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Population health in a digital age

The use of digital technology to support and monitor health in Wales

Alisha R. Davies, Catherine A. Sharp, Lucia Homolova, Mark A. Bellis

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Foreword

We live in a digital age. Technology is transforming the way we live our lives, engage with each other, our communities and our health. Today, digital technology offers both opportunities and challenges to population health, and looking to the future will be at the heart of Public Health Wales' approach to improving health and wellbeing, helping us to predict, prevent and treat ill-health.

Yet, whilst the majority of us are increasingly going online, there are many who do not. Some of the underlying reasons for differences in engagement with digital technology include inequalities in internet connectivity, access to internet-enabled devices (e.g. mobile phones, computers), low levels of digital literacy and, for some, an underlying lack of interest and trust.

This raises an important question of equity in health in a digital age. How can we innovate through digital technology and transform population health, whilst leaving no-one behind? To address this we need to better understand who engages with digital technologies, and how do people use it to support their health. An understanding of social differences will help us to maximise the benefits of digital technology for health, whilst being mindful to prevent against inadvertently increasing health inequalities.

In Wales, we have carried out this first nationally representative survey exploring social patterns in engagement with digital technologies for health purposes. This is a timely report for us providing valuable insights to inform our work, and that of others, to support the digital transformation of health in Wales and further afield.

The findings also support the need for continued development of evidence-based digital health technologies, underpinned by behavioural insights, to understand why and how people engage and to help us understand the positive and negative impact on health.

Finally, a key challenge is the pace of change. Digital technology develops rapidly, and we need to be bold, embrace innovation, test and learn and be agile to maximise opportunities. **Digital technology has the potential to revolutionise health within a generation, but as the findings in this report demonstrate, that will only be possible if we understand and consider social patterns in access and engagement.**

Dr Tracey Cooper

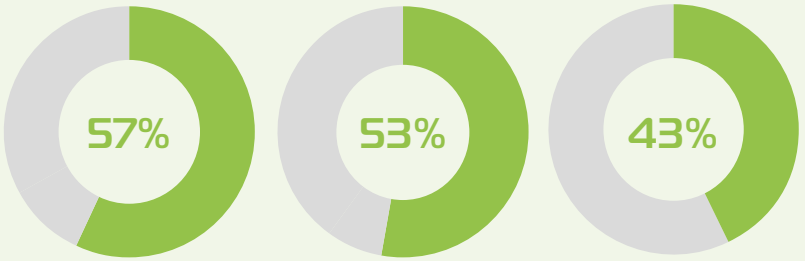
Chief Executive
Public Health Wales

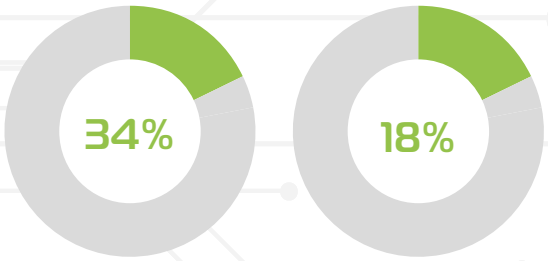
Use of digital technology for health in Wales

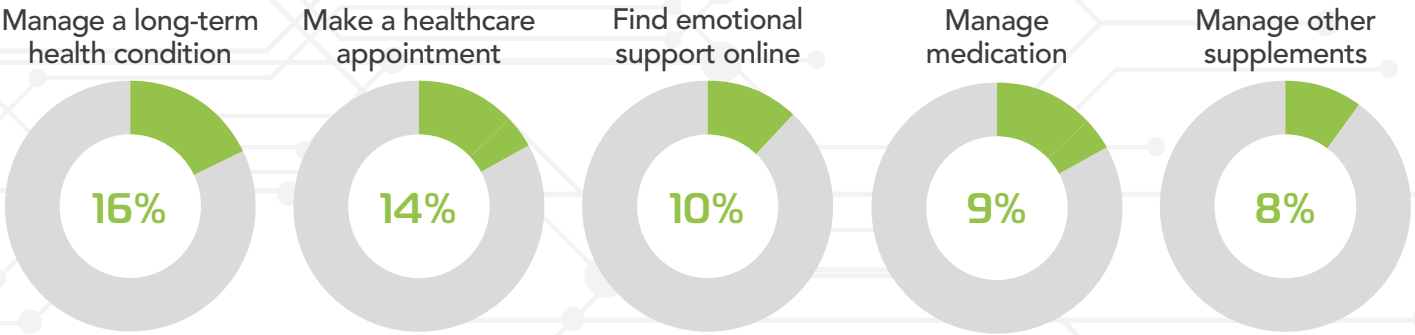
A nationally representative household survey asked 1,240 individuals aged 16+ years, resident in Wales, about how they use digital technology to support and monitor their health.

2 in 3 people[a] in Wales use digital technology to support their health through one or more of the following:

Find information about...







The proportion[b] using digital technology to support their health

By gender[c]

71% Women

65% Men

By age group[c]

87% 16-29 year olds

24% 70+ year olds

By deprivation quintile[c]

51% Most deprived

84% Least deprived

By general health[c]

68% High

72% Average

62% Low

By mental wellbeing[d]

69% Average

65% Low

By HHBs[c,e]

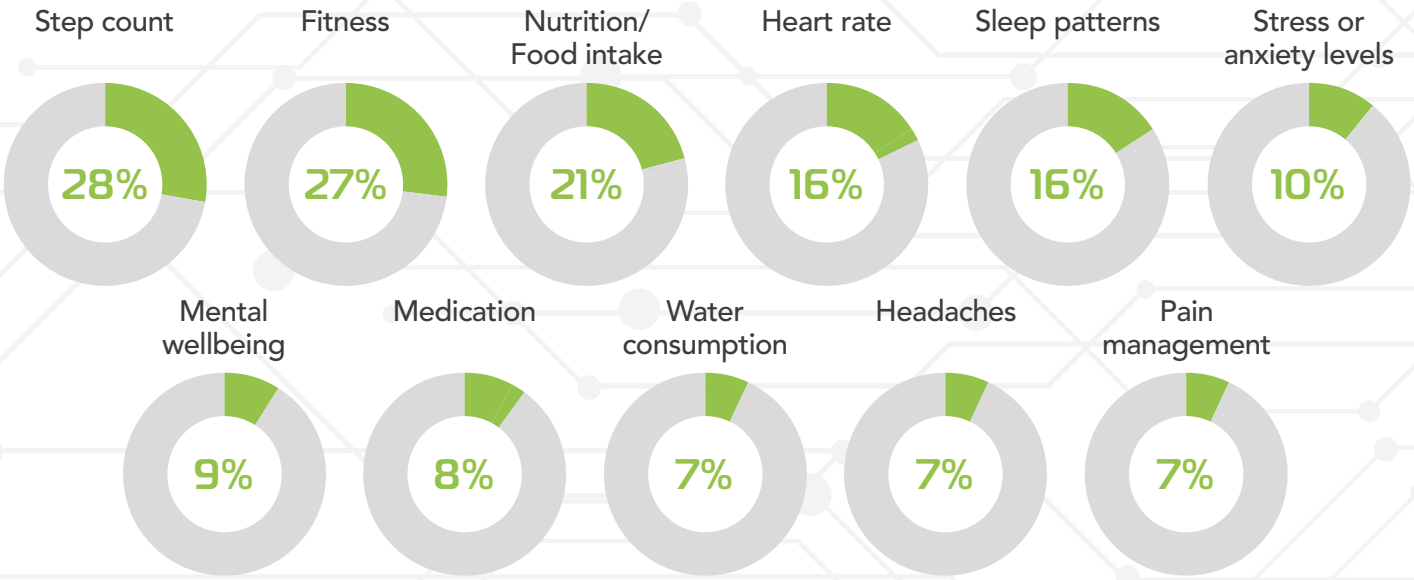
76% 0 HHBs

65% 1 HHB

57% 2-3 HHBs

[a]Weighted to the population Welsh Index of Multiple Deprivation 2015; [b]Proportion adjusted to the sample mean for age, gender and deprivation. See report for full details; [c]Differences between groups presented were found to be statistically significant ($p<0.05$); [d]Differences between groups presented were not found to be statistically significant ($p>0.05$); [e]HHB = Health-harming behaviour (smoking, binge drinking, physically inactive).

1 in 3 people[f] in Wales use digital technology to **monitor** their health through one or more of the following:



The proportion[g] using digital technology to **monitor** their health

By gender[h]

39% Women

20% Men

By age group[h]

52% 16-29 year olds

6% 70+ year olds

By deprivation quintile[h]

40% Most deprived

20% Least deprived

By general health[i]

29% High

31% Average

24% Low

By mental wellbeing[i]

30% Average

24% Low

By HHBs[h]

34% 0 HHBs

27% 1 HHB

19% 2-3 HHBs

More than 1 in 10 people in Wales do not have access to the internet at home

Access is lower amongst the following groups: older adults, those living in more deprived areas, and those with poorer health.

[f]Weighted to the population WIMD 2015; [g]Proportion adjusted to the sample mean for age, gender and deprivation. See report for full details; [h]Differences between groups presented were found to be statistically significant ($p<0.05$); [i]Differences between groups presented were not found to be statistically significant ($p>0.05$).

The Digital Technology and Health survey captured the opinions of 1,252 individuals (12 excluded from the analysis) aged 16+ years from across Wales through a nationally representative household survey. We are grateful to all those who voluntarily gave their time to participate. The information in this infographic is taken from the report: **Population Health in a digital age. The use of digital technology to support and monitor health in Wales.** Davies AR, Sharp CA, Homolova L, Bellis MA (2019) Public Health Wales & Bangor University. Available from: phw.nhs.wales/DigitalTechnologyandHealth

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Executive Summary

Background

- The advancement of personal technology, the internet and mobile applications (apps) has revolutionised the way many people live their lives, address their personal health needs and connect socially. Harnessing the potential of the digital age to support population health is of importance in Wales and internationally.

- Understanding the extent of engagement in health-related activities through digital technology is essential to inform the development of an equitable population health system in a digital era. **The aim of this study was to examine levels of engagement with digital technology (see Box A) to support and monitor health among people in Wales, across population groups and health status. This is the first nationally representative study in this area in Wales.**

- The Digital Technology and Health survey was undertaken in 2018 through face-to-face interviews with a national sample of 1,252 residents in Wales aged 16 years and above. The questionnaire covered the following topics: (i) access to the internet and digital technology, (ii) use of digital technology, (iii) perceptions of the impact of digital technology on health, (iv) health status and (v) demographics.

- Of the eligible households visited by an interviewer, 70% participated in the study. Analyses were completed on the **population sampled,** and then sub-analyses were limited to **digital technology users only** to understand the contribution of access and use of digital technology to differences across population groups (see Box A).

- This is the first report in a series of publications on population health in a digital age and focuses on the use of digital technology to support and monitor health.

Box A: Key definitions

Digital technology was defined as devices such as mobile phones, computers, tablets, personal assistant technology and wearable devices; devices which all connect to the internet.

Digital technology users were defined as individuals who actively use any form of digital technology in their lives at home, work or elsewhere for any purpose.

Population sampled included (a) ***digital technology users*** (i.e. individuals who went online at home, work or elsewhere for any purpose, and/or used wearable devices), and (b) ***non-digital technology users*** (i.e. individuals who did not have access to the internet at home or elsewhere, or use wearable devices).

Findings

Inequalities in access to the internet at home are evident in Wales (see Section 3.1)

In 2018, **13%[a] of people aged 16 years and above in Wales reported having no access to the internet at home**; this was comparable to a previous national survey in Wales.

Differences within the population sampled[b]

Internet access decreased with increasing age (41% of those aged 70+ years reported no internet access at home) **and increasing deprivation** (18% in the middle and 16% in the highest deprivation quintiles had no internet access at home).

Internet access decreased with decreasing health status. One in four of those with low general health (25% compared to 6% of those with high levels of general health), and one in five of those with low mental wellbeing (19% compared to 12% amongst those with average mental wellbeing reported no access to the internet at home.

Table A. Proportion of the population in Wales[a] (16+ years) who reported using digital technology to support their health through the following actions

	Health-related actions	%
	One or more health-related action (listed below)	**66.1**
Find information	Find information about general health	56.5
	Find information about health services	53.0
	Find information about activities to support your health	42.9
Manage health	Self-diagnose a health condition	33.6
	Manage a long-term health condition	15.9
	Manage medication	9.2
	Manage other supplements	8.0
Other	Track personal health goals	17.6
	Make a healthcare appointment	14.3
	Find emotional support online	9.6

Using digital technology to support health[a] (see Section 3.2)

Two thirds (66%) of the population in Wales aged 16+ years have used digital technology to support their health through one or more of the 10 actions explored. The most commonly reported actions were *finding information about general health* (57%), about *health services* (53%) and about *activities to support health* (43%; see Table A).

Differences within the population sampled[b] in the use of digital technology to support health through one or more of the health-related actions listed in Table A were:

A higher proportion of women (71% compared to 65% of men) have used digital technology to support health. When examining differences within specific actions, a significantly **higher proportion** of **women than men** used technology to: *find information about general health* (61% and 52%, respectively), *activities to support health* (44% and 36%, respectively); *to self-diagnose* (36% and 26%, respectively); *to manage a long-term health condition* (18% and 12%, respectively); and *to find emotional support* (9% and 3%, respectively; see Section 3.2.1).

The proportion who used digital technology to support health decreased with increasing age (from 87% of 16-29 year olds to 24% of 70+ year olds). However, across specific actions, a higher proportion of those in the middle age groups used digital technology to *manage a long-term condition* (40-59 year olds) and *self-diagnose* (30-39 year olds; see Section 3.2.1).

[a] Weighted to the national Welsh population using mid-2015 population estimates for Lower Super Output Areas (LSOAs) by gender, age group and deprivation quintile (Welsh Index of Multiple Deprivation; Welsh Government, 2015; ONS, 2016).

[b] Proportion adjusted to the sample mean for age, gender and deprivation, using a generalised linear model.

The proportion who used digital technology to support health decreased with increasing levels of deprivation (from 84% of those living in the least deprived area to 51% of those living in the most deprived area**;** see Section 3.2.1).

Those with average levels of general health (72%) were more likely to use digital technology to support health compared to those with low (62%) levels of general health. However, differences within specific actions were evident; a higher proportion of individuals with low general health used digital technology to *manage a long-term condition* (21% low; 15% average; 10% high) and to *manage medication* (13% low; 9% average; 5% high; see Section 3.2.2).

Overall, there was no difference in the proportion engaging in actions to support health by mental wellbeing (65% low; 69% average). However, **a higher proportion of individuals with low mental wellbeing used digital technology to *find emotional support*** (10%) than those with average mental wellbeing (5%; see Section 3.2.2).

The use of digital technology to support health decreased with increasing number of health-harming behaviours (HHBs; i.e. smoking, binge drinking and physical inactivity). Three quarters (76%) of individuals with no HHBs have used digital technology to support their health; this decreased to 65% and 57% amongst those with 1 HHB and 2-3 HHBs, respectively. A similar trend was evident across the following six actions: *finding information about general health, about activities to support health, and about health services; tracking health goals; managing other supplements;* and *making healthcare appointments* (see Section 3.2.2).

When limited to digital technology users only:

The proportion who reported engaging in any of the 10 actions increased from 68% to 76% (see Section 3.2, Table 2).

Using digital technology to monitor health[c] (see Section 3.3)

One third (34%) of the population in Wales aged 16 years and over have used digital technology to monitor one or more health-related activity. The most common activities were related to physical health such as *step counting* (28%), *fitness* (27%) and *nutritional intake (21%; see Table B)*. Ten percent reported monitoring *stress or anxiety levels*.

Differences within the population sampled[d] in the use of digital technology to monitor health through one or more of the health-related activities listed in Table B were:

A higher proportion of women (39% compared to 20% of men) have used digital technology to monitor their health. When examining differences within specific activities, a significantly higher proportion of women used digital technology to monitor *mental wellbeing, stress or anxiety levels, headaches and sleep patterns* (see Section 3.3.1).

Table B. Proportion of the population in Wales[c] (16+ years) who reported using digital technology to monitor their health through the following health-related activities

Health-related activity	%
One or more health-related activity (listed below)	**33.8**
Step count	27.5
Fitness i.e. running, cycling	26.9
Nutrition/food intake	20.8
Heart rate	16.4
Sleep patterns	15.5
Stress or anxiety levels	10.3
Mental wellbeing	9.4
Medication	8.4
Menstrual cycle	7.4
Water consumption	7.1
Headaches	6.8
Pain management	6.5

[c] Weighted to the national Welsh population using mid-2015 population estimates for Lower Super Output Areas (LSOAs) by gender, age group and deprivation quintile (Welsh Index of Multiple Deprivation; Welsh Government, 2015; ONS, 2016).

[d] Proportion adjusted to the sample mean for age, gender and deprivation, using a generalised linear model.

The proportion using digital technology to monitor health decreased with increasing age (from 52% of 16-29 year olds to 6% of 70+ year olds) **and increasing levels of deprivation** (from 40% of those living in the least deprived area to 20% of those living in the most deprived area: see Section 3.3.1).

There was no significant difference in the proportion monitoring one or more activity across the levels of general health (24% amongst low, 31% amongst average and 29% amongst high). However, compared to those with high levels of general health, a significantly higher proportion of those with average general health monitored their *stress or anxiety levels* (8% average, 4% high), *pain* (7% average, 4% high) and *headaches* (4% average, 2% high). Whereas a higher proportion of those with average (22%) general health have used digital technology to monitor *fitness* than those with low general health (15%; see Section 3.3.2).

There was no difference in the proportion monitoring one or more activity by mental wellbeing (24% amongst those with low mental wellbeing compared to 30% amongst those with average mental wellbeing). However, differences within specific actions were evident with a **higher proportion of those with low mental wellbeing having used digital technology to monitor *stress or anxiety* levels** (16% low; 5% average), ***mental wellbeing*** (12% low; 4% average) and ***headaches*** (7% low; 3% average; see Section 3.3.2).

The use of digital technology to monitor health decreased with an increasing number of HHBs. Approximately a third (34%) of individuals engaging in no HHBs have used digital technology to monitor their health; this decreased to 27% and 19% amongst those with 1 HHB and 2-3 HHBs, respectively. A similar trend was evident across the following five activities – *fitness, step count, nutritional intake, heart rate* and *sleep* (see Section 3.3.2).

When limited to digital technology users only:

The proportion who reported monitoring one or more health-related activity increased slightly from 29% to 33% (see Section 3.3.2, Table 3).

The proportion who reported monitoring activities increased across groups with greatest increases in the older age groups, and the most deprived quintiles, suggesting that some of the difference by age and deprivation is attributable to patterns of digital technology access and use (see Section 3.3.1).

Conclusions

This is the first population-based survey in Wales, exploring how people are using digital technology to support their health. The survey provides a valuable insight into inequalities in access to and engagement with technology to support health.

Digital inclusion and health (see Section 4.1)

Inequalities in access to the internet at home remain evident in Wales, with lower access in older populations, more deprived populations and those in poorer health. **Continued efforts through Digital Communities Wales and others to address digital inclusion is vital, but must extend beyond internet connectivity and skills. Understanding underlying motivators and barriers to engagement in health-related activities through digital technology, and addressing differences across population groups, will help ensure everyone can benefit from advances in digital health.**

Understanding and addressing differences in the use of digital technology to support health (see Sections 4.2 and 4.3)

Engaging with digital technology to support and monitor health in Wales is a common activity. Two thirds of the population have used digital technology to complete actions to support health, largely looking for health-related information (see Table A); and one third of the population have used digital technology to monitor health, largely related to physical health (see Table B). However, levels of engagement vary across population groups and are not solely attributable to differences in access to digital technology. **As health systems seek to empower populations to manage their health using digital technology, equity must be considered so those who have the greatest needs are not left behind. Such insights will help ensure digital technology, as an enabler of change, addresses rather than exacerbates existing inequalities in health.**

Harnessing digital technology to support mental wellbeing (see Section 4.4)

A higher proportion of those with low mental wellbeing used digital technology to find emotional support online, but the survey cannot ascertain if the association is beneficial or detrimental to mental wellbeing. **Further research is needed to better understand the links between digital technology and mental wellbeing, to capitalise on the potential benefits and protect against potential harms.**

Using digital technology to support health: realising the potential whilst mitigating against inequalities and harms (see Section 4.5)

This national survey has highlighted that 34% of the Welsh population have used technology to self-diagnose, 16% to manage a long-term condition and 9% to manage medications. These findings suggest that certain population groups are already engaged in using digital technology to manage health. The development of effective and inclusive digital innovation to empower populations to manage health through technology has the potential to benefit population health. **Digital innovation should be underpinned by evidence-based approaches and behavioural science to ensure users have access to reliable information delivered in a way which supports positive and sustainable action. Novel approaches to the evaluation of digital technology are also needed to ascertain the impact on outcomes to inform future developments in population health.**

In conclusion, improving our understanding of the digital divide and its potential impact on health inequalities is essential to the development of an equitable population health system in a digital age. Social differences in the use of digital technology, combined with digital health inequalities have the potential to widen health inequalities by disproportionally benefitting those already at an advantage. Potentially this risks leaving the social groups who experience poor health as the most likely to lack the skills and access to effectively use online health systems. These findings have important implications to maximise the opportunities for digital technology to support health, whilst ensuring that such activity does not exacerbate inequalities.

1. Introduction

The advancement of personal digital technology (e.g. mobile phones, wearable devices), the internet and mobile applications (apps) has revolutionised the way many people live their lives, address their personal health needs and connect socially. Harnessing the potential of this digital age to support population health is of importance across global health systems[1,2].

In Wales, the national strategy for Welsh Government, *Prosperity for All*[3], emphasises the importance of harnessing technology, and improving digital infrastructure and skills to support health, education and access to employment. This includes "*work(ing) with NHS Wales to provide people with digital ways of accessing health and care services and information, helping empower patients and carers to take greater control of their health and wellbeing*"[3]. In Welsh Government's plan for health and social care, *A Healthier Wales (2018),* digital technology is identified as a "*key enabler of transformational change*" to support populations to have more control and become active participants in their own health and wellbeing, enabled through social media and digital platforms[4].

Realising the potential of digital technology to underpin population health systems has been highlighted in Wales[4–6], across the UK[7–10] and internationally[1,11,12]. Digital technology has the potential to empower and support people to live healthier lives, including accessing health information and health services, supporting behaviour change, monitoring and diagnosing symptoms, managing long-term health conditions and making social connections[11,13]. However, these opportunities are not without challenges, due to uncertainties about the impact of digital technology on mental health[14–16] and the potential for those in poor health or with less financial resource to lack the access and skills needed to make effective use of technology to support health[17]. If left unaddressed, existing digital inequalities[6,18] alongside social inequalities in health, may further exacerbate health inequalities in a population health system delivered through technology - resulting in a digital health divide[19,20].

People are engaging in health-related activities through digital technology, seeking and sharing health-related information online, through social networking sites and health apps, and monitoring indicators of health such as number of steps taken. In Wales, 2017/18 estimates suggest that 94% of people use the internet daily[21], and approximately one in five (21%) people aged 16 years and above reported going online to look for information on health-related issues in the previous week[22], a figure similar to the UK overall (22%; 2017 figures)[23]. Yet, very little is known about how patterns of activity differ across population groups.

Understanding the extent of engagement in health-related activities through digital technology across socio-demographic groups is essential to inform the development of an equitable population health system in a digital age. This study seeks to address that gap and is the first nationally representative study exploring how people engage with digital technology to support and monitor their health in Wales. A secondary aim of the study is to explore the differences between the population sampled and digital technology users (see Box 1 for definition).

Box 1. Key definitions

Population sampled included (a) ***digital technology users*** (i.e. individuals who went online at home, work or elsewhere for any purpose, and/or used wearable devices), and (b) ***non-digital technology users*** (i.e. individuals who did not have access to the internet at home or elsewhere, or use wearable devices).

Digital technology users were defined as individuals who **actively use any form of digital technology** in their lives at home, work or elsewhere for any purpose.

Digital technology was defined as devices such as mobile phones, computers, tablets, personal assistant technology and wearable devices; **devices which all connect to the internet.**

2. Methods

This research was conducted as a survey administered through face-to-face interviews. A random probability sampling approach was used to identify a nationally representative household sample of 1,250 individuals aged 16 years and above, resident in Wales. One individual per household was randomly selected to complete a face-to-face questionnaire delivered by a professional market research company between April and June 2018 using Computer Assisted Personal Interviewing (CAPI). A total of 1,252 questionnaires were completed (69.5% compliance rate). After exclusion of those with missing demographic data the final sample size for analysis was 1,240. Full details of the methodology and sample demographics are provided in Appendix 1.

Measures used in the questionnaire

The questionnaire collated quantitative information on respondents on the following topics: access to the internet and digital technology (objective 1), use of digital technology (objective 2), perceptions of the impact of digital technology on health (objective 3), and health status and demographic information. This report presents the findings on how people use digital technology to support and monitor their health, taking into consideration their access to digital technology (objectives 1 and 2). The health-related actions and activities within the questionnaire were derived from common themes in the literature identified by the research team. Further details on the questions are provided in Appendix 1. Analysis on other variables will be presented in future publications.

Socio-demographic information (i.e. gender, age group, ethnicity, employment status and education) was recorded at interview and deprivation quintile (Welsh Index of Multiple Deprivation [WIMD][24]) and rurality[25] were assigned based on the residents' postcode (see Appendix 1). Information on general health, mental wellbeing and three health-harming behaviours (HHBs; smoking status, binge drinking frequency and physical activity levels) were collected using validated tools, where possible, or adapted from national surveys (see Box 2).

Data analysis

Estimates of the proportion of the Welsh population (aged 16 years and above) using digital technology to support and monitor their health were based on the final population sample weighted to reflect the socio-demographic distribution of the Welsh population.[e]

Unless specified, the population sample (N=1,240) was used in all analyses. The population sampled included (a) **digital technology users** (i.e. individuals who went online at home, work or elsewhere for any purpose, and/or used wearable devices; 85.4% [n=1,059], and (b) **non-digital technology users** (i.e. individuals who did not have access to the internet at home or elsewhere, or use wearable devices; 14.6% [n=181]; Box 1). Where specified, sub-analyses on the *digital technology users* were conducted, to understand the contribution of access and use of digital technology to differences across population groups.

To investigate inequalities in access to digital technology, and differences in use to support and monitor health, we tested the relationship between digital technology access or use and socio-demographics (i.e. age, gender, deprivation quintile[f]) and health status (i.e. self-reported general health, mental wellbeing, HHBs) using Chi-square, followed by binary logistic regression analysis adjusting for age, gender and deprivation. The adjusted proportion of individuals who reported each action and activity was determined using a generalised linear model, to calculate averages adjusted to the sample mean for age, gender and deprivation (using estimated marginal means and 95% confidence intervals).

[e] Using mid-2015 population estimates for Lower Super Output Areas (LSOAs) by gender, age group (ONS, 2016) and deprivation quintile (Welsh Index of Multiple Deprivation; Welsh Government, 2015).

[f] This report focused on differences across age, gender and deprivation quintiles. Differences across the other socio-demographic indicators collected will be considered in future publications.

Box 2. Single questions asked to obtain health-related information

Health	Question	Categories *(Responses)*
Binge drinking frequency*	In the last year how often have you had 6 or more alcoholic drinks in a single drinking occasion?	Regularly *(daily; weekly)* Occasionally *(monthly; less than monthly)* Never *(never; I don't drink at all)*
Smoking status^	In terms of smoking tobacco, which of the following best describes you?	Current *(I smoke daily; I smoke occasionally but not daily)* Ex-smoker *(I used to smoke but do not smoke at all now)* Never *(I have never smoked)*
Physical activity levels~	On how many days each week do you engage in at least 30 minutes physical activity (enough to make you out of breath and sweat)?	0-1 day *(never; 1 day or less)* 2-4 days *(2-4 days)* 5+ days *(5 days or more)*
Mental wellbeing‡	From the Short-Warwick and Edinburgh Mental-Wellbeing Score	Average Low *(Raw scores converted to metric score and categorised into* average *and low. Individuals who did not answer all 7 statements were not assigned a wellbeing score).*
Self-reported general health†	If 100 is the best state of health you could possibly imagine and 0 is the worst state of health you can imagine, how good or bad is your own health generally?	*Low (0-60; ≤ 25th percentile)* *Average (61-84; > 25th - <75thpercentile)* *High (85-100; ≥ 75thpercentile)* *(Response derived from 0-100 visual analogue scale)*

*Adapted from AUDIT-C tool https://www.gmmh.nhs.uk/download.cfm?doc=docm93jijm4n639.pdf&ver=1017;
^National Survey for Wales http://gov.wales/docs/caecd/research/2017/170420-national-survey-2017-18-questionnaire-en.pdf;
~Scottish Physical Activity Screening Questionnaire http://www.paha.org.uk/Resource/scottish-physical-activity-screening-question-scot-pasq;
‡Short Warwick and Edinburgh Mental Wellbeing Score conversation using https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/development/swemwbs/ categorised into average and low (calculated as the mean -1 standard deviation).
†Question adapted from the EQ-5D https://euroqol.org/wp-content/uploads/2016/09/EQ-5D-5L_UserGuide_2015.pdf categorised into three levels of health status.

3. Findings

3.1. Are there inequalities in access to the internet in Wales?

People were asked whether they have access to the internet at home, and how often they accessed the internet at home or elsewhere. Within the Welsh population, 87% had access to the internet at home. Of the 13% who had no access to the internet at home, 3% had access to the internet elsewhere. These figures are comparable to a previous national survey in Wales, which reported 15% of the population in Wales had no access to the internet at home (2017/18 figures)[21].

Inequalities in access to the internet at home by socio-demographics

Within the population sampled, the proportion with no access to the internet at home was greater amongst those of older age and those living in more deprived areas (middle and highest deprivation quintiles; Table 1, unadjusted data).

Table 1. Percentage of those with no internet access at home by demographics and health status (population sampled; unadjusted)

		%	X^2	p
All		13.1	-	-
Age group (years)	16-29	3.0		
	30-39	2.7		
	40-49	3.6		
	50-59	11.7		
	60-69	14.4		
	70+	40.6	209.448	< 0.001
Gender	Men	13.0		
	Women	13.7	0.149	0.700
Deprivation quintile	1 (Least)	10.1		
	2	10.5		
	3	18.1		
	4	12.4		
	5 (Most)	16.2	10.828	0.029
General health	High	6.1		
	Average	10.5		
	Low	25.3	63.812	< 0.001
Mental wellbeing	Average	12.4		
	Low	19.4	6.152	0.013
Health-harming behaviours (HHBs)	0	5.5		
	1	18.8		
	2-3	13.4	41.266	< 0.001

Inequalities in access to the internet at home by health status

Within the population sampled, a greater proportion of those with low general health, with low mental wellbeing, and those engaging in a higher number of HHBs (see Box 2) were found to have no access to the internet at home (see Table 1).

These associations remained when adjusting for socio-demographics (age, gender, deprivation; see Appendix 2).

3.2. Do people in Wales use digital technology to support their health?

Key message:

- **Two thirds (66%) of people in Wales aged 16+ years have used digital technology to support their health through at least one of 10 actions (see Table 2). The most common actions were finding information about *general health*, *health services* and *activities to support health*.**

Respondents were asked whether they have used digital technology to do any of the 10 health-related actions listed in Table 2. To understand levels of engagement with health-related actions across the population in Wales, figures from the population sampled were weighted to the national population demographics as described in the methods.

Overall, two thirds (66%) of the Welsh population have used digital technology to support their health (see Table 2). The most common actions involved finding health-related information (43 to 57%). Over a third of the Welsh population (34%) have used digital technology to self-diagnose a health condition, 16% to manage a long-term health condition and 9% to manage medication.

The proportion of the population sampled (adjusting for socio-demographics) undertaking the activities complimented the pattern of the Welsh population. When limited to the digital technology users only, the proportion who reported any action increased from 68% to 76% within the population sampled, and an increase was evident within each of the actions.

Table 2. Proportion of the population in Wales (16+ years), the population sampled and the digital technology users who support their health through the following health-related actions

	Health-related actions	Welsh population % (weighted*)	Population sampled n = 1,240 % (95% CI) (unweighted^)		Digital technology users only n = 1,059 % (95% CI) (unweighted^)	
	One or more of the health-related actions listed below	**66.1**	**68**	**(65-71)**	**76**	**(73-78)**
Find information	Find information about general health	56.5	57	(54-60)	64	61-67)
	Find information about health services	53.0	52	(49-55)	59	(55-62)
	Find information about activities to support your health	42.9	40	(37-43)	46	(42-49)
Manage health	Self-diagnose a health condition	33.6	31	(28-34)	36	(32-39)
	Manage a long-term health condition	15.9	15	(13-17)	18	(15-20)
	Manage medication	9.2	9	(7-11)	11	(9-13)
	Manage other supplements	8.0	8	(6-9)	9	(7-11)
Other	Track personal health goals	17.6	13	(11-15)	15	(12-18)
	Make a healthcare appointment	14.3	13	(11-15)	15	(13-18)
	Find emotional support online	9.6	6	(4-8)	7	(5-9)

*Weighted to the socio-demographic distribution of the Welsh population aged 16+ years;
^Unweighted but adjusted for age, gender and deprivation quintile within the sample. CI Confidence interval.

3.2.1 Differences by *socio-demographic characteristics*

Key messages:

- **A higher proportion of women, those of younger age and living in areas of lower levels of deprivation have used digital technology to support their health.**
- **The proportion using digital technology to *manage a long-term condition* was highest amongst those aged 40-49 and 50-59 years, and to *self-diagnose* a health condition was highest amongst 30-39 year olds.**

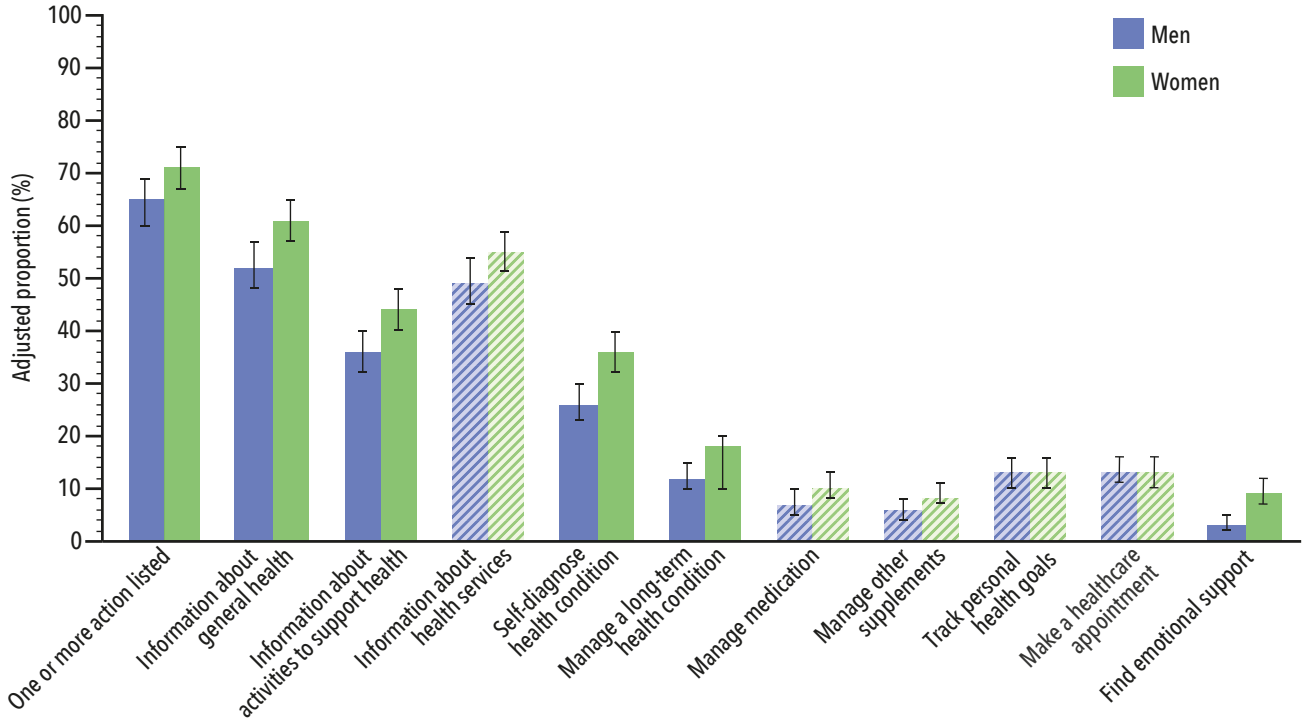
Within the population sampled and digital technology users, differences in the use of digital technology to support health by gender, age and deprivation quintile were explored (see Appendix 3-6).

By gender

Women consistently made more use of digital technology to support health than men, and this difference remained evident when limited to digital technology users (see Figure 1). A significantly higher proportion of women reported using digital technology *for one or more of the health-related actions* compared to men (71% and 65%, respectively, $p < 0.05$).

A significant difference between the genders was found for five out of 10 actions. Women were more likely than men to *find information about general health* (61% and 52%, respectively, $p < 0.05$); *find information about activities to support their health* (44% and 36%, respectively, $p < 0.05$); *manage a long-term health condition* (18% and 12%, respectively, $p < 0.05$); *self-diagnose a health condition* (36% and 26%, respectively, $p = 0.001$) and *find emotional support online* (9% and 3%, respectively, $p < 0.001$). The same proportion of women and men used digital technology to *track personal health goals* and *make a healthcare appointment* (both 13%, $p > 0.05$).

Figure 1. Adjusted proportion (95% confidence intervals) of the population sampled who used digital technology for each health-related action by gender (solid bars represent a significant difference between genders; patterned bars represent a non-significant difference [Appendix 5])



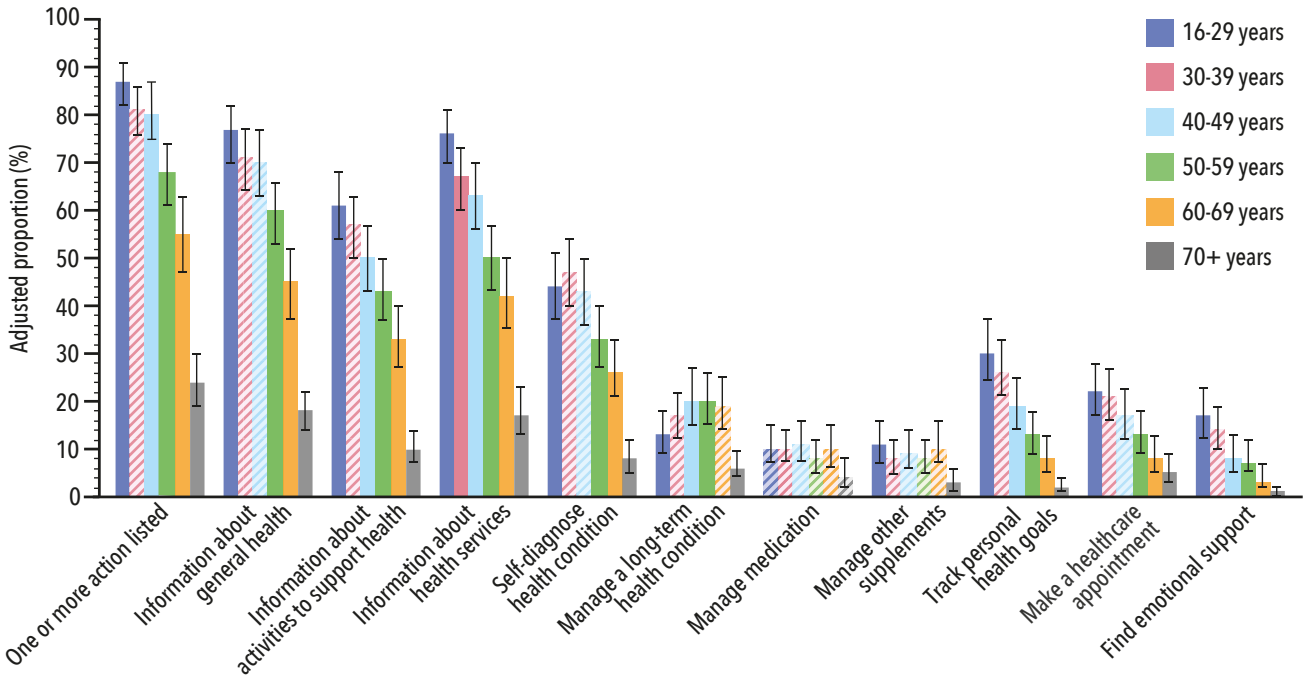
When limited to digital technology users, the proportion of women and men engaging in each of the actions increased. The proportion using digital technology for *any of the actions* increased from 71% to 79% in women and from 65% to 72% in men. The significant differences by gender across the individual actions remained, and a significantly higher proportion of women than men were *finding information about health services* was evident (62% and 55%, respectively, $p < 0.05$).

By age group

The proportion using digital technology to support health through one or more of the health-related actions decreased with increasing age from 87% of 16-29 year olds to 68% amongst 50-59 year olds, and 24% amongst 70+ year olds ($p < 0.001$ compared to 16-29 year olds; see Figure 2).

Lower levels of engagement with increasing age were found for each health-related action ($p < 0.05$, compared to 16 to 29 year olds) with the exception of *managing medication* ($p > 0.05$; Figure 2). Non-linear associations were found for (i) *managing a long-term health condition* where the proportion increased from 13% amongst 16-29 year olds, to 20% amongst 40-59 year olds and 19% amongst 60-69 year olds; and (ii) *self-diagnosing a health condition* which increased slightly then decreased across age groups (from 44% amongst 16-29 year olds; 47% amongst 30-39 year olds; to 8% amongst 70+ year olds).

Figure 2. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related action by age group (solid bars represent a significant difference to the reference category 16-29 year olds; patterned bars represent a non-significant difference [Appendix 5])



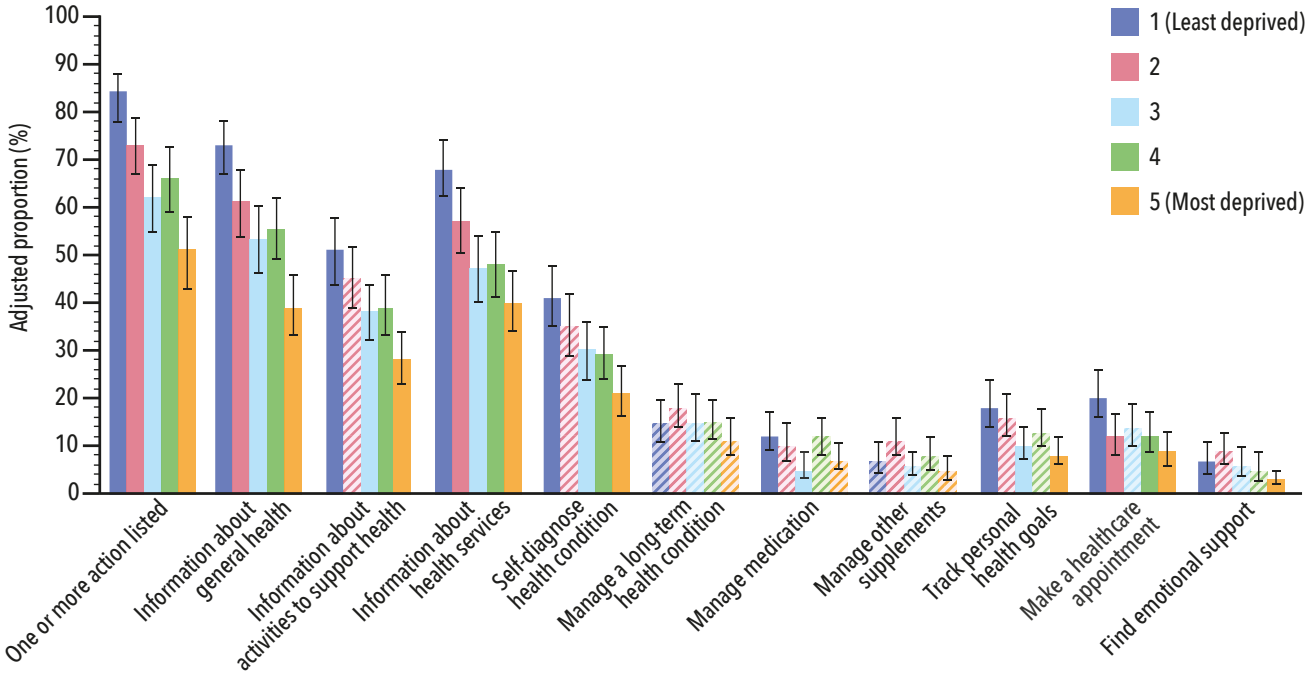
When limited to digital technology users, the proportion of 16-49 year olds engaging in the actions remained largely consistent with the population sampled. However, the use of digital technology to support health increased markedly in the older age groups (e.g. *any action listed* increased from 68% to 79% in 50-59 year olds, from 55% to 65% in 60-60 year olds and from 24% to 47% in 70+ year olds).

The overall trend of lower engagement with increasing age remained consistent across eight actions (with the exception of *managing medication* and *other supplements*). Amongst digital technology users, notable trends were (i) *managing a long-term health condition* (13% amongst 16-29 year olds, peaking at 24% amongst 50-59 year olds, and declining to 12% of 70+ year olds, $p < 0.05$); and (ii) *making a healthcare appointment* (from 22% in 16-29 year olds declining to 10% in 70+ year olds, $p < 0.05$).

By deprivation quintile

The use of digital technology for health-related actions decreased with increasing levels of deprivation. Of those living in the least deprived area, 84% reported *any action* compared to 51% of those living in the most deprived area (see Figure 3). Significant differences across deprivation quintiles were found in eight of the 10 actions. A greater proportion of those in the least deprived quintile have used digital technology to *find information about activities to support health* (51% least deprived, 28% most deprived, $p < 0.001$), to *self-diagnose a health condition* (41% least deprived, 21% most deprived, $p < 0.001$), and *make a healthcare appointment* (20% least deprived, 9-14% across the other deprivation quintiles; $p < 0.05$). Smaller, albeit significant, declines with increasing levels of deprivation were found for *tracking personal health goals* (18% least deprived, 8% most deprived, $p < 0.05$) and *finding emotional support online* (7% least deprived, 3% most deprived, $p < 0.05$). A significant difference was found for *managing medication* between the middle deprivation group and the least deprived (12% least deprived, 5% in the middle deprivation group, $p < 0.05$), but there was no overall trend.

Figure 3. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related action by deprivation quintile (solid bars represent a significant difference to the reference category deprivation quintile 1 [least deprived]; patterned bars represent a non-significant difference [Appendix 5])



When limited to digital technology users, the proportion engaging in the health-related actions increased across all deprivation quintiles, with greater increases in the most deprived quintile (from 51% to 63% amongst the most deprived compared to 84% to 87% amongst the least deprived). The overall trend, decreasing use with increasing deprivation, remained evident but the absolute difference in the proportion reporting each action between the most and least deprived decreased. This was evident across *finding information about general health, health services, and activities to support health; self-diagnose a health condition; tracking health goals*; *making a healthcare appointment*; and *finding emotional support online*. *Managing medication* was no longer significantly different by deprivation.

3.2.2 Differences by *health status*

Key messages:

- **A higher proportion of those with average levels of general health (72%) have used digital technology to support their health, compared to those with low (62%) general health (see Section 3.2.2). However, amongst those with low general health, a higher proportion have used digital technology to manage a long-term condition (21% low, 15% average, 10% high) and manage medication (13% low, 9% average, 5% high).**
- **A lower proportion of those with high general health (3%) have used digital technology to find emotional support online compared to those with average and low general health (both 7%; see Section 3.2.2).**
- **A higher proportion of individuals with low mental wellbeing reported using digital technology to find emotional support online (10% compared to 5% amongst those with average mental wellbeing; see Section 3.2.2).**
- **The use of digital technology to support health decreased with an increasing number of HHBs (smoking status, binge drinking frequency and physical inactivity; see Section 3.2.2).**

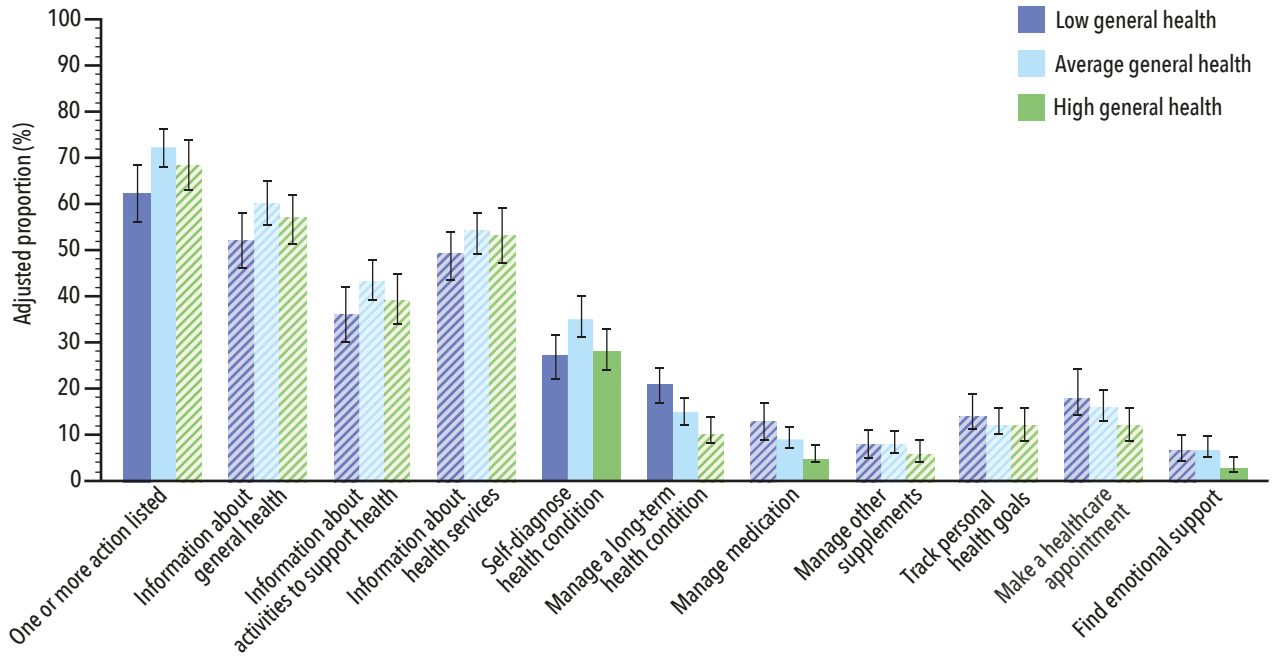
Within the population sampled and digital technology users, differences in the use of digital technology to support health by general health, mental wellbeing, and HHBs were explored (see Appendix 3-6 for more detail).

By general health

There was no consistent pattern for the different health-related actions across levels of general health (Figure 4). Compared to those who reported average general health, the proportion reporting *one or more actions* was lower amongst those with low general health (62%, compared to 72% amongst those with average health, $p < 0.05$).

Of the 10 individual actions (see Table 2), significant differences were found amongst four actions. The proportion who reported *managing a long-term health condition* or *managing medication* was greatest amongst those with low general health and decreased with increasing health (*managing a long-term health condition:* 21% low, 15% average, 10% high, $p < 0.001$; *managing medication:* 13% low, 9% average, 5% high, $p < 0.05$). *Self-diagnosing a health condition* was greatest amongst those with average general health (35%, compared to 27% low, 28% high general health, $p < 0.05$). The proportion *finding emotional support online* was lowest amongst those with high general health (3%; compared to average and low general health, both 7%, $p < 0.05$).

Figure 4. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related action by general health (solid bars represent a significant difference to the reference category average general health; patterned bars represent a non-significant difference [Appendix 5])

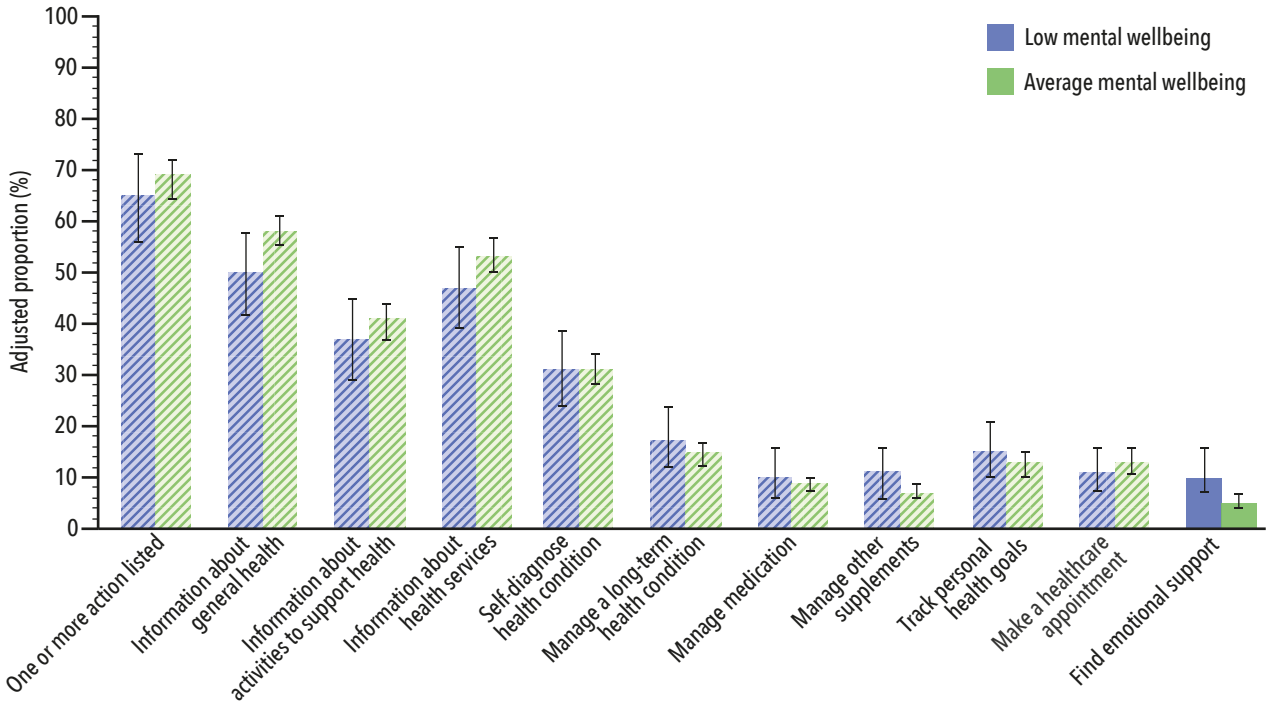


When limited to digital technology users, the proportion engaging in the health-related actions increased across all three levels of general health, with the greatest increase in those with low general health. The four significantly different actions within the population sampled remained significant. For example, the proportion of those in low general health using digital technology to *manage a long-term health condition* increased to 28% (from 21%) while those in average and high general health only increased by 1% each (16% and 11%, respectively, $p < 0.001$). This pattern was also seen for *managing medication* (low general health increased from 13% to 17%; average and high health increased by 2% to 11% and 7%, respectively, $p = 0.001$).

By mental wellbeing

There was no difference by mental wellbeing in the proportion engaging in one or more health-related actions to support their health (65% low; 69% average; see Figure 5). Only one significant difference was found across the actions; a higher proportion of individuals with low mental wellbeing reported using digital technology to *find emotional support online* (10% and 5%, respectively, $p < 0.05$). Although non-significant differences ($p > 0.05$) were found across the remaining nine statements, a greater proportion of individuals with average mental wellbeing found health-related information using digital technology compared to individuals with low mental wellbeing (e.g. *finding information about health*; 47% amongst those with average mental wellbeing, and 53% amongst those with low mental wellbeing).

Figure 5. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related action by mental wellbeing (solid bars represent a significant difference compared to the reference category average mental wellbeing, and patterned bars represent a non-significant difference [Appendix 5])



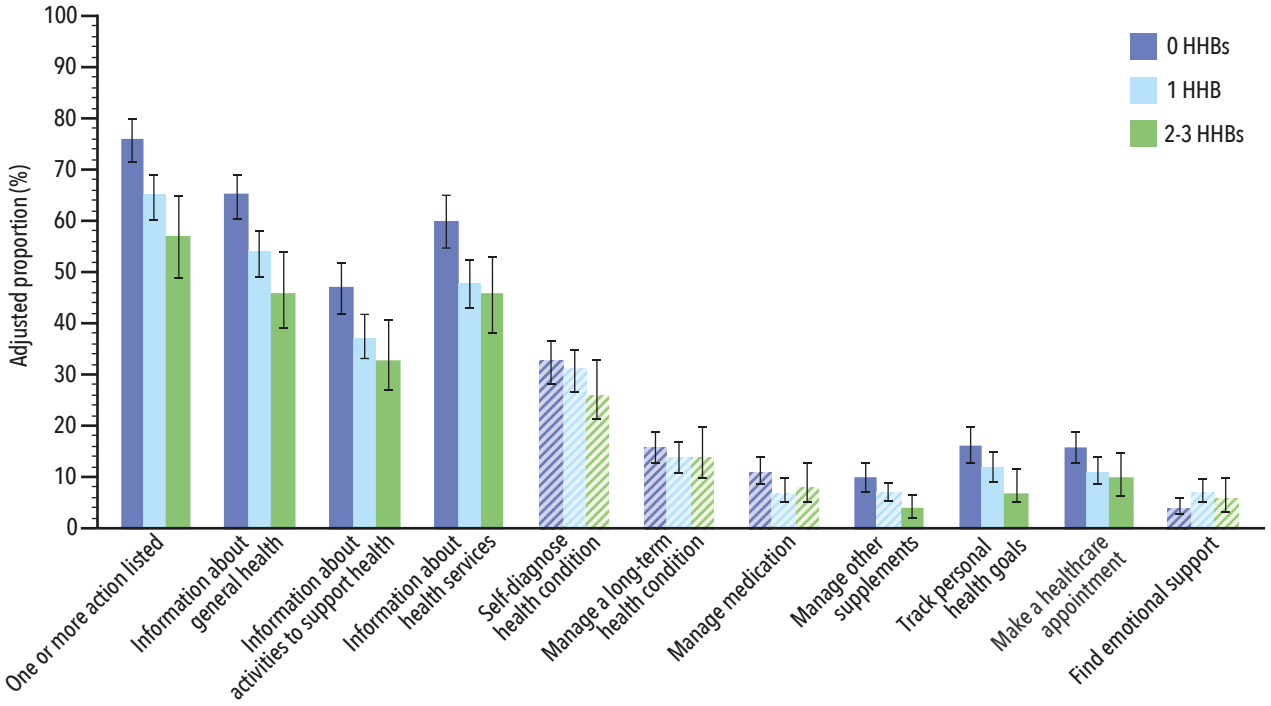
When limited to digital technology users, the pattern remained consistent, and the proportion who reported using digital technology to *find emotional support* online increased slightly (low mental wellbeing: from 10% to 13%, average mental wellbeing: from 5% to 6%, p = 0.001).

By health-harming behaviours (HHBs)

The use of digital technology for health-related actions decreased with an increasing number of HHBs, with 76% of those with no HHBs reported *any action listed*, compared to 65% with 1 HHB and 57% with 2-3 HHBs ($p < 0.001$; see Figure 6). A linear association was evident in six of the 10 health-related actions - the proportion who engaged in each action decreased with increasing number of HHBs (e.g. *finding information about general health* decreased from 65% amongst those with no HHBs to 46% amongst those with 2-3 HHBs, $p < 0.001$).

A higher proportion of those with no HHBs reported *tracking health goals* (16% compared to 12% with 1 HHB, and 7% with 2-3 HHBs, $p < 0.05$); and *making a healthcare appointment* (16% compared to 11% with 1 HHB, 10% with 2-3 HHBs, $p < 0.05$). A higher proportion of those with no HHBs was also evident for *managing other supplements* (e.g. vitamin tablets; 10%, compared to 7% with 1 HHB, 4% with 2-3 HHBs, $p < 0.05$), but no significant difference was found for *managing medication* ($p > 0.05$).

Figure 6. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related action by health-harming behaviours (HHBs); (solid bars represent a significant difference compared to the reference category no HHBs, patterned bars represent a non-significant difference [Appendix 5])



When limited to digital technology users, the proportion reporting each health-related action increased across the HHB groups, but the greatest increase was amongst those with 2-3 HHBs. The proportion using digital technology for *any action* increased from 76% to 80% amongst those with 0 HHBs, from 65% to 73% amongst those with 1 HHB and from 57% to 71% amongst those with 2-3 HHBs. The pattern across actions remained consistent, decreasing with increasing HHBs, but the differences were reduced across five actions and was no longer significant for *managing other supplements* or *making a healthcare appointment* ($p > 0.05$). The difference for *tracking personal health goals* remained consistent with the population sampled (0 HHBs: 19%, 1 HHB: 14%, 2-3 HHBs: 9%, $p < 0.05$).

3.3. Do people in Wales use digital technology to monitor their health?

Key messages:

- **One third (34%) of people in Wales aged 16+ years have used digital technology to monitor a health-related activity. The most common activities were related to physical health such as step counting (28%), fitness (27%) and nutritional intake (21%).**
- **Ten percent reported monitoring stress or anxiety levels using digital technology.**

Participants were asked if they have used digital technology to monitor 14 health-related activities (see Table 3). To understand levels of engagement with health-related activities across the whole population in Wales, figures from the population sampled were adjusted to the national population demographics.

Approximately one third (34%) of the Welsh population (aged 16+ years) use digital technology to monitor a health-related activity. The most common activities were related to physical health such as *step counting* (28%), *fitness* (27%) and *nutritional intake* (21%). Ten percent reported monitoring *stress or anxiety levels*.

The proportion of the population sampled (adjusting for socio-demographics) undertaking the activities complimented the pattern of the Welsh population. When limited to digital technology users, the proportion who reported any activity listed increased from 29% to 33% (see Table 3).

Table 3. Proportion of the population in Wales (16+ years), the adjusted population sampled and adjusted sample of digital technology users who reported monitoring their health through one or more of the following activities.

Health-related activities	Welsh population % (weighted*)	Population sampled n = 1,240 % (95% CI) (unweighted^)		Digital technology users only n = 1,059 % (95% CI) (unweighted^)	
One or more health-related activity listed below	**33.8**	**29**	**(26-32)**	**33**	**(30-36)**
Step count	27.5	22	(20-25)	26	(23-29)
Fitness i.e. running, cycling	26.9	20	(17-23)	23	(20-26)
Nutrition/food intake	20.8	17	(14-19)	19	(16-22)
Heart rate	16.4	13	(11-15)	15	(13-18)
Sleep patterns	15.5	11	(9-14)	13	(11-16)
Stress or anxiety levels	10.3	6	(5-8)	7	(6-10)
Mental wellbeing	9.4	5	(4-7)	6	(4-8)
Medication	8.4	7	(6-9)	9	(7-11)
Menstrual cycle (yours or your partners)~	7.4	~		~	
Water consumption	7.1	4	(3-6)	5	(3-7)
Headaches	6.8	3	(2-5)	4	(3-6)
Pain management	6.5	6	(5-8)	7	(5-9)
Alcohol consumption	4.7	~		~	
Smoking	3.2	~		~	

*Weighted to the socio-demographic distribution of the Welsh population aged 16+ years;
^Unweighted but adjusted for age, gender and deprivation quintile within the sample.
~Results not available; regression was not possible due to insufficient data in the model. CI Confidence interval.

Due to insufficient data, three of the health-related activities (menstrual cycle, alcohol consumption and smoking) have been excluded from the analyses hereafter. Conclusions drawn for monitoring water consumption, headaches and pain management should be interpreted with caution due to overall low numbers.

3.3.1 Differences by *socio-demographic characteristics*

Key message:

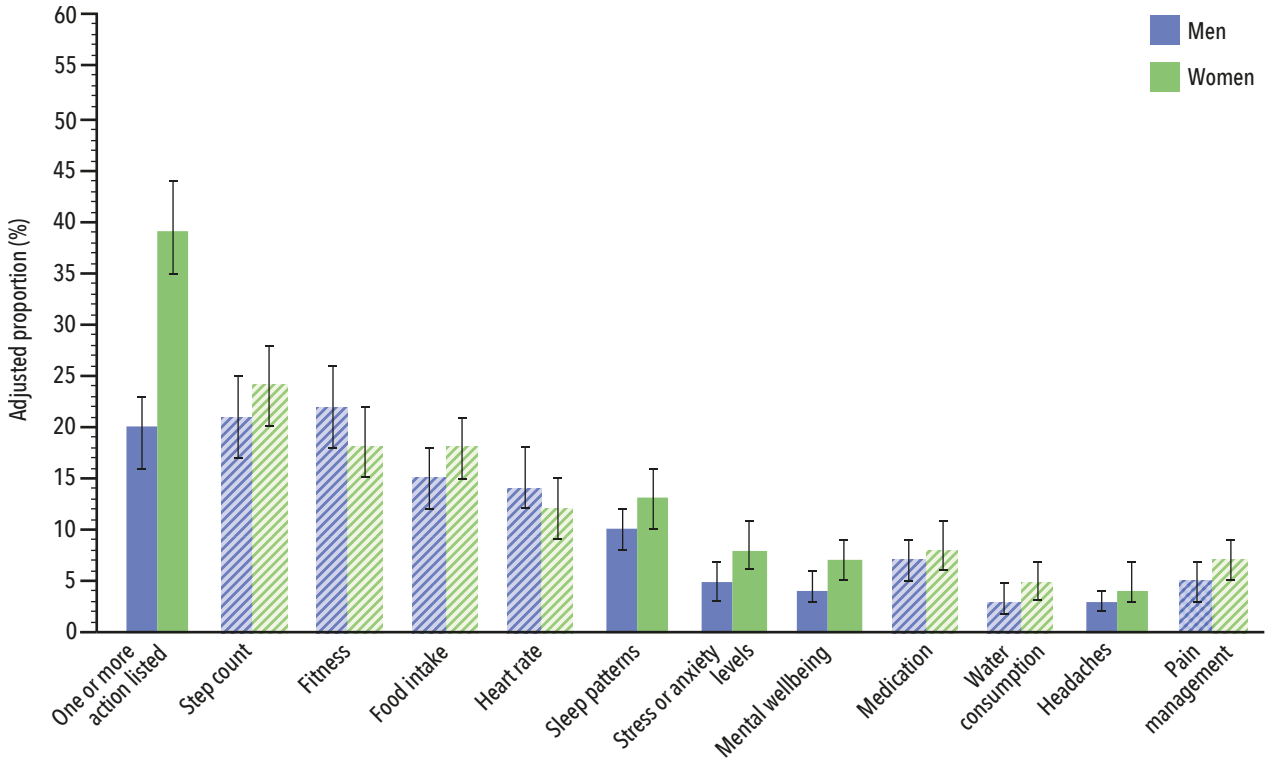
- **A higher proportion of women, those of younger age and those living in the least deprived areas have used digital technology to monitor their health. For example, a significantly higher proportion of women have used digital technology to monitor mental wellbeing, stress or anxiety levels, headaches and sleep patterns.**

Within the population sampled and digital technology users, differences in use of digital technology to monitor health by gender, age and deprivation quintile were explored (see Appendix 7-10).

By gender

A significantly higher proportion of women reported using digital technology for *any of the health-related activities* compared to men (39% and 20%, respectively, $p < 0.001$; see Figure 7). Although figures were low, a significant difference between the genders was found amongst four of the activities. Women were more likely than men to use digital technology to monitor their *mental wellbeing* (7% to 4%, respectively, $p < 0.05$), *stress or anxiety levels* (8% to 5% respectively, $p < 0.05$), *headaches* (4% to 3%, respectively, $p < 0.05$) and *sleep patterns* (13% to 10%, respectively, $p < 0.05$).

Figure 7. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by gender (solid bars represent a significant difference between genders and patterned bars represent a non-significant difference [Appendix 9])



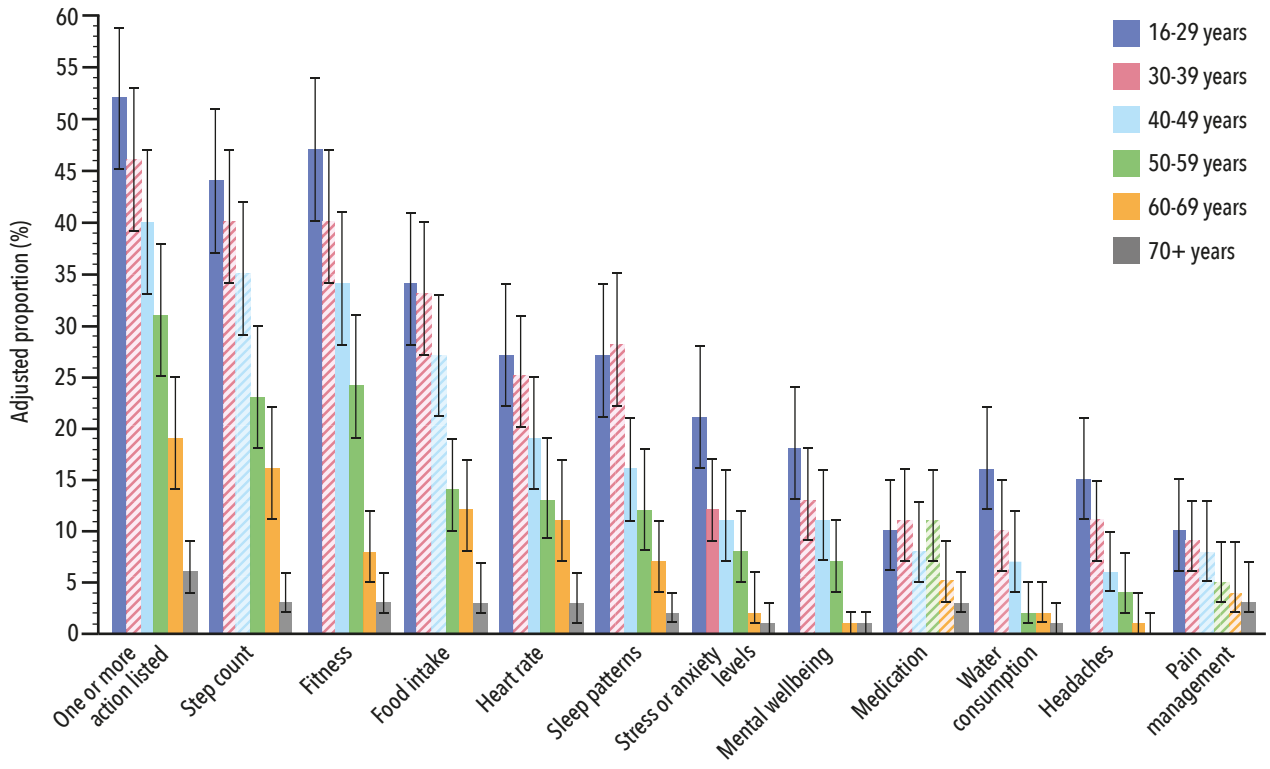
When limited to digital technology users, the proportion of women and men engaging in each activity increased. The proportion using digital technology for *any of the activities* increased from 39% to 45% in women and 20% to 23% in men. The significant differences by gender across the four activities remained (*monitoring sleep patterns, stress or anxiety, mental wellbeing* and *headaches).*

By age group

Across the population sampled, the proportion reporting each health-related activity decreased with increasing age (see Figure 8). Overall, 52% of 16-29 year olds reported *any activity* and this proportion declined steadily as age increased to 40% amongst 40-49 year olds and 6% amongst 70+ year olds ($p < 0.001$).

A negative association was evident in nearly all activities; decreasing engagement with increasing age (10 of 11 activities, $p < 0.05$). Monitoring pain management was the exception ($p > 0.05$). The greatest differences between the youngest and oldest groups was found for fitness (47% of 16-29 year olds compared to 8% of 60-69 year olds and 3% in 70+ year olds, $p < 0.001$). Younger groups were more likely to monitor their sleep patterns, with 27-28% of 16-39 year olds having reported the activity compared to 12% of 50-59 year olds ($p < 0.001$).

Figure 8. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by age group (solid bars represent a significant difference to the reference category 16-29 year olds; and patterned bars represent a non-significant difference [Appendix 9])



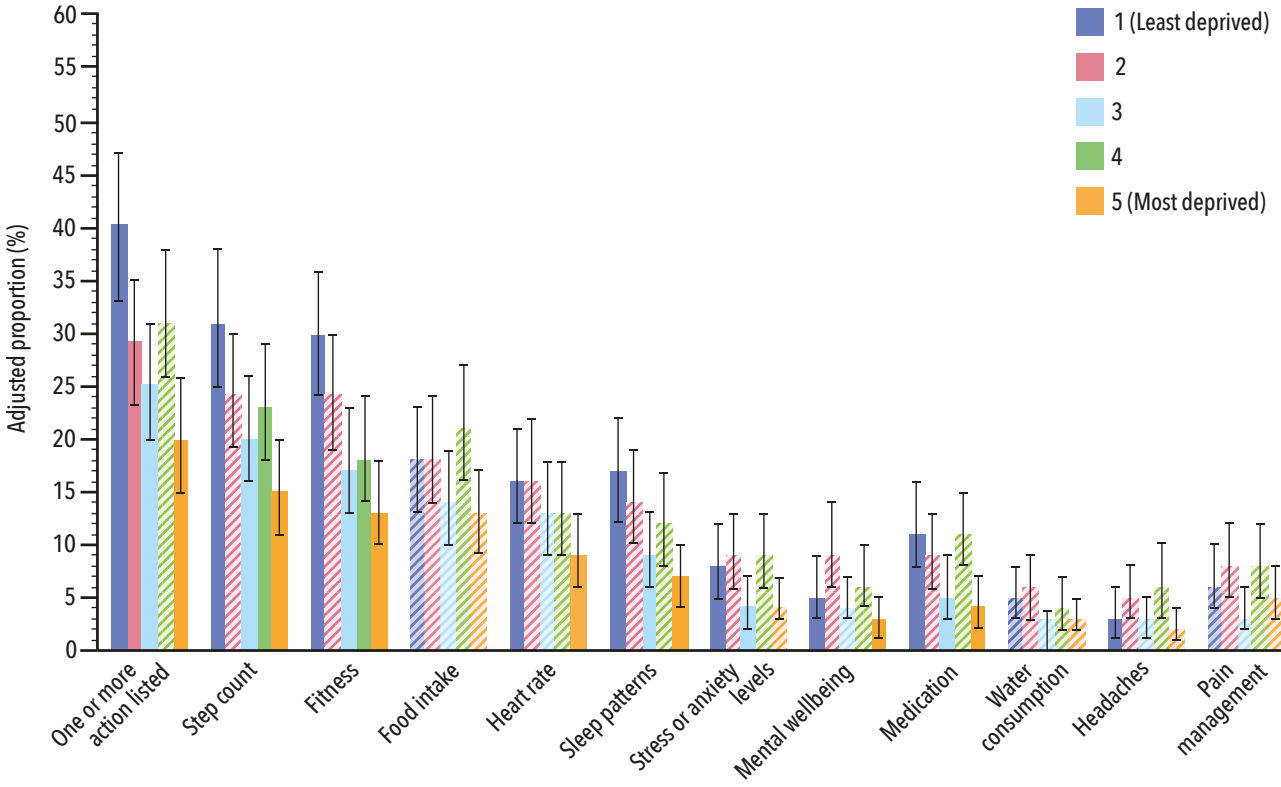
When limited to digital technology users, the proportion engaging in each activity remained largely consistent with the population sampled. The significant pattern of decreasing activity with increasing age remained across the activities, with the exception of using technology to *monitor medication* which became non-significant ($p > 0.05$).

By deprivation quintile

Using digital technology to monitor health-related activity decreased with increasing deprivation; 40% of those living in the least deprived area reported monitoring *any health-related activity* compared to 20% amongst the most deprived ($p < 0.001$; see Figure 9).

Significant differences by deprivation were found amongst seven of the 11 activities. Patterns of decreasing activity for increasing levels of deprivation were found for *fitness* (from 30% in least deprived to 13% in most deprived, $p < 0.001$), *step count* (31% and 15%, respectively, $p = 0.001$) and *sleep patterns* (17% and 7%, respectively, $p = 0.001$). A significant difference was found for monitoring *mental wellbeing* ($p < 0.05$), *stress or anxiety* levels ($p < 0.05$), *medication* ($p < 0.05$) and *headaches* ($p < 0.05$), however, the pattern across deprivation quintiles was less clear.

Figure 9. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by deprivation quintile (solid bars represent a significant difference compared to the reference category deprivation quintile 1 (least deprived); and patterned bars represent a non-significant difference [Appendix 9])



When limited to digital technology users, the proportion monitoring health-related activities increased slightly across all deprivation quintiles and the same pattern remained as for the population sampled. For example, those who reported using digital technology for one or more of the activities listed in the least deprived increased from 40% to 43%, and those in the most deprived from 20% to 25% ($p < 0.05$).

3.3.2 Differences by *health status*

Key messages:

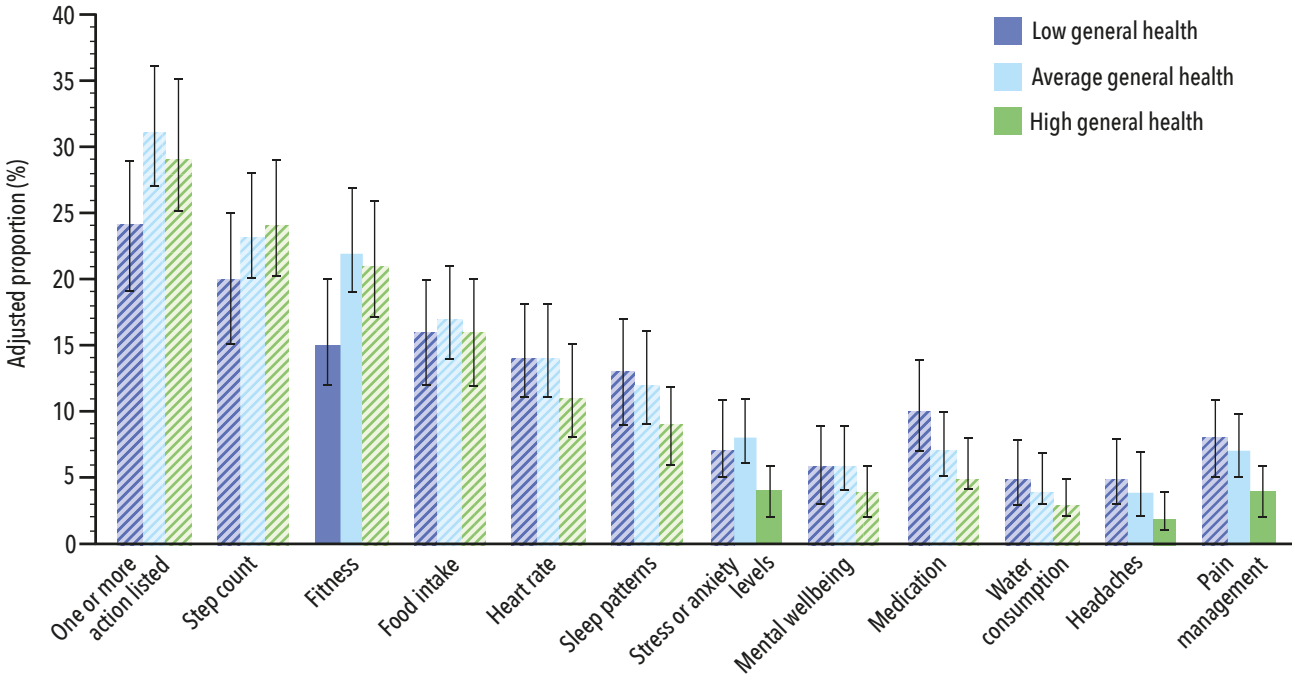
- **Overall, no significant difference was found in the proportion monitoring one or more activity across levels of general health (24% low, 31% average, 29% high). However, differences within individual activities were found:**
  - **Amongst those with average general health, a higher proportion have used digital technology to monitor stress or anxiety levels, pain management and headaches, compared to those with high general health.**
  - **A higher proportion of those with average general health have used digital technology to monitor fitness levels than those with low general health.**
- **A higher proportion of individuals with low mental wellbeing reported using digital technology to monitor stress or anxiety levels, mental wellbeing and headaches.**
- **The use of digital technology to monitor health-related activities decreased with increasing number of HHBs.**

Within the population sampled and digital technology users, differences in the use of digital technology to monitor health by general health, mental wellbeing, and HHBs were explored (see Appendix 7-10).

By general health

There was no significant difference found in the proportion monitoring *any health-related activity* across the levels of general health (24% low, 31% average, 29% high, $p > 0.05$; see Figure 10). Significant differences by general health were found within four of the 11 activities. The proportion using digital technology to monitor *fitness* was greater amongst people with average and high levels of general health (22% and 21%, respectively, compared to 15% with low levels of general health, $p < 0.05$). However, a greater proportion of people with average levels of general health monitored their *stress or anxiety levels* (8%, compared to 4% with high levels, $p < 0.05$), *headaches* (4%, compared to 2% with high levels, $p < 0.05$) and *pain management* (7%, compared to 4% with high levels, $p < 0.05$).

Figure 10. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by general health (solid bars represent a significant difference compared to reference category average levels of general health; patterned bars represent a non-significant difference [Appendix 9])

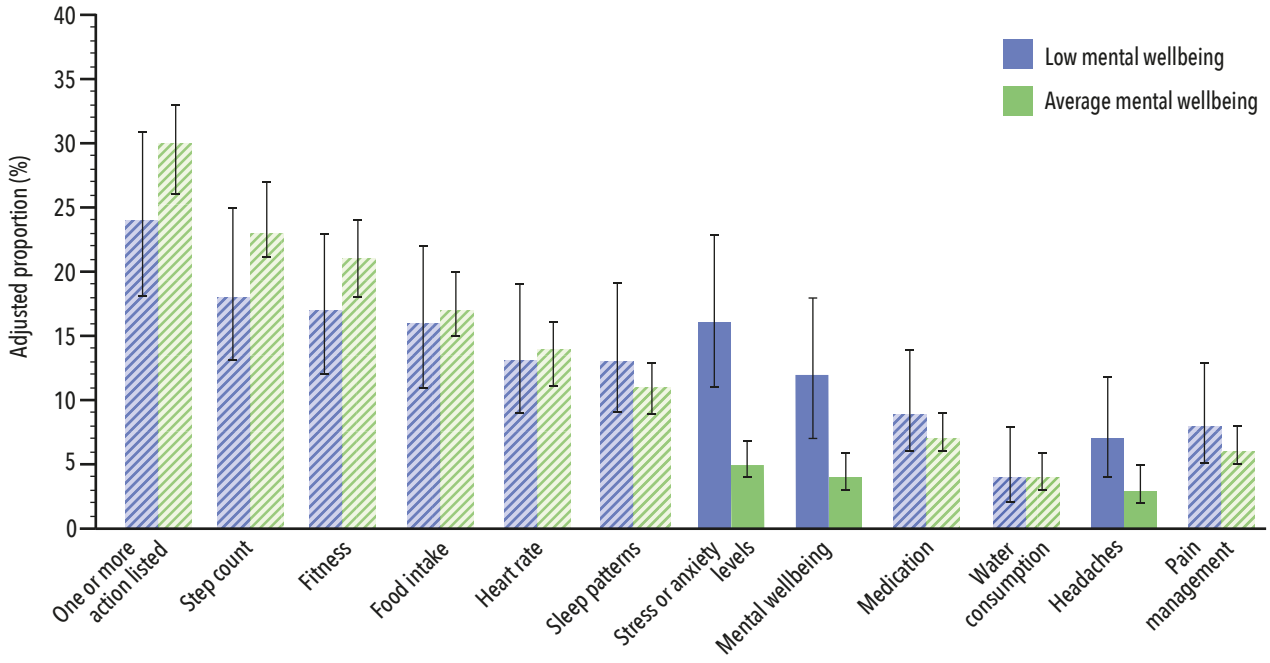


When limited to digital technology users, the proportion using digital technology to monitor health increased across all levels of general health, moreover, the differences in monitoring *fitness* became non-significant ($p > 0.05$). Significant differences remained amongst the remaining three activities (*stress or anxiety levels, headaches and pain management),* and additional significant differences were found for monitoring *sleep patterns* (16% low, 14% average, 10% high, $p < 0.05$); and *medication* (13% low, 9% average, 7% high, $p < 0.05$).

By mental wellbeing

Across the population sampled, no significant difference by mental wellbeing in monitoring *one or more health-related activity* was found (24% low mental wellbeing, 30% average mental wellbeing, $p > 0.05$; see Figure 11). A significantly higher proportion of those with low mental wellbeing was evident within three of the 11 different activities: *stress or anxiety levels* (16% low mental wellbeing, 5% average mental wellbeing, $p < 0.001$), *mental wellbeing* (12% and 4%, respectively, $p < 0.001$) and *headaches* (7% and 3%, respectively, $p = 0.001$).

Figure 11. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by mental wellbeing (solid bars represent a significant difference compared to average mental wellbeing, and patterned bars represent a non-significant difference [Appendix 9])

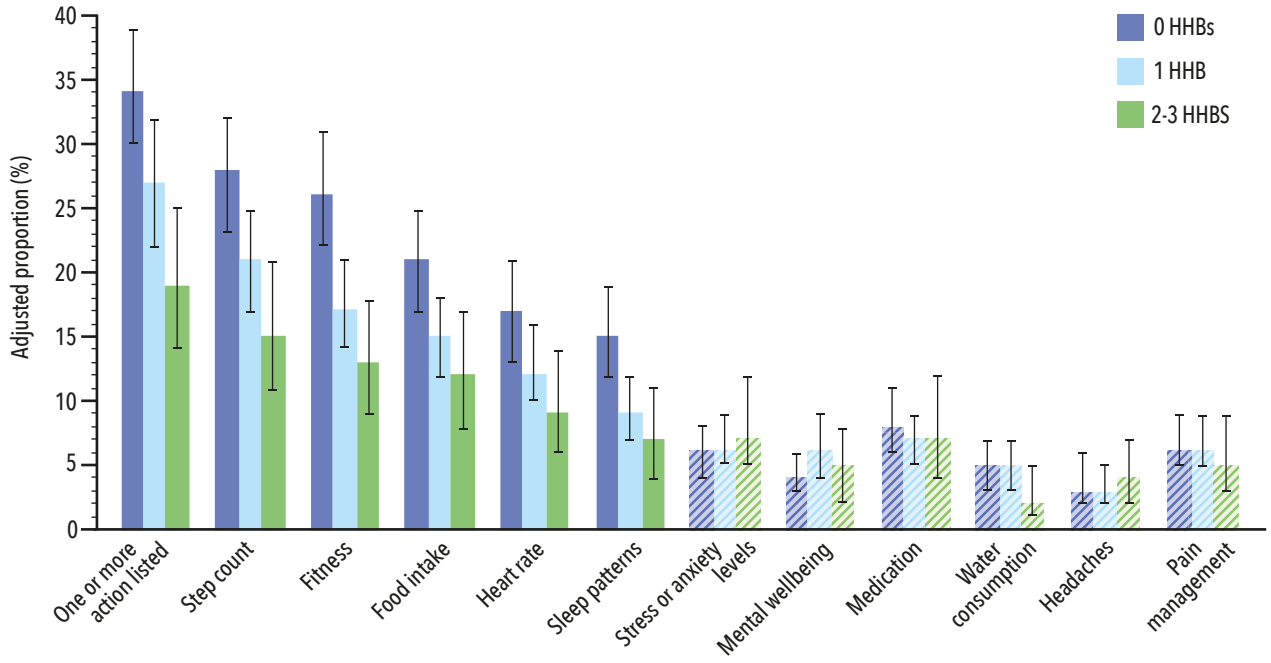


When limited to digital technology users, the proportion who reported using digital technology for all activities increased, and the four significant differences found in the population sampled remained. For example, for *stress or anxiety levels*, this increased from 16% to 20% in low mental wellbeing individuals and from 5% to 6% in average mental wellbeing.

By health-harming behaviours

Overall, the use of digital technology to monitor *any activity listed* decreased with increasing HHBs, from 34% amongst those with no HHBs, 27% in those with 1 HHB, to 19% in those with 2-3 HHBs ($p < 0.001$; Figure 12). Significant differences were found in five of the 12 activities; the proportion monitoring each activity decreased with increasing number of HHBs. For example, the proportion monitoring *fitness* decreased from 26% amongst no HHBs to 17% amongst 1 HHB, to 13% amongst 2-3 HHBs ($p < 0.001$); and monitoring *step count* from 28% in no HHBs, to 21% in 1 HHB to 15% in 2-3 HHBs ($p = 0.001$).

Figure 12. Adjusted proportion (95% confidence intervals) of the population sampled who use digital technology for each health-related activity by health-harming behaviours (HHBs) (solid bars represent a significant difference compared to no HHBs and patterned bars represent a non-significant difference [Appendix 9])



When limited to digital technology users, the proportion reporting each health-related activity increased across the HHB groups, with the greatest increase amongst those with 2-3 HHBs. The proportion using digital technology to monitor *one or more activity* increased from 34% to 38% among those with no HHBs, from 27% to 32% among those with 1 HHB and from 19% to 24% among those with 2-3 HHBs. The pattern across activities remained consistent, decreasing with increasing HHBs, and the significant difference across four actions remained evident.

4. Discussion

The national transformation programme for health and social care, *A Healthier Wales*, looks to digital technology as a "*key enabler of change*". Using data to improve our understanding of what influences behaviour and the choices we make, using social media and digital platforms to improve communication, and giving people greater control to become "*more active participants in their own health and wellbeing*"[4].

Understanding the extent of engagement in health-related activities through technology is essential to inform the development of an equitable population health system in a digital age, so all can benefit. This is the first nationally representative population survey for Wales examining levels of engagement with digital technology to support and monitor health in Wales, across population groups and health status. The findings provide valuable insights into how the population in Wales engage with digital technology to support and monitor their health to help inform the approach to a digitally enhanced population health system.

4.1. Digital inclusion and health

In our survey 13% of Welsh residents (aged 16+ years) do not have access to the internet at home, with those of older age and those living in more deprived areas less likely to have access. The proportion with internet access at home was also lower amongst those with low mental wellbeing or general health, irrespective of age, gender or deprivation. These findings are comparable to the National Survey for Wales which reported 15% of households do not have access to the internet and inequalities in access amongst similar socio-demographic and health status groups[21].

We found that inequalities in digital technology extended beyond access, as the proportion using technology to support health through different actions remained lower in older age groups, more deprived populations, and those with poorer health when limited to those who have access to digital technology. Other studies have shown that access is not the only barrier to engagement with the internet, but also a general lack of interest, and concerns about complexity, privacy and security[6,26].

Actions to address digital connectivity and inclusion are underway[27], including supporting skills, digital literacy and confidence[28]. Within Wales, addressing digital exclusion has been a priority since 2010 with the launch of the Digital Inclusion Framework, updated in 2016[18] and progress has been made towards making Wales a digitally inclusive society, for example, through Digital Communities Wales[6,29].

As systems in Wales and further afield[1,4,11] explore digital ways of delivering health services and empowering populations to support their health, ensuring that those who have the greatest need are able to benefit[17,29,30] is essential to prevent health inequalities being compounded by digital inequalities[31]. For example, harnessing digital technology to reach those most in need, including engagement amongst older populations, those with limiting long-standing illnesses[29], and vulnerable groups such as homeless populations[32]. **To ensure that all population groups benefit from future advances in digital technology to support health, digital inclusion programmes must extend beyond internet connectivity and skills, to understand and address motivators and barriers across society to engagement in health-related activities through digital technology.**

4.2. Understanding and addressing differences in the use of digital technology to support health-related actions

In this survey, we asked respondents if they used digital technology to carry out one or more of 10 health-related actions. These actions covered finding information to supporting and managing health, tracking health goals, finding emotional support online and booking healthcare appointments. We found that two thirds (66%) of people aged 16 years and above, use digital technology to support their health through one or more of the actions explored. The most common actions were to find information about general health (56%), health services (53%) and activities to support health (43%). These figures are comparable to other national surveys which estimated that 47% of individuals in Wales (16 years and above) go online for health information, with 21% reporting this activity in the last week[22]. UK figures suggest the proportion of internet users looking for health-related information online each week is increasing from 22% in 2016 to 27% in 2017[33].

In line with other studies, we found more women and younger age groups are using digital technology to support and monitor health, and lower use amongst the most deprived[33,34–38]. Overall, a higher proportion of those with average general health (72%) reported using digital technology to support health through one of the 10 actions explored, compared to 68% amongst those with low (68%) and high general health (62%), suggesting engagement with digital technology to support health is not limited to those in high self-reported health.

When we looked within *individual types of actions*, different patterns were found:

• Using digital technology to find information to support health

Using digital technology to find information to support health was the most common activity, supporting evidence from other studies. Yet promoting and providing information about health online may not reach those most in need due to lower engagement amongst older groups, more deprived and those with poorer health[39]. We found a lower proportion of those who reported HHBs (smoking, physical inactivity and binge drinking) used digital technology to find information about general health, activities to support health, and health services; track health goals; manage supplements; and make healthcare appointments. Overall, 76% of those with no HHBs reported using digital technology for any action to support their health, compared to 65% with 1 HHB and 57% with 2-3 HHBs. **Further research exploring the behavioural insights amongst populations with the greatest capacity to benefit has the potential to help tailor more effective digital solutions to support population health**[40].

• Using digital technology to find information about health services

This survey estimated that whilst 53% of the population in Wales use technology to find information about health services, only 14% reported making a healthcare appointment online (comparable to UK figures[41]). In Wales, 'My Health Online'[9] is a digital platform enabling citizens to book general practice appointments and request repeat prescriptions online. This platform has the potential to address missed appointments, as non-attendance is associated with younger patients (who are more likely to book an appointment using digital technology)[42] but the gains will be greater with wider engagement across the

[9] https://www.myhealthonline-inps2.wales.nhs.uk/welcome

population. **The potential for digital innovation has been recognised within Wales' digital programme for health and social care, including the need to invest in skills training for staff to support *all* citizens to engage with digital services[6].**

- **Using digital technology to manage a long-term condition and medication**

Amongst digital technology users, 18% and 11% reported using digital technology to manage a long-term condition and medication, respectively. Using digital technology to manage a long-term condition peaked in the age group 40-59 years, and to self-diagnose peaked amongst those aged 30-39 years. We also found a greater proportion of those with low levels of general health managing a long-term condition and medication, and lower use amongst those in good health. These patterns may reflect a higher prevalence of long-term health conditions amongst these populations. It is not known whether the engagement with digital technology will be sustained as this population ages, but there is the potential to build on these cohorts to empower patient populations to support their health through digital technology into older age.

Other studies have demonstrated how digital technology is empowering patients living with long-term conditions to support their health. For example, young individuals with mental health and diabetes routinely access health information online, for both professional and user driven content, as a means of gaining factual and experiential insights[36], becoming an 'informed patient'[43]. The majority of health-related internet searches by patients are for specific medical conditions, and typically aim to seek information to manage own healthcare independently for reassurance or due to dissatisfaction with the amount of details provided by their health professional[43].

As health systems seek to empower populations through digital technology to manage their health through finding information to support health, equity must be considered, so those who have the greatest needs are not left behind. Such insights will ensure digital technology is an enabler of change addresses rather than exacerbates existing inequalities in health.

4.3. Understanding and addressing differences in the use of digital technology to monitor health-related activities

In this survey, we asked respondents if they used digital technology to monitor one or more of 14 health-related actions. After adjusting to the Welsh population, we found one third (34%) of people aged 16+ years reported using digital technology to regularly (at least once a week) monitor one or more health-related activity. The most common activities were related to physical health, such as *step counting* (28%), *fitness* (27%) and *nutritional intake* (21%), and may reflect more accessible technology to monitor these activities.

Given the wealth of personal health-related activity data, the potential to use this data to support health system innovation and development has been recognised, but there are many considerations to address before the potential is realised including information governance, ethics, data ownership challenges and public trust[44,45]. The under-representativeness of certain population subgroups (e.g. men, older age groups, those living in more deprived areas, and those with poorer

health) will limit the potential for such data to provide information to address inequalities.

Within the health groups, two groups were evident. Those with good health (i.e. average or high general health, or with no HHBs) were monitoring *fitness, step count, nutrition/food intake, heart rate* and *sleep*; and those in poorer health (i.e. lower levels of general health, low mental wellbeing) were monitoring *stress or anxiety levels*, *sleep, medication, and mental wellbeing*. However, the impact of monitoring these indicators on an individual's health and behaviours is not clear. **Further understanding of the theoretical approaches underpinning digital intervention[46,47], drawing from behavioural science[48], and evaluating the impact on outcomes[13,49] is needed to help inform and develop digital technology to positively impact health.**

4.4. Harnessing digital technology to support mental health

Amongst digital technology users 7% reported finding emotional support online. A greater proportion of those with low mental wellbeing reported finding emotional support online (13% compared to 6% amongst those with average mental wellbeing), and a greater proportion reported monitoring *mental wellbeing*, *stress or anxiety*. We also found activities related to mental wellbeing to be more common in women, building on other findings suggesting women are more likely to use the internet to access social support[17]. However, in this cross-sectional study we are not able to explore if the association between emotional support and mental wellbeing is beneficial, whereas recent reports have highlighted the risks of digital technology, in particular social media, to mental health[14,50]. **Further research is needed to better understand the links between digital technology and mental wellbeing, to capitalise on the potential benefits and protect against the harms.**

4.5. Using digital technology to support health: realising the potential whilst mitigating against inequalities and harms

This national survey has highlighted that two thirds of the population in Wales are engaging with technology to support health and one third to monitor their health. The activities are largely related to finding information about health and tracking fitness, but also using technology to self-diagnose (35%), manage a long-term condition (16%) and manage medication (9%).

Realising the potential for digital technology as a key enabler of change, whilst minimising the risks of widening inequalities is essential. Benefits reported from other studies include access to information 24/7, anonymity for sensitive health conditions, finding and connecting with people with similar health conditions, sharing data with health care professionals, and more personalised support across different populations[40,51,52]. However, there is also recognition of the need to support people to prevent them from acting on misinformation, especially on unregulated and user-generated platforms[53]. A UK content analysis study of a Facebook diabetes patient group reported that 26% of posts related to commercial advertisement of health-related products, and a lack of awareness amongst some patients about unsolicited advice and claims[54]. There is also a risk that the lack of scientific validity of some apps is capable of causing harm[40,47,52,55,56]. Concerns over efficacy, safety, and the lack of evidence-base are common reasons why NHS doctors are hesitant in advising patients to use specific apps[57]. Despite this, studies in the United States have shown a high level of trust in the accuracy and safety of apps by the general public[37]. User ratings tend to be based on the ease of use rather than scientific validity[58], and the most popular apps can be those with the weakest adherence to the evidence-base (e.g. for smoking cessation[59]). There is also a lack of clarity amongst scientists on the underpinning theories of information retrieval, communication, decision-making, behavioural science or adherence to the evidence-base, and evidence to support effectiveness or cost-effectiveness[44]. To support strengthening the evidence-

base for digital technology and health the World Health Organization (WHO) has developed an evaluation framework for digital health interventions[h].

Digital health interventions have the potential to provide a cost-effective, scalable tool to support health and wellbeing but at present, there are real challenges including inequalities in access and engagement across population groups as demonstrated in this study.

4.6. Limitations of this study

As in any population survey, the accuracy of the estimates provided will reflect the representativeness of the population surveyed and the validity of the approach used. Participants were able to opt-out of the survey, either in advance or on the doorstep. Those who do not use digital technology may have felt that the survey would have been irrelevant for them, and the estimates of internet use presented here may over-estimate population levels, but our figures for no access to the internet at home are comparable with the National Survey for Wales (13% in this survey compared to 15% [2017/18 figures][21]). In our study sample there was a slightly higher proportion of women and older age groups compared to the population of Wales and we have adjusted for this difference in the estimates provided.

The survey relied on participants self-reporting answers to the interviewer, who then entered the responses into a CAPI device. Where possible, we used validated measures to collect responses. However, some of the questions were unique to this survey and have not been validated. Some questions were more sensitive than others, and participants may have had concerns about sharing their answers with the interviewer, potentially resulting in a response bias. An extensive list of current and emerging activities which could be monitored were included in the survey, but as a result of small numbers in some of the health-related activities, some variables were excluded and for others conclusions must be interpreted with due caution (e.g. pain management, headaches and water consumption; see Section 3.4).

During the survey period, the General Data Protection Regulations (GDPR) was implemented. As a result, there was an increased awareness of the importance of secure handling of personal data. Applying this regulation, the interviewers reminded participants that they did not have to share personal information which may have reduced the willingness of participants to disclose socio-demographic information.

[h] World Health Organization (2016) and others (MRC) frameworks for evaluation of digital health interventions e.g. http://www.who.int/reproductivehealth/publications/mhealth/digital-health-interventions/en/

4.7. Conclusion

Improving our understanding of the digital divide and its potential impact on health inequalities is essential to the development of an equitable population health system in a digital age, to ensure that those who have the greatest need also have the capacity to benefit. Social differences in the use of technology, combined with digital health inequalities have the potential to widen health inequalities by disproportionally benefitting those already at an advantage. Potentially this risks leaving the population groups who experience poor health as the most likely to also lack the skills and access to effectively use health systems online. These findings have important implications to maximise the opportunities for digital technology to support health, whilst ensuring that such activity does not exacerbate inequalities.

Key considerations for future action are:

- **Continued efforts through Digital Communities Wales and others to address digital inclusion is vital, but efforts must extend beyond internet connectivity and skills, to understand and address underlying motivators and barriers to engagement in health-related activities through digital technology to ensure that a digital health system is accessible to all.**
- **As health systems seek to empower populations through digital technology to manage their health, equity must be considered so those who have the greatest needs are not left behind. Such insights will ensure digital technology as an enabler of change addresses rather than exacerbates existing inequalities in health.**
- **Digital innovation should be underpinned by evidence-based approaches and behavioural science to ensure users have access to reliable information delivered in a way which supports positive and sustainable action. Novel approaches to evaluation of digital technology are also needed to ascertain the impact on outcomes to inform future developments in population health.**
- **Further research is needed to better understand the links between digital technology and mental wellbeing, to capitalise on the potential benefits and protect against the harms.**

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6. Appendices

Appendix 1 – Methods and population demographics

Between April and June 2018, a cross-sectional survey of residents in Wales was conducted by Public Health Wales and Bangor University Public Health Collaborating Unit. The fieldwork was carried out by BMG Research, a professional market research company. All interviewers followed the Market Research Society (MRS) Code of Conduct. On completion of the interview, individuals were provided with a thank you leaflet.

NHS research permissions were gained from the Public Health Wales Research and Development Office and ethical approval was granted by Bangor University Healthcare and Medical Sciences Academic Ethics Committee.

Sample

Residents of Wales aged 16 years or over were recruited to complete a household survey (one person per household) using a stratified random probability sampling framework based on Lower Super Output Areas (LSOA)[i], Welsh Index of Multiple Deprivation (WIMD)[j], local health boards and rurality.[k]

To allow adequate representation of residents of Wales by relevant characteristics (e.g. age, gender and deprivation), a target sample size of 1,250 individuals was set.

Participation rate

A total of 3,870 households were informed through a bilingual letter inviting them to voluntarily participate or to opt out of the study; 6.5% of households opted out at this stage. Of the eligible households visited by interviewers where there was a response, in 46.5% housholds (someone answered, n=1,801). Of those households where there was a response 1,252 face-to-face interviews were completed (compliance rate of 69.5%). The most common reason for declining to participate was 'no reason given' or the 'individual had no time'.

Interviews were conducted at the participants house using a questionnaire delivered by professionally trained interviewers using Computer Assisted Personal Interviewing (CAPI), in English (98.3% of interviews), Welsh (1.0%) or other languages (0.7%). A total of 181 questionnaires (14.6%) were short questionnaires, completed by those who never accessed the internet at home, work or elsewhere on a phone, tablet, computer or voice controlled personal assistant, never use wearable technology and never go on social media websites or apps.

The population surveyed was representative of the general population of Wales across deprivation quintiles and rurality, but included a slightly higher proportion of women and those aged 30-39 years (Table A1). The majority of those surveyed were of white ethnicity (95.8%). Given the high proportion of white ethnicity and small sample size, population weighted estimates and adjusted proportions were adjusted for age, gender and deprivation.

[i] Office for National Statistics (2017). Mid-2016 Population Estimates for Lower Layer Super Output Areas in England and Wales. Available at: https://www.nomisweb.co.uk/ Accessed on 13 December 2018.

[j] NHS Wales Informatics Service (2014) Deprivation Quintile (Overall), WIMD, LSOA (Census 2011 based) Available at: https://www.healthmapswales.wales.nhs.uk/IAS/metadata/view/indicatorinstance?pid=11326&id=543060&norefer=true

[k] NHS Wales Informatics Service (2011) Rural Urban Classification, Classification, LSOA Available at: https://www.healthmapswales.wales.nhs.uk/IAS/metadata/view/indicatorinstance?pid=10389&id=539170&norefer=true

Table A1. Demographics of sample compared to ONS mid year (2016) Welsh population estimates.

		Sample (N = 1,252)		Population (ONS 2016)		X_2
		n	%	n	%	*p*
Gender	Men	575	45.9%	1,248,369	48.8%	0.039
	Women	677	54.1%	1,307,702	51.2%	
Age group (years)	16-29	198	16.0%	560,563	21.9%	<0.001
	30-39	222	17.9%	358,010	14.0%	
	40-49	195	15.7%	394,276	15.4%	
	50-59	205	16.5%	423,797	16.6%	
	60-69	181	14.6%	382,233	15.0%	
	70+	239	19.3%	437,192	17.1%	
	No data	*12*				
Deprivation quintile	1 (Least deprived)	259	20.7%	476,309	18.6%	0.343
	2	252	20.1%	504,420	19.7%	
	3	253	20.2%	533,482	20.9%	
	4	254	20.3%	528,384	20.7%	
	5 (Most deprived)	234	18.7%	513,476	20.1%	

Population data obtained from Office for National Statistics: Mid-2016 Population Estimates for Wales. Available at: https://www.nomisweb.co.uk/. Accessed on 13 December 2018.

Questionnaire

The questionnaire content was developed drawing on questions about digital technology, internet use, health status and demographics from validated sources where possible or developed by the research team drawing on themes from the literature (Table A2). The questionnaire was piloted internally by the research team and externally by BMG Research prior to implementation.

In order to determine if the participant was an active digital technology user, the questions in Box A1 were asked in order to classify each participant as either a "digital technology user" or a "non-digital technology user". Participants were asked whether they used digital technology to do any of 10 health related actions or monitor 14 health-related activities. Response options were '*yes in the last 3 months*', '*yes but more than 3 months ago*' and '*never*'. For the purpose of the analysis the responses were dichotomised into '*yes*' and '*never*'.

Socio-demographic measures

Area level deprivation quintiles were assigned by mapping individual postcodes to the mid-year 2014 ONS lower super output area deprivation quintiles[l]. Geographical classifications of rurality were assigned at a household level based on LSOA[m].

Data analysis

Data analysis were undertaken using IBM SPSS Statistics 24 and Stata Version 14.

[l] NHS Wales Informatics Service (2014) Deprivation Quintile (Overall), WIMD, LSOA (Census 2011 based) Available at: https://www.healthmapswales.wales.nhs.uk/IAS/metadata/view/indicatorinstance?pid=11326&id=543060&norefer=true

[m] NHS Wales Informatics Service (2011) Rural Urban Classification, Classification, LSOA Available at: https://www.healthmapswales.wales.nhs.uk/IAS/metadata/view/indicatorinstance?pid=10389&id=539170&norefer=true

Table A2. Topics included in the questionnaire

Topics		Source
Access to the internet and technology	Type of mobile phone used	n/a
	Access to the internet at home	National Survey for Wales*
	At home, how do you connect to the internet?	National Survey for Wales*
	How often do you access the internet, whether at home, work or elsewhere?	National Survey for Wales*
	Use of wearable technology	n/a
Use of technology	Technology addiction	Adapted from the Bergen Facebook Addiction Scale^
	Ability to use technology to perform health supporting tasks	Adapted from the Digital Skills framework (The Get Digital)~
	Use of wearable technology to monitor health activity or status	*List of actions and activites informed by literature review on common themes, and Ofcom Technology Tracker (2017)‡ and Teens, Health and Technology National Survey (2016)†.*
	Use of technology to perform health supporting tasks	
	Use of technology to monitor health status and behaviours	
	Use of social media	
	Use of technology in employment	
Perceptions of digital technology impact on health	Explore how technology has changed experiences of health behaviours	List of actions and activites informed by literature review on common themes.
	Explore motivators for use of technology to support health	
Health status	Self-reported health status	EQ-5D¶
	Mental health status	Short Warwick-Edinburgh Mental Well-Being Scale (SWEMWBS)**
	Presence of long-term health condition or illness	National Survey for Wales*
	Impact of health condition or illness on activities of daily living	National Survey for Wales*
	Smoking tobacco	National Survey for Wales*
	E-cigarettes use	
	Alcohol consumption	AUDIT C^^
	Physical activity participation	Scottish Physical Activity Screening Questionnaire~~

*National Survey for Wales 2017-18 Available at: http://gov.wales/docs/caecd/research/2017/170420-national-survey-2017-18-questionnaire-en.pdf

^Andreassen CS *et al (2012). Development of a Facebook Addiction Scale.* Psychological Reports. Vol 110, 501-517. Available at: https://doi.org/10.2466/02.09.18.PR0.110.2.501-517

~The Get Digital (2015) Available at: https://www.thetechpartnership.com/basic-digital-skills/basic-digital-skills-framework/

‡OFcom Technology Tracker. Available at: https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2017/interactive/technology-tracker

†Wartella E *et al* (2016) Teens, Health and Technology: A National Survey. Media and Communication. vol 4, 13-23. Available at: https://www.researchgate.net/publication/304067667_Teens_Health_and_Technology_A_National_Survey/fulltext/577e9ca408ae9485a43686fd/304067667_Teens_Health_and_Technology_A_National_Survey.pdf?origin=publication_detail

¶Available at: https://euroqol.org/wp-content/uploads/2016/09/EQ-5D-3L_UserGuide_2015.pdf

**Short Warwick-Edinburgh Mental Well-Being Scale (SWEMWBS) © NHS Health Scotland, University of Warwick and University of Edinburgh, 2008, all rights reserved https://warwick.ac.uk/fac/med/research/platform/wemwbs/swemwbs_7_item.pdf.

^^AUDIT-C tool. Available at: https://www.integration.samhsa.gov/images/res/tool_auditc.pdf

~~Scottish Physical Activity Screening Questionnaire http://www.paha.org.uk/Resource/scottish-physical-activity-screening-question-scot-pasq;

Box A1. Single questions asked to obtain information on access to the internet and/or digital technology

Outcomes	Question	Categories (Responses)
Access to the internet	Do you have a mobile phone?*	Yes, no
	Do you have access to the internet at home?*	Yes, no
Access to technology	How often do you access the internet, whether at home, work or elsewhere* by • mobile phone? • desktop computer/laptop? • tablet computer? • voice controlled personal assistant?	Often (several times a day, daily, weekly) Never (less than weekly, never)
	How often do you use wearable technology such as Fitbit®, Garmin, Apple Watch®, to track your health behaviours?	Often (5-7 days a week, 2-4 days a week, 1 day a week/weekly), Never (less than weekly, never)

*Adapted from the National Survey for Wales
http://gov.wales/docs/caecd/research/2017/170420-national-survey-2017-18-questionnaire-en.pdf

Appendix 2 - Access to the internet at home

Percentage of those with no internet access at home by demographics and health status (population sampled N=1,240); Unadjusted and adjusted results (sample mean adjusted for gender, age, deprivation).

			n	Unadjusted %	Adjusted % (95% CIs)
All	No internet access		166	13.1	8 (6-10)
Age group (years)	16-29		6	3.0	2 (1-5)
	30-39		6	2.7	2 (1-5)
	40-49		7	3.6	3 (1-7)
	50-59		24	11.7	11 (7-16)
	60-69		26	14.4	15 (10-21)
	70		97	40.6	42 (36-49)
		X^2	209.448		
		P	<0.001		
Gender	Male		74	13.0	7 (5-10)
	Female		92	13.7	8 (6-10)
		X^2	0.149		
		P	0.700		
Deprivation quintile	1 (Least deprived)		26	10.1	4 (3-7)
	2		26	10.5	5 (3-8)
	3		45	18.1	11 (8-16)
	4		31	12.4	7 (5-11)
	5 (Most deprived)		196	16.2	14 (10-20)
		X^2	10.828		
		P	0.029		
General health (excludes 6 missing responses)	High		23	6.1	4 (3-7)
	Average		53	10.5	13 (10-18)
	Low		89	25.3	6 (4-9)
		X^2	63.812		
		P	<0.001		
Mental wellbeing (excludes 14 missing responses)	Average		131	12.4	7 (5-9)
	Low		33	19.4	14 (9-20)
		X^2	6.152		
		P	0.013		
Health-harming behaviours (excludes 9 missing responses)	0		26	5.5	3 (2-5)
	1		108	18.8	9 (7-12)
	2-3		31	13.4	14 (9-20)
		X^2	41.266		
		P	<0.001		

Appendix 3 – Use of digital technology to support health by socio-demographics and health status

Values are percentages within the population sampled (unadjusted, association by Chi-squared provided).

		Any action	Make a healthcare appointment	Find information about health services	Find information about general health	Find information about activities to support your health	Self-diagnose a health condition	Manage a long-term health condition	Manage medication	Manage other supplements	Track personal health goals	Find emotional support online
All	n	807	179	644	696	523	416	198	116	98	204	117
	%	65.1	14.4	51.9	56.1	42.2	33.5	16	9.4	7.9	16.5	9.4
Age group (years)	16-29	84.8	21.2	73.7	73.7	59.6	42.4	13.1	10.1	10.6	29.3	18.2
	30-39	79.7	20.7	65.3	69.4	56.3	46.8	17.1	10.8	7.7	26.6	15.3
	40-49	77.9	16.9	62.6	69.2	50.3	43.1	21.0	11.8	9.2	19.5	9.7
	50-59	67.3	13.2	50.2	59.5	43.9	33.7	20.5	8.3	7.8	13.2	8.8
	60-69	58.6	9.4	45.3	48.6	35.9	29.3	19.3	11	10.5	9.4	4.4
	70+	27.6	5.9	19.2	21.3	11.3	9.2	6.7	5.0	2.9	2.1	0.8
	X^2	220.671	33.668	168.178	176.903	144.638	97.559	25.093	8.234	12.279	85.640	52.840
	P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.144	0.031	<0.001	<0.001
Gender	Male	62.5	14.6	49.5	52.5	38.4	28.9	12.6	7.7	6.5	16.5	5.4
	Female	67.3	14.3	54.0	59.3	45.4	37.5	18.8	10.7	9.1	16.4	12.8
	X^2	3.197	0.014	2.561	5.779	6.104	10.017	8.75	3.328	2.89	0.001	19.722
	P	0.074	0.907	0.110	0.016	0.013	0.002	0.003	0.068	0.089	0.972	<0.001
Deprivation	1 (least)	75.2	19.8	61.6	65.9	47.7	39.9	15.9	12.0	7.0	19.4	9.7
	2	67.7	12.5	54.4	58.5	45.2	36.3	19.0	10.5	12.1	18.5	12.5
	3	60.2	15.3	47.4	53.4	40.2	32.1	16.5	5.2	6.4	13.3	10
	4	64.5	13.5	49.0	55.8	42.2	32.3	15.9	11.6	8.4	17.5	8.8
	5 (most)	56.8	10.7	46.6	46.2	35.0	26.5	12.4	7.3	5.6	13.2	6.0
	X^2	21.979	9.655	15.943	20.750	9.402	11.168	3.921	10.181	8.889	6.216	6.248
	P	<0.001	0.047	0.003	<0.001	0.052	0.025	0.417	0.037	0.064	0.184	0.181
General health	High	70.7	13.6	57.9	61.1	33.2	34.3	11.5	6.4	6.9	18.7	7.2
	Average	69.2	15.8	53.8	59.6	45.4	37.9	15.8	9.7	9.1	16.2	11.0
	Low	53.1	13.6	42.9	45.7	45.9	25.9	21.0	11.9	7.4	14.5	9.4
	X^2	31.128	1.125	17.544	21.571	15.742	13.74	12.381	6.696	1.558	2.354	3.743
	P	<0.001	0.570	<0.001	<0.001	<0.001	0.001	0.002	0.035	0.459	0.308	0.154
Mental wellbeing	Average	65.7	12.4	52.8	57.2	42.7	33.4	15.6	9.2	7.4	16.1	8.3
	Low	62.9	14.9	48.2	51.2	40.6	34.7	18.8	10.6	11.2	19.4	17.1
	X^2	0.510	0.762	1.247	2.167	0.266	0.113	1.159	0.330	2.861	1.140	13.228
	P	0.475	0.383	0.264	0.141	0.606	0.737	0.282	0.566	0.091	0.286	<0.001
Health -harming behaviours	0	74.7	18.1	61.1	65.5	50.2	37.0	17.7	11.9	10.4	21.9	7.9
	1	58.5	11.9	44.9	50.1	36.6	31.4	14.5	7.7	6.8	13.8	10.3
	2-3	60.1	11.7	50	50.5	38.8	31.4	16.0	8.0	4.3	11.2	10.6
	X^2	32.055	9.335	27.48	27.748	20.489	4.109	1.944	5.958	8.578	16.947	2.162
	P	<0.001	0.009	<0.001	<0.001	<0.001	0.128	0.378	0.051	0.014	<0.001	0.339

Appendix 4 – Use of digital technology to support health by socio-demographics and health status

Values are percentages limited to digital technology users only (unadjusted, association by Chi-squared provided).

		Any action	Make a healthcare appointment	Find information about health services	Find information about general health	Find information about activities to support your health	Self-diagnose a health condition	Manage a long-term health condition	Manage medication	Manage other supplements	Track personal health goals	Find emotional support online
All	n	807	179	644	696	523	416	198	116	98	204	117
	%	76.2	16.9	39.2	65.7	49.4	39.3	18.7	11.0	9.3	19.3	11.1
Age group (years)	16-29	85.3	21.4	74.1	74.1	59.9	42.6	13.2	10.2	10.7	29.4	18.3
	30-39	80.1	20.8	65.6	69.7	56.6	47.1	17.3	10.9	7.7	26.7	15.5
	40-49	82.2	17.8	65.9	73.0	53.0	45.4	22.2	12.4	9.8	20.7	10.4
	50-59	78.9	15.4	58.9	69.7	51.4	39.4	24.0	9.7	9.1	15.4	10.3
	60-69	67.9	10.9	52.6	56.4	41.9	34.2	22.6	13.1	12.3	11.0	5.2
	70+	52.8	11.2	36.8	40.8	21.6	17.6	12.8	9.6	5.6	4.0	1.6
	X^2	58.710	12.540	53.781	53.717	56.555	35.752	13.288	1.755	4.916	48.369	31.547
	P	<0.001	0.028	<0.001	<0.001	<0.001	<0.001	0.021	0.882	0.426	<0.001	<0.001
Gender	Male	72.8	17.0	57.7	61.1	44.8	33.8	14.7	9.0	7.6	19.3	6.4
	Female	79.1	16.9	63.5	69.6	53.4	44.0	22.2	12.7	10.7	19.3	15.2
	X^2	5.800	0.002	3.767	8.449	7.857	11.518	9.604	3.595	3.004	0.001	20.659
	P	0.016	0.965	0.052	0.004	0.005	0.001	0.002	0.058	0.083	0.977	<0.001
Deprivation	1 (least)	84.3	22.2	69.1	73.9	53.5	45.0	17.8	13.5	7.9	21.7	10.9
	2	75.7	14.0	60.8	65.3	50.7	40.5	21.4	11.8	13.6	20.8	14.2
	3	75.4	19.2	59.3	66.8	50.3	40.2	20.6	6.5	8.0	16.6	12.6
	4	74.3	15.6	56.4	64.2	48.6	37.2	18.3	13.3	9.7	20.3	10.2
	5 (most)	70.0	13.2	57.4	56.8	43.2	32.6	15.3	8.9	6.8	16.3	7.4
	X^2	12.985	8.809	9.579	13.844	4.746	7.266	3.105	7.720	7.246	3.367	5.411
	P	0.011	0.066	0.048	0.008	0.314	0.122	0.540	0.102	0.123	0.498	0.248
General health	High	75.7	15.0	62.0	65.4	49.1	36.9	29.4	6.9	7.4	20.0	7.8
	Average	77.8	18.0	60.5	67.0	51.0	42.7	17.7	10.9	10.2	18.2	12.5
	Low	73.9	19.0	59.7	63.6	46.4	36.0	29.4	16.7	10.3	20.2	13.1
	X^2	1.433	2.354	0.357	0.807	1.36	4.184	24.438	14.395	2.192	0.588	5.760
	P	0.489	0.308	0.836	0.668	0.508	0.123	<.001	0.001	0.334	0.745	0.056
Mental wellbeing	Average	76.3	17.3	61.3	66.4	49.6	38.8	18.1	10.7	8.6	18.8	9.6
	Low	77.5	15.2	59.4	63.0	50.0	42.8	23.2	13	13.8	23.9	21.2
	X^2	0.098	0.371	0.186	0.605	0.007	0.78	2.03	0.66	3.75	2.03	15.97
	P	0.754	0.542	0.666	0.437	0.933	0.377	0.15	0.42	0.053	0.16	<0.001
Health -harming behaviours	0	80.7	19.6	66.0	70.80	54.30	40.0	19.10	12.90	11.30	23.70	8.50
	1	72.5	14.7	55.6	62.10	45.60	39.0	18.0	9.6	8.50	17.10	12.90
	2-3	73.9	14.4	61.40	62.10	47.70	38.60	19.6	9.8	5.20	13.10	13.20
	X^2	8.733	4.497	10.100	8.541	6.999	0.134	0.281	2.800	5.576	9.882	4.943
	P	0.013	0.106	<0.006	0.014	0.030	0.935	0.869	0.247	0.062	0.007	0.084

Appendix 5 – Use of digital technology to support health by socio-demographics and health status

Adjusted proportion (95% confidence intervals) of the population sampled adjusting for age, gender and deprivation

		Any action	Make a healthcare appointment	Find information about health services	Find information about general health	Find information about activities to support your health	Self-diagnose a health condition	Manage a long-term health condition	Manage medication	Manage other supplements	Track personal health goals	Find emotional support online
Age group (years)	16-29	87 (82-91)	22 (17-28)	76 (70-81)	77 (70-82)	61 (54-68)	44 (37-51)	13 (9-18)	10 (7-15)	11 (7-16)	30 (24-37)	17 (12-23)
	30-39	81 (76-86)	21 (16-27)	67 (60-73)	71 (64-77)	57 (50-63)	47 (40-54)	17 (12-22)	10 (7-14)	8 (5-12)	26 (21-33)	14 (10-19)
	40-49	80 (73-85)	17 (12- 23)	63 (56-70)	70 (63-77)	50 (43-57)	43 (36-50)	20 (15-27)	11 (7-16)	9 (6-14)	19 (14-25)	8 (5-13)
	50-59	68 (61-74)	13 (9- 18)	50 (43-57)	60 (53-66)	43 (37-50)	33 (27-40)	20 (15-26)	8 (5-12)	8 (5-12)	13 (9-18)	7 (5-12)
	60-69	55 (47-63)	8 (5-13)	42 (35-50)	45 (37-52)	33 (27-40)	26 (21- 33)	19 (14-25)	10 (6-15)	10 (7-16)	8 (5-13)	3 (2-7)
	70+	24 (19-30)	5 (3-9)	17 (13-23)	18 (14-22)	10 (7-14)	8 (5-12)	6 (4-10)	4 (2-8)	3 (1-6)	2 (1-4)	1 (0-2)
Gender	Male	65 (60-69)	13 (11-16)	49 (45-54)	52 (48-57)	36 (32-40)	26 (23-30)	12 (10-15)	7 (5-10)	6 (4-8)	13 (10-16)	3 (2-5)
	Female	71 (67-75)	13 (10-16)	55 (51-59)	61 (57-65)	44 (40-48)	36 (32-40)	18 (10-20)	10 (8-13)	8 (7-11)	13 (10-16)	9 (7-12)
Deprivation	1 (least)	84 (78-88)	20 (16-26)	68 (62-74)	73 (67-78)	51 (44-58)	41 (35-48)	15 (11-20)	12 (9-17)	7 (4-11)	18 (14-24)	7 (4-11)
	2	73 (67-79)	12 (8-17)	57 (50-64)	61 (54-68)	45 (39-52)	35 (29-42)	18 (14-23)	10 (7-15)	11 (8-16)	16 (12-21)	9 (6-13)
	3	62 (55-69)	14 (10-19)	47 (40-54)	53 (46-60)	38 (32-44)	30 (24-36)	15 (11-21)	5 (3-9)	6 (4-9)	10 (7-14)	6 (4-10)
	4	66 (59-73)	12 (9-17)	48 (41-55)	55 (49-62)	39 (33-46)	29 (24-35)	15 (11-20)	12 (8-16)	8 (5-12)	13 (10-18)	5 (3-9)
	5 (most)	51 (43-58)	9 (6-13)	40 (34-47)	39 (33-46)	28 (23-34)	21 (16-27)	11 (8-16)	7 (5-11)	5 (3-8)	8 (6-12)	3 (2-5)
General health	High	68 (63-74)	12 (9-16)	53 (47-59)	57 (51-62)	39 (34-45)	28 (24-33)	10 (8-14)	5 (4-8)	6 (4-9)	12 (9-16)	3 (2-5)
	Average	72 (68-76)	16 (13-20)	54 (49-58)	60 (55-65)	43 (39-48)	35 (31-40)	15 (12-18)	9 (7-12)	8 (6-11)	12 (10-16)	7 (5-10)
	Low	62 (56-68)	18 (14-24)	49 (43-54)	52 (46-58)	36 (30-42)	27 (22-32)	21 (17-25)	13 (9-17)	8 (5-11)	14 (11-19)	7 (4-10)
Mental wellbeing	Average	69 (66-72)	13 (11-16)	53 (50-57)	58 (55-61)	41 (37-44)	31 (28-34)	15 (12-17)	9 (7-10)	7 (6-9)	13 (10-15)	5 (4-7)
	Low	65 (56-73)	11 (7-16)	47 (39-55)	50 (42-58)	37 (29-45)	31 (24-39)	17 (12-24)	10 (6-16)	11 (7-16)	15 (10-21)	10 (7-16)
Health -harming behaviours	0	76 (72-80)	16 (13-19)	60 (55-65)	65 (60-69)	47 (42-52)	33 (28-37)	16 (13-19)	11 (9-14)	10 (7-13)	16 (13-20)	4 (3-6)
	1	65 (60-69)	11 (9-14)	48 (43-52)	54 (49-58)	37 (33-42)	31 (27-35)	14 (11-17)	7 (5-10)	7 (5-9)	12 (9-15)	7 (5-10)
	2-3	57 (49-65)	10 (6-15)	46 (38-53)	46 (39-54)	33 (27-41)	26 (21-33)	14 (10-20)	8 (5-13)	4 (2-7)	7 (5-12)	6 (3-10)

Appendix 6 – Use of digital technology to support health by socio-demographics and health status

Adjusted proportion (95% confidence intervals) of the digital technology users adjusting for age, gender and deprivation

		Any action	Make a healthcare appointment	Find information about health services	Find information about general health	Find information about activities to support your health	Self-diagnose a health condition	Manage a long-term health condition	Manage medication	Manage other supplements	Track personal health goals	Find emotional support online
Age group (years)	16-29	87	22	76	76	61	43	13	10	10	31	17
		(82-91)	(17-28)	(69-81)	(70-82)	(54-68)	(37-51)	(9-18)	(7-15)	(7-16)	(24-37)	(12-23)
	30-39	81	21	66	71	57	47	17	10	7	26	14
		(76-86)	(16-27)	(60-72)	(64-76)	(50-63)	(41-54)	(12-22)	(7-15)	(5-12)	(21-33)	(10-19)
	40-49	83	18	66	74	53	45	21	12	9	20	9
		(77-88)	(13-24)	(59-73)	(67-80)	(45-60)	(38-52)	(16-28)	(8-17)	(6-14)	(15-27)	(6-14)
	50-59	79	15	59	70	51	38	24	9	9	15	9
		(73-85)	(10-21)	(51-66)	(62-76)	(43-58)	(31-46)	(18-30)	(6-14)	(5-14)	(10-21)	(5-13)
	60-69	65	10	49	53	39	31	22	12	11	10	4
		(56-72)	(6-15)	(41-57)	(44-61)	(32-47)	(24-39)	(16-29)	(8-18)	(7-17)	(6-15)	(2-8)
	70+	47	10	33	36	19	15	12	8	5	3	1
		(38-56)	(6-16)	(25-42)	(28-45)	(13-26)	(10-22)	(8-19)	(5-14)	(2-10)	(1-8)	(0-4)
Gender	Male	72	15	55	59	41	30	14	8	7	15	4
		(67-76)	(12-19)	(51-60)	(54-63)	(36-46)	(26-35)	(11-18)	(6-11)	(5-10)	(12-18)	(3-6)
	Female	79	15	62	69	51	41	22	12	10	15	11
		(76-83)	(12-18)	(58-66)	(65-73)	(46-55)	(37-45)	(18-25)	(9-15)	(8-13)	(12-18)	(8-14)
Deprivation	1 (least)	87	22	72	77	54	44	16	13	7	20	8
		(82-91)	(17-28)	(65-77)	(71-82)	(48-61)	(38-51)	(12-22)	(9-18)	(5-12)	(15-26)	(5-12)
	2	77	13	61	65	49	38	20	11	13	18	10
		(70-82)	(10-19)	(54-67)	(58-71)	(42-56)	(32-45)	(15-26)	(8-16)	(9-18)	(13-23)	(7-15)
	3	73	17	55	63	45	36	19	6	7	12	7
		(66-79)	(13-23)	(48-63)	(56-70)	(38-52)	(29-43)	(14-26)	(4-11)	(4-12)	(8-17)	(5-12)
	4	74	14	54	63	45	34	18	13	9	15	6
		(67-80)	(10-19)	(47-61)	(56-69)	(38-52)	(28-40)	(13-23)	(9-18)	(6-14)	(11-21)	(4-10)
	5 (most)	63	11	50	49	35	26	14	8	6	10	4
		(55-70)	(7-16)	(42-57)	(42-57)	(28-42)	(21-33)	(10-20)	(5-13)	(4-11)	(7-15)	(2-6)
General health	High	73	12	57	61	43	31	11	7	7	14	4
		(67-77)	(9-16)	(51-63)	(55-66)	(37-48)	(26-36)	(8-15)	(5-10)	(4-10)	(10-18)	(2-6)
	Average	78	16	59	66	48	39	16	11	9	14	8
		(74-82)	(13-20)	(54-64)	(61-70)	(43-53)	(35-44)	(13-20)	(8-14)	(7-12)	(11-18)	(5-11)
	Low	76	18	60	64	45	34	28	17	9	18	8
		(70-81)	(14-24)	(54-67)	(58-70)	(39-52)	(28-40)	(22-34)	(13-22)	(6-13)	(13-23)	(5-13)
Mental wellbeing	Average	76	15	59	65	46	35	17	10	8	15	6
		(73-79)	(13-18)	(56-63)	(61-68)	(43-50)	(32-39)	(14-19)	(8-12)	(6-10)	(12-17)	(4-8)
	Low	76	13	55	60	44	38	22	12	12	17	13
		(68-83)	(9-20)	(46-64)	(51-68)	(36-53)	(30-47)	(16-30)	(7-18)	(8-19)	(12-25)	(8-20)
Health -harming behaviours	0	80	18	64	69	50	36	18	12	10	19	5
		(76-84)	(14-22)	(59-69)	(64-73)	(45-55)	(31-41)	(14-22)	(9-15)	(8-13)	(16-24)	(3-7)
	1	73	14	54	61	43	36	17	9	8	14	8
		(68-79)	(11-17)	(50-59)	(57-66)	(38-48)	(32-41)	(14-21)	(6-12)	(6-11)	(11-18)	(6-11)
	2+	71	12	57	58	41	33	19	9	5	9	7
		(62-78)	(8-18)	(48-65)	(49-66)	(34-50)	(26-41)	(13-26)	(6-15)	(2-9)	(6-14)	(4-12)

Appendix 7 – Use of digitatl technology to monitor health by socio-demographics and indicators of health

Values are percentages within the population sampled (unadjusted, association by Chi-squared provided)

		Any	Fitness	Step count	Nutrition	Sleep	Heart rate	Headaches	Medication	Stress or anxiety	Mental wellbeing	Pain	Water
All	n	412	314	331	250	190	197	82	105	120	111	81	88
	%	33.2	25.3	26.7	20.2	15.3	15.9	6.6	8.5	9.7	9	6.5	7.1
Age group (years)	16-29	50.5	45.5	42.4	33.8	26.3	26.8	15.7	9.6	21.2	18.7	9.6	16.2
	30-39	47.3	39.6	40.1	33.3	28.8	24.8	11.7	11.7	13.5	13.5	8.6	14.9
	40-49	41.5	34.4	35.4	26.7	16.4	19.0	6.7	8.7	11.8	11.8	8.2	7.2
	50-59	32.7	21.5	23.9	13.7	11.2	13.7	4.4	11.2	8.3	7.8	5.4	2.0
	60-69	22.7	8.8	17.1	11.6	7.7	9.4	1.1	6.1	2.8	1.1	4.4	1.7
	70+	7.5	3.8	3.8	3.3	2.1	2.9	0.4	3.8	1.3	1.3	3.3	0.8
	X^2	132.801	161.271	126.414	107.666	92.590	68.562	60.951	13.51	64.623	62.001	11.181	75.557
	P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.019	<0.001	<0.001	0.048	<0.001
Gender	Male	23.5	27.2	25.3	18.8	13.2	17.4	5.3	7.7	7.5	6.8	5.6	6.1
	Female	41.5	23.7	27.9	21.3	17.2	14.6	7.8	9.1	11.5	10.7	7.3	7.9
	X^2	44.896	1.952	1.103	1.265	3.81	1.732	3.112	0.762	5.494	5.760	1.457	1.464
	P	<0.001	0.162	0.294	0.261	0.051	1.88	0.078	0.383	0.019	0.016	0.227	0.226
Deprivation	1 (least)	39.5	29.8	31.4	19.0	19.0	16.7	4.7	10.9	9.7	7.8	6.2	7.0
	2	31.9	27.4	27.0	20.6	16.9	18.1	7.7	8.9	11.7	13.3	8.5	8.9
	3	29.7	22.5	24.5	16.9	12.4	15.7	5.2	5.6	6.4	7.6	3.6	5.6
	4	35.9	24.7	27.9	25.5	16.7	16.3	10.4	12	12.4	10.4	8.4	7.2
	5 (most)	28.6	21.8	22.2	18.8	11.1	12.4	5.1	4.7	8.1	5.6	6.0	6.8
	X^2	9.227	6.015	6.115	6.632	8.342	3.248	9.36	12.762	6.867	10.680	6.539	2.036
	P	0.056	0.198	0.191	0.157	0.080	0.517	0.053	0.012	0.143	0.03	0.162	0.729
General health	High	37.6	30.7	32.3	22.7	14.9	16.3	4.5	6.9	7.2	8.0	4.3	6.7
	Average	35.5	27.6	27.8	20.7	16.6	17.2	7.9	8.7	12.0	10.5	7.5	7.3
	Low	25.3	16.2	19.3	16.5	13.9	13.9	7.1	9.7	9.1	8.0	7.4	7.1
	X^2	14.426	22.607	16.040	4.533	1.184	1.662	4.080	1.818	5.957	2.237	4.369	0.133
	P	0.001	<0.001	<0.001	0.104	0.553	0.436	0.130	0.403	0.051	0.327	0.113	0.936
Mental wellbeing	Average	33.8	25.9	27.6	20.1	14.9	15.8	5.6	8.3	7.5	7.3	6.2	6.9
	Low	31.8	23.5	23.5	21.8	18.8	17.1	13.5	10.0	23.5	19.4	9.4	8.2
	X^2	0.266	0.433	1.235	0.246	1.73	0.161	14.734	0.509	42.88	26.231	2.494	0.38
	P	0.606	0.511	0.266	0.620	0.188	0.689	<0.001	0.476	<0.001	<0.001	0.114	0.538
Health -harming behaviours	0	40.0	33.4	33.8	25.5	21.3	20.2	7.2	9.8	9.4	8.3	7.0	8.1
	1	30.0	20.4	22.9	16.6	11.9	13.4	5.6	7.3	8.9	9.2	6.3	7.0
	2-3	26.6	20.2	21.3	17.6	11.2	12.8	8.0	8.0	12.2	9.6	5.9	4.8
	X^2	16.082	26.100	19.289	13.791	20.578	10.504	1.490	2.077	1.859	0.399	0.385	2.236
	P	<0.001	<0.001	<0.001	0.001	<0.001	0.005	0.397	0.354	0.395	0.819	0.825	0.327

Appendix 8 – Use of digital technology to monitor health by socio-demographics and indictors of health

Values are **percentages** within the population sampled (unadjusted, association by Chi-squared provided)

		Any	Fitness	Step count	Nutrition	Sleep	Heart rate	Headaches	Medication	Stress or anxiety	Mental wellbeing	Pain	Water
All	n	412	314	331	250	190	197	82	105	120	111	81	88
	%	38.9	29.7	31.3	23.6	18.0	18.6	7.8	9.9	11.4	10.5	7.7	8.3
Age group (years)	16-29	50.8	45.7	42.6	34.0	26.5	26.9	15.8	9.6	21.4	18.9	9.7	16.3
	30-39	47.5	39.8	40.5	33.5	29.0	24.9	11.8	11.8	13.6	13.6	8.6	14.9
	40-49	43.8	36.2	37.3	28.1	17.3	20.0	7.0	9.2	12.4	12.5	8.7	7.7
	50-59	38.3	25.1	28.0	16.0	13.1	16.0	5.1	13.2	9.8	9.2	6.3	2.3
	60-69	26.3	10.3	19.9	13.5	9.0	10.9	1.3	7.1	3.2	1.3	5.1	1.9
	70+	14.4	7.2	7.2	6.4	4.0	5.6	0.8	7.2	2.4	2.4	6.4	1.6
	X^2	62.456	99.100	67.591	60.897	55.814	35.824	42.190	5.557	41.748	40.753	3.850	53.162
	P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.352	<0.001	<0.001	0.571	<0.001
Gender	Male	27.4	31.7	29.5	21.9	15.3	20.2	6.1	9.0	8.8	8.0	6.6	7.2
	Female	48.8	27.9	32.8	25.1	20.2	17.2	9.1	10.7	13.5	12.7	8.6	9.3
	X^2	50.565	1.825	1.331	1.500	4.239	1.620	3.255	0.873	5.818	6.020	1.563	1.577
	P	<0.001	0.177	0.249	0.221	0.039	0.203	0.071	0.350	0.016	0.014	0.211	0.209
Deprivation	1 (least)	44.3	33.5	35.2	21.3	21.3	18.7	5.2	12.2	10.9	8.8	7.0	7.9
	2	35.6	30.6	30.3	23.0	18.9	20.3	8.6	10.0	13.1	14.9	9.5	10.0
	3	37.2	28.1	30.7	21.1	15.6	19.6	6.5	7.0	8.0	9.5	4.5	7.1
	4	41.3	28.4	32.1	29.4	19.4	18.8	11.9	13.8	14.2	11.9	9.6	8.3
	5 (most)	35.3	26.8	27.4	23.3	13.7	15.3	6.3	5.8	10.0	6.8	7.4	8.4
	X^2	5.723	2.807	3.213	5.435	5.295	1.945	8.498	10.358	5.027	8.705	5.120	1.234
	P	0.221	0.591	0.523	0.245	0.258	0.746	0.075	0.034	0.285	0.069	0.752	0.873
General health	High	37.6	32.9	34.7	24.3	16.0	82.6	4.9	7.4	7.7	8.6	4.6	7.2
	Average	35.5	31.0	31.3	23.3	18.7	80.7	8.9	9.8	13.6	11.8	8.4	8.2
	Low	35.5	22.5	26.9	22.9	19.4	80.6	9.9	13.5	12.7	11.1	10.3	9.9
	X^2	14.426	8.301	4.142	0.178	1.406	0.550	6.490	6.065	7.194	2.213	7.556	1.445
	P	0.001	0.016	0.126	0.915	0.495	0.760	0.039	0.048	0.027	0.331	0.023	0.486
Mental wellbeing	Average	33.8	30.1	32.1	23.3	17.3	18.4	6.5	9.7	8.7	8.5	7.2	8.1
	Low	31.8	29.0	29.0	76.7	23.4	21.0	16.7	12.3	29.0	241	11.7	10.2
	X^2	0.266	0.067	0.531	0.792	2.957	0.541	17.104	0.907	48.702	30.653	3.356	0.721
	P	0.606	0.796	0.466	0.373	0.085	0.462	<0.001	0.341	<0.001	<0.001	0.067	0.396
Health -harming behaviours	0	40.0	36.1	36.6	27.6	23.0	21.8	7.8	10.6	10.1	9.0	7.6	8.8
	1	30.0	25.3	28.4	20.6	14.8	16.7	6.9	9.1	11.1	11.5	7.8	8.7
	2-3	26.6	24.8	26.1	21.6	13.7	15.7	9.8	9.8	15.0	11.8	7.2	5.9
	X^2	16.082	14.477	9.216	6.544	12.516	4.996	1.330	0.575	2.744	1.807	0.067	1.386
	P	<0.001	0.001	0.100	0.038	0.002	0.082	0.514	0.750	0.254	0.405	0.967	0.500

Appendix 9 – Use of digital technology to monitor health socio-demographics and health status

Adjusted proportion (95% confidence intervals) of the population sampled adjusting for age, gender and deprivation

		Any	Fitness	Step count	Nutrition	Sleep	Heart rate	Headaches	Medication	Stress or anxiety	Mental wellbeing	Pain	Water
Age group (years)	16-29	52 (45-59)	47 (40-54)	44 (37-51)	34 (28-41)	27 (21-34)	27 (22-34)	15 (11-21)	10 (6-15)	21 (16-28)	18 (13-24)	10 (6-15)	16 (12-22)
	30-39	46 (39-53)	40 (34-47)	40 (34-47)	33 (27-40)	28 (22-35)	25 (20-31)	11 (7-15)	11 (7-16)	12 (9-17)	13 (9-18)	9 (6-13)	15 (11-20)
	40-49	40 (33-47)	34 (28-41)	35 (29-42)	27 (21-33)	16 (11-21)	19 (14-25)	6 (4-10)	8 (5-13)	11 (7-16)	11 (7-16)	8 (5-13)	7 (4-12)
	50-59	31 (25-38)	24 (19-31)	23 (18-30)	14 (10-19)	12 (8-18)	13 (9-19)	4 (2-8)	11 (7-16)	8 (5-12)	7 (4-11)	5 (3-9)	2 (1-5)
	60-69	19 (14-25)	8 (5-12)	16 (11-22)	12 (8-17)	7 (4-11)	11 (7-17)	1 (0-4)	5 (3-9)	2 (1-6)	1 (0-3)	4 (2-9)	2 (1-5)
	70+	6 (4-9)	3 (2-6)	3 (2-6)	3 (2-7)	2 (1-4)	3 (1-6)	0 (0-2)	3 (2-6)	1 (0-3)	1 (0-3)	3 (2-7)	1 (0-3)
Gender	Male	20 (16-23)	22 (18-26)	21 (17-25)	15 (12-18)	10 (7-12)	14 (12-18)	3 (2-4)	7 (5-9)	5 (3-7)	4 (3-6)	5 (3-7)	3 (2-5)
	Female	39 (35-44)	18 (15-22)	24 (20-28)	18 (15-21)	13 (10-16)	12 (9-15)	4 (3-7)	8 (6-11)	8 (6-11)	7 (5-9)	7 (5-9)	5 (3-7)
Deprivation	1 (least)	40 (33-47)	30 (24-36)	31 (25-38)	18 (13-23)	17 (12-22)	16 (12-21)	3 (1-6)	11 (8-16)	8 (5-12)	5 (3-9)	6 (4-10)	5 (3-8)
	2	29 (23-35)	24 (19-30)	24 (19-30)	18 (14-24)	14 (10-19)	16 (12-22)	5 (3-8)	9 (6-13)	9 (6-13)	9 (6-14)	8 (5-12)	6 (3-9)
	3	25 (20-31)	17 (13-23)	20 (16-26)	14 (10-19)	9 (6-13)	13 (9-18)	3 (1-5)	5 (3-9)	4 (2-7)	4 (3-7)	3 (2-6)	3 (2-6)
	4	31 (26-38)	18 (14-24)	23 (18-29)	21 (16-27)	12 (8-17)	13 (9-18)	6 (3-10)	11 (8-15)	9 (6-13)	6 (4-10)	8 (5-12)	4 (2-7)
	5 (most)	20 (15-26)	13 (10-18)	15 (11-20)	13 (9-17)	7 (4-10)	9 (6-13)	2 (1-4)	4 (2-7)	4 (3-7)	3 (1-5)	5 (3-8)	3 (2-5)
General health	High	29 (25-35)	21 (17-26)	24 (20-29)	16 (12-20)	9 (6-12)	11 (8-15)	2 (1-3)	5 (4-8)	4 (2-6)	4 (2-6)	4 (2-6)	3 (2-5)
	Average	31 (27-36)	22 (19-27)	23 (20-28)	17 (14-21)	12 (9-16)	14 (11-18)	4 (2-7)	7 (5-10)	8 (6-11)	6 (4-9)	7 (5-10)	4 (3-7)
	Low	24 (19-29)	15 (12-20)	20 (15-25)	16 (12-20)	13 (9-17)	14 (11-18)	5 (3-8)	10 (7-14)	7 (5-11)	6 (3-9)	8 (5-11)	5 (3-8)
Mental wellbeing	Average	30 (26-33)	21 (18-24)	23 (21-27)	17 (15-20)	11 (9-13)	14 (11-16)	3 (2-5)	7 (6-9)	5 (4-7)	4 (3-6)	6 (5-8)	4 (3-6)
	Low	24 (18-31)	17 (12-23)	18 (13-25)	16 (11-22)	13 (9-19)	13 (9-19)	7 (4-12)	9 (6-14)	16 (11-23)	12 (7-18)	8 (5-13)	4 (2-8)
Health -harming behaviours	0	34 (30-39)	26 (22-31)	28 (23-32)	21 (17-25)	15 (12-19)	17 (13-21)	3 (2-6)	8 (6-11)	6 (4-8)	4 (3-6)	6 (5-9)	5 (3-7)
	1	27 (23-32)	17 (14-21)	21 (17-25)	15 (12-18)	9 (7-12)	12 (10-16)	3 (2-5)	7 (5-9)	6 (5-9)	6 (4-9)	6 (5-9)	5 (3-7)
	2+	19 (14-25)	13 (9-18)	15 (11-21)	12 (8-17)	7 (4-11)	9 (6-14)	4 (2-7)	7 (4-12)	7 (5-12)	5 (3-8)	5 (3-9)	2 (1-5)

Appendix 10 – Use of digital technology to monitor health socio-demographics and health status

Adjusted proportion (95% confidence intervals) of the digital technology users adjusting for age, gender and deprivation

		Any	Fitness	Step count	Nutrition	Sleep	Heart rate	Headaches	Medication	Stress or anxiety	Mental wellbeing	Pain	Water
Age group (years)	16-29	52 (45-59)	47 (40-54)	44 (37-51)	34 (28-41)	27 (21-34)	27 (21-34)	15 (11-21)	10 (6-15)	21 (16-28)	18 (13-25)	10 (6-15)	16 (12-22)
	30-39	46 (39-53)	40 (34-47)	41 (34-47)	33 (28-40)	28 (23-35)	25 (20-31)	11 (7-15)	11 (7-16)	12 (9-17)	13 (9-18)	8 (5-12)	15 (11-20)
	40-49	42 (35-50)	36 (29-43)	37 (30-44)	28 (22-35)	16 (12-22)	20 (15-26)	6 (4-11)	9 (5-14)	11 (8-17)	11 (7-17)	8 (5-13)	8 (5-13)
	50-59	37 (30-44)	24 (19-31)	27 (21-34)	16 (11-22)	12 (8-18)	16 (11-22)	5 (2-9)	12 (8-18)	9 (6-14)	8 (5-13)	6 (3-11)	2 (1-6)
	60-69	22 (17-30)	9 (5-14)	18 (13-25)	13 (9-20)	8 (4-13)	11 (7-17)	1 (0-4)	6 (3-11)	3 (1-6)	1 (0-6)	5 (0-9)	2 (1-6)
	70+	11 (7-17)	6 (3-11)	6 (3-12)	6 (3-12)	3 (1-13)	6 (3-11)	1 (0-4)	6 (3-11)	2 (1-6)	2 (1-6)	6 (3-11)	2 (0-6)
Gender	Male	23 (19-27)	25 (21-29)	24 (20-28)	17 (14-21)	11 (8-14)	17 (13-20)	3 (2-5)	8 (6-11)	6 (4-8)	5 (3-7)	6 (4-8)	4 (3-6)
	Female	45 (41-50)	21 (18-25)	27 (24-32)	21 (17-25)	15 (12-19)	14 (11-17)	5 (3-8)	10 (7-12)	10 (7-13)	8 (6-11)	8 (6-10)	5 (4-8)
Deprivation	1 (least)	43 (36-50)	32 (26-39)	34 (28-41)	20 (15-26)	19 (14-25)	18 (13-24)	3 (2-7)	12 (9-17)	9 (6-13)	6 (4-10)	7 (4-8)	6 (3-9)
	2	31 (25-38)	26 (21-33)	27 (21-34)	20 (15-26)	16 (11-21)	18 (14-24)	5 (3-9)	10 (7-15)	10 (6-14)	10 (7-15)	9 (6-10)	7 (4-11)
	3	30 (24-37)	20 (15-27)	24 (19-31)	16 (12-22)	11 (7-16)	16 (11-21)	3 (2-6)	7 (4-12)	5 (3-8)	5 (3-9)	4 (2-8)	4 (2-7)
	4	36 (30-44)	21 (16-27)	26 (21-33)	24 (19-31)	14 (10-19)	15 (11-21)	7 (4-11)	14 (10-19)	10 (7-15)	7 (4-11)	9 (6-14)	4 (3-8)
	5 (most)	25 (19-32)	16 (12-22)	19 (14-25)	16 (11-21)	8 (5-12)	11 (7-15)	3 (1-5)	6 (3-10)	5 (0-9)	3 (2-6)	6 (4-11)	4 (2-7)
General health	High	32 (27-38)	23 (19-28)	26 (22-32)	18 (14-22)	10 (7-13)	13 (10-17)	2 (1-4)	7 (5-10)	4 (3-6)	4 (3-7)	5 (3-7)	3 (2-5)
	Average	35 (30-40)	25 (21-30)	26 (22-31)	19 (16-24)	14 (11-18)	16 (13-20)	5 (3-8)	9 (7-12)	9 (7-13)	7 (5-10)	8 (6-11)	5 (3-7)
	Low	30 (25-37)	19 (15-25)	24 (19-30)	20 (15-25)	16 (12-21)	18 (14-23)	6 (3-9)	13 (9-18)	9 (6-13)	7 (4-11)	10 (7-15)	6 (4-10)
Mental wellbeing	Average	34 (30-37)	24 (21-27)	27 (23-30)	19 (16-22)	13 (10-15)	15 (13-18)	4 (2-6)	8 (7-11)	6 (4-8)	5 (3-0)	7 (5-8)	5 (3-7)
	Low	29 (33-43)	20 (24-34)	21 (26-35)	19 (19-27)	16 (13-21)	17 (15-23)	9 (2-7)	11 (7-12)	20 (4-9)	14 (3-7)	10 (5-10)	5 (3-8)
Health -harming behaviours	0	38 (27-37)	29 (16-24)	30 (20-29)	23 (14-21)	17 (8-14)	19 (11-18)	4 (1-6)	9 (6-11)	6 (5-11)	5 (5-10)	7 (5-10)	5 (3-8)
	1	32 (27-37)	20 (16-24)	24 (20-29)	17 (14-21)	11 (8-14)	14 (11-18)	4 (1-6)	8 (6-11)	8 (5-11)	7 (5-10)	7 (5-10)	5 (3-8)
	2+	24 (18-31)	16 (11-22)	19 (14-26)	15 (10-21)	9 (5-13)	12 (8-17)	4 (2-8)	9 (5-15)	9 (6-14)	6 (3-10)	6 (3-11)	3 (1-6)

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