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Feasibility study of a digital NHS Health Check

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Abstract

Background Use of digital methods for remote delivery of the NHS Health Check (NHSHC) is central to the development of this national cardiovascular disease risk identification and management programme. This study aimed to explore the feasibility of a web-based digital NHSHC implemented across three general practices in Cornwall.

Methods Feasibility was explored in terms of acceptability, practicability, limited efficacy (response and completion overall, by socio-demographic group), implementation and integration, and patient safety. Quantitative data were non-identifiable participant-level data ($n=2036$) from the digital providers and online participant surveys ($n=109$). Qualitative data were gathered through semi-structured one-to-one interviews (37 NHSHC participants, 11 stakeholders).

Results Of the 2036 individuals invited, 670 responded (32.9%), and 193 (9.5%) completed all parts of the digital NHSHC. Patterns in response and completion indicated that age and gender patterns were similar to those for in-person NHSHC. Survey and interview data confirmed the need for greater promotion to demonstrate the legitimacy of the programme and raise awareness, and to consider alternative methods of cholesterol testing and blood pressure measurement, which were the least acceptable components of the process. Interview participants recognised potential for a digital NHSHC to reduce primary care demand and increase flexibility to patients. But there was a general preference for a hybrid offer combining digital and in-person options. Key practical issues to implementation included a reliance on manual processes (and potential human error) around invitations and participant results (sharing with participant and writing them into primary care records).

Conclusions To address feasibility issues of this web-based digital NHSHC, we recommend: greater promotion/awareness and credible/trusted invitation methods to improve response rate; flexibility around blood pressure and cholesterol measurement, and possible hybrid options, to improve completion; improvements to participant alerts when results are ready or errors occur; and greater automation of processes to mitigate human error and increase efficiency.

Keywords Digital health, CVD, Health check, General Practice, Level of risk, Acceptability, Feasibility, Digital technology

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Background

NHS Health Check (NHSHC) is a national programme in England overseen by the Office for Health Improvement and Disparities (OHID; formerly Public Health England). NHSHC is a core component of England's cardiovascular disease (CVD) prevention pathway, and aims to prevent heart disease, stroke, diabetes and some cases of dementia and chronic kidney disease (CKD) among adults aged 40–74 years [1]. Local authorities are responsible for commissioning NHSHC. They are typically delivered by a practice nurse or healthcare assistant in a 15–20 min primary care consultation in which the patient's risk of CVD in the next 10 years is assessed [2]. Ten-year CVD risk is calculated (QRISK3) on the basis of blood pressure, body mass index, smoking status, blood glucose and cholesterol, in addition to age, sex, ethnicity and postcode-derived deprivation [3]. Other patient information is gathered (e.g., alcohol and physical activity) and discussed as a basis for offering brief interventions, such as lifestyle advice, GP referral, or signposting to other services.

Nationally, the proportion of the eligible population receiving an NHSHC has ranged from 9.0% in 2013/14 to 7.2% in 2022/23 (but dropped markedly during COVID-19) [4]. The proportion of those taking up an NHSHC when invited was close to 50% pre-COVID [46.8% 2015/16–2019/20] and has since dropped to approximately 40% [4]. Uptake has remained a particular challenge among the under-50s and males, with some local variation by socio-economic status and ethnicity [5–18]. The requirement to attend primary care in person is a frequently cited barrier, given people's time constraints and difficulties in accessing GP care [19].

The government-commissioned 2021 NHSHC programme review recommended the development of a digital service to allow remote completion [20, 21], in line with accelerated use of remote primary care consultations post-COVID-19 [22]. In addition to reducing the primary care burden, one hypothesised benefit was improved reach of NHSHC and the possibility of more equitable coverage. The relatively limited literature on CVD-related digital health interventions suggested that they tend to reach a small proportion of those invited [23]. However, the low response rates (e.g., < 10% [24], 33% [25]), apparently lower than for in-person NHSHC, are difficult to compare given the varied approaches to invitations and delivery. Other potential limitations of digital models include the need for access to, and competence with digital technologies, which could create barriers and widen inequities in access [26]. As uptake of digital health interventions can be low, generally [27] and when specific to CVD [23], it was necessary to understand the feasibility of a digital NHSHC in reaching and engaging the target population. The tool used in the present pilot was selected through an independent review of digital health tools that could meet the requirements of NHS Health Check regarding data capture, data analysis, and behaviour change and clinical management [28]. Brief user testing was undertaken among individuals involved in project design and implementation.

Methods

Aim

The overarching aim was to explore the feasibility of a digital NHSHC through addressing several objectives (Table 1).

Design

This feasibility study used a mixed methods approach, with triangulation, whereby quantitative and qualitative data were collected and considered concurrently [30]. The framework for feasibility studies from Bowen et al. [29] (Table 1) was adapted and aligned with study objectives to aid the design and interpretation. Prior to this pilot, the digital tool was selected through an independent review of digital health tools that could meet the requirements of NHS Health Check regarding data capture, data analysis, and behaviour change and clinical management [28]. Brief user testing was undertaken

Table 1 Study objectives aligned with feasibility domains (adapted from [29])

Objective	Feasibility Domain
1. Acceptability of a digital NHSHC to participants, local NHSHC providers and NHSHC commissioners	Acceptability
2. Practical requirements of integrating a digital element within local NHSHC delivery pathways	Practicality, implementation, and integration
3. Response rate (uptake) and completion for digital NHSHC	Limited efficacy – overall response and completion rates
4. Potential impact on equity of access to, and uptake to NHSHC using a digital NHSHC offer	Limited efficacy—'equity' in response and completion rates
5. Potential risks to participant safety and unintended consequences of digital NHSHC*	Practicality ('side effects')

* Factors relating to patient safety were considered under practicality, implementation and integration

among individuals involved in project design and implementation.

Settings and participants

This work involved three general practices in Cornwall, a largely rural county in South West England, UK. Participants of the feasibility study were patients registered at one of the three practices who were invited for a digital NHSHC (which was provided a third party), and stakeholders involved in programme development and delivery.

Procedures

Participant identification

Practices identified the population eligible for an NHSHC based on national criteria (aged 40–74 years; without a CVD diagnosis or statin prescription), excluding those with CKD classified as stage 3–5 (NICE clinical guideline 182), diabetes, hypertension, atrial fibrillation, transient ischaemic attack, hypercholesterolemia, heart failure or peripheral arterial disease, with history of stroke, or who had an NHSHC (last 5 years), or found to have 10-year CVD risk of 20% or higher risk through any NHS provided check. To allow participation in the digital NHSHC, participants were also excluded if they did not have a valid mobile telephone number in their patient record and, therefore, could not be sent an SMS digital invitation. There were no specific exclusion criteria for stakeholders.

This identified 3500–5749 eligible patients per practice. Each practice uploaded information for the eligible population to the digital provider, including NHS Number, Egton Medical Information Service (EMIS) ID, date of birth, sex at birth, surname, ethnicity, and postcode. Digital providers created user accounts for potential participants, which were then used to send SMS invitations.

Participant invitations

A pseudorandom selection of participants (invited in batches based on month of birth) were invited to complete a digital NHSHC via SMS from "NHSnoreply". Weekly reminder messages were sent for three weeks. Invitations were staggered using a weekly schedule agreed with practices. The initial target was 500 completed digital NHSHCs. Given the unknown response rate and likelihood that it would be lower than for in-person NHSHC (i.e., < 40%), initial plans were to invite 1500–2000 participants across the three practices.

Completing the digital NHSHC

Participants who responded to the SMS invitation completed the digital NHSHC by providing self-reported information on physical activity [31], alcohol consumption [32], smoking status, and height/weight to derive body mass index (BMI), and basic demographics information. Participants were also sent a home blood sampling kit to collect blood and return for cholesterol testing, and a subsample identified as having a BMI ≥ 30 kgm^{-2} or being from a higher risk ethnic group received a blood sampling kit for HbA1c (to assess diabetes risk). The digital check also included a postcode look up so participants could identify locations offering free blood pressure checks (e.g., general practice reception, pharmacy). See Supplementary file (S1) for detail. If all data were collected, the digital provider updated the participant's medical record and sent a summary to their GP to enable the timely follow-up of any abnormal results. The participant was sent an SMS to confirm that their results were available on the digital NHSHC platform. Where data fields remained incomplete, participants were sent several reminders from the digital provider to complete, after which time they were considered partial completers. We defined participants according to their level of engagement: *non-responders*—did not respond to or declined the invitation; *responders*—started the NHSHC; *partial completers*—responders who did not complete all parts of the digital NHSHC; *completers*—responders who completed all parts of the digital NHSHC.

Quantitative data

To explore response and completion rates of a digital NHSHC and socio-demographic patterns, non-identifiable data on all those invited were extracted by the digital provider: age (years); sex at birth (male, female); ethnicity (data were not useable); Lower Super Output Area (LSOA). LSOA is a geographical identifier that allowed derivation of: (i) deprivation using the Index of Multiple Deprivation (IMD) 2019 [33] explored using deciles based on national rankings, then grouped into within-sample tertiles (where tertile 1 was most deprived); (ii) income deprivation domain of the IMD, where the percentage value indicates the proportion of residents of that area classified as income deprived (i.e., higher value reflects higher income deprivation); (iii) urban/rural residential location using 2011 rural–urban classification (5 categories: urban, rural—town and fringe, rural—town and fringe in sparse setting, rural—village/dispersed, rural—village/dispersed in sparse setting) [34]. The digital provider shared anonymised data with the research team via a Secure File Transfer Protocol (which was included in a project Data Protection Impact Assessment) and made possible by a data sharing agreement between practices, the digital provider, and university.

Qualitative data

Semi-structured one-to-one interviews were undertaken with digital NHSHC participants and stakeholders.

Participants: Through an online survey, all those invited to a digital NHSHC were asked to express their interest in participating in an interview and to provide contact details. Those expressing an interest were followed up within a week to seek informed consent and arrange the interview. The number of participants who expressed an interest was insufficient for planned purposive sampling to maximise the sample spread in terms of age, gender, ethnicity, and deprivation.

Stakeholders: Individuals representing the range of organisations involved in the project (e.g., commissioners, local authority, primary care) were invited to take part in a semi-structured interview. The local authority public health team helped to identify stakeholders and made the initial approach by email. Those expressing an interest were followed up to seek informed consent and arrange the interview.

Interviews were conducted by experienced qualitative researchers over the telephone/MS Teams. Interview topic guides were co-designed with public health colleagues and other stakeholders specifically for this study (Supplementary file S2). They covered experience of the process, satisfaction, issues encountered, areas for improvement, barriers, facilitators, perceived benefits and potential risks/drawbacks. Participants (who were not stakeholders) were offered a £20 retail voucher in appreciation of their time.

A total of 37 interviews were conducted with participants who completed or partially completed (responders) the digital NHSHC. For analysis, these interview data were supplemented by open text responses to an online survey completed by 109 of those who were invited for a digital NHSHC (quantitative survey data are not reported here). Interviews were conducted by MS Teams ($n=23$) or telephone ($n=14$) and lasted, on average, 25 min (range 12–53). Eleven stakeholders were interviewed via MS Teams, with an average duration of 35 min (range 17–56).

Data analysis

Quantitative data: Associations between groups (responders/non-responders; partial completes/completers) and socio-demographic characteristics were explored through chi-squared tests. Between-group differences for continuous variables (e.g., age) were examined using the non-Mann–Whitney U test.

Qualitative data: Interviews were transcribed and analysed using inductive reflexive Thematic Analysis following the processes set out by Braun and Clarke [35, 36]. Analysis was conducted using NVivo R1. Extensive reading was conducted for familiarisation of data before data coding and generation of initial themes. Themes were then reviewed and developed to ensure they were data driven and reflected participant opinion. Data were coded independently by two experienced qualitative researchers (LS, HG) before agreement of initial themes and relationships. These were then refined, defined, and verified by a third member of the evaluation team (NE), before being named and finalised.

Results

Characteristics of those invited for the digital NHSHC

Of the 2036 invited for a digital NHSHC, there were more females (1121, 55.1%) than males (915, 44.9%), with an average age of 54.15 ± 9.59 years (range 39.7–75.1; Supplementary file S3). The proportion of the invited population aged over 60 years (629, 30.9%), was lower than for the younger age groups (713, 35.0% aged 40–49 years; 694, 34% 50–59 year). Over 80% (1636) lived in rural areas. Based on national rankings for the overall Index of Multiple (IMD) deprivation, the sample was clustered around the middle deciles (86% in deciles 4–6). Therefore, for analysis, the within-sample tertiles were used.

For each feasibility domain, findings from quantitative and qualitative analysis are presented. For qualitative data, themes are supported by participant quotations using anonymised codes (P1, P2, P3, etc., for interview participants; S1, S2, S3, etc. for survey participants; T1, T2, T3, etc. for stakeholders).

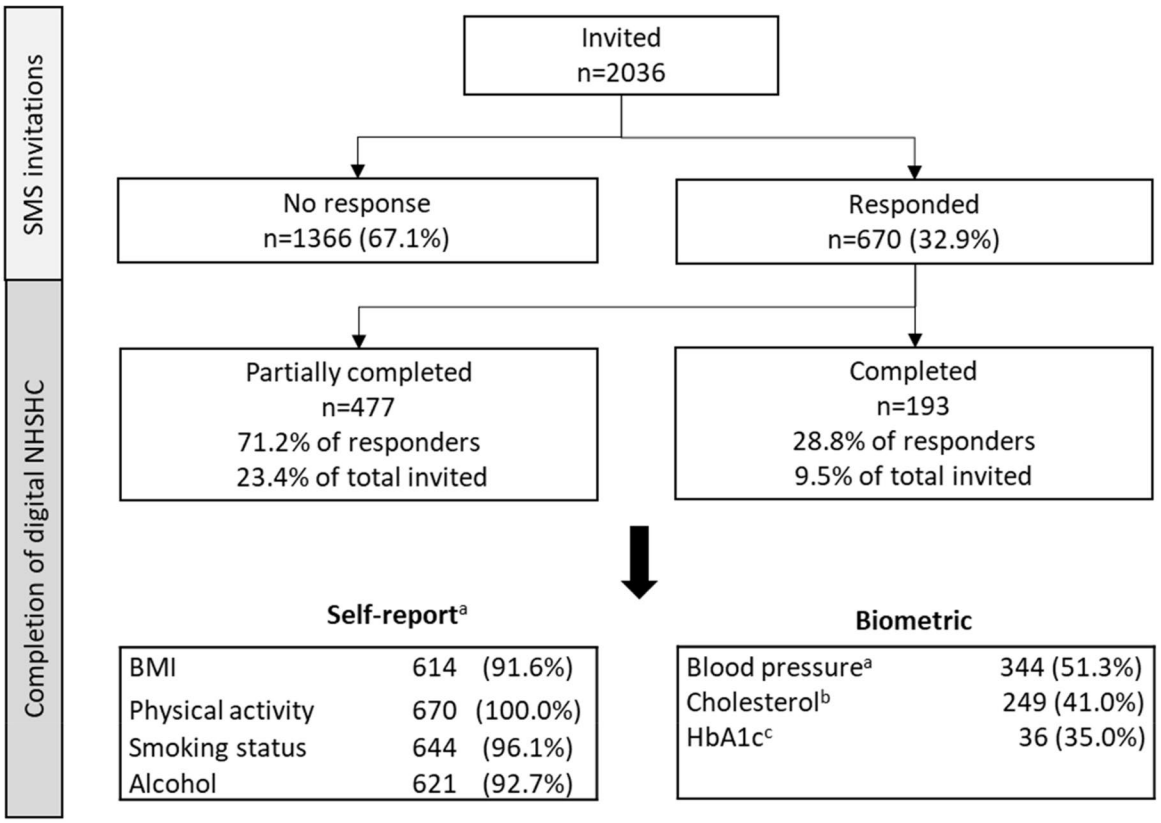
Limited efficacy

Non-responders versus responders

Figure 1 summarises the rates of response to invitations and rates of completion of digital NHSHC. Characteristics of responders and non-responders are detailed in the Supplementary file (S3). Mean ages of non-responders (54.01 ± 9.68) and responders (54.44 ± 9.42) were similar. Among the 670 responder, there were more females (407, 60.7%) than males (263, 39.3%). The highest level of response was observed for those aged 60–64 years (96, 38.71%) and 65–69 years (73, 36.68%). There were non-significant trends towards a lower response rate in those residing in more deprived areas (IMD tertile 1 vs. tertiles 2 and 3), and in urban or town/fringe areas, compared with rural.

Partial completers versus completers

Characteristics of those who partially or fully completed the digital NHSHC are detailed in Supplementary file S4). Just over one-quarter of those who started the digital NHSHC went on to complete all parts (28.8%), representing 9.5% of the 2036 invited. Incomplete NHSHC were predominantly a result of not completing non-completion ofblood pressure and/or cholesterol tests (Fig. 1).



[a] % derived as proportion of the 670 responders
[b] % derived as proportion of the 607 patients who received a test kit
[c] % derived as proportion of the 103 patients who received a second vial for HbA1c

Fig. 1 Flow diagram summarising response to and completion of digital NHSHC

The mean age of completers was statistically higher (55.56 ± 9.66 years) than for partial completers (53.75 ± 9.24 years; Mann–Whitney U = 52,754, $p = 0.003$). Completion rate was significantly lower in those living in the most deprived areas (IMD tertile 1 vs. 2 or 3). Income deprivation was lower for completers (11.15 ± 6.41%) than for partial completers (12.27 ± 6.41; Mann–Whitney U = 57,256, $p = 0.002$), and lower than for the mean for all 2,036 invited (13.1 ± 6.6%)d.

Acceptability

Participants found the digital NHSHC user friendly, with clear instructions and familiar terminology. The process of completing the digital NHSHC was described as "easy and straightforward" (P14) and "generally quite a positive experience" (P39). It was anticipated that participants would require guidance from the chat function, but it was rarely used: "we were figuring on everyone doing a health check would need some sort of support…it seemed that it was quite straightforward to use" (T93). When it was used, experiences were positive: "incredibly quick to… [reply with a] message explaining things" (P43).

Participants commented that a digital NHSHC was convenient, offered flexibility for those who worked, and some expressed a willingness to take ownership of monitoring their own health through a digital NHSHC: "everybody has to be proactive and looking after their own health…[and] if we can all take our part in that, that has got to help [the NHS]" (P74).

There was little evidence of technological or 'digital' barriers (e.g., internet connection, knowledge), but some expressed a preference to receive the invitation by email (not SMS), which would allow them to complete the NHSHC on a larger device:

I did it on the phone because it was easy. But most things I do on my iPad but I don't get the texts on my iPad…sending it to an email…[means] you could do it on a different device…[as on] the iPad you can make the text really big (P18)

The digital NHSHC had a save function as "people might start and then get distracted…and then they can come back and do it [later]" (T91). This was mostly appreciated by participants, although one participant experienced issues with lost data:

I got all the way to the end and then it said I needed all this information [biometrics] and I wasn't able to do it there and then. So I had to… wait until I had that information… When I came back to complete it, it had lost all my information (P21)

As the quantitative data indicated, the need for home blood sampling (to send for cholesterol and HbA1c testing) and blood pressure measurement was the least acceptable part of the process: 255 of 607 (41.8%) who were sent a home blood sampling kit, did not return a sample to the lab for cholesterol testing; 344 of 670 responders (51.3%) entered a blood pressure reading. For home blood sampling, some were deterred by the time required and others found the process painful and/or frustrating:

there was no way on earth, having killed…each of my fingers trying to fill this vial that they honestly thought I could fill from pricking my finger, when I was lucky if I could get more than a tiny dribble out of each finger. But the pain was excruciating… and they still hurt now (P49)

For blood pressure, unless they owned a monitor, participants needed to visit a local facility. Most were signposted to local pharmacies to access a free-to-use monitor. Stakeholders reported "opportunities to go to the pharmacy, do it in your home, or the surgeries" (T99). However, some information in the postcode lookup was inaccurate; some pharmacies were unable to help and signposted participants to the GP: "[I] went to my pharmacy and they said 'no we don't do that…[as] we don't have the staff to use the machine'… so they suggested going to my GP" (P10). One stakeholder recognised this "extra point of friction in the process" (T92) that caused delays and non-completion: "I did not bother with the blood pressure test. [I was] disappointed by the experience when I had high hopes" (S58). Many participants owned or borrowed a blood pressure monitor, and some purchased one which had potential benefit of mitigating 'white coat syndrome' (P102): "I thought that it might be handy…not just for me, but for other members of the family" (P74).

Lifestyle questions (self-report) were well-completed (92.7–100.0%; Fig. 1), which indicated high acceptability. The only concerns expressed were around the limited data collected, which one participant described as "simplistic [and] not deep enough" (P103).

On completing the digital NHSHC, participants received an SMS informing them that their results were available: "[I could read the] results online afterwards… [and found it] quite user friendly, it was easy to understand" (P39). Others liked that they were "visual…[with an] explanation of risk" (P11). However, some found the results "simplistic" (P2) and focussed on "fairly obvious areas [like] cut down on your smoking, increase your exercise, cut down on drinking" (P110). Another participant explained that "there wasn't enough explanation… and there were no reference ranges for things like the cholesterol, it [just] said healthy" (P10). Others felt the results did not consider the whole person as "it didn't ask for any emotional or mental health difficulties" (P30), thus questioning the CVD focus of NHSHC.

Participants with previous experience of an in-person NHSHC described the digital version using terms such as "quite mechanical" (P103) and "very general, very non-specific …impersonal" (P106). Although this is somewhat inevitable when the human contact is removed, there were related concerns about the quality of care: missing what "clinicians learn…from just looking at their patients" (P107) and having the "opportunity to open up about potential problems…it's more comprehensive…it's much easier to talk about…underlying conditions and potential symptoms" (P33).

Practicality, Implementation, and Integration

The digital NHSHC was launched without an advertising campaign as stakeholders were "keen to understand what participation would be like just based on GP invitation and text messaging" (T92). However, a press release was issued post-launch due to low response. On reflection, most stakeholders recognised the need for initial awareness campaign to foster engagement.

Primer SMS were sent to participants to alert them to the impending invitation and reassure them of its legitimacy. But their successful delivery could not be tracked (with some participants apparently not receiving the primer SMS) and several participants still thought the invitation text was "spam…[and] didn't want to click on the link straightaway" (P43). Some reported that the initial GP contact made them "feel a little bit safer" (P110), but others felt "bombarded" (P49) with reminder texts to encourage completion: "people don't want to be saturated by messages" (T99). Communication by SMS was

also considered a potential limitation for those living in remote rural areas where they "don't get a very good signal as the messages aren't always going to get delivered" (T96), and alternative means of communication might be preferable.

Aside from the negative experiences around blood sampling, there were unforeseen practical issues. Postal strikes caused delays in some participants receiving test kits and/or returning them to the lab for analysis: "a lot of the blood tests kits failed…because they got to the lab too late" (T93). Compounded by insufficient communication with participants in general, this issue further reduced the number of people with complete digital NHSHCs. It was evident that general practices needed to offer blood test appointments (10 were completed in primary care), but this approach was felt to "negate the fact of doing it on-line" (P102).

Those completing all parts of the digital NHSHC should have received an SMS alerting them to view their results, with mixed experiences. Some reported inaccuracies in results which they found alarming and confusing. Others would have preferred to have an opportunity to discuss results with a healthcare professional for a more "nuanced" discussion (P46): "it's fine doing the check online yourself, but then perhaps the personal aspect needs to be when the results come" (P106).

There were also practical issues in delivery of results which were either not sent to the GP before the participant, not received by the participant, or the participant did not know how to access them.

> *I had no reason to know that is how they would be accessible…I have got no text or message…I just presumed that clicking in was the actual…[health check], not to click back in to...see the results" (P30)*

A technical error resulted in several participants receiving the SMS with a link to access their results that did not work. Moreover, the contingency for communicating to participants when blood tests failed, did not work and participants did not receive their results.

A major novelty and potential advantage of this digital NHSHC model was the ability to write the results directly into participant primary care records. However, there were delays with this process which caused concern when participants received results "saying that they had a risk, but…had to wait a few more days for it to go to the doctor" (T91) and GPs needing to wait for results before actioning a patient referral to avoid repeating the tests.

Discussion

Main findings

We report data from a feasibility study of a web-based digital NHSHC (provided by a third party) that was piloted with three general practices in Cornwall. Quantitative and qualitative data were gathered to understand engagement (limited efficacy—response/completion and equity), acceptability and practical challenges.

Limited efficacy—Overall engagement

Response and completion rates for the digital NHSHC were far lower than for in-person NHSHC. Just 32.9% of the 2036 invited, started their digital NHSHC, and only 9.5% completed it. Less than 10% completion is far lower than for in-person delivery in Cornwall (37.8%, 2022/23) and nationally (38.7%, 2022/23) [4]. It compares more favourably with some other digital health offers [23], although differences in delivery and research designs make direct comparisons difficult. For example, Healthy Ageing through Internet Counselling in the Elderly (HATICE) uses an internet-based platform to reduce CVD risk through a coach trained in motivational interviewing providing remote support for older people [24]. An RCT of HATICE in 3 European countries reported less than 11% of those invited by post expressed an interest (4,857/45,466), but subsequent telephone and in-person screening/recruitment led to a large proportion of 'responders' who were assigned to the intervention, going on to complete (1194/1389, 85%). A Dutch web-based health risk assessment with tailored feedback to reduce CVD risk was evaluated in a worksite population [25]. Risk assessment was completed in 33% of those invited (368/1108). This was far greater than the 9.5% who completed the digital NHSHC, but perhaps not surprisingly as biometric measures in the Dutch programme were taken on site (i.e., not at home by participants). The Australian Consumer Navigation of Electronic Cardiovascular Tools (CONNECT) is a consumer-focused web application that, like the digital NHSHC, had integration with primary health care patient records [37]. Of 3552 patients invited by letter, 934 (26.3%) were randomised to and took up the intervention (or control); similar to the 32.9% who expressed an interest here. In other digital offers that used less targeted, mass media and community outreach recruitment, far lower levels of engagement have been reported (e.g., 1% of the eligible population [38]). Overall, this feasibility study accords with generally low uptake of digital interventions [27], and makes the case for awareness raising campaigns and diverse invitation methods to improve reach.

Limited efficacy—Equity

There were two potential equity considerations: whether this digital offer could mitigate social patterning in uptake observed for in-person NHSHC; if other disparities were introduced through digital exclusion [39]. It appeared that social patterning for in-person delivery

was also observed here: lower engagement among males (vs. females) and in those from the most deprived areas (most deprived 33% vs. less deprived areas), and greater engagement in the over-60 s (compared with younger age groups). Higher response rates in more rural dwellers of the digital NHSHC (non-significant trend) is a potential advantage that warrants further exploration in a larger sample with more even mix of urban/rural areas. Characteristics of those who took up and completed all parts of the digital NHSHC provide some insight regarding the extent to which the digital NHSHC offer is more or less equitable across socio-demographic groups. Findings are tentative given the modest sample size, but data do not indicate that this digital offer could overcome socioeconomic bias in uptake observed in some NHSHC studies [12, 40]. There was little evidence of digital exclusion in this sample based on access to, and competence with digital technologies, which could otherwise introduce inequalities into digital NHSHC [26] (discussed further under 'practicality').

Acceptability

Digital healthcare has evolved over the recent years, with evidence of feasibility and acceptability for several telemedicine interventions from primary care [41]. Acceptance of remote healthcare delivery was accelerated by COVID-19 and the resulting shift away from in-person consultations [42, 43]. Recipients of the digital NHSHC identified benefits including convenience (i.e., completion in participant's own time, away from healthcare setting) and reduced demand on primary care at a time when the NHS is overwhelmed and making routine appointments is difficult [44]. This sample also expressed a willingness to take responsibility for their own health through this type of digital method [45].

Barriers reducing the acceptability of digital health interventions include perceptions that they are impersonal [46, 47]. This was evidenced through a preference for in-person NHSHC (when participants had experienced them) or for a hybrid model that combined digital and in-person components. A qualitative study of considerations when designing alternatives to in-practice health consultations concluded that they are more likely to succeed if they are "*co-designed initiatives that start with the least controversial and most promising changes for the practice*" ([48], p1). For digital NHSHC, this could entail invitation and completion of the self-reported data online, with the option to visit health facilities for biometrics and, perhaps, communication of results. Given that CVD risk communication is challenging and often not well performed during in-person NHSHCs [49], potential for confusion with online messaging around CVD risk in digital NHSHC results must be considered.

It was clear from quantitative and qualitative data that participants needing to self-sample blood or seek a blood pressure test were the least acceptable components of this digital NHSHC model. There are alternative remote methods. For example, some diagnostic digital tools can measure vital signs, including blood pressure, using a smartphone or wearable device [45]. This could offer convenience and mitigate risks of white coat hypertension [50]. There are fewer digital health interventions for remote testing of blood biomarkers that could solve observed barriers to cholesterol measurement [51]. While technologies are such as biosensors might provide future solutions [52], the most practical solutions might be using a capillary sampling (rather than vial sample) or having someone else take the blood sample (e.g., healthcare professional as part of a hybrid model). Such issues might have been mitigated through more thorough user testing prior to feasibility testing. As noted previously, design specification was assessed through a separate review [28], and there was a period of brief user testing. But this did not include patients or public. Usability testing in a small number of patients/public using methods such as "Think-Aloud" protocol, interviews or focus groups [53], could have identified and addressed some issues around acceptability.

Practicality

There were other practical challenges. First, SMS invitations limited the potential pool of invitees (to those with valid mobile telephone numbers on record), created some distrust of invitation legitimacy, and meant that some participants were unable to complete the digital NHSHC on a preferred device. Various in-person NHSHC recruitment methods have been tried, from traditional and modified postal invitations, to SMS, telephone, and in-person invitations such as opportunistic invitations, or outreach [14]. There is some RCT evidence that using behaviourally informed invitations with SMS pre-notifications and reminders can be beneficial [54], and a general pattern of higher uptake when people are invited in-person [9, 12, 55] (somewhat skewed by the apparent 100% uptake of opportunistic invitations as those who decline are rarely recorded). Fostering engagement with digital health interventions at scale poses substantial challenges [47], but for NHSHC, a combination of SMS and telephone invitations (perhaps with behaviourally informed letters) could improve uptake beyond rates observed here.

Second, some participants expressed concern if unable to see the status of their digital NHSHC or results in the digital platform. This was primarily a consequence of insufficient information on how to access results.

Participant digital skills were not identified as practical barriers to completing the digital NHSHC. It is, however, possible that the lower response and completion rates in those from more deprived areas reflected inequities in internet access, skills or confidence with digital devices [56] that were not evident from our qualitative data due to sample bias (i.e., participants had a current mobile telephone numbers and were sufficiently engaged/motivated to be interviewed).

Finally, there were cases of erroneous results, participants feeling confused or concerned, or being able to access results before they were written into their medical record (and therefore, accessible to participants before the primary care team). These reflected a key practical implementation and integration need: to eliminate human error through complete automation of processes and more seamless integration with primary care data. This is one of many considerations when integrating digital health tools in existing health systems [57], and is critical to maximise the potential advantage of digital methods and minimise risks to participants.

Strengths and limitations

Strengths of this study were the triangulation of quantitative data from over 2000 individuals invited for a digital NHSHC and qualitative data from a large subsample of participants and stakeholders (total $n=48$). Study limitations are recognised. First, the model was tested with three general practices in one local authority area which was largely rural, with little ethnic diversity. This limits transferability to other areas (particularly urban, and more ethnically diverse areas). Second, useable data on participant ethnicity were not provided for analysis of response and completion rates. Third, the qualitative sample was prone to selection bias (those willing to respond to an initial online survey and express an interest in interviews). Planned stratification of the qualitative sample by age, sex, and deprivation was not possible given the numbers who expressed an interest.

Conclusions

Overall, this web-based digital NHSHC was acceptable in some ways (e.g., invitation methods, self-reported data) but less acceptable in others (biometrics). The level of engagement was in line with other digital health interventions, but lower than in-person NHSHC and with similar social patterning. Several implementation challenges would need to be addressed before attempts to scale-up. Uptake could be improved through greater promotion/awareness-raising campaigns. Acceptability and completion could be improved through a more flexible model that allowed participants choice over remote or in-person biometrics and/or discussion of results, and greater automation of processes to mitigate human error and increase efficiency.

Abbreviations

BP	Blood Pressure
CKD	Chronic Kidney Disease
DPIA	Data Protection Impact Assessment
GP	General Practitioner
NHS	National Health Service
NHSHC	NHS Health Check
OHID	Office for Health Improvement
PHE	Public Health England

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44247-025-00161-9.

Supplementary Material 1.

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Authors' contributions

The study was conceptualised by CG, VR, NE, GW, AN and KT; Methodology was developed by CG, VR, NE, RP, AN and KT; Funding acquisition was by CG, VR and NE; Data curation and analysis involved CG, VR, LS, NE and HG; Project administration involved CG, VR, LS, GW, and AN; Supervision was by CG and KT; CG led the writing of the original manuscript draft; all authors contributed to manuscript reviewing and editing, and approved the final manuscript.

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Data availability

The data and materials generated and analysed during the feasibility study are not available publicly or on request, as consent was not obtained from participants nor general practices.

Declarations

Ethics approval and consent to participate

This study was conducted in compliance with the Declaration of Helsinki. The research team secured ethical approval for the feasibility study from the North East – Newcastle & North Tyneside 2 Research Ethics Committee and the Health Research Authority (23rd March 2022, ref: 22/NEC/0045). OHID secured approval from UKSHA Research Ethics and Governance Group (REGG) for implementation. Informed consent was obtained from participants in advance of accessing NHS Health Check data and undertaking interviews. Sharing of anonymised demographic data for all those invited for an NHS Health Check was shared with the research team as covered through the Data Sharing Agreement (note: this excluded those who had opted out of third-party data sharing with by their general practice).

Consent for publication

Not applicable.

Competing interests
AN is employed by OHID, the funder of this work. KT is a former employee of OHID. GW is employed by the local authority where this work took place. The remaining authors declare that they have no competing interests.

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