



Evaluation of the heart age test:

Findings from test user data, an online survey and follow-up interviews

Report commissioned and funded by Public Health England. Ethical approval was obtained by Staffordshire University's Ethics Committee.

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Acknowledgements

This research was a collaboration between the Centre for Health and Development (CHAD) and Public Health England. The research was commissioned and funded by Public Health England.

We would like to thank Catherine Lagord and Joshua Woolner for providing the HAT quantitative user data.

We would also like to thank all participants who took part, through the online survey and follow-up interview.

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Executive Summary

Background

The Heart Age Test (HAT) is an online test to indicate an individual's potential CVD risk through estimated Heart Age, which can be compared to their actual age. The test aims to increase understanding of CVD risk, provide information and signpost individuals to resources regarding heart health, improve knowledge and understanding of CVD risk, and encourage individuals to take up the offer of an NHS Health Check (NHSHC).

Assessment of data extracted in 2015 found the test was completed over 500,000 times (between February and July 2015), with a demographic that broadly resembled the adult population of England (1). Data suggested the HAT was accessed by some groups not easily reached through conventional primary care processes (e.g., males and younger adults) and highlighted users' limited awareness of their own risk factors (i.e., cholesterol and blood pressure). Yet it is not known how the test is perceived by users and if the information provided affects intentions or behaviours to reduce CVD risk.

This evaluation was commissioned and funded by Public Health England and delivered by Staffordshire University. It aimed to understand users' experience of HAT and future behaviour intentions.

Methods

This study comprised three parts. First, HAT user data from Public Health England (HAT data collected between February 2015 and June 2020) were analysed and summarised to understand who is accessing the test and their socio-demographic characteristics and risk profile. Second, an online survey was distributed (January-March 2021) to explore the impact of the test on knowledge and understanding of CVD risk, confidence in interpreting CVD risk and the effect of the test on future behaviour intentions and potential engagement with primary care services. The survey was completed by 819 respondents (following completion of HAT), either opportunistically or as part of the study. Third, semi-structured interviews with a subsample of survey participants (n=33 participants; data collected February-March 2021) were conducted to explore the online survey aim in more depth. Data were analysed using reflexive thematic analysis.

The self-selecting sample introduces a degree of bias but aimed to be representative of people likely to engage with pre-screening tests, such as HAT (i.e., ecologically valid).

Main findings

Evaluation of HAT user data found the test was completed almost 5 million times between February 2015 and June 2020. Overall, HAT was completed by more males (54.8%), those aged 50-59 (27.2%), from a White British background (81%) and living in least deprived areas (26.1% from least deprived 20% of areas – Q5). This was similar to assessment of data from 2015 (1). Engagement with the tool was higher in groups typically underrepresented in the

NHSHC programme including males, younger eligible adults and individuals from Indian and 'other' ethnic backgrounds (2).

More than a third of test completions were calculated during the national campaign (September 2018, 37.4%; n=1,834,336), with increased completions for both males and females, of all age groups, and from ethnic minority backgrounds during the campaign and for the following month. Compared with October 2018 onwards, more males, those aged 30-39 and 50-59, and who lived in least deprived areas completed the HAT during the month of the campaign. This indicates that the national campaign contributed to increased engagement in these groups during the campaign period. However, the campaign did not appear to increase completions for those at an increased risk of a heart attack or stroke (i.e., based on the difference between estimated Heart Age and chronological age).

Data from the online survey and semi-structured interviews suggested that completing HAT elicited a negative emotional response when the score did not equate to what was expected, that HAT users understood the meaning of a higher estimated Heart Age, reported at least some improvements to understanding of their CVD risk and felt more confident in their understanding and control of their CVD risk. Participants raised concerns about the accuracy of the test, largely because many did not know information on blood pressure (48.7%) or cholesterol (76.8%) to enter when completing HAT (which are otherwise estimated to derive Heart Age and the limited information required to complete the HAT). Yet, for many, it served as a 'wake up' call.

Participants reported that they would or had already recommended the HAT to others, would be more likely to take up the offer of an NHSHC, would use the test again to check their heart health, and had made or intended to make changes to their lifestyle or were encouraged and motivated by the HAT to maintain lifestyle changes. Pre-screening tests such as the HAT, may be a good way to encourage individuals to evaluate their lifestyle choices and to increase intentions to change behaviour.

Recommendations

Evaluation of the HAT showed that individuals are interested to learn more about their heart health leading to a positive impact on understanding, confidence and intentions to change behaviour. These data have informed several recommendations:

- The national campaign increased use of the test generally but not among those at an increased risk of a heart attack or stroke and may, therefore, not be a strategy to mitigate socio-economic inequalities relating to CVD risk.
- Participants questioned the credibility of their result due to the relatively few data fields required to complete it and when risk-factor information (i.e., cholesterol and blood pressure) were missing. It is recommended to provide a link to information about how the test calculates an individuals' estimated Heart Age for those who wish to find out more. There should also be more clear statements about the accuracy of the result if risk-factor information is not available.
- For most, the HAT result provided a wake-up call but, for the minority, the credibility of estimated Heart Age was questioned, and the results subsequently dismissed. Signposting to support should be more easily accessible and/or visible for those who

are left feeling concerned or confused by their result and interested to understand their CVD risk further.

- The majority of participants believed they had a good understanding of their HAT result which suggests the test may be a good way to improve population understanding of CVD risk. However, presentation of CVD event-free survival should be removed to avoid user confusion and overestimation of risk.
- Pre-screening tests like the HAT may be a good way to encourage individuals who do not regularly see their GP to visit their practice to understand more about their heart health. But additional planning may be required during campaigns to deal with potential increases in demand (e.g., outreach, community provision).
- Further work should explore the extent to which the beneficial effects of HAT could affect health inequalities (positively or negatively).

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Evaluation of the Heart Age Test

1. Introduction

The research outlined in this report was conducted by the Centre for Health and Development (CHAD)^a. CHAD was established as an innovative partnership between Stoke-on-Trent City Council, Staffordshire County Council and Staffordshire University. Its purpose is to contribute to the reduction of health and social inequalities and improve the health and wellbeing of our local population through carrying out high quality translational and internationally recognised research.

1.1 Heart Age

There is evidence that traditional short-term percentage risk scores used in programmes like the NHS Health Check are limited in terms of patient and practitioner understanding (3–7), which in turn limits the likelihood of patients adopting risk-reducing behaviours (3). In recent years, attention has increasingly turned to other CVD risk metrics, including Heart Age.

Heart Age provides a measure of lifetime risk whereby an individual's chronological age is compared to someone of the same level of CVD risk but with optimal modifiable risk factors (8). If at least one of the individual's risk factors (e.g., cholesterol, blood pressure) is not optimal, their Heart Age will be higher than their chronological age. Heart Age has advantages over percentage risk scores (e.g., not underestimating risk in younger adults), and appears to be more easily understood (9). There is also evidence that Heart Age is more emotionally impactful (9,10), is easier for practitioners to communicate (4,11), is better understood and recalled by patients (11–13) and motivates patients to make healthier lifestyle choices (8,9,14–18) compared to percentage risk scores.

However, evidence of reductions in CVD risk factors following the communication of Heart Age is conflicting. A recent review reported communication of Heart Age resulted in improvements to some risk factors and behaviour intentions (15), whilst other published studies found no improvements to behaviour intentions (19) or reductions in cholesterol or improved omega-3 status when compared to conventional methods (17). There is also concern about the emotional impact on an individual when presented with a Heart Age much older than their chronological age (20), leading to overestimation of risk (19,21) or decreased perceived credibility (14,19,21) when Heart Age did not match prior risk perception.

There is increasing evidence regarding the potential of Heart Age, compared to short-term absolute risk, on improving patient outcomes (9,10,15–18). Yet further research is required to fully understand the impact of communicating CVD risk in this way.

1.2 Heart age test (HAT)

A public-facing UK version of JBS3's 'Heart Age' Tool (22), developed by Public Health England (PHE), the British Heart Foundation (BHF), the Joint British Society (JBS), and NHS

^a www.chadresearch.co.uk

Choices (The government run health website for the NHS), was introduced in 2015 known as the Heart Age Test (HAT) (1). The HAT is an online test that can be used to indicate an individual's potential CVD risk through estimated Heart Age, which can be compared to their actual age. The test aims to increase understanding of CVD risk, provide information and signpost individuals to resources, improve health literacy, and encourage individuals to take up the offer of an NHS Health Check.

Initial assessment of HAT data, extracted in 2015, found the test was completed by over 500,000 individuals (between February and July 2015), with a demographic that broadly resembled the population of England (1). Data suggested the HAT was accessed by individuals not easily reached through conventional primary care processes and highlighted users' limited awareness of their own risk factors (i.e., cholesterol and blood pressure). Yet, it is not known how the test is perceived by users and if the information provided leads to intentions to engage in and/or an increase in risk-reducing behaviour.

Since the launch of the HAT, researchers have suggested there is no evidence of benefit to the HAT, but a potential for harm (23), and positive outcomes resulting from the communication of Heart Age have occurred only within a clinical context (19). Pre-screening tests such as the HAT fail to take into consideration existing lifestyle and circumstances leading to overestimation of risk, reduced credibility of the results and unnecessary clinical testing (12,14,19,21,23). However, a recent evaluation of the Australian version of the Heart Age calculator launched by the National Heart Foundation of Australia in 2019 found it provoked positive emotional responses, self-reported lifestyle changes (i.e., improvement to diet, physical activity and weight loss) and clinical checks for over half of survey respondents (21).

Evidence for the impact of the HAT is limited, therefore, further investigation is warranted to understand users' experience of the UK version of the HAT and future behaviour intentions.

2. HAT logic model

Drawing on the PHE guidance 'Evaluating Digital Health products' (24), development of a logic model for the HAT was facilitated by University College London's Institute of Health Informatics, with contributions by members of the Heart Age Test Steering Group. Following discussions regarding the function of the test, individual responses to the test and the short-, medium- and long-term outcomes for HAT, a logic model was agreed (Figure 1).

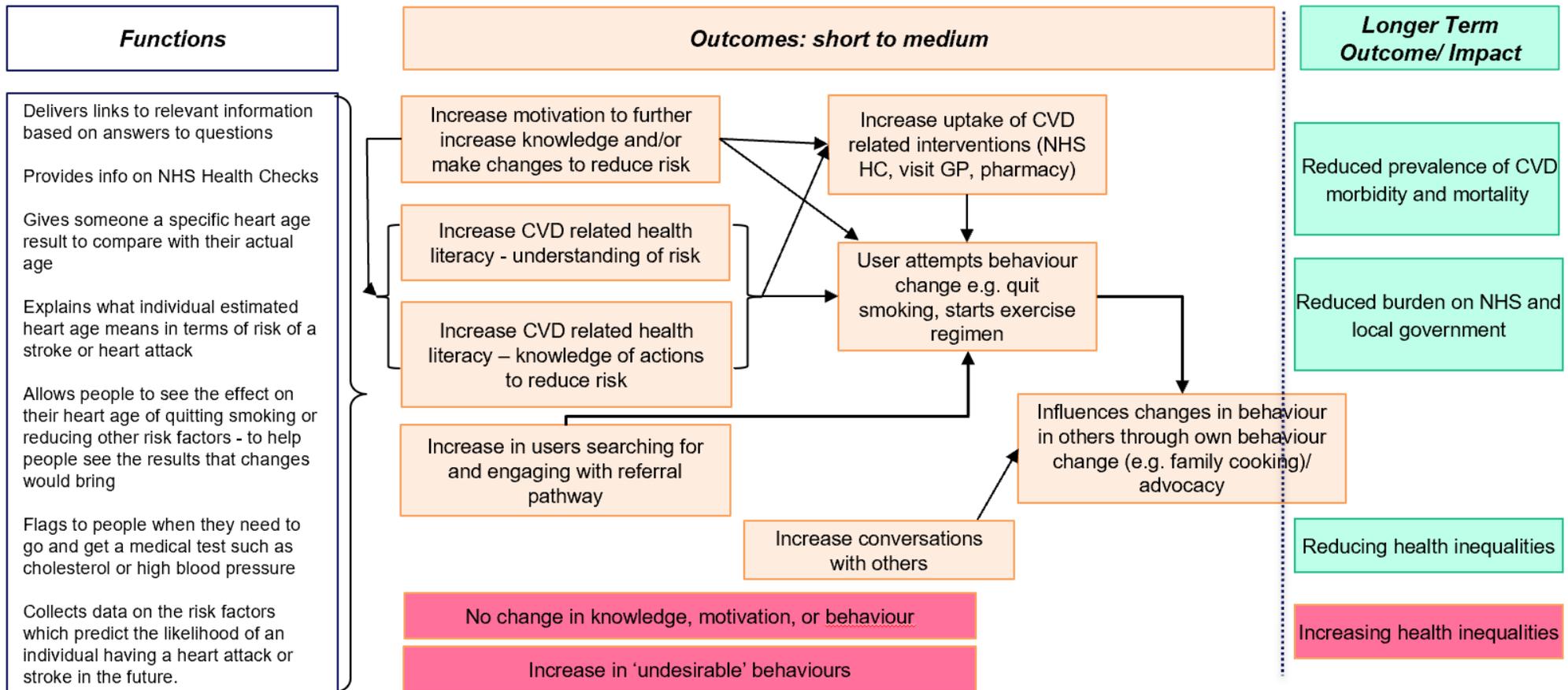


Figure 1. HAT Logic model agreed by Public Health England

It was hypothesised that HAT would have direct and measurable impact on short to medium term outcomes and would contribute to longer term outcomes. Whilst HAT may contribute to longer term outcomes, it was acknowledged that success/failure could not be attributed to HAT directly.

3. Aim and objectives

Following development of the HAT logic model (Figure 1), an evaluation of HAT was conducted to achieve the following objectives:

1. To understand who is accessing the test and their socio-demographic characteristics and risk profile
2. To understand the impact of the test on knowledge and understanding of CVD risk and confidence in interpreting CVD risk
3. To understand the effect of the test on future behaviour intentions
4. To understand the impact of the test on potential engagement with primary care services i.e. BP test, NHS Health Check

4. Methods

4.1 Design

The research included a combination of quantitative and qualitative methods to understand users' experience of HAT and future behaviour intentions. Ethical approval was secured from Staffordshire University's Ethics Committee.

4.2 Settings and participants

Participants were invited to participate in the evaluation of HAT in one of three ways: 1. through completion of an online survey; 2. through completion of an online survey and interview; 3. through completion of an interview only. All three options were presented to participants through a URL link whereby they were provided information about the evaluation and how to participate. The evaluation URL link was distributed through several platforms including FaceBook, Twitter, Staffordshire University website, and the CHAD newsletter. Users of HAT were also invited to participate in the evaluation through a pop-up which appeared on the results page of the test. To encourage participation, both the online survey (through a prize draw) and interview (a £20 online retail voucher was offered to those who completed the interview) were incentivised. Following substantial interest in the interview, the interview only option was removed from the evaluation URL link shortly after the online survey was launched. Due to the geographical proximity of participants and COVID-19 restrictions, interviews were conducted via telephone.

4.3 Data collection and analysis

Data were collected for the evaluation in three ways: 1. HAT user data analysed and received by Public Health England; 2. an online survey; 3. semi-structured interviews. How the data were collected and analysed is explained in the following sub-sections.

4.3.1 Heart age test user data

Quantitative HAT user data, routinely collected by Public Health England, were analysed and sent to Staffordshire University in March 2021. The data were summarised by CHAD to profile the population of those who engage with and complete the HAT, and to track trends since the launch of the test in 2015. Data from September 2018 (month of the national campaign) were compared with data from previous and subsequent years and a comparative month (September 2017, 2019; October 2017, 2018, 2019) to explore changes in use of the test during the 2018 campaign.

4.3.2 Online survey

Data were collected between January-March 2021 via an online survey (Appendix 1). Respondents were asked to complete the HAT and then answer questions related to their experience of the test, the impact of the test, future behaviour intentions and demographics.

To encourage completion, the survey was incentivised through a prize draw. At the end of the survey, respondents were invited to express interest in participating in a follow-up interview to talk about their experience in more detail. Survey data were analysed descriptively and are summarised in section 5.2.

4.3.3 Semi-structured interviews

Semi-structured, one-to-one telephone interviews were conducted with a sub-sample of respondents who completed the online survey (Section 4.3.2) to understand users' experience of HAT and future behaviour intentions. The sample size was sufficient for use of thematic analysis and to stratify and purposively sample to match as closely as possible, the typical profile of HAT users (Section 4.3.1). A topic guide was used to direct discussion and was informed by the HAT logic model (section 2), an unpublished survey created by Public Health England to understand usefulness of the HAT, and through discussions with Public Health England colleagues. Topics included perceptions of the Heart Age Test, understanding of Heart Age, future behaviour intentions and interest in an NHS Health Check (Appendix 2). Participants were offered a £20 online retail voucher in appreciation of their time.

Interviews were audio-recorded and transcribed verbatim before being analysed using inductive, reflexive Thematic Analysis (25,26). Following processes set out by Braun and Clarke (25), familiarisation of data was conducted through extensive reading before preliminary codes and themes were identified by two researchers. Transcripts were independently dual-coded by the researchers to check for coding consistency (i.e., 1 in every 5 transcripts to achieve 20% overall). Manual checks of dual-coded transcripts indicated excellent coding consistency between the researchers. All preliminary codes were reviewed

by both researchers before agreement of initial themes and their relationships. Themes were then reviewed to ensure they were data driven and discussed between the researchers and project co-lead before being finalised.

5. Results

5.1 HAT user data

5.1.1 Overall HAT user data

Since the launch of the HAT in February 2015, almost 5 million calculated Heart Age cases^b were recorded by the test (4,898,532) up to June 2020.

Overall, more males (2,682,544; 54.8%), aged 50-59 (1,334,195; 27.2%), from a White British and White or not stated background^c (3,972,293; 81%) completed the test between February 2015-June 2020. When looking specially at data from ethnic minorities, more individuals from Indian or 'other' ethnic backgrounds obtained a valid calculated heart age than any other minority ethnic group listed in the HAT (Figure 2). This is broadly representative of the national population in England and Wales (86% White, 7.5% Asian, 3.3% Black African/Black Caribbean, 2.2% Mixed and 1% Other ethnic group) (27).

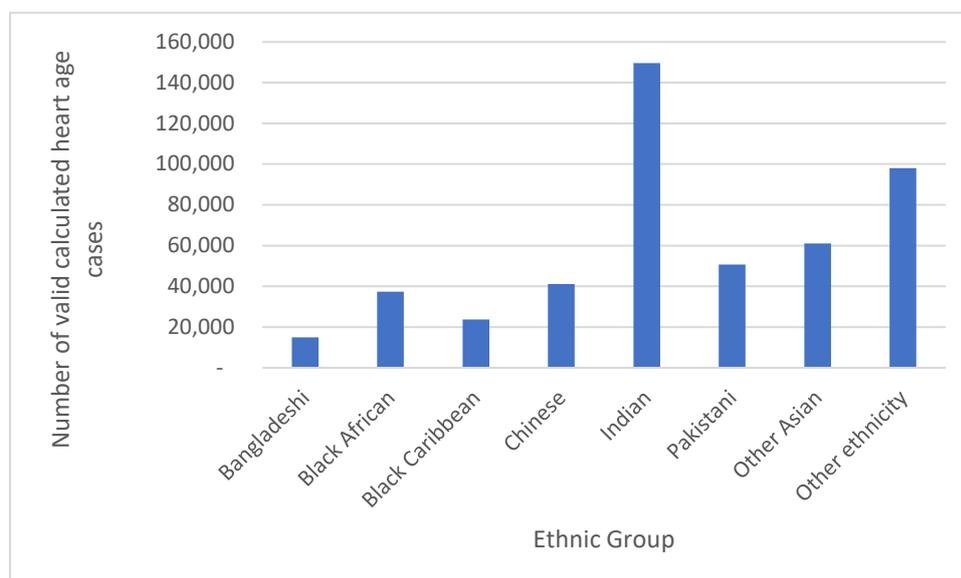


Figure 2. Valid calculated Heart Age by ethnic group

^bCalculated heart age 'cases' (Data are described as cases as an individual could have completed the test several times)

^c Individuals from 'white' background were grouped with 'not stated' during the launch year of the test

Users are asked to provide their postcode when completing the test which is then used to determine the Lower Layer Super Output Areas (LSOA) and associated level of deprivation based on the Index of Multiple Deprivation (IMD) 2019 (28), which are presented as quintiles, where 1 is most deprived and 5 is least deprived. The highest proportion of responses were in the least deprived groups (14.4%; Figure 3), but were representative across the strata with percentages decreasing as the scale moves from least to most deprived areas (1 = most deprived; 5 = least deprived) (Figure 3). Deprivation could not be determined for almost half of users (48.8%) as the LSOA calculation could not be defined until September 2016 (robust information on deprivation is only available from 1st October 2017); users can also choose not to input their postcode.

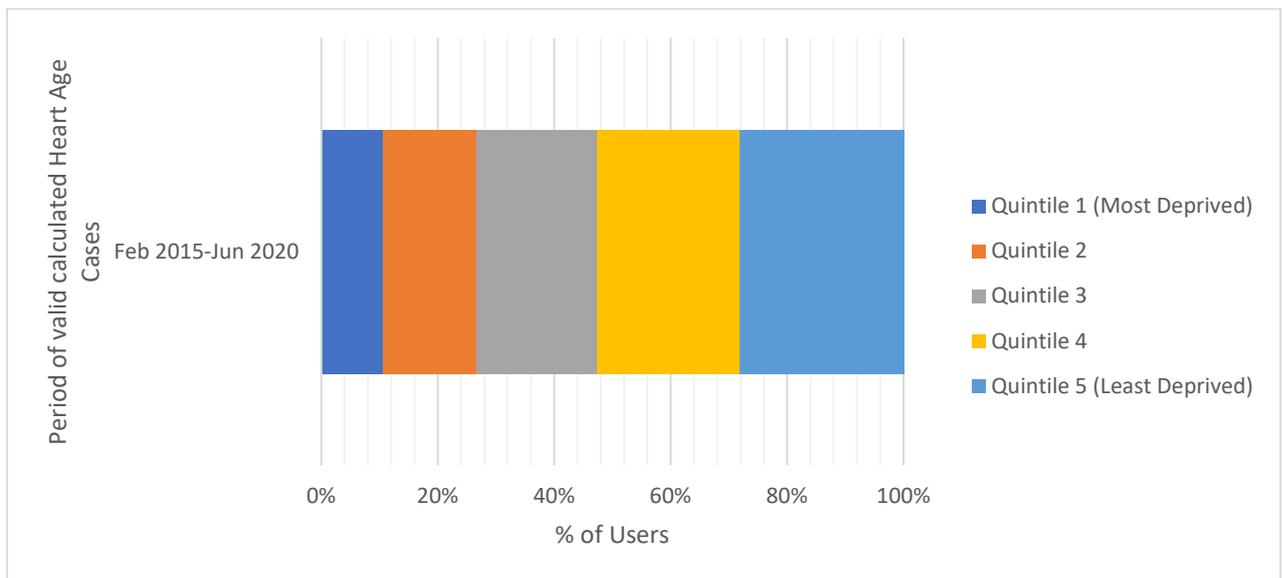


Figure 3. Valid Calculated Heart Age Cases by IMD Quintiles

Data for individuals with a valid calculated Heart Age showed that they typically had an estimated Heart Age 1-4 years older than their chronological age, followed by 5-9 years older and 1 year younger than chronological age (Figure 4). Data did not differ by year of completion.

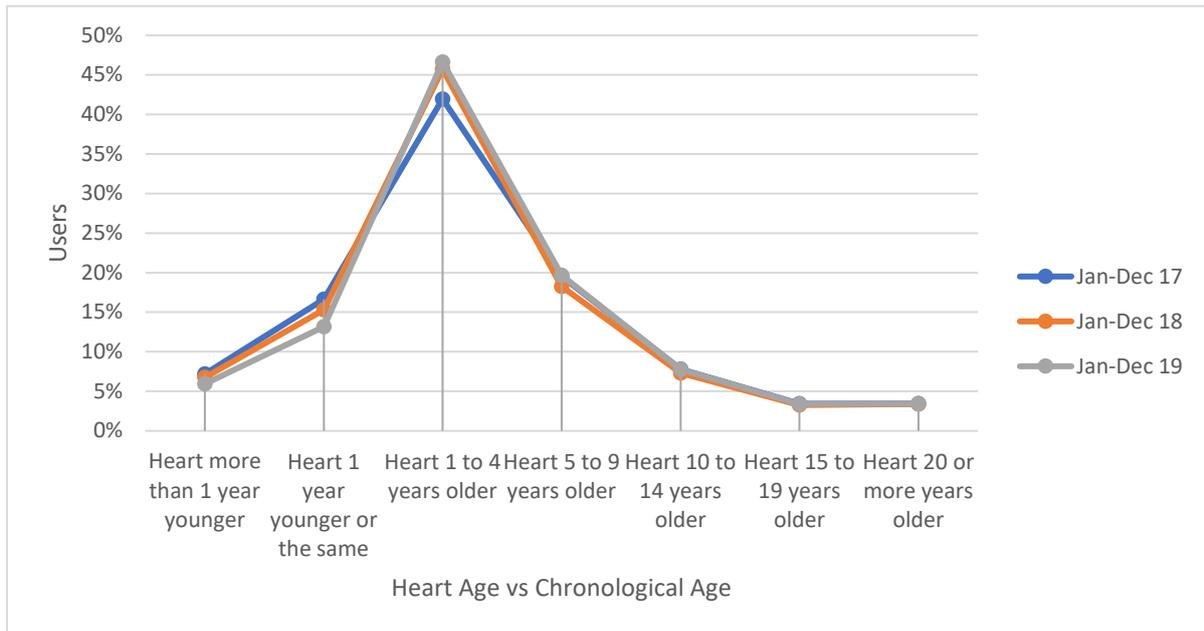


Figure 4. Difference between valid calculated Heart Age and Chronological Age

Data for user awareness of risk factors such as blood pressure and cholesterol showed just over half of users (52.9%) were unable to report their blood pressure numbers and more than three-quarters of users were unable to report their cholesterol numbers (76.6%). Just over half of users were able to report either cholesterol or blood pressure (51.4%), whilst just under half were unable to report both (48.6%). This suggests that HAT users have limited awareness of cholesterol and blood pressure information.

5.1.2 HAT national campaign (September 2018)

A national campaign for the HAT was launched between 4th-30th September 2018 to encourage user engagement. There was widespread television media coverage on the day of launch across national, regional and consumer press (625 media pieces). The core target audience for the campaign was lower socio-economic adults aged 40-60, followed by higher socio-demographic adults aged 40-60 and all adults aged 30-70. To encourage engagement from the target audience, partners including pharmacies, local authorities, NHS organization, charities, retailers, commercial organisations, gyms and leisure centres helped to support the campaign.

During the campaign, there were reportedly 2.2 million test completions on the launch day (4th September 2018) and 2.9 million completions over the campaign period (4th-30th September; including 2.2 million on the launch day collected by analytical software and the marketing team). Data collected by the test itself suggests there were 1,834,336 completions (4th-30th September 2018), accounting for 59% of total valid calculated Heart Age cases for that year (between Sept 2018-Aug 2019). Discrepancies in the two datasets can be explained by software issues for the HAT due to a surge in demand during the campaign. For consistency, data collected by the test will be presented in this report.

More males (1,136,047; 62%), aged 50-59 (515,891; 28.1%), from a White British background (1,412,408; 77%) completed the test in September 2018. The HAT was generally completed

by more individuals living in least deprived areas (Figure 5), whilst deprivation data was not available for more than a third of completed cases (37%), representing a demographic reflective of HAT user data overall.

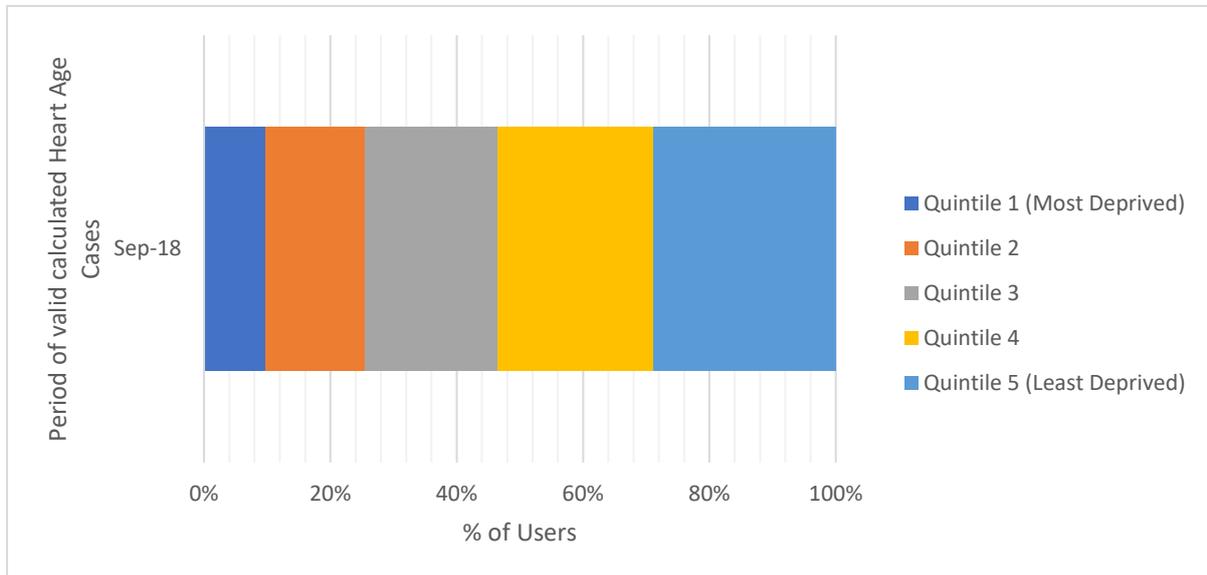


Figure 5. Valid calculated Heart Age for September 2018 by IMD quintile

5.1.3 September 2018 campaign vs previous and following months and years

Over a third of valid calculated Heart Age cases were calculated in the month of the national campaign (1,834,336; 37.4%).

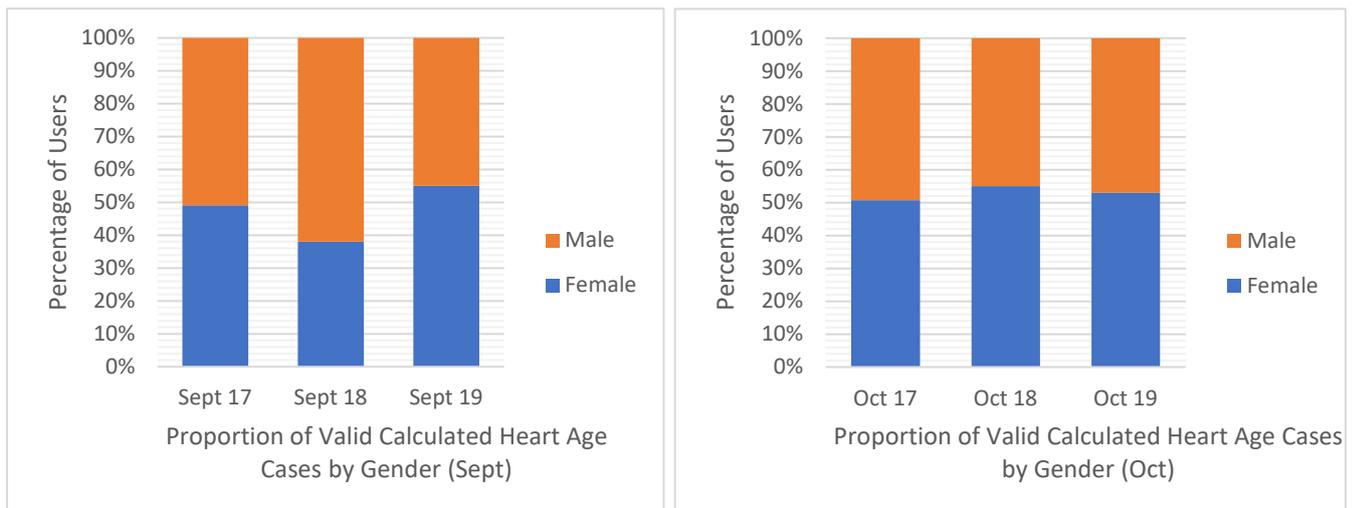


Figure 6/7. Comparison of Valid Calculated Heart Age cases by month/year and reported sex (Left to right; Campaign period vs following month and years)

Compared to other years and a comparative month of HAT engagement, more females generally completed the test except for the month of the campaign (Figure 6), suggesting that the campaign increased engagement with males. Except for 2019, individuals aged 50-59 most commonly completed the test, followed by those aged 40-49 and 60-69 (Figure 8). In October 2018 more individuals aged 60-69 completed the test compared to those aged 40-49 which may be explained by delayed engagement in this group following the national campaign. In 2019, the test was most commonly completed by individuals aged 40-49, followed by 50-59 and 60-69 suggesting that the age of users who complete the test may be moving in favour younger adults. The number of valid calculated Heart Age cases in all reported age groups was considerably higher compared to other years and a comparative month which may be explained by the national campaign.

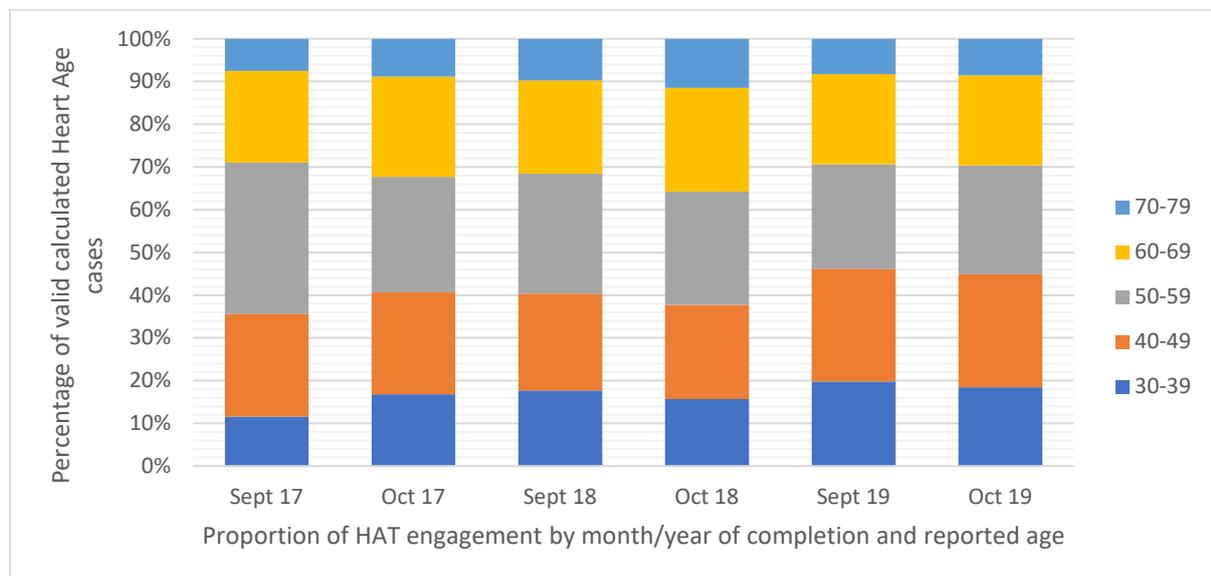


Figure 9. Proportion of valid calculated Heart Age cases by time period and reported age

Individuals from a white background most commonly completed the HAT regardless of the month or year of completion (Figure 9). The volume of valid calculated Heart Age cases increased considerably in those from a white background, ethnic minorities and unreported ethnicity. However, compared to the previous and following year, the proportion of valid calculated Heart Age cases from ethnic minorities decreased in the year of the campaign (17/18, 10.3%; 18/19, 9%; 19/20, 10.1%) suggesting that the campaign did not lead to increased engagement from ethnic minorities.

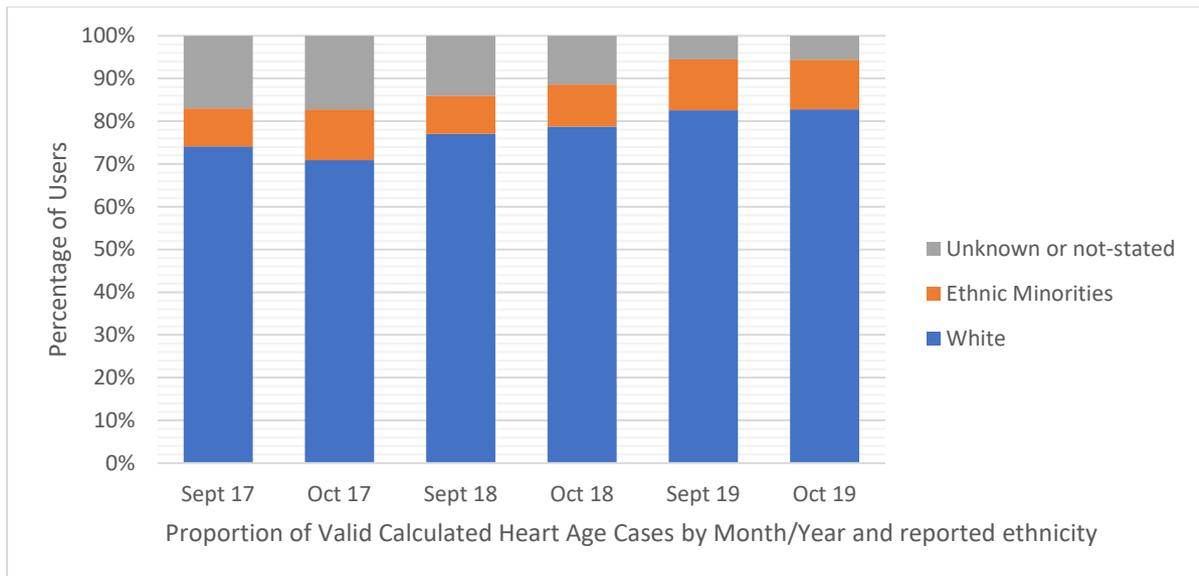


Figure 9. Valid calculated Heart Age cases by time period and reported ethnic group

When comparing data for the month of the campaign to a comparative month and other years, valid calculated Heart Age cases by IMD quintiles did not differ (Figure 10).

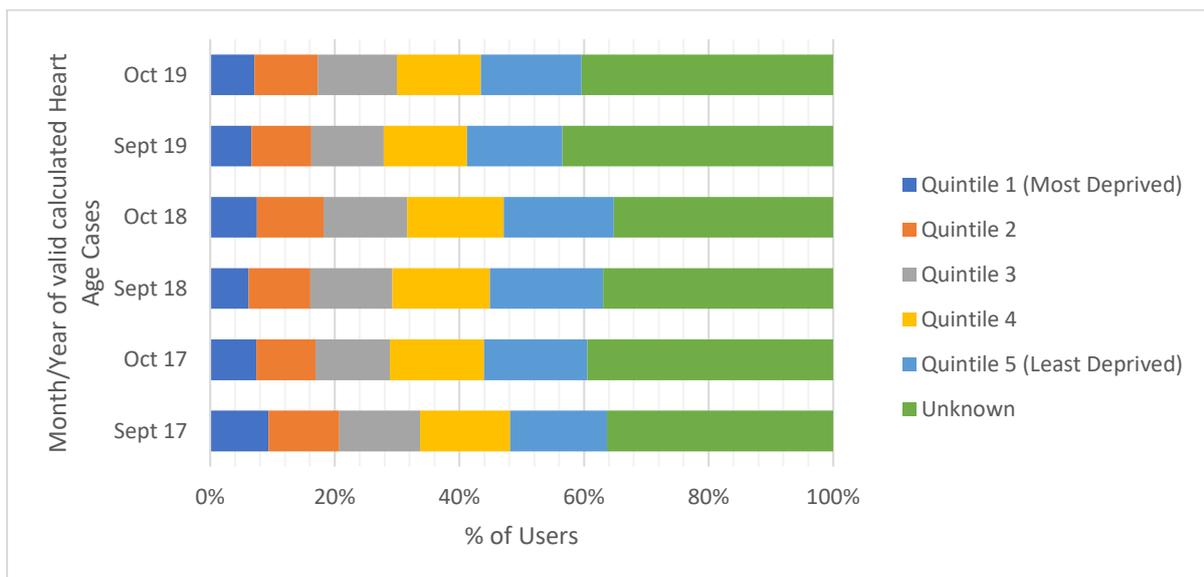


Figure 10. Percentage of valid calculated Heart Age cases by time period and IMD quintiles

When comparing percentage change in HAT user completions between September 2018 and October 2018 onwards (Figure 11-14), there was a considerable decrease in valid calculated Heart Age cases from October 2018 onwards for males, those aged 30-39 and 50-59, living in lesser deprived areas and unknown or unreported ethnicity. This suggests the national campaign in September 2018 led to increased engagement in these groups, which was not sustained beyond the campaign. The volume of valid calculated Heart Age cases in these groups remained higher in October 2018 than in previous and following years (i.e., 2017, 2019) suggesting the impact of the campaign lasted beyond the month it was held.

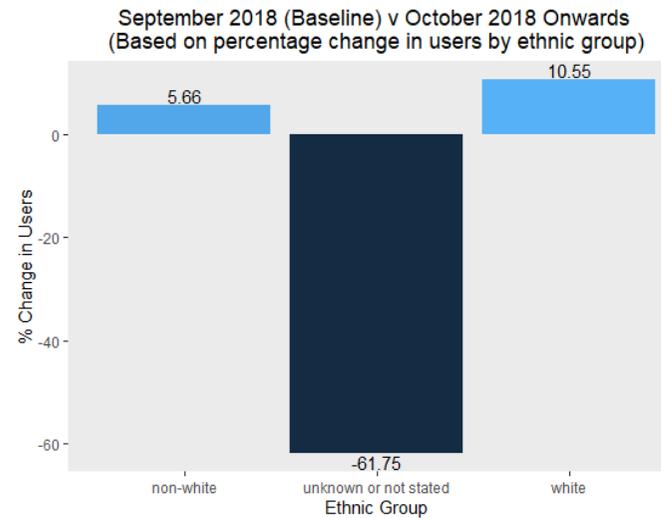
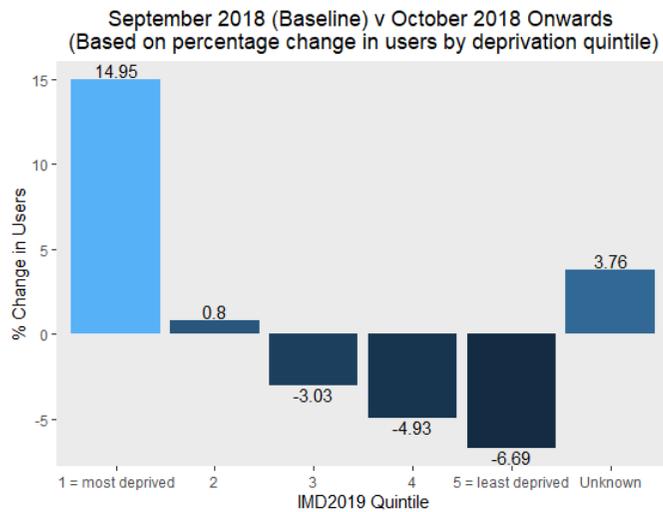
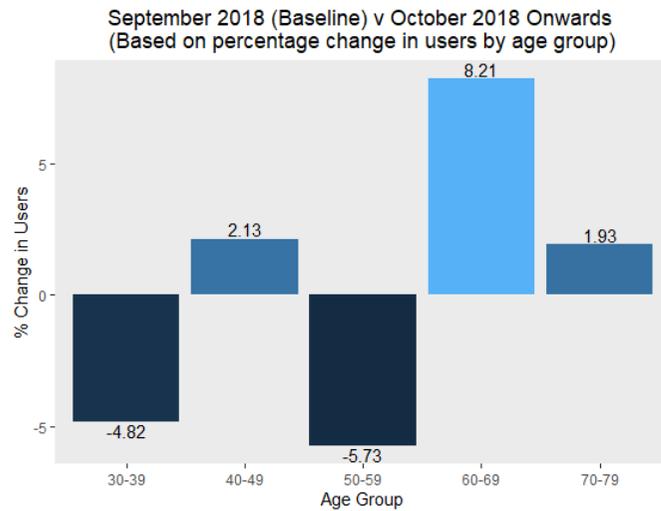
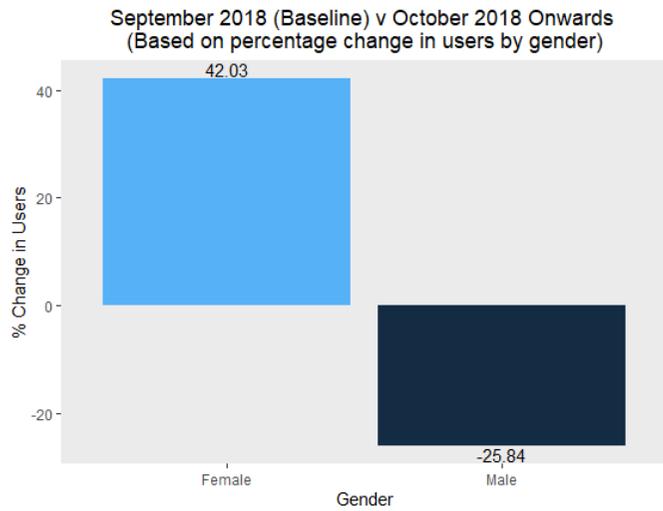
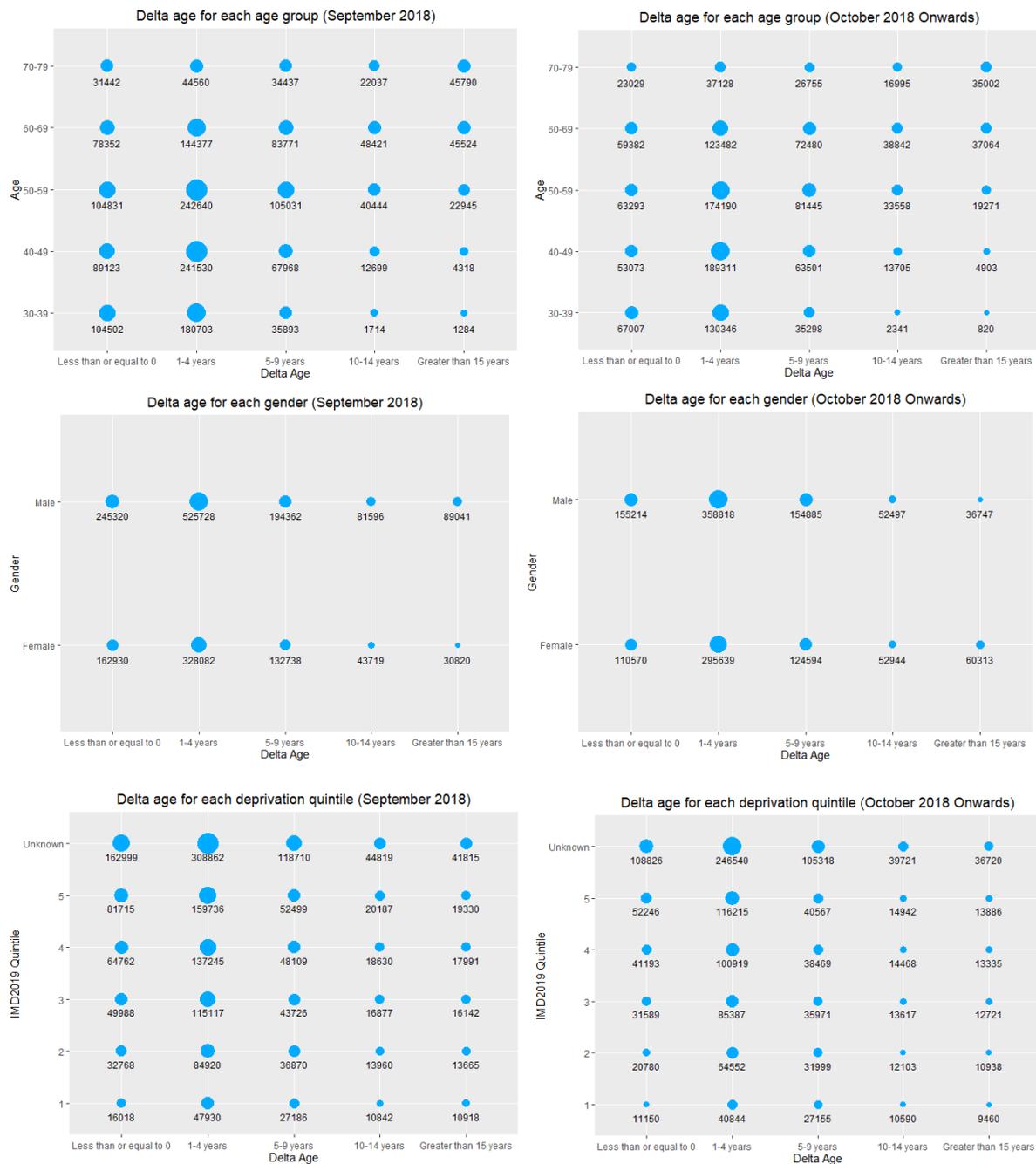
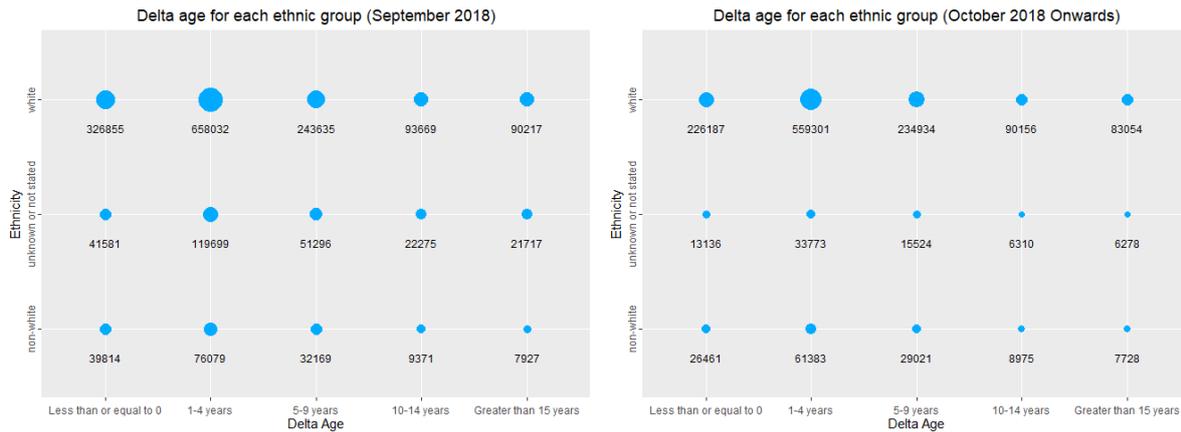


Figure 11-14 (Left to right). Percentage change in users by time period and gender/age/deprivation/ethnicity

Differences in Heart Age by period of HAT completion and gender, age, ethnicity and deprivation were also explored to compare data collected for the national campaign and October 2018 onwards (Figures 15-22; the size of the dot is proportionate to the number of people in the category).





Figures 15-22 (Left to right). Differences in age by time period and gender, age, ethnicity and deprivation

During the national campaign in September 2018, there were more completions from males, aged 40-49, from quintile three and individuals from both white and ethnic minorities had an estimated Heart Age *'less than or equal to'* chronological age compared to HAT completions in October 2018 onwards. There were also more completions by those reportedly aged 70-79 that were found to have an estimated Heart Age *'greater than or equal to 15 years older'* from data collected in October 2018 onwards compared to data from the national campaign. This suggests that overall, the campaign did not lead to increases in completions by those estimated to be at an increased risk of a heart attack or stroke.

Data available for when individuals interact with the HAT show completion of the test was highest in September between 2016 and 2018 (Figure 23). Number of valid calculated Heart Age cases then decreased in October and November 2018 following the completion of the national campaign but remained markedly higher than previous and following years.

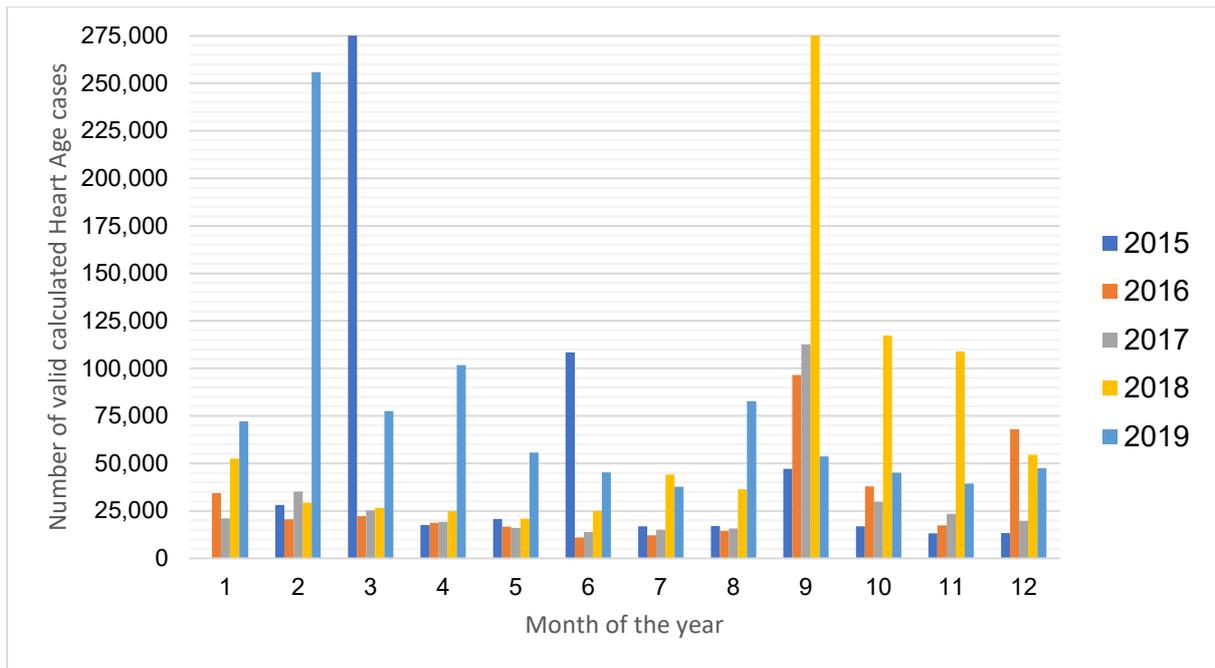


Figure 23. Number of valid calculated Heart Age cases by month (1= Jan; 12= Dec) and year

There were also spikes in completion of HAT between December-March for 2016-2017, 2018-2019, 2019-2020 that may be related to an increase in health-related goals following the beginning of a new year.

HAT usage data suggests individuals are more likely to engage with the test at the beginning-mid week irrespective of a campaign and on the launch day of a campaign. Individuals were more likely to complete the test on a Tuesday in September 2018 compared to a Monday in September 2017 and 2019 (2017 for Males only; Figure 24). The national campaign was launched on Tuesday 4th September, which may explain the peak in usage during this month. The second day of the week was also most common for completion of HAT in a comparable month (i.e., October 2017 and 2018; Figure 25), except for 2019 when a Wednesday and Thursday saw the highest activity of valid calculated Heart Age cases. When comparing the two figures, HAT usage by month was relatively consistent in October whilst usage in September was varied, likely due to the launch day of the campaign.

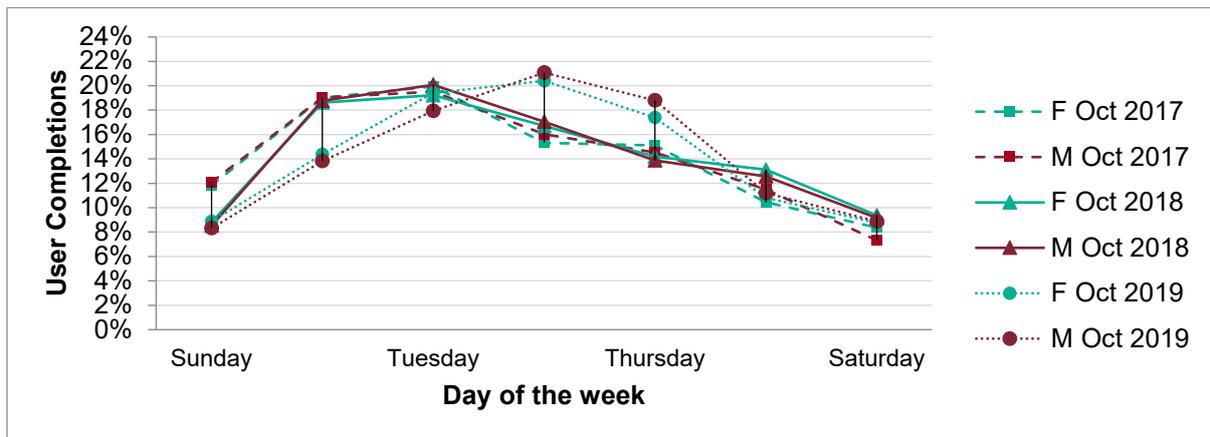
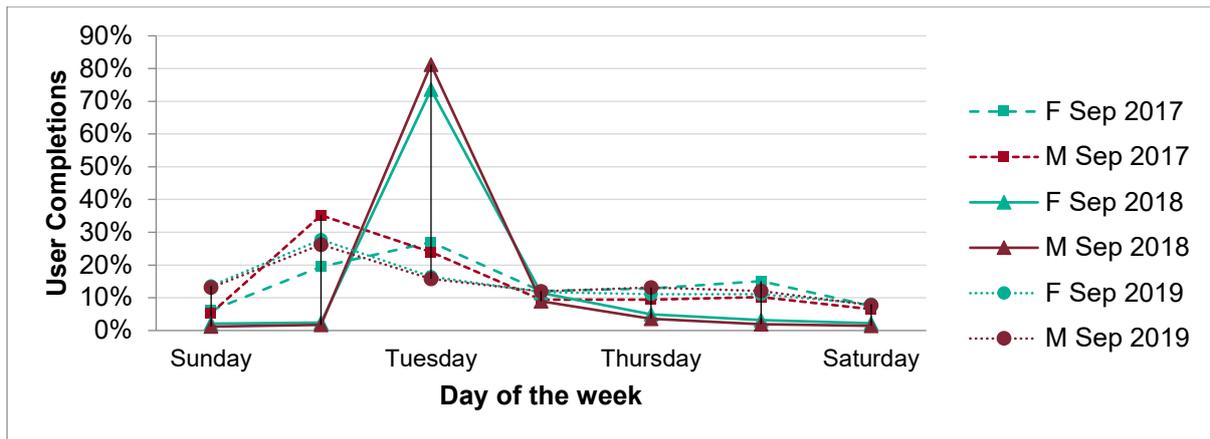


Figure 24-25 (Top to bottom). Comparison of HAT usage distribution across the week by gender (M= Male, F= Female) (September vs October)

When comparing the data by gender, there were no differences in completion of the HAT by day of the week except for September 2017. During September 2017, females generally completed the HAT on a Tuesday when compared to males (males were more likely to complete the test on a Monday).

HAT activity for hour of the day suggests individuals were more likely to complete the test during lunch hours and early evening of the HAT campaign compared to previous and following years. For usage by hour of the day, individuals were more likely to complete the HAT between 12-1pm for both males and females and between 8-9am for males only in September 2018 (compared to 11am in September 2017 and between 10-3pm in September 2019; Figure 26). Hour of completion was more diverse in a comparable month in previous and following years (i.e., between 10am-4pm in October 2017 and 2018; Figure 27). When comparing the two figures, HAT usage by time of day in September was more sporadic, with fluctuations particularly between the hours of 7am-9pm compared to October. A notable difference is highlighted between the hours of 5-7pm for the year and month of the campaign, where usage spikes during this time compared to previous and following years and months (lower in other years and generally a dip in usage between these hours in October).

When comparing the data by gender, there were no apparent differences in completion of the HAT in September by hour of the day except for September 2018 when more males than females completed the test between 8-9am (Figure 26).

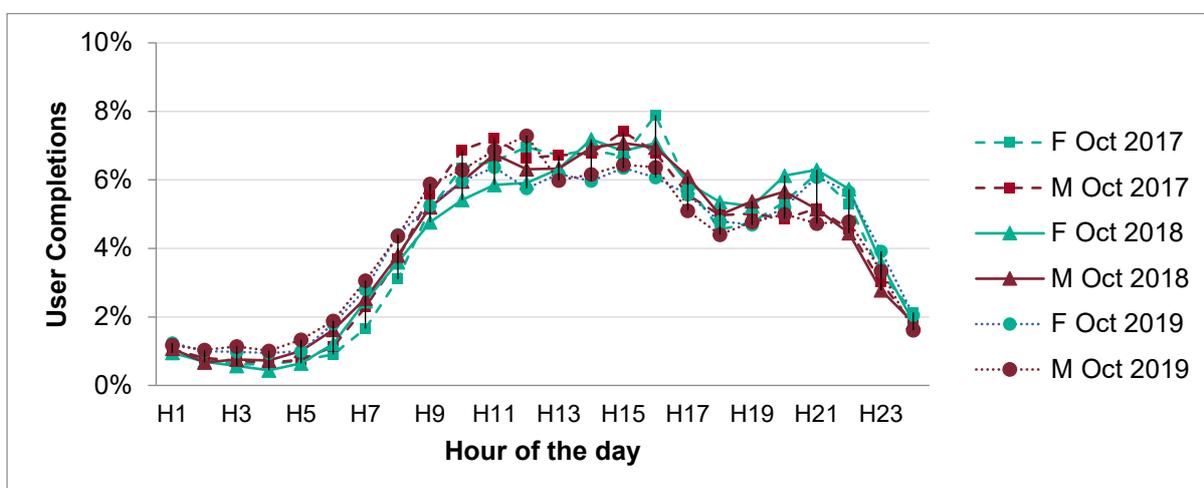
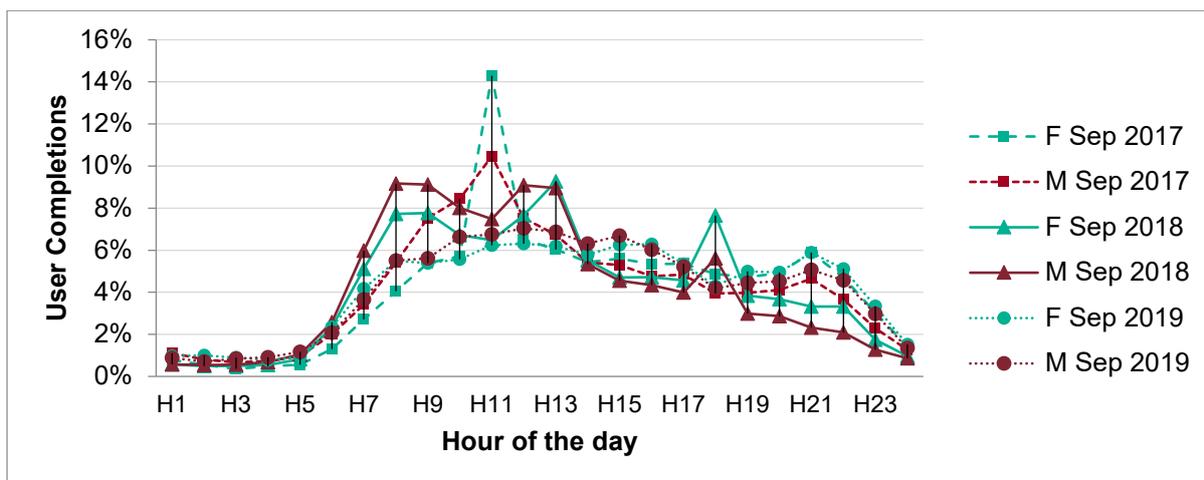


Figure 26-27 (Top to bottom). Comparison of HAT usage distribution across hours of the day by gender (M= Male, F= Female) (September vs October)

Hour of completion varied between genders when data were explored in a comparable month in previous and following years. In October 2017 and 2018, female usage of HAT was highest at 4pm and 2-4pm compared to between 10am-4pm and 11am-5pm for males, respectively. Whereas usage was highest between 11-12pm for males in October 2019 compared to females whose usage was highest between 10am-5pm and 9-10pm. HAT activity for hour of the day by gender showed no specific trends by gender.

5.2 Online survey

5.2.1 Sample profile

In total, 819 survey responses were received between January-March 2021. Fifteen survey responses were only partially completed and therefore demographic information is not available for these cases. Respondents were most commonly white (92.2%), females (71.4%), aged 56-60 (15.6%) and from the least deprived quintile (Q5; 26.1%) (Table 1). This is mostly in line with HAT user data reported in section 5.1.

Table 1. Survey demographics information

Demographics		N (819)	%
Age	30-35	65	7.9
	36-40	69	8.4
	41-45	52	6.3
	46-50	90	11.0
	51-55	108	13.2
	56-60	128	15.6
	61-65	121	14.8
	66-70	87	10.6
	71-75	47	5.7
	75+	37	4.5
	Missing	15	1.8
Gender	Male	219	26.8
	Female	585	71.4
	Missing	15	1.8
Ethnic Group	White	755	92.2
	Indian	13	1.6
	Pakistani	4	0.5
	Bangladeshi	1	0.1
	Other Asian	3	0.4
	Black Caribbean	4	0.5
	Black African	5	0.6
	Chinese	3	0.4
	Other ethnic group	13	1.6
	Prefer not to answer	3	0.4
	Missing	15	1.8
Deprivation (IMD Quintiles)	1	75	9.1
	2	109	14
	3	148	18.1
	4	170	20.7
	5	212	26.1
	Missing	99	12.1
Last contact with GP	In the last week	88	10.7
	In the last month	118	14.4
	In the last 3 months	150	18.3

	In the last 6 months	89	10.9
	In the last 12 months	94	11.5
	Over 12 months ago	265	32.4
	Missing	15	1.8
Have a longstanding illness, disability or disorder	Yes	259	31.7
	No	527	64.3
	Prefer not to answer	18	2.2
	Missing	15	1.8

Almost a third of the sample had not spoken with their GP (via telephone or face-to-face) for more than 12 months (32.4%) and had a longstanding illness, disability or disorder (31.7%; of which 54% were aged 56+; comparable to 58% of individuals aged over 60 and living with a long-standing illness in England (29)). Reasons for participating in the online survey included 'other' (40.3%, most commonly through advertisements on social media or on a website related to health), to participate in the evaluation of HAT (24.7%) and because they found the test on a news website (15%).

More respondents were unable to provide their cholesterol numbers (76.8%), whereas approximately half did provide blood pressure (48.7%), when prompted by the Heart Age Test, also in line with HAT user data. This was largely due to not having their cholesterol (61.3%) or blood pressure (35.8%) tested within the last three months, as per requirements of the test.

5.2.2 Perception of estimated Heart Age

Over a third of respondents reported their estimated Heart Age to be '*a little higher*' than they expected (34.4%) or '*a lot higher than expected*' (29.1%) (Table 2).

Table 2. Estimated Heart Age compared to chronological age of respondents

Estimated Heart Age	N	%
A lot higher than you expected	238	29.1
A little higher than you expected	282	34.4
As you expected	162	19.8
A little lower than you expected	59	7.2
A lot lower than you expected	16	2.0
No expectation	62	7.6

More respondents reported a negative emotional response to their estimated Heart Age as they largely disagreed about feeling happy, satisfied, and reassured by their result and instead felt concerned, surprised or discouraged (where agreement with statements was rated on a scale of 0 = Strongly Disagree; 50 = Neither agree nor disagree; 100 = Strongly Agree) (Figure 28-29). Most respondents neither agreed or disagreed that they felt satisfied, reassured, surprised and discouraged by their estimated Heart Age.

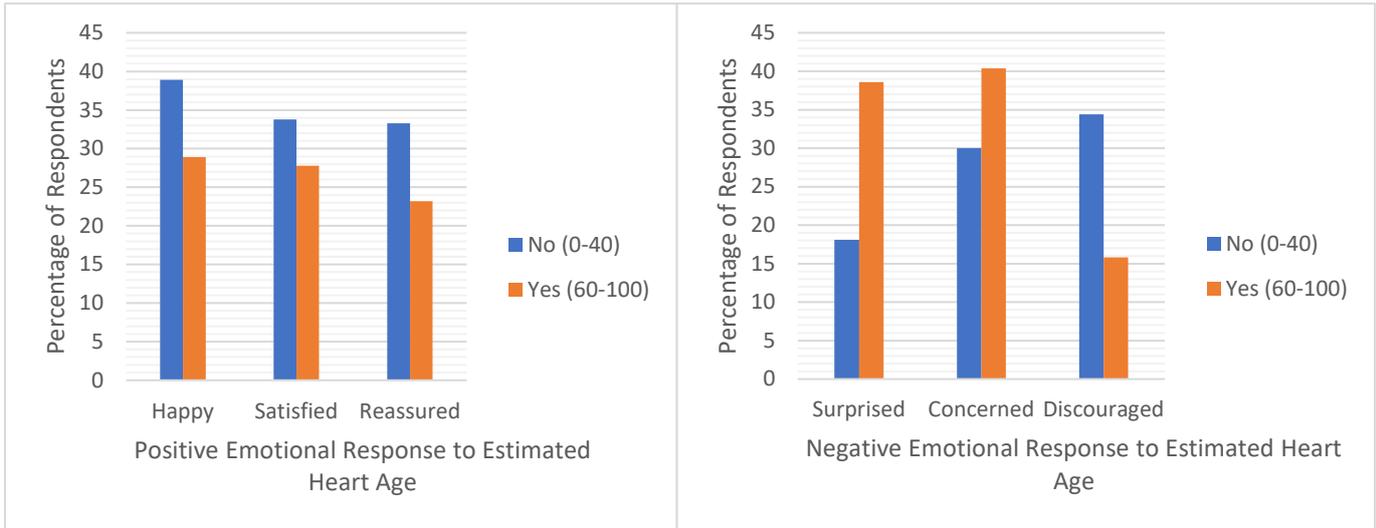


Figure 28-29 (Left to right). Respondents' emotional response to HAT result

5.2.3 Confidence and understanding of estimated Heart Age

When asked what they understood from their Heart Age result, the majority of respondents suggested they understood that if it *'was higher than my actual age, I'm more likely to have a heart attack or stroke in the future'* (83.6%).

Respondents were also asked to what extent the Heart Age Test had increased their understanding of their risk, factors that can increase and reduce their risk and actions that can be taken to reduce their risk (Figure 28).

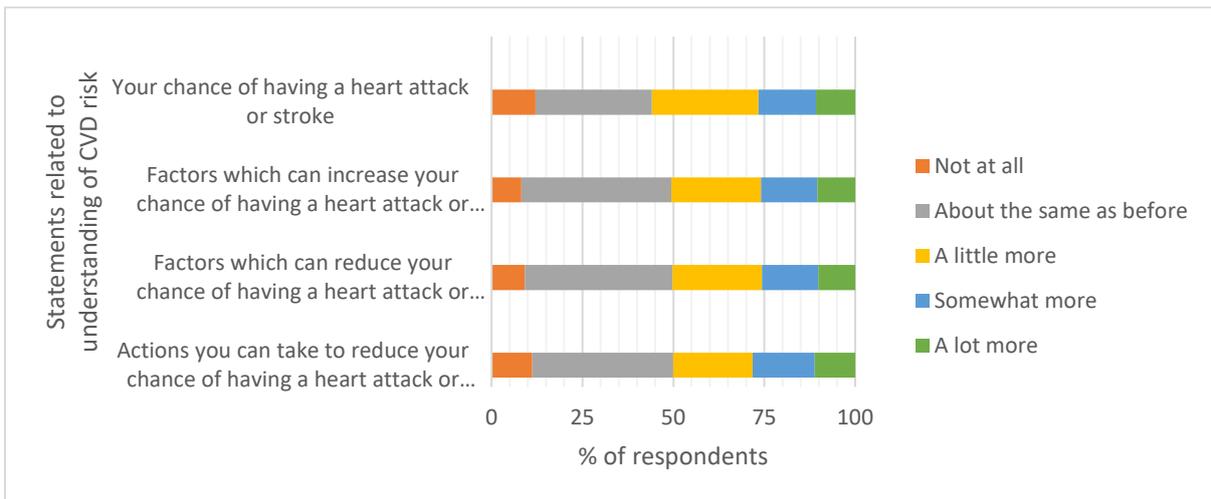


Figure 28. Respondents' understanding of CVD risk following completion of the Heart Age Test

Respondents most commonly reported that the Heart Age Test did not increase their understanding of their risk, or factors that can increase or reduce their CVD risk or actions they can take to reduce their CVD risk (Figure 28). However, understanding of CVD risk reportedly improved at least ‘a little more’ in over 50% of respondents (i.e., chance of CVD, 55.9%; factors increasing risk, 50.5%; factors reducing risk, 50.2%; actions to reduce risk, 50.1%). The same was found for confidence in understanding and control of CVD risk (i.e., factors increasing risk, 55.3%; changing risk, 55.7%; control over risk, 54.1%; reducing risk, 56.2%; and skills/support to reduce risk, 50.9%) (Figure 29).

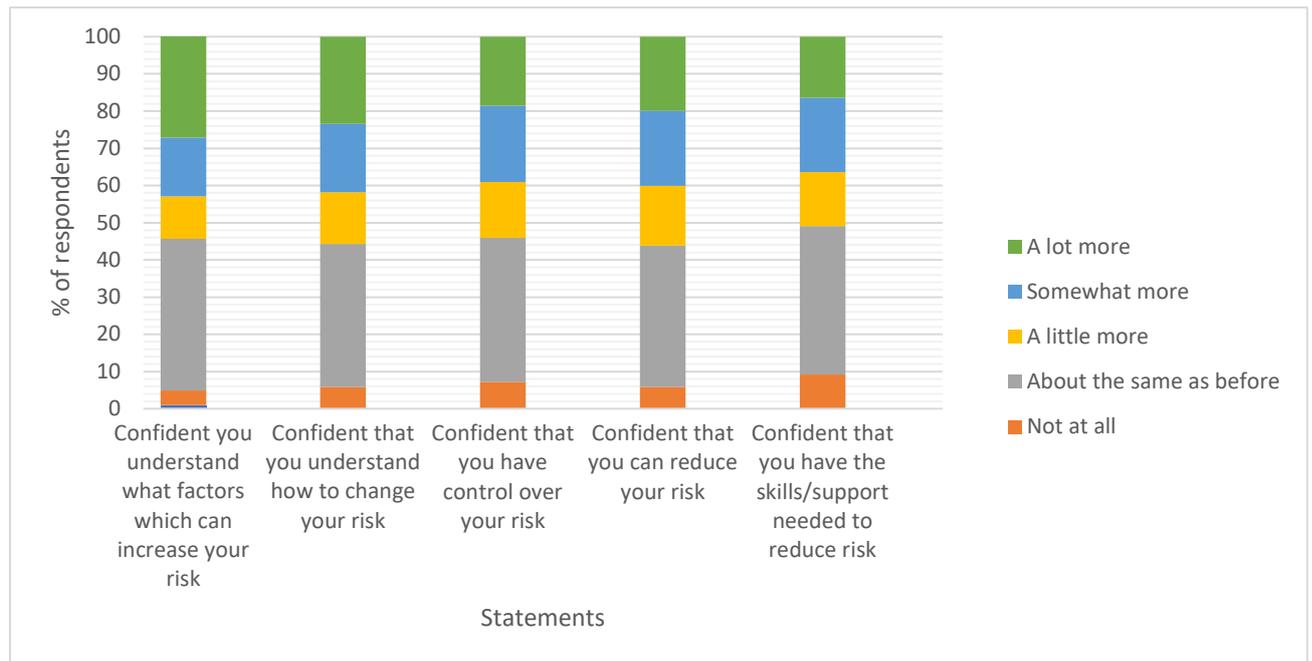


Figure 29. Respondents' confidence in understanding and control of CVD risk

5.2.4 Intended actions following the Heart Age Test

The majority of respondents suggested that they intended to take action following communication of their estimated Heart Age (Table 3). Most commonly, respondents reported they would set a goal to lose weight (45.7%), followed by a goal to get more active (36.9%), and a goal to eat more healthily (34.6%). More respondents suggested they intended to complete one action, followed by two and three actions (19.9%, 17.5%, 17.6% respectively). The action ‘setting a goal to lose weight’ combined with ‘setting a goal to eat more healthily’ or ‘get more active’ was most selected by respondents.

Table 3. Intended action resulting from the Heart Age Test

Action	N	%
Get my blood pressure checked by a GP, Nurse or Pharmacist	127	15.5
Check my blood pressure myself using a home blood pressure monitor	211	25.8
Book an appointment to get my cholesterol levels checked	236	28.8

Set a goal to attempt to quit smoking	17	2.1
Set a goal to lose weight	374	45.7
Set a goal to eat more healthily	283	34.6
Set a goal to get more active (i.e., going for a walk a day)	302	36.9
Look for more information about heart health	111	13.6
I do not intend to take any action	146	17.8

*respondents were able to select more than one option, therefore sum of percentages exceeds 100

Less than a fifth of respondents suggested they did not intend to take any action following their Heart Age Test result (17.8%). Reasons included perceived inaccuracy of the result, the test said they were healthy for their age, and other (e.g., relating to COVID restrictions, continuing healthy behaviour or changes already implemented before taking the test).

The majority of respondents also suggested they would be more likely to take up the offer of an NHS Health Check following completion of the test (76.2%) and would definitely (45.8%) or probably (32.2%) use the HAT again to check their heart health.

5.3 Semi-structured interviews

5.3.1 Sample profile

Thirty-three semi-structured interviews (average duration 21 [+/-SD = 6 minutes long) were conducted by telephone between February-March 2021. The majority of participants were females (58%), aged 51-60 (34%), from a white background (82%) and lived in least deprived areas (58%) (Table 4). The time between participants completing the HAT and participating in the follow-up interview ranged from 2-13 days (average 8 [+/-SD = 3] days).

Table 4. Interview participant characteristics

Participant Characteristics	N (33)	%
Gender		
Males	14	42
Females	19	58
Age		
30-35	1	3
36-40	5	15
41-45	4	12
46-50	2	6
51-55	5	15
56-60	6	19
61-65	4	12
66-70	3	9
71-75	2	6
75+	1	3
Ethnic Group		

White	27	82
Ethnic minorities	6	18
Deprivation		
Most Deprived (IMD 1-5)	14	42
Least Deprived (IMD 6-10)	19	58

Over half of participants self-reported that they did not have a longstanding illness, disability or disorder (55%) and more than half of the total sample had spoken (face-to-face or via telephone) to their GP within the last three months (51%).

5.3.2 Results

Four main themes were identified; *'emotional response to estimated Heart Age'*, *'perceived understanding CVD risk'*, *'perception of the Heart Age Test'*, and *'making a change?'*, each theme is discussed in turn and supported by evidence from participant transcripts. Each quote is labelled to denote participant number (PX), age, gender (M=Male; F=female), IMD quintile (QX) and ethnicity (WB=White British; EM=ethnic minorities).

Emotional response to estimated Heart Age

Upon learning their estimated Heart Age, some participants were *"a little bit surprised [by their result] because [they were] really active, [they] do a lot of exercise"* (P25, 36-40y, F, Q5, WB). Others suggested it was *"a little bit of a shock because [it] doesn't fit with [their] experience of most people [their] age"* (P7, 56-60y, F, Q4, WB). Recalculating their estimated Heart Age shocked one participant *"even more"* following retrieval of their *"blood pressure figures... [because their estimated Heart Age] went up to 89"* (P21, 66-70y, F, Q2, WB). Emotional responses to estimated Heart Age were stronger for those who did not expect their result to be as high as it was *"because [their] blood pressure is good, [their] weight is good"* (P24, 41-45y, F, Q5, WB) and because they *"would class [themselves] as fairly healthy"* (P7, 56-60y, F, LD, WB). Often participants were looking for *"confirmation [they were] doing OK, the fact that [they] didn't see [their] biological age... I think that was...frustrating"* (P32, 51-55y, M, Q2, EM). Therefore, for some estimated Heart Age served as a *"real wake-up call"* (P21, 66-70y, F, Q2, WB):

it just gives you that bit of [a] kicking up the bum... just a bit of a boost to say actually 'yeah I do need to understand these levels'. You know I am no... you know I am 30, but I am not sort of 20 anymore...I could do better with my own lifestyle." (P9, 30-35y, M, Q3, WB)

Participants suggested the HAT had made them re-evaluate their lifestyle and think *"right I have got to start doing something now because I have not done any exercises for a good ten years"* (P33, 56-60y, M, Q1, WB).

Some participants were *"pleasantly surprised that [they weren't] more unhealthy, but equally it didn't say 32 either did it?"* (P4, 36-40y, F, Q5, WB). They anticipated that their estimated Heart Age would be higher than their chronological age due to engagement in unhealthy behaviours: *"I don't do much exercise as I used to, or I would like to"* (P12, 41-45y, M, Q3,

WB); *“I am over-weight, I know I need to do something about that”* (Participant 2, Age 51-55, F, MD, WB). Others suggested it was because of known health conditions: *“because I have COPD, I thought it was going to be slightly higher anyway.”* (P23, 61-65y, F, Q3, EM).

Those who received an estimated Heart Age similar or lower than their chronological age thought their result *“was actually quite pleasing”* (P10, 61-65y, M, Q3, WB) and it *“reassured [them that] ‘oh there is a point to [a healthy lifestyle]”* (P11, 71-75y, M, Q5, WB). These participants believed the test had *“reinforced the fact that yes... [they are] doing the right thing by losing some weight”* (P5, 46-50y, M, Q5, WB). Completion of the HAT resulted in both positive and negative emotional responses from participants, which were largely influenced by whether their result was what they expected prior to taking the test. For those who received an estimated Heart Age older than their chronological age, the test served as a wake-up call and encouraged them to re-evaluate their lifestyle.

Perceived understanding of CVD risk

The majority of participants perceived that they had a good understanding of their estimated Heart Age: *“my understanding was that my behaviour, what I am eating, doing, isn’t making my heart necessarily any worse”* (P4, 36-40y, F, Q5, WB). Participants took their estimated Heart Age as being like that of *“a 79-year-old person”* (P20, 66-70y, M, Q2, WB) when it was estimated to be older than their chronological age and suggested that *“there is obviously a little bit more that [they] could do just to look after [themselves]”* (P25, 36-40y, F, Q5, WB).

Not only did these participants perceive themselves to have a good understanding of their HAT result, but also of their CVD risk generally: *“I think if your cholesterol is lower, it’s less strain on your heart”* (P19, 71-75y, F, Q1, WB). Participants were already aware that if risk factors such as blood pressure and cholesterol were low *“then you have got a far better chance of not having a stroke, or a heart attack”* (P31, 56-60y, F, Q5, EM). Equally, participants were aware of other risk factors such as *“being overweight, not being as fit as you could be, you know smoking”* (P14, 51-55y, F, Q1, WB).

For this reason, the majority of those interviewed felt that they had not learnt anything new about their heart health because they were already aware of behaviours that increase their risk: *“I understand lifestyle, exercise, diet and all those elements have an effect, and a lot of stress and things like that”* (P12, 41-45y, M, Q3, WB). Participants suggested they were already aware of factors that can increase your risk of a heart attack or stroke through *“social media and previous knowledge”* (P15, 66-70y, F, Q4, WB) or due to experiences of family members: *“I have family members that have had issues with their hearts and stuff like that, so I have already got a background knowledge of you know why you need to look after your body unfortunately”* (P9, 30-35y, M, Q3, WB). Therefore, these participants reported feeling confident in their understanding of risk and felt they had already got *“a fairly good grasp of what you need to do in order to reduce your chances of, having heart disease and having a stroke.”* (P17, 61-65y, M, Q3, WB).

A minority of participants suggested they did not understand their risk which was perceived to be largely related to their understanding of CVD event-free survival age (presented in HAT; see Figure 30): *“54 was my sort of heart age, predicted, I know it is quite loose perhaps but I was predicted to die at 77”* (P5, 46-50y, M, Q5, WB).



Figure 30. Screenshot of CVD event-free survival age presented in HAT output (text presented in the yellow box)

Whilst another participant suggested that the HAT “said that I would die at 76” (P9, 30-35y, M, Q3, WB) and “from age 53, I should be expecting to have a heart attack. That is how I read it anyway” (P32, 51-55y, M, Q2, EM). This was concerning for participants and as a result the interviewer had to explain the result to the participants to provide some reassurance. For this reason, participants who did not understand their result wondered why their estimated Heart Age was so high:

I am telling you I am 52 and I am telling you that I don't have high blood pressure and I am telling you I don't have [high] cholesterol. Why are you telling me I am 53 for my heart age at the end, do you know what I mean? (P32, 51-55y, M, Q2, EM)

Some participants were unsure what factors led to a higher estimated Heart Age, leaving them to speculate:

my blood pressure...on the tablets, it is 120 over 80, so that's about normal as far as I can see. So, I don't know whether it's the cholesterol figure I put in, that is the only thing I can think of at the minute (P8, 56-60y, F, Q4, WB)

Consequently, these participants wanted more information to fully understand their risk: “because thinking of my own knowledge, if somebody is guiding us [ethnic minorities] in the proper way then it will be helpful” (P27, 36-40y, F, Q5, EM). Particularly for participant 27, knowledge and understanding of cardiovascular risk within their community was perceived to be limited and could be improved to encourage individuals to think more about their heart health. Another participant suggested that people “know the factors that impact on the[ir] heart health, but [they] don't know to what extent and at what rate” (P12, 41-45y, M, Q3, WB). Understanding of risk following completion of HAT may have been influenced by participants’ engagement with the information on the results page as some participants “didn't bother following any of the links, [they] just completed the questions and got [their] age at the end” (P14, 51-55y, F, Q1, WB). One participant even suggested the HAT could be improved by presenting your estimated Heart Age and then “because you didn't know your cholesterol, your blood pressure etc, we would like you to come in for a check” (P16, 51-55y, M, Q4, WB).

The HAT already makes this suggestion for those who do not provide a blood pressure and cholesterol reading.

Most participants perceived to have a good understanding of their CVD risk following completion of the HAT and suggested they were already aware of factors that can increase your risk prior of a heart attack or stroke prior to taking the test. A minority of participants struggled to understand the concept of CVD Event-Free survival age, included in HAT, which led to confusion about their results and their level of risk. This led to intentions to find out more information about their risk to improve their understanding following a negative response to estimated Heart Age.

Perception of the heart age test

Most participants thought the HAT was “*easy to use and interesting*” (P2, 51-55y, F, Q2, WB), was “*simple enough*” (P32, 51-55y, M, Q2, EM), and was “*really easy to follow, very clear and concise, it was good!*” (P9, 30-35y, M, Q3, WB). Whilst participants perceived themselves to already know a lot about the risk factors for cardiovascular disease (see *understanding of risk*), it was believed that “*anything that can help raise that profile is really good*” (P10, 61-65y, M, Q3, WB). Participants also thought it was “*quite helpful...it was quite informative at the end, the information it gave you*” (P14, 51-55y, F, Q1, WB) and would be useful “*for people like my Mum [individuals who could improve their lifestyle] ...yeah people like that*” (P6, 51-55y, F, Q5, WB).

Yet, most comments were related to the ease of the test which may be due to the amount of information required to complete it: “*the [amount] of information that I gave it, I don't think it had much to go on*” (P5, 46-50y, M, Q5, WB). As the HAT was a short test that did not require a large amount of information from participants, they “*didn't feel [their result] was accurate*” (P17, 61-65y, M, MD, WB):

I don't believe it, I still don't believe... based on my blood pressure which is managed with medication and is not serious... my cholesterol is within normal range and I exercise, I sleep, I don't drink, I eat sensibly and all the rest of it (P32, 51-55y, M, Q2, EM)

Subsequently, some participants, who received an estimated Heart Age older than their chronological age, chose to ignore their result:

it probably aged about 10 years older than I was and so that was annoying... I think 'well what did I do this thing for, it doesn't mean anything anyway' and then you just discount the whole thing because you just don't believe it, it's how it is, isn't it, they have got it wrong (P11, 71-75y, M, Q5, WB)

Perceived accuracy of the HAT was largely related to whether participants could provide their BP and cholesterol numbers: “*I found the information a little difficult to kind of identify with, because you weren't sure it was really a true kind of heart age, because I knew there was information that I couldn't put in*” (P12, 41-45y, M, Q3, WB). Participants suggested that “*with those answers [BP and cholesterol] it may have been more precise, or maybe a bit more accurate*” (P23, 61-65y, F, Q2, EM) and would have made them feel “*more comfortable*” (P9, 30-35y, M, Q3, WB) about their result. If an individual was unable to provide a blood pressure

and cholesterol reading, participants questioned “*how useful [it] would be... they are fairly important measurements to put in aren't they?*” (P4, 36-40y, F, Q5, WB). This was reiterated by those who did have their readings to complete the test: “*I would feel like 'what's the point of doing it' because... it's not going to give me a true representation of me... if I didn't have a clue what mine [numbers] were*” (P24, 41-45y, F, Q5, WB).

Some participants also felt the HAT “*could have the option to go into a bit more detail*” (P5, 46-50y, M, Q5, WB). One participant believed the test could have asked more questions about their past smoking habits:

I used to smoke years and years and years ago and then there was an option for an ex-smoker which is alright but there wasn't any difference in how long I had been a non-smoker because I know for a fact that... there is a difference in terms of your likelihood of you being at risk... of either a heart disease and stuff like that. Whether you stopped yesterday, whether you have been smoking for 10 years, 15 years, I mean all of that (P32, 51-55y, M, Q2, EM)

Others highlighted that the test “*didn't ask me like alcohol intake... I don't recall alcohol intake ... that sort of surprise[d] me*” (P10, 61-65y, M, Q3, WB) or physical activity: “*I don't remember there being an exercise question... if I did exercise, would that affect it?*” (P8, 56-60y, F, Q4, WB). Participants understood that these risk factors could impact their risk and wanted to know why they were not included in the test.

Despite this, most participants suggested that they would recommend the HAT to others “*because I think it made me think a little bit about how it is all connected and sort of you know really connecting lifestyle and health to my heart age, I thought it was a really good idea*” (P26, 36-40y, F, Q5, WB). Some participants had already recommended the test to their family members: “*my son is 33 and I said to him you need to be doing this now. My niece, I rang her and told her and my sister*” (P21, 66-70y, F, Q2, WB); “*I was telling them [their daughters] about it... the youngest one, she said she wanted to have a go at it, just you know out of interest.*” (P2, 51-55y, F, Q2, WB). One participant had even shared the test within their institute:

I would and I have done because I send a daily email to my [concealed for anonymity] members and I included the link in one of those and that goes to 52 other people, whether they have engaged in it, I don't know but I thought it was important to share it (P15, 66-70y, F, Q4, WB)

Participants suggested they would recommend the test “*to some, not to all, it probably depends on where I think they are at, at the time*” (P30, 41-45y, F, Q4, EM). This was also the main reason why a minority of participants suggested they would not recommend the test to others:

as a member of the public I am not sure it is my ... our job... because you kind of get into the world of stigma and fat shaming and all sorts of stuff don't you. It is quite a delicate subject (P16, 51-55y, M, Q4, WB)

Some participants questioned whether it would be appropriate to recommend a test that may suggest an individuals' lifestyle should be improved and if the individual would question their motive for sharing the test. Overall, participants liked the ease of the test but questioned its

accuracy due to the level of information required to complete it and whether they were able to provide a blood pressure and cholesterol reading. Despite this, the majority of participants would recommend or had already recommended the test to others. This suggests that even though participants had reservations about the accuracy of HAT, they found some benefit from completing the test.

Making a change?

Most participants suggested the HAT had “prompted [them] to start thinking about doing more exercises” (P6, 51-55y, F, Q5, WB) and to look at their dietary intake: “I am just thinking about calorie intake more carefully... just trying to keep on top of that... I have a tracker that I use on my phone, so just keeping up-to-date with that really” (P25, 36-40y, F, Q5, WB). Participants also suggested they had intentions to reduce their weight: “I have set myself an objective now to try and reduce certainly 3[kgs], I was 95, I am trying to get down to about 92 now” (P10, 61-65y, M, Q3, WB). Others considered making an appointment to get their blood pressure and cholesterol checked:

it said something about ‘you can get it done at the pharmacy’... I mean if I get chance I may pop in, or you know make an appointment to go and have it done and then just run through the questions again (P14, 51-55y, F, Q1, WB)

As participants were unable to provide their blood pressure and cholesterol numbers, they thought it “would be interesting to find out [what they were]” (P30, 41-45y, F, Q4, EM) following completion of the HAT. Participants also suggested the HAT “promote[d] [them] to think ‘right yeah, I need to go and book into the doctors and just have a check-up to make sure that all [their] levels are OK” (P9, 30-35y, M, Q4, WB). However, a minority of participants questioned “whether that motivation [would] persist” (P1, 36-40y, M, Q4, WB) once the burden of the coronavirus pandemic became more manageable for GPs and they could subsequently book a check-up.

Some participants even suggested they had already made changes to their lifestyle since completing the test including “doing more regular exercise...we have been doing these dancing videos that we have.... me, and my lad, laughing at one another, it has been fun.” (P3, 41-45y, F, Q1, WB). Whilst others had already made changes to their diet: “it has been like 20 days I have been doing this walking, so researching about my food portions...checking calories, how much do you need, so I am keeping an eye on that” (P27, 36-40y, F, Q5, EM). One participant had already been to see their GP following completion of the HAT:

I did the test I think on the Wednesday and on the Friday, I had an appointment for my monthly blood test [for an existing health condition], so I mentioned it to the nurse and she said ‘I will just add, I will add your cholesterol onto this blood test’ and then I booked in... for a blood pressure test and she said ‘come back in an hour’s time for it’. So, it all happened on the Wednesday and then as I say, I should have gone back on the Friday for another blood pressure test which I did, but meanwhile on the Thursday when my blood had come back showing a high inflammation rate, the doctor rang me on the Thursday and we discussed it altogether and he said well because you have got a rheumatoid flare up at the moment, that would put your blood pressure up so he has given me some medication for that which he said should bring my blood pressure

down...if I hadn't had done that, that survey I wouldn't have had a clue (P21, 66-70y, F, Q2, WB)

Through completion of the HAT, the participant identified that they had high blood pressure and their pre-existing health condition was inflamed which were now being managed with medication. Another participant suggested the test had made them re-consider their smoking habit:

It brought it home a bit more to me, I must admit, with the test... I am getting older, I'm getting more aches and pains and that type of thing as people do, I suppose but... it was just the test that really said to me, you know, 'Hang on [name], do you have to have a cigarette now' and that has been 'no', so it is just breaking habits (P20, 66-70y, M, Q2, WB)

Following completion of the HAT, the participant had chosen to reduce their smoking and to change their route to work to help break their habit. Those who had made changes to their lifestyle suggested it was largely related to receiving their estimated Heart Age but also "because of my family history [they] thought it was really important" (P24, 41-45y, F, Q5, WB) and the influence of other family members:

my little lad, he is 12 now, to hear him say 'you know mum that has put so many years on your age which means you are going to lose those years'. That was... that was a big factor hearing my little boy say that (P3, 41-45y, F, Q1, WB)

The majority of participants also reported that they had already made changes to some aspects of their lifestyle prior to the completion of HAT: "I ended up buying a bike about six weeks ago, so I have been going a bit crazy with that... I have cycled miles and miles and miles, and I have lost some weight which is great" (P29, 56-60y, M, Q2, WB). Others had already made improvements to their lifestyle following a health diagnosis:

So last year... I changed my diet completely and then I stopped eating sugars and increased my physical activities and everything else. So, my medication has been stopped, the one for the high cholesterol and my cholesterol is quite good now. Which I am very happy about (P32, 51-55y, M, Q2, EM)

Whilst the majority of participants were already engaged in some health behaviours prior to the completion of the HAT, the test encouraged them to stay motivated:

initially [their motivation] was to do with my dad's health and my grandparents, but obviously it has made a difference doing the [test] now... I was halfway there in my head anyway to carry on doing what I do, and keeping fit and going out for a walk every morning but that's, I suppose that's now instigated it because, you know, if I can reduce it down, then hopefully, you know, it will keep me here a bit longer (P8, 56-60y, F, Q4, WB)

Participants felt the test had given them "a little bit of impetus" (P14, 51-55y, F, Q1, WB) to maintain their healthy lifestyle choices and wanted to complete the test "again in 12 months' time...because anything that can reassure you that what you are doing is beneficial, even though you believe it might be, it is nice to have some tool... that sort of proves it" (P10, 61-65y, M, Q3, WB).

Most participants suggested that they “*have no excuse not to do some exercise or go for a walk or... make healthy food*” (P21, 66-70y, F, Q2, WB). Yet, COVID-19 restrictions were perceived to be a barrier to making healthy lifestyle choices:

during the last year we have all been locked down, people I think have been eating and drinking out of boredom and all the rest of it. I should imagine obesity levels have increased, alcohol consumption has increased, people may have found it even harder to give up smoking which they may have already done in January and so you might find that heart health has actually sort of been negatively impacted by what is happening in people’s lifestyle, enforced lifestyles (P5, 46-50y, M, Q5, WB)

COVID-19 restrictions were also described as being “*confined to barracks, you are either at work or at home*” (P28, 46-50y, F, Q5, WB), making it difficult to keep physically active. Having a positive mindset and motivation to make changes were also considered barriers: “*it is just up to me in the end... there is nothing really to stop me apart from my own attitude towards that I suppose really*” (P29, 56-60y, M, Q2, WB).

Mental health was perceived to be important for living a healthy lifestyle; “*if you are well mentally, then generally your diet and things come with it don’t they?*” (P9, 30-35y, M, Q3, WB). However, barriers to a healthy lifestyle were perceived to be temporary and most participants believed that opportunities to make changes would improve following changes in COVID-19 restrictions: “*there are things in there that I am planning on doing once the Government restrictions are kind of lifted and we can get on with a more normal life*” (P33, 56-60y, M, Q1, WB). The hope of “*better weather maybe a bit more freedom*” (P11, 71-75y, M, Q5, WB) encouraged participants to think about what they could do in the future to improve their heart health.

Only a minority of participants suggested they did not intend to make changes to their lifestyle following completion of the HAT. Some participants suggested their estimated Heart Age was “*close enough that... [they] don’t need to feel pressured to... do significantly more than what [they] already do*” (P1, 36-40y, M, Q4, WB). Whilst another participant suggested they would like to have more concrete information about their risk:

I think I need to talk to my GP about possibly having a few more tests and it is really the tests that would determine whether I change any behaviour. Because right now, everything is just supposition... but there is nothing concretely wrong and I do worry that I am actually worrying excessively, if you see what I mean you know? (P22, 56-60y, M, Q3, EM)

Health risk information “*coming from a trusted health professional rather than kind of an online test*” (P32, 51-55y, M, Q2, EM) would have been more impactful for some participants and would have resulted in action if they were told they were at an increased risk of having a heart attack or stroke. With that said, the majority of participants suggested that they would attend an NHSCH following completion of the HAT because “*the more information you can get on a subject I think the better*” (P23, 61-65y, F, Q2, EM), “*it would be nice to understand more about ...the actual health of my heart*” (P26, 36-40y, F, Q5, WB) and “*it would be good to know if there is anything else that I could do, make changes with.*” (P3, 41-45y, F, Q1, WB).

Despite COVID-19 presenting temporary barriers to lifestyle change, most participants intended to make changes to their lifestyle or had already done so following completion of the

HAT. For those who had already made changes to their lifestyle prior to taking the HAT, the test was an added source of motivation and encouragement to maintain those changes. Although participants suggested their intentions to and/or changes to behaviour had resulted from the completion of the HAT, the majority of participants had already made some lifestyle changes prior to taking the test suggesting that participants were already invested in improving their health.

6. Discussion

Evaluation of the HAT suggested there is considerable public interest in the test to estimate individual heart health (almost 5 million completions up to June 2020). Overall, user data showed the test was completed by more males, aged 50-59, from a White British background and living in least deprived areas, similar to a previous assessment of the tool published in 2016 (1). Engagement with the tool was higher in groups typically underrepresented in the NHSHC programme including males, younger eligible adults and individuals from Indian and 'other' ethnic backgrounds (2).

Exploration of data to understand the impact of the national campaign showed over a third of valid calculated Heart Age cases were calculated in September 2018 (37.4%; n=1,834,336), with increased completions for both males and females, of all age groups, and ethnic and deprivation backgrounds during the campaign and for the month after the campaign. Compared to October 2018 onwards, more males, those aged 30-39 and 50-59, living in lesser deprived areas completed the HAT during the month of the campaign. This indicates that the national campaign contributed to increased engagement in these groups during the campaign period. However, the campaign did not appear to increase completions for those at an increased risk of a heart attack or stroke and, therefore, may not be a good strategy to mitigate socio-economic inequalities relating to CVD risk.

Analysis of survey responses found participants reported a negative emotional response to HAT because their score did not equate to what they expected (i.e., felt concerned and discouraged and less so happy, satisfied and reassured). The findings were supported by follow-up interviews which suggested the emotional response to the result was influenced by prior risk perception. However, for many it served as a 'wake up' call. There is evidence that Heart Age is more emotionally impactful (9,30) than absolute risk which has led to concerns about its use due to overestimation of risk (19,21) or decreased perceived credibility (14,19,21,23) when it does not match prior risk perception. Questions about credibility of the test were also evident in the data reported here, largely due to limited knowledge about participants' own risk factors (i.e., blood pressure and cholesterol) and the level of information required to complete the test. This suggests that the level of information required by HAT and reported by the user to complete the test influences individuals' emotional reactions to the result and the perceived credibility of the test.

As with previous research (11–13), the majority of participants had a good understanding of the meaning of a higher Heart Age, and also reported at least some improvements to understanding of their CVD risk and were confident in their understanding and control of their CVD risk. But a minority of participants did not understand CVD event-free survival age as presented in HAT, which led to confusion about why their estimated Heart Age was higher than their chronological age. There is limited evidence about the significance of CVD event-

free survival age, yet poor understanding of the concept has been reported by both patients and practitioners (3). As with participant accounts reported here, it was perceived by patients as an estimate of life expectancy (3), suggesting greater clarity is needed when reporting CVD event-free survival age.

Following completion of HAT, participants reported intentions to and self-reported lifestyle changes including setting a goal to lose weight, being more active and eating more healthily. Participants also suggested they would or had already recommended the HAT to others, would be more likely to take up the offer of a preventative health check and would use the test again to check their heart health. There is increasing evidence that communication of Heart Age motivates individuals to make healthier lifestyle choices (8,9,14–18,21) and prompts lifestyle changes and clinical checks (15,21).

Engagement in behaviour change is complex and is said to be determined by three factors: capability, opportunity, and motivation (31). The majority of participants suggested their understanding had increased at least '*a little*' following completion of HAT and were confident in their understanding of their CVD risk (i.e., capability). COVID-19 restrictions were considered to be the main barrier to lifestyle change but participants suggested this would be temporary (i.e., opportunity) and were motivated to take-up healthy lifestyle behaviours following the completion of HAT (i.e., motivation). However, participants suggested they were already aware of factors that increased their risk of a heart attack or stroke, had engaged in some healthy behaviours prior to completing the test and were also motivated to reduce their risk due to other factors including support of family and friends and having a history of cardiovascular disease. Therefore, intentions to change behaviour and subsequent behaviour change reported in the evaluation cannot be solely attributed to the completion of HAT alone. Whilst the HAT is not a behaviour change intervention, it appeared to have a positive immediate impact for the majority of participants and longer-term outcomes should be promoted and explored.

6.1 Strengths and limitations

Strengths

- This is the first evaluation of the UK version of the HAT to include user experiences.
- The evaluation included three sources of data to cross-validate findings and participant experiences.
- The sample represents individuals from various age groups, ethnic backgrounds and deprivation levels; similar to a demographic that broadly resembles the population of England.
- The interview sample was purposively sampled to represent the typical profile of HAT users with over-representation of individuals from ethnic minority backgrounds compared to the population as a whole.
- The evaluation included a robust approach to qualitative analysis, including checks for consistency in coding between researchers.

Limitations

- The self-selecting sample introduces a degree of bias but is largely reflective of people likely to engage with pre-screening tests, such as HAT (i.e., ecologically valid). Selection bias may be greater in the interview sample, representing those who are more informed or positive about their health. However, both positive and negative experiences were reported by participants.
- Fewer older individuals participated in follow-up interviews, as to be representative of typical HAT users. These individuals are more likely to be at an increased risk of CVD which may impact on their perception of the test and future behaviour intentions.
- Trends highlighted in the HAT user data cannot be solely attributed to the national campaign; other factors may have impacted on users' intentions to complete the test. Further exploratory analyses of trends were not explored given the breadth of unmeasured potential confounders.
- Deprivation could not be defined for almost half of HAT users (48.8%), as the LSOA calculation could not be defined until September 2016 (robust information on deprivation is only available from 1st October 2017). This limits the conclusions that can be drawn from the HAT user data.
- A controlled study with pre- and post-test measures to explore the evaluation objectives would have provided a more robust design. However, this was not feasible within the given timescales.
- Whilst participants suggested intentions to change behaviour or actual behaviour change resulted from completion of the HAT, these outcomes cannot be attributed to the HAT alone due to their self-reported awareness of their CVD risk and lifestyle changes made prior to the HAT. Further research that seeks to explore how the immediate impact of the HAT can be extended is warranted.

6.2 Implications for practice

The evaluation of the HAT shows that individuals are interested to learn more about their heart health leading to a positive impact on understanding, confidence and intentions to change behaviour. The findings reported in this evaluation indicate that there are some benefits of using pre-screening tests such as the HAT, and highlight important implications:

- Exploration of trends in HAT user data suggested the national campaign led to increased completions across all demographic groups, particularly males, those aged 30-39 and 50-59, and living in less deprived areas (compared to following years). While completions decreased following conclusion of the campaign, engagement remained higher in the following month when compared to previous and following years where there was no campaign. This suggests that campaigns may lead to some increased engagement in groups typically underrepresented in take-up of preventative health checks (i.e., males, younger eligible adults and some ethnic minority groups), which remains for a short period following conclusion of the campaign. However, the campaign did not appear to increase completions for those at increased risk of a heart attack or stroke which may limit the impact of the test.
- Participants reported a negative emotional response to their estimated Heart Age (e.g., concerned, discouraged, shocked) which was largely influenced by whether the result

matched their prior risk perception. For the majority, the result served as a wake-up call but, for the minority, the credibility of estimated Heart Age was questioned and subsequently dismissed, as reported elsewhere (23). Adequate sign-posting to support should be more easily accessible and/or visible for those who are left feeling concerned or confused by their result and interested to understand their CVD risk further.

- Due to the level of information required by the test and missing risk-factor information (i.e., cholesterol and blood pressure), participants questioned the accuracy of their estimated Heart Age. It may be advisable to provide a link to information about how the test calculates an individuals' estimated Heart Age for those who wish to find out more about how Heart Age is calculated. There should also be more clear warnings about the accuracy of the result if risk-factor information is not available.
- The majority of participants suggested they had a good understanding of their HAT result following completion of the HAT which suggests that the test may be a good way to improve population understanding of CVD risk. However, presentation of CVD event-free survival should be removed to avoid user confusion and overestimation of risk.
- Participants reported a number of intentions to change or actual changes to their lifestyle following the completion of the HAT. This suggests that pre-screening tests may be a good way to encourage individuals to evaluate their lifestyle choices and consider changes to improve their health as a precursor to attending a preventative health check.
- Attendance for an NHS Health Check and intentions to arrange a blood pressure or cholesterol check following removal of COVID restrictions were also reported by participants. Pre-screening tests like the HAT may be a good way to encourage individuals, who do not regularly see their GP, to visit their practice to understand more about their heart health. However, campaigns for HAT may lead to potential increases in primary care demand (23), therefore additional planning may be required (e.g., outreach, community provision).
- Further work could explore the extent to which the beneficial effects of HAT could affect health inequalities (positively or negatively).

A systematic review of the effects of Heart Age for the purpose of risk communication is currently underway, with likely recommendations for how the concept should be presented to patients and users alike (32).

6.3 Potential changes to HAT

Several changes could be introduced to the HAT, based on findings outlined in this report, to improve user satisfaction, understanding and behaviour change intentions:

- Immediate removal of CVD event-free survival to avoid user confusion and overestimation of risk.
- Clearer warnings or acknowledgement about the accuracy of the result if risk-factor information (i.e., blood pressure and cholesterol) is not available.
- A link to or further information about how the test calculates an individuals' estimated Heart Age for those who would like further information about their CVD risk. This could also include an explanation of which risk factors led to a higher heart age to aid user understanding.

- Clearer signposting to support those concerned or confused by their result.
- Inclusion of other risk-factors (e.g., alcohol consumption, physical activity levels, years since quit smoking) as suggested by users or an explanation to help users understand why such factors are not included in the estimation of Heart Age.

6.4 Conclusion

An evaluation of the HAT showed participants elicited a negative emotional response to their estimated Heart Age when their score did not equate to what they expected, understood the meaning of a higher estimated Heart Age, reported at least some improvements to understanding of their CVD risk and felt more confident in their understanding and control of their CVD risk. Concerns were raised about the accuracy of the test, largely due to the absence of information for most individuals (i.e., BP, Cholesterol) and the limited information required to complete the HAT. Despite this, participants would or had already recommended the HAT to others, would be more likely to take up the offer of an NHS HC, would use the test again to check their heart health, and had made or intended to make changes to their lifestyle or were encouraged and motivated by the HAT to maintain lifestyle changes. Pre-screening tests such as the HAT, may be a good way to encourage individuals to evaluate their lifestyle choices and to increase intentions to change behaviour. However, a clearer explanation around the reasons why an individual's estimated Heart Age is older than their chronological age, signposting to support if concerned and the concept of CVD event-free survival age should be considered to improve satisfaction and avoid confusion.

Concepts, like Heart Age, are becoming increasingly familiar during the debate around risk and behaviour (33), therefore future research should seek to understand whether the immediate positive impact of pre-screening tests such as the HAT can be extended to encourage longer-term engagement in risk-reducing behaviour.

7. References

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Appendix 1. HAT Online Survey

Staffordshire University and Public Health England wish to understand users' experiences of the Heart Age Test. We would like to know more about users' experiences, the impact of the test and future behaviour intentions.

You can choose to participate in the evaluation in one of three ways:

- Through completion of an online survey (in which you can be entered into a prize draw to win up to £50 of retail vouchers (1st prize £50, 2nd prize £25)); or
- Through expressing your interest in participating in a telephone or online interview (As a thank you for your time, you would receive a £20 online retail voucher); or
- By completing both the online survey and expressing your interest in participating in a follow-up interview (you can be entered into the prize draw and would receive a £20 retail voucher as a thank you for participating in an interview).

Participation is entirely voluntary and you can choose not to participate at any time.

All data will remain confidential. You will have the option of adding details at the end should you be willing for us to follow-up with you at a later date. If you do this, your data will be stored separately from your personal information, keeping all information given confidential. Data will be stored securely for 10 years before being destroyed and will only be used by Staffordshire University Centre for Health and Development team conducting the evaluation. Data will be summarised and used anonymously in relevant publications about users' experiences of the tool. If you would like to receive a copy of the study when it is published, please indicate this at the end of the survey.

Further information about the evaluation can be obtained by contacting Victoria.Riley@staffs.ac.uk

Completion of the online survey signifies that you have consented to participate in the evaluation.

By clicking to continue, I agree that I am over 18 years of age and I consent to taking part in this evaluation.

Continue to survey (you will also have the option to provide your contact details to participate in the follow-up interview at the end of the survey).

Continue to provide details to be contacted about the interview only.

(If interview only)

We are interested in speaking to users of the test to understand their experience in more detail through a telephone or online interview. If you have not already done so, please open a separate browser and visit <https://www.nhs.uk/conditions/nhs-health-check/check-your-heart-age-tool/> to calculate your own estimated Heart Age. Once you have completed the test please click the below link to provide your contact details for further information about the interview.

Please provide your name and contact telephone number and/or email to receive further information about the telephone or online interview?

Name: _____

Contact telephone number/email: _____

SUBMIT

(If survey)

The purpose of this survey is to understand users' experiences of the Heart Age Test. If you have not already done so, please open a separate browser and visit <https://www.nhs.uk/conditions/nhs-health-check/check-your-heart-age-tool/> to calculate your own estimated Heart Age.

Please Note: once you have submitted your responses, data can be withdrawn within 1 week of completing the survey. Please make sure you read the section at the end of the survey with details of how to do this, and other information about who to contact if you needed.

Once you have completed the test please come back to the survey to complete the following questions:

Q1. What prompted you to use the Heart Age Test today?

- To participate in the evaluation of the test
- A healthcare professional (such as a GP or practice nurse) told me about the test
- A friend/family member told me about the test
- I found the test on a news website
- I read about the test in a newspaper or magazine
- I heard about the test on the TV or radio
- Something else, please give details: _____

Q2. How easy was the test to complete?

Very easy, Quite easy, Neither easy nor difficult, Quite difficult, Very difficult

Q3. What was most helpful about the test?

Q4. What was least helpful about the test?

Q5. If you would like to share, what was your estimated Heart Age?

Q6. Was your estimated Heart Age...

A lot higher than you expected, a little higher than you expected, as expected, a little lower than expected, a lot lower than expected, no expectation

Q7. How did you feel about your estimated Heart Age (visual analogue scale)?

- Happy – unhappy
- Satisfied – dissatisfied
- Concerned/worried – unconcerned/not worried
- Reassured – shocked
- Surprised - unsurprised
- Encouraged – discouraged

Q8. Which of the following did you understand from your Heart Age Test result?

- If my Heart Age Test result was higher than my actual age, I'm more likely to have a heart attack or stroke in the future
- If my Heart Age Test result was higher than my actual age, I'm less likely to have a heart attack or stroke in the future
- My Heart Age makes no difference to my chance of having a heart attack or stroke in the future. I was confused about what my Heart Age meant

Q9. Following completion of the Heart Age Test, on a scale of a lot – not at all, has it helped you to understand more about:

- your chance of having a heart attack or stroke
 - the factors which can increase your chance of having a heart attack or stroke
 - the factors that can reduce your chance of having a heart attack or stroke
 - the actions you could take to reduce your chance of having a heart attack or stroke
-

Q10. Did you know your blood pressure (within the last 3 months) to enter in to the Heart Age Test?

Yes, No, I'm not sure

Q11. If not, why?

- I cannot remember my blood pressure
- I haven't had my blood pressure checked within the last 3 months
- I don't want to share this information online
- Because of restrictions on movement (due to COVID-19) I have not been able to access a blood pressure test
- I do not want to go for a blood pressure test
- Other, please give details: _____

Q12. Did you know your cholesterol (within the last 3 months) to enter in to the Heart Age Test?

Yes, No, I'm not sure

Q13. If not, why?

- I cannot remember my cholesterol numbers
- I haven't had my cholesterol checked within the last 3 months
- I don't want to share this information online
- Because of restrictions on movement (due to COVID-19) I have not been able to access a cholesterol test
- I do not want to go for a cholesterol test
- Other, please give details: _____

Q14. Following completion of the Heart Age Test, on a scale of extremely – not at all, how confident are you that you...

- understand what risk factors increase your chance of having a heart attack or stroke
- understand how to change your chance of having a heart attack or stroke
- have control over your chance of having a heart attack or stroke
- can reduce your chance of having a heart attack or stroke
- have the skills or support that you need to reduce your chance of having a heart attack or stroke

Q15. Having found out your estimated Heart Age, do you intend to take any of the following actions:

- Get my blood pressure checked by a GP, nurse or pharmacist
- Check my blood pressure myself using a home blood pressure monitor

- Book an appointment to get my cholesterol levels checked
 - Set a goal to attempt to quit smoking
 - Set a goal to lose weight
 - Set a goal to eat more healthily
 - Set a goal to get more active (i.e., going for a walk a day)
 - Look for more information about heart health
 - I do not intend to take any action
 - Something else, please provide details:
-

Q16. (If no, undecided to Q15) Please tell us why you're not planning to take any action:

- The Heart Age Test said my heart is healthy for my age
 - I don't know what to do
 - I'm not confident that I could make a change
 - I don't want to do anything about it
 - I do not believe my estimated Heart Age is accurate
 - The Heart Age Test is not of concern to me currently
 - Other
-

Q17. Having completed the Heart Age Test, would you be more likely to take up the offer of a free heart health check offered by the NHS?

Yes, No, I don't know, Other

Q18. Would you consider using the Heart Age Test in future to check your heart health?

Definitely, probably, probably not, definitely not, undecided

Q19. If you have any other comments you would like to share about your experience of using the Heart Age Test, please add them below:

We would now like to ask you a few questions about yourself. Everything you tell us will be kept confidential.

Q1. What is your age?

30-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, 66-70, 71-75, 75+

Q2. What was your sex at birth?

Male, Female

Q3. Please enter your postcode (please note, we only need postcode to explore the types of areas that people who use the Heart Age Test live in)

Q4. When did you last speak with your GP (face-to-face or via telephone)?

In the last week, month, 3 months, 6 months, 12 months, >12 months

Q5. Do you have a long-standing illness, disability or disorder (for example, diabetes or asthma) that requires you to have regular medical care or check-ups?

Yes, No, I don't know, Prefer not to answer

Q6. (if yes to Q5) What condition(s) do you have?

Q7. Which of the following best describes your ethnic group?

White, Indian, Pakistani, Bangladeshi, Other Asian, Black Caribbean, Black African, Chinese, Other ethnic group, Prefer not to answer

Please create an ID using up to 6 numbers or letters that can be given by you should you wish to contact us about removing any of your data. This can be done up to 7 days after completing the survey.

We are interested in speaking to users of the test to understand their experience in more detail through a telephone or online interview. As a thank you for your time, you would receive a £20 online retail voucher. Would you be interested in participating in this part of the research and like to receive further information?

Yes; details are as follows: _____ No

Thank you for taking the time to complete the survey. Your responses will help us to understand users' experience of the Heart Age Test.

If you would like to be entered into the prize draw then please enter your email address or phone number. These will be kept confidential and only used for this purpose.

Once complete PLEASE CLICK THE RED ARROW TO SUBMIT RESPONSES

Name _____

Email address or phone number _____

Thank you very much for helping us with this research.

If you would like to receive a copy of the research once completed, please get in touch via the email address below.

If you later decide you wish to withdraw your data, please send your unique ID number to the email address below and we will delete any data you have provided.

Contact email address: Victoria.Riley@staffs.ac.uk

If taking part in this research has caused any concern, please contact your GP.

Appendix 2. HAT Evaluation Interview Topic Guide

Firstly, I would just like to thank you again for agreeing to participate in this interview. The interview will ask you a series of questions concerning your experience of completing the Heart Age Test. We would like to understand users' experiences, the impact of the test and future behaviour intentions. There are no right or wrong answers. The interview is anonymous and so all names will be replaced with a fake name. Therefore, you will not be identified in any written reports, though we will use quotations from the interviews in our reports, these will not be linked to any one person. Do you have any questions before we begin?

- ✓ **Ask permission to start the recording and obtain informed consent by asking for verbal consent (read through consent form), in addition to that obtained by email (ask to complete form or reply to email with 'I consent to all aspects of research').**
- ✓ **Remember to collect participants' age, gender, ethnicity, postcode and when they completed the HAT prior to interview questions.**

1. Experience of using the Heart Age Tool

a. What did you think about the Heart Age Test?

How did you complete the test? When?

Did you do it on your own, with a family member?

What aspects of the test did you interact with (i.e., read about your risk factors, follow links, download digital product, found out more about NHSHC)?

2. Understanding of Heart Age

a. How did you feel about your estimated Heart Age?

Was the result what you expected?

b. What was your understanding of your Heart Age Test result?

c. Did the Heart Age Test tell you anything you didn't already know about the things that can increase your chance of having a heart attack or stroke?

d. Did you explore how your Heart Age might change if you made some changes to the risk factors (i.e., blood pressure, cholesterol, smoking)?

If so, what main messages did you take away from this part of the test?

Did you understand the potential impact of [lowering blood pressure/cholesterol, stopping smoking etc] on your heart health?

e. How confident do you feel that you understand your chance of having a heart attack or stroke?

3. Future Behaviour Intentions

a. Has being told your estimated Heart Age affected your view of your heart health? Please explain your answer.

b. Can you remember if the test highlighted any factors that were putting your heart health at increased risk (i.e., smoking, increased weight, lack of exercise, high BP or cholesterol)?

If so, what were they?

c. Since receiving your estimated Heart Age, what changes (big or small) have you considered to reduce your chance of having a heart attack or stroke (*Engaged in risk-reducing behaviour (i.e., made changes to diet, increased exercise, reduced alcohol); spoken to/seen a health professional*)?

What else do you think you might need to help you make these changes?

Do you have adequate opportunity to make a change?

How confident are you that you could make a change?

From what you have learnt through the Heart Age Test, how motivated are you to make a change?

How motivated do you feel to reduce your chance of having a heart attack or stroke (from a scale of 1-10)?

d. Since receiving your estimated Heart Age, have you felt encouraged to re-engage or to continue to engage in healthy behaviour (i.e., made changes to diet, increased exercise)?

e. How confident do you feel that you could reduce your chance of having a heart attack or stroke? Why?

f. Would you recommend the Heart Age Test to your friends/family? Why?

4. NHS Health Check Programme

a. The Heart Age Test has been developed to encourage participation in the NHS Health Check programme. Having completed the test, how would you feel if you were invited to attend a preventative heart health check offered by the NHS?

Would you attend? Please explain your answer.

5. Conclusion

a. Is there anything else you would like to add or anything you think we would find interesting that we haven't already talked about?

Thank you for your time in taking part in our study. Your experience will help to inform our evaluation of the Heart Age Test. Voucher code will be sent to you via email.

Appendix 3. Survey data related to figures included in body of the report.

Respondents' emotional response to HAT result (data related to Figure 16)

	Happy	Satisfied	Concerned	Reassured	Surprised	Discouraged
Disagree (0-40)	38.9	33.8	30	33.3	18.1	34.4
Neither (40-60)	32.2	38.4	29.6	43.5	43.3	49.8
Agree (60-100)	28.9	27.8	40.4	23.2	38.6	15.8

Respondents' understanding of CVD risk following completion of the Heart Age Test (data related to Figure 17).

	Statement							
	Your chance of having a heart attack or stroke		Factors which can increase your chance of having a heart attack or stroke		Factors which can reduce your chance of having a heart attack or stroke		Actions you can take to reduce your chance of having a heart attack or stroke	
Response	N	%	N	%	N	%	N	%
Not at all	99	12.1	67	8.2	75	9.2	92	11.2
About the same as before	262	32.0	338	41.3	333	40.7	317	38.7
A little more	240	29.3	202	24.7	201	24.5	179	21.9
Somewhat more	130	15.9	127	15.5	127	15.5	140	17.1
A lot more	88	10.7	85	10.4	83	10.1	91	11.1

Respondents' confidence in understanding and control of CVD risk (data related to Figure 18).

	Statement			
	Actions you can take to reduce your chance of having a heart attack or stroke	Factors which can reduce your chance of having a heart attack or stroke	Factors which can increase your chance of having a heart attack or stroke	Your chance of having a heart attack or stroke
Response	%	%	%	%
Not at all	11.2	9.2	8.2	12.1
About the same as before	38.7	40.7	41.3	32.0
A little more	21.9	24.5	24.7	29.3
Somewhat more	17.1	15.5	15.5	15.9
A lot more	11.1	10.1	10.4	10.7