2023-2025 reversed the direction (OR 1.04), an instance of Simpson's Paradox driven by the concurrent rise in digital adoption (14.1% to 18.5% population coverage) alongside shifts in patient case mix [21]. The year-stratified estimates describe the within-period relationship and are the appropriate basis for interpretation. At any given time, digital users of equivalent age and sex carry a lower comorbidity burden, which likely reflects both clinical appropriateness, with patients managing complex chronic conditions continuing to rely on in-person care, and selection effects, whereby healthier individuals within each age stratum adopt digital services more readily.

Lower engagement among older adults may reflect usability barriers, preferences for in-person interaction, or differences in clinical appropriateness for digital encounters.

Regardless of the mechanism, these patterns raise equity concerns in a publicly funded system. Targeted strategies such as assisted digital onboarding, caregiver-supported use, or integration of digital services into selected chronic care pathways may help broaden inclusion.

Approximately 86% of digital encounters did not result in a follow-up appointment being booked at the time of the digital encounter, suggesting that the digital channel is clinically well suited to the acute, low-complexity case mix it attracts. The follow-up rates observed here were lower than those reported by Lakoma et al. [9] and Glock et al. [11], both of whom reported higher rates of in-person follow-up encounter than observed in the present study. The present study's 14-day follow-up rate of 16.8% is compared with Lakoma et al., and the 30-day rate of 23.4% with Glock et al. Both studies identified conditions such as acute cystitis and urinary tract infections among the most common drivers of in-person follow-up, presentations that are now frequently managed within the digital pathway, which likely accounts for much of the difference. Closer examination of care pathways showed that digital encounters were frequently followed by physician consultations in situations where prescription authority was required, such as suspected urinary tract infections requiring antibiotic treatment. This pattern reflects the intended nurse-led design of the service, in which nurses function as the initial point of contact and escalate cases to physicians when clinically indicated.

The findings point to a dual role for the digital clinic: direct management of common, low-acuity conditions, and triage of patients requiring further assessment to other modalities. The predominance of minor acute diagnostic codes supports the interpretation that digital services are primarily used for frequent, lower-complexity presentations that benefit from rapid and accessible care.

Among encounters progressing to in-person visits, conditions requiring physical examination were overrepresented, including skin lesions such as naevi, lacerations, and respiratory conditions in which complications such as pneumonia were suspected. This supports a complementary rather than substitutive relationship between digital and traditional modalities: the digital encounter functioned as an initial assessment step that directed patients to the appropriate level of care, rather than replacing it.

Most digital encounters were episodic and few patients with high comorbidity burden used the digital pathway for routine chronic care follow-up, though a small proportion used it for incidental acute concerns. Expanding digital services to include selected chronic care tasks, such as remote monitoring, is a promising direction for future development [22]. Digital utilisation for mental health concerns was likewise modest, despite the potential of digital platforms to lower access barriers. Prior research suggests this may reflect limited perceived personal connection, lack of trust, and concerns about privacy and confidentiality in digital encounters [23,24]. Finland's Therapy Navigator programme, integrated into the digital clinic platform, is one emerging response to these barriers [25].

Evidence indicates that digital services can improve access for specific populations [26,27]. The lower uptake among older adults in this setting points to the core implementation challenge: ensuring that digital expansion does not widen access gaps. In line with previous recommendations [28-31], hybrid models that preserve in-person options, build users' digital skills, and offer personalised support (including remote assistance), together with patient-centred platform design with intuitive interfaces and clear clinical guidance, can help broaden inclusion [31,32].

Limitations

This study relied on registry healthcare data, which carries inherent limitations. Some outcomes like clinical resolution or patient satisfaction were not directly measured; we inferred resolution from follow-up rates, which could miss cases where patients sought care outside the system under study. There is also potential misclassification in diagnostic coding. Since this was an observational study within one wellbeing services county, generalisability may be limited; factors unique to Päijät-Häme (such as the specific app used or population characteristics) might affect results. Additionally, our comparisons between digital and traditional users are subject to confounding, as the groups differ by age and health status by design.

The φ-correction applied to coverage estimates for 2021-2023 introduces assumptions that are not fully verifiable. The most likely source of bias relates to the representativeness of 2024-2025 digital users as a reference population for early-phase users in 2021-2022. Early adopters of digital services in newly launched systems tend to be more engaged and may be more likely to use the digital channel as their primary or exclusive point of contact, implying a lower true φ in those years than the value derived from the mature system. Under this scenario, the φ-correction would apply too large an adjustment, underestimating the number of genuinely new unique patients from the digital system and thereby underestimating overall coverage for 2021-2022. However, as digital encounters constituted a relatively small share of total encounters in those years (19.6% and 22.2% respectively), the absolute impact on the coverage percentage is constrained. As shown in Supplementary Table S2, across the full range of plausible φ values (0 to 1), coverage estimates for 2021 range from 31.7% to 41.4% and for 2022 from 36.2% to 48.0%, with the primary estimates of 35.6% and 40.9% falling at φ ≈ 0.6. These bounds demonstrate that, while precise coverage estimates for those years carry uncertainty, the direction of the overall trend is robust across all plausible assumptions.

Attribution of effects should be cautious. Concurrent system improvements under the joint venture mean that attributing all observed changes to the digital channel risks overstatement. As an observational study, we cannot establish causality.

Conclusions

Digital encounters through the Päijät-Sote application grew to account for approximately 30% of all primary care encounters by 2025, predominantly serving younger adults with acute, low-complexity presentations, most of which were managed without a subsequent visit. Escalation to physician consultation or in-person care followed a pattern consistent with the nurse-led triage model.

Digital service use was concentrated among younger patients, and unadjusted comorbidity prevalence was lower among digital users. Within each year, age- and sex-adjusted comorbidity prevalence remained lower among digital users, indicating that the digital channel primarily attracts healthier individuals even within age strata. Within each calendar year, digital users had consistently lower adjusted odds of comorbidity than traditional users of equivalent age and sex (OR 0.87-0.90); pooling across years reversed this association due to temporal shifts in both digital adoption and patient case mix, and the year-stratified estimates are the appropriate basis for clinical interpretation. Older adults continued to rely primarily on traditional care. As digital services expand within publicly funded systems, equity-conscious implementation, including hybrid models, digital literacy support, and accessible platform design, will be essential to ensure that efficiency gains do not come at the cost of inclusive access.

Declaration statements

Data Availability

All data generated or analysed during this study are presented within the published article and its supplementary materials. Patient-level data are not publicly available due to privacy and data protection regulations.

Code Availability

The underlying code for this study is available at https://github.com/achdahlberg/coverage-utilisation-digital-clinic-2025.

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Authors' Contributions

A.D.: Conceptualisation, Data curation, Formal analysis, Investigation, Methodology, Project Administration, Software, Validation, Visualisation, Writing - original draft, Writing - review & editing. **T.K.:** Conceptualisation, Resources, Supervision, Validation, Writing - review & editing. **S.J.:** Conceptualisation, Methodology, Resources, Software, Supervision, Validation, Writing - review & editing. **P.O.:** Conceptualisation, Funding acquisition, Project administration, Resources, Supervision, Writing - review & editing.

Competing Interests

All authors are employed by Mehiläinen, the healthcare organisation responsible for developing and operating the digital clinic assessed in this study. Some authors also hold personal financial interests in the company. The study received funding from Mehiläinen, and institutional support was provided by the leadership of Harjun terveys throughout the research process. The analytic plan was defined prior to data extraction, and the authors retained full independence in the conduct, interpretation, and publication of this research. The data access permit was issued by the Päijät-Häme Wellbeing Services County as an independent public authority.

References

[1] Dorsey ER, Topol EJ. State of Telehealth. New England Journal of Medicine. 2016;375(2):154-161.
[2] De Guzman KR, Snoswell CL, Caffery LJ, et al. Economic evaluations of videoconference and telephone consultations in primary care: A systematic review. Journal of Telemedicine and Telecare. 2021;30(1):3-17.
[3] Campbell K, Greenfield G, Li E, et al. The Impact of Virtual Consultations on the Quality of Primary Care: Systematic Review. J Med Internet Res. 2023;25:e48920.
[4] Neves AL, Burgers J. Digital technologies in primary care: Implications for patient care and future research. Eur J Gen Pract. 2022;28(1):203-208.
[5] Ward K, Vagholkar S, Sakur F, et al. Visit Types in Primary Care With Telehealth Use During the COVID-19 Pandemic: Systematic Review. JMIR Med Inform. 2022;10(11):e40469.
[6] Ministry of Social Affairs and Health. Strategy for digitalisation and information management in healthcare and social welfare. 2023.
[7] Gentili A, Failla G, Melnyk A, et al. The cost-effectiveness of digital health interventions: A systematic review of the literature [Systematic Review]. Frontiers in Public Health. 2022;10.
[8] Dahlberg A, Jukarainen S, Kaartinen T, et al. Cost minimization analysis of digital-first healthcare pathways in primary care. npj Digital Medicine. 2025;8(1):546.
[9] Lakoma S, Pasanen H, Lahdensuo K, et al. Quality of the digital gp visits and characteristics of the users: retrospective observational study. Scand J Prim Health Care. 2024;42(4):686-694.
[10] Darley S, Coulson T, Peek N, et al. Understanding How the Design and Implementation of Online Consultations Affect Primary Care Quality: Systematic Review of Evidence With Recommendations for Designers, Providers, and Researchers. J Med Internet Res. 2022;24(10):e37436.
[11] Glock H, Jakobsson U, Borgström Bolmsjö B, et al. eVisits to primary care and subsequent health care contacts: a register-based study. BMC Primary Care. 2024;25(1):297.
[12] Eskola P, Tuompo, W., Riekki, M., Timonen, M., & Auvinen, J. . Hoidon jatkuvuusmalli - Omalääkäri 2.0 -selvityksen loppuraportti. In: Health FMoSAa, editor. Institutional Repository for the Government2022.
[13] Official Statistics of Finland. Population structure 2025. Available from: https://stat.fi/tilasto/vaerak

[14] Brusselaers N, Lagergren J. The Charlson Comorbidity Index in Registry-based Research. Methods Inf Med. 2017;56(5):401-406.

[15] Harris CR, Millman KJ, van der Walt SJ, et al. Array programming with NumPy. Nature. 2020;585(7825):357-362.

[16] The pandas development t. pandas-dev/pandas: Pandas. latest. Zenodo; 2020.

[17] Hunter JD. Matplotlib: A 2D Graphics Environment. Computing in Science & Engineering. 2007;9(3):90-95.

[18] Waskom ML. seaborn: statistical data visualization. Journal of Open Source Software. 2021;6(60):3021.

[19] Virtanen P, Gommers R, Oliphant TE, et al. SciPy 1.0: fundamental algorithms for scientific computing in Python. Nature Methods. 2020;17(3):261-272.

[20] Act on the Secondary Use of Health and Social Data Finland552/2019. Available from: https://www.finlex.fi/fi/laki/ajantasa/2019/20190552

[21] Simpson EH. The Interpretation of Interaction in Contingency Tables. Journal of the Royal Statistical Society Series B (Methodological). 1951;13(2):238-241.

[22] Melchiorre MG, Papa R, Rijken M, et al. eHealth in integrated care programs for people with multimorbidity in Europe: Insights from the ICARE4EU project. Health Policy. 2018;122(1):53-63.

[23] Berry N, Lobban F, Bucci S. A qualitative exploration of service user views about using digital health interventions for self-management in severe mental health problems. BMC Psychiatry. 2019;19(1):35.

[24] Liberati E, Richards N, Parker J, et al. Remote care for mental health: qualitative study with service users, carers and staff during the COVID-19 pandemic. BMJ Open. 2021;11(4):e049210.

[25] Saarni S, Nurminen S, Mikkonen K, et al. The Finnish Therapy Navigator – Digital support system for introducing stepped care in Finland. Psychiatria Fennica. 2022;53:120-137.

[26] Erku D, Khatri R, Endalamaw A, et al. Digital Health Interventions to Improve Access to and Quality of Primary Health Care Services: A Scoping Review. Int J Environ Res Public Health. 2023;20(19).

[27] Talwar G, Sinha S. How are digital platforms affecting the accessibility of healthcare services? Health Services Management Research. 2025:09514848251358328.

[28] Beaunoyer E, Dupéré S, Guitton MJ. COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. Computers in Human Behavior. 2020;111:106424.

[29] Nguyen MH, Hargittai E, Marler W. Digital inequality in communication during a time of physical distancing: The case of COVID-19. Computers in Human Behavior. 2021;120:106717.

[30] Xie B, Charness N, Fingerman K, et al. When Going Digital Becomes a Necessity: Ensuring Older Adults' Needs for Information, Services, and Social Inclusion During COVID-19. Journal of Aging & Social Policy. 2020;32(4-5):460-470.

[31] Wilson S, Tolley C, Mc Ardle R, et al. Recommendations to advance digital health equity: a systematic review of qualitative studies. npj Digital Medicine. 2024;7(1):173.

[32] Kaihlanen A-M, Virtanen L, Buchert U, et al. Towards digital health equity - a qualitative study of the challenges experienced by vulnerable groups in using digital health services in the COVID-19 era. BMC Health Services Research. 2022;22(1):188.

[33] ChatGPT [Large language model] [Internet]. 2025. Available from: https://chat.openai.com/chat.