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NHS Health Checks for people with mental ill-health 2013–2017: an observational study

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Original Article

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Abstract

Aims. People living with serious mental ill-health experience adverse cardiovascular outcomes causing some of the greatest health inequality gaps in England, UK. We describe uptake of the NHS Health Check programme in people with mental ill-health, and rates of new diagnoses and management of cardiovascular risk factors in those who attend NHS Health Checks in comparison to those people without mental ill-health.

Methods. We used a large nationally representative database of people registered with general practitioners in England (QResearch). Between 2013 and 2017, we analysed attendance at NHS Health Checks and outcomes in the succeeding 12 months, in people with serious mental illness (SMI) including psychoses and in people prescribed long-term antidepressant medications (LTAD), with comparison to attendees who did not have these conditions. Hazard ratios (HR) were used to describe the association between outcomes and SMI and LTAD adjusting for sociodemographic variables.

Results. In those eligible for the NHS Health Check programme, we found a higher percentage of people with SMI attended an NHS Health Check (65 490, 19.8%) than those without SMI (524 728, 16.6%); adjusted HR 1.05 [95% confidence interval 1.02–1.08]. We also observed a higher percentage of attendance in people on LTAD (46 437, 20.1%) compared to people who were not prescribed LTAD (543 781, 16.7%); adjusted HR 1.10 (1.08–1.13). People with SMI were more likely to be identified with chronic kidney disease (CKD, HR 1.23, 1.12–1.34) and type 2 diabetes (HR 1.14, 1.03–1.25) within the 12 months following their NHS Health Check compared with those without SMI. People on LTAD were more likely to be identified with CKD (HR 1.55, 1.42–1.70) and type 2 diabetes (HR 1.45, 1.31–1.60) and also hypertension, cardiovascular disease, non-diabetic hyperglycaemia, familial hypercholesterolemia and dementia within the 12 months following their NHS Health Check. Statins were more likely to be prescribed to NHS Health Check attendees with SMI and those on LTAD than those without these conditions; HR 1.31 (1.25–1.38) and 1.91 (1.82–2.01), respectively. Antihypertensives were more likely to be prescribed to those on LTAD; HR 1.21 (1.14–1.29).

Conclusions. We found evidence that people with SMI or on LTAD treatment were 5–10% more likely to access NHS Health Checks than people without these conditions. People with SMI or on LTAD treatment who attended NHS Health Checks had higher rates of diagnosis of CKD, type 2 diabetes and some other relevant co-morbidities and increased treatment with statins and also anti-hypertensive medication in people on LTAD. This is likely to contribute to equitable reduction in adverse cardiovascular events for people with mental ill-health.

Introduction

Around 1 million NHS Health Checks are now completed annually in a 5-year rolling programme designed to prevent cardiovascular disease (CVD) in people aged 40–74 years in England, UK. One of the challenges for such programmes is to deliver care equitably and contribute to reductions in inequalities in health outcomes. In England, 0.86% of the population (483 933 people) registered with a GP are included on the serious mental illness (SMI) register (NHS Rightcare, 2015). Public Health England's evidence review of prescribed medicines, using NHS Digital data, showed that antidepressants were prescribed for 7.3 million people in 2017–2018, over 17% of the 43.0 million adult population in England. Among all adults who received an antidepressant prescription at any time, 4.4 million (43%) had at least one prescription in each of the three preceding years (2015–2018), and 0.9 million (21%) had received prescriptions continuously for 3 years (Taylor *et al.*, 2019). People living with SMI experience a number of adverse health outcomes of which CVD is the largest cause (Reilly *et al.*, 2015). This leads to some of the greatest health inequality gaps in England. The life expectancy for people with SMI is 15–20 years lower than the general population and there has been concern that this may be partly due to a lack of access to appropriate services, including health services, as well as increased exposures to adverse circumstances (Public Health England, 2018). Smoking is the largest avoidable cause of premature death. More than 40% of adults with SMI are smokers compared with 16.7% in the

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general population (NHS Digital, 2016). Individuals with SMI also have double the risk of obesity, diabetes and metabolic syndrome, and five times the risk of dyslipidaemia (Mental Health Taskforce, 2016). People on long-term antidepressant medications (LTAD) also experience a range of adverse health outcomes and increased mortality (Coupland *et al.*, 2016).

In 2016, the Five Year Forward View for Mental Health considered that people living with SMI were not being supported to use available health information and advice, or to take up tests and interventions that reduce the risk of preventable health conditions despite their higher risk of poor physical health (Mental Health Taskforce, 2016). It is thought that in some mental health care settings, patients may have less access and opportunity for cardiovascular risk screening and prevention than would be expected in a non-psychiatric population (De Hert *et al.*, 2009). High levels of smoking and lack of smoking cessation support have been particular issues of concern (Cohen *et al.*, 2018).

The available research evidence on mental ill-health and cardiovascular outcomes describes a complex picture (Foguet-Boreu *et al.*, 2016). In people with SMI compared to those without SMI, CVD risks are relatively higher at younger ages (Vinogradova *et al.*, 2010; Cunningham *et al.*, 2019). However, patients with bipolar disorder or schizophrenia have lower rates of diagnoses and prescribed medication for hypertension and other cardiovascular outcomes (Mitchell *et al.*, 2012; Smith *et al.*, 2013*a*).

Large increases in chronic kidney disease (CKD) associated with antipsychotic use, particularly lithium, have been reported (Iwagami *et al.*, 2018). There is a robust association of antipsychotic and antidepressant use with weight gain and type 2 diabetes (Nielsen *et al.*, 2010). No clear association has been established between antipsychotic use and ischaemic heart disease (Brauer *et al.*, 2011) though there is an association with risk of stroke (Douglas and Smeeth, 2008). There are also cardiovascular risk concerns for people on LTAD treatment (Hazuda *et al.*, 2019) and increased risks of diabetes (Hamer *et al.*, 2011). Most studies have found no increased risks of ischaemic heart disease with selective serotonin reuptake inhibitor (SSRI) antidepressants, though the evidence of association with tricyclics has been mixed (Oh *et al.*, 2014; Coupland *et al.*, 2016). An increased risk of stroke has been associated with SSRI use (Shin *et al.*, 2014). Younger people with SMI were more likely to be prescribed statins than those without SMI though under-prescription of statins to people over 75 years living with SMI has been reported (Blackburn *et al.*, 2018; Osborn *et al.*, 2018). For people 65 years or older, the NHS Health Checks include advice about dementia awareness. People with dementia are often treated with antidepressants. A retrospective nationwide cohort study in Taiwan found association between antidepressant and occurrence of dementia after controlling for the status of depression (Then *et al.*, 2017).

Despite the large literature on the association between mental ill-health and adverse cardiovascular outcomes, and the concerns of policy makers to improve services, we are not aware of any studies of NHS Health Checks in community settings that have examined uptake or outcomes in people with mental ill-health.

The objectives of the study were to assess uptake of NHS Health Checks; risk factor recording; CVD risk scores; treatment with statins and antihypertensives and clinical outcomes (new diagnosis of hypertension, CVD, type 2 diabetes, non-diabetic hyperglycaemia, CKD, familial hypercholesterolemia, atrial fibrillation and dementia) for people with and without SMI and for those with and without LTAD.

Methods

The study conforms to the STROBE reporting recommendations (von Elm *et al.*, 2008). We carried out the study using version 43 of the QResearch database, a validated nationally representative primary care database containing the health records of 35 million people registered with 1500 general practices in the UK using the same electronic record (Egton Medical Information System, EMIS). All analyses were conducted using Stata MP V.16.0.

Inclusion/exclusion criteria

We included an open cohort of registered patients aged 40–74 (i.e. eligible patients for an NHS Health Check) between April 2013 and March 2017 in England. Patients must have been registered for a minimum of 1 year at the study entry date. Date of study entry was defined as the latest of: (a) date of registration with the GP practice plus 12 months or (b) 1 April 2013 or (c) date of 40th birthday. We excluded patients who were not eligible for the NHS Health Check programme which includes people already on statins or with a diagnosis of hypertension, CVD (ischaemic heart disease, stroke or transient ischaemic attack), atrial fibrillation, heart failure, peripheral arterial disease, CKD, familial hypercholesterolemia, and type 2 or type 1 diabetes on the study entry date. Patients were also excluded if they had a previous NHS Health Check in the past 5 years.

Case definition

We identified patients recorded with SMI prior to their NHS Health Check or index date, using the national Quality and Outcomes Framework definition which includes psychosis, schizophrenia and bipolar affective disease (NHS Digital, 2015). Patients without those diagnoses were grouped as non-SMI. We identified people on LTAD medication defined as having been prescribed six or more prescriptions of antidepressants prior to their NHS Health Check or index date, of which at least one of these antidepressant prescriptions was within the 6 months prior to the NHS Health Check or index date. For those without an NHS Check during the study period, we allocated an index date of 1 April in each year after the patient entered in the cohort. All other patients not on LTAD therapy matching our case definition were the comparator group.

Outcome measures

The main outcome was attendance at an NHS Health Check. Patients were followed from their study entry date up until they were censored at the earliest date when: they left a practice (at the day of deregistration); they died; or the study period ended at 31 March 2017. Secondary outcomes evaluated in people who attended an NHS Health Check were new diagnoses or new prescribed treatment at the NHS Health Check or in the 12 months after. For secondary outcomes censor dates were whichever came first: left a practice, death; or 12 months after the NHS Health Check. The secondary outcomes were new diagnoses of hypertension, CVD (ischaemic heart disease, stroke or transient ischaemic attack), type 2 diabetes, non-diabetic hyperglycaemia (fasting plasma glucose 6.0–6.9 mmol/l or HbA1c: 42–47 mmol/mol), CKD (eGFR <60 ml/min/1.73 m^2; category 3–5) and familial hypercholesterolemia. New diagnosis of atrial fibrillation and dementia were assessed in patients aged 65–74 years. Two or more prescriptions of a first ever treatment of statins and

antihypertensives within 12 months of the NHS health Check were the outcomes considered for new treatment. Antihypertensive prescriptions included the three main classes thiazide, calcium channel blocker and ACE/angiotensin receptor blocker.

Risk factors

The cohort was described according to sex, age group in years (40–49, 50–59, 60–69, 70–74) and self-reported ethnic group using Office of National Statistics categories: white (British, Irish, other white ethnic groups); South Asian (Bangladeshi, Indian, Pakistani); black African; black Caribbean; Chinese; other (any other recorded ethnic group including mixed ethnic groups) and ethnic group not recorded (Office of National Statistics, 2015). Deprivation was assessed using the Townsend score based on 2011 Census-derived measures of overcrowding, car ownership and education, obtained by linking the individuals' postcode to UK Census information at lower super output area, containing ~150 households (Townsend *et al.*, 1988). Individuals were grouped into fifths of deprivation.

Data were extracted on 31 May 2018. 'Read' codes were used to code clinical data. Outcome data were extracted from the general practitioner record on or within 12 months of an NHS Health Check or an index date in non-attendees of 1 April in the year of cohort entry. Sociodemographic, risk factor recording and data for related measures were extracted from the closest date prior to or on NHS Health Check or index date.

Statistical analysis and missing values

We classified missing values for ethnicity and deprivation onto a 'not stated or recorded' category. Cox's proportional hazards models were used to describe the association between the outcomes and SMI and LTAD. We assessed the proportional hazards assumption by using log minus log plots. When the proportional hazards assumption for Cox regression was not met, Royston-Parmar proportional hazards models were used instead. All models controlled for clustering by general practice, by allowing outcomes to vary across practices. We calculated unadjusted hazard ratios (HR) for SMI or LTAD and fitted two separate models to calculate adjusted HR with 95% confidence intervals (CIs) for each SMI and LTAD. We adjusted for sex, age, ethnic group, Townsend deprivation score and region. We considered a significance level of 0.01 (two tailed) as statistically significant.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. JR is the corresponding author. CG is the alternative corresponding author who had access to all the data and responsibility for submission of the article.

Results

Descriptive analysis

The flowchart Fig. 1 shows the cohort definition. There were 3 492 816 people eligible for an NHS Health Check of whom 330 685 (9.5%) had SMI and 230 502 (6.6%) were on LTAD treatment. There were 590 218 NHS Health Check attendees who comprised 65 490 (11.1%) with SMI and 46 437 (7.9%) NHS Health Check attendees were on LTAD treatment. Table 1 describes characteristics of 65 490 people attending an NHS Health Check with SMI, and 46 437 who were on LTAD treatment. There were 19 868 patients who had both SMI and LTAD treatment.

Uptake of NHS Health Checks

Table 2 shows the unadjusted and adjusted HR for NHS Health Check attendance for people with SMI or on LTAD adjusted for age, sex, ethnicity, region and deprivation. People with SMI were more likely to attend an NHS Health Check than people without SMI. Of eligible people with SMI, 65 490 (19.8%) attended an NHS Health Check in comparison to 524 728 (16.6%) of those without SMI (Table 1); adjusted HR 1.05 (95% CI 1.02–1.08). Table 1 shows that 46 437 (20.1%) people on LTAD attended an NHS Health Check compared to 543 781 (16.7%) of people who were not prescribed LTAD. Table 2 shows that after adjustment this difference remained significant; HR 1.10 (95% CI 1.08–1.13). Among NHS Health Check attendees there were fewer men than women, particularly for the SMI and LTAD groups (45.6% were men in non-SMI/non-LTAD attendees, 32.5% men among attendees with SMI, 27.7% men among attendees on LTAD Table 1; overall unadjusted HR 0.79, 95% CI 0.78–0.80 for attendance in men compared with women, Table 2). Lower attendance is also observed in men than women in models adjusted for age, sex, ethnic group, Townsend deprivation score and region and either SMI or LTAD; adjusted HR for attendance in men compared with women 0.87 (95% CI 0.86–0.88) and HR 0.87 (95% CI 0.86–0.89), respectively. Lower attendance in men than women is also seen for SMI patients ($n = 330\,685$) when adjusted for age, sex, ethnic group, Townsend deprivation score and region, HR 0.88 (95% CI 0.86–0.90); and for LTAD patients ($n = 230\,502$), HR 0.94 (95% CI 0.92–0.96).

People at older ages were more likely to attend an NHS Health Check in comparison to the younger age group 40–49 years; adjusted HR peaked at age 60–69 years in both models (Table 2). Adjusted HR just for SMI and LTAD patients also peaked at age 60–69 years, HR 1.35 (95% CI 1.29–1.41) and HR 1.32 (95% CI 1.26–1.37), respectively.

Most non-white ethnic groups (Bangladeshi, Indian, Pakistani, black Caribbean and black African) were more likely to attend an NHS Health Check than white ethnic groups in both models. This pattern is also observed in SMI and LTAD patient groups [e.g.: Bangladeshi *v.* white: HR 2.37 (95% CI 1.99–2.82) and HR 2.38 (95% CI 2.04–2.78), respectively]. People living in the most deprived areas (quintiles Q4 and Q5) were less likely to attend an NHS Health Check than those in the most affluent quintile (Q1) in both models. We found similar results with deprivation for the groups of patients with SMI and on LTAD [Q4 *v.* Q1: HR 0.90 (95% CI 0.84–0.97) and HR 0.93 (95% CI 0.87–1.00), respectively; Q5 *v.* Q1: HR 0.92 (95% CI 0.83–1.01) and HR 0.94 (95% CI 0.86–1.03), respectively].

Table 3 describes NHS Health Check attendance in people with and without SMI and LTAD in relation to recorded risk factors and outcomes. In people with SMI, new hypertension within 12 months of an NHS Health Check was diagnosed in 23/1000 compared with 25/1000 for those without SMI. This difference was not significant in either unadjusted or adjusted analysis (Table 4). Hypertension within 12 months of an NHS Health Check was more likely to be diagnosed in people on LTAD 26/1000 in comparison to those not on LTAD, 25/1000 which was significant in the adjusted analysis HR 1.12 (95% CI 1.05–1.20).

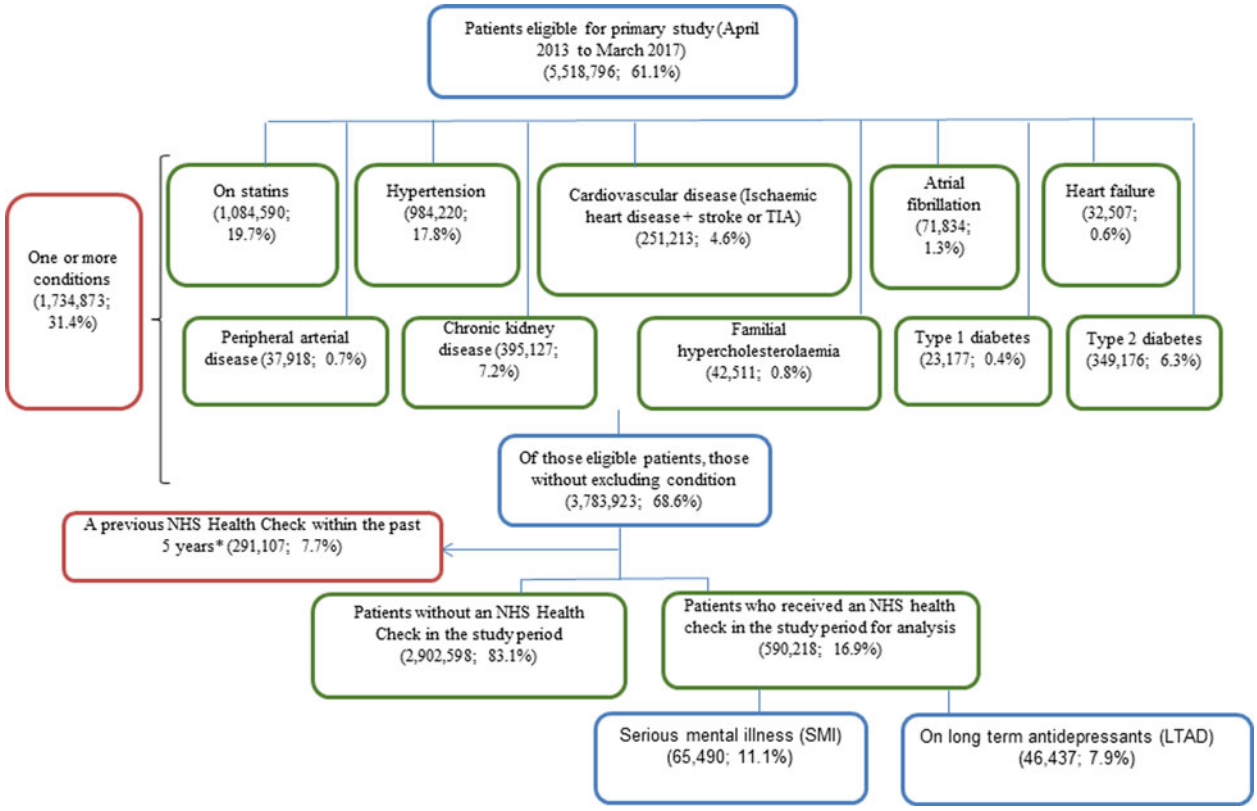

Fig. 1. Flowchart showing selection criteria of patients eligible for an NHS Health Check. Primary study period April 2013 to March 2017.

New diagnosis of CVD

A new diagnosis of CVD in the 12 months after an NHS Health Check was made in 2.7/1000 attendees with SMI compared with 2.8/1000 for those without SMI (Table 3); adjusted HR 1.15 (95% CI 0.99–1.33) (Table 4). LTAD prescription was significantly related to new diagnoses of CVD within 12 months: 3.8/1000 compared to 2.7/1000 in people not prescribed LTAD; adjusted HR 1.66 (95% CI 1.41–1.94) (Table 4).

New diagnosis of type 2 diabetes

For people with and without SMI, new diagnoses of type 2 diabetes in the 12 months after an NHS Health Check were the same 7.7/1000 (Table 3) and there was no significant association in the unadjusted analysis. However, SMI became significant in the adjusted analysis [HR 1.14 (95% CI 1.03–1.25)] (Table 4). For people on LTAD attending NHS Health Checks, new type 2 diabetes diagnosis was 9.1/1000 compared with 7.6/1000 for those not on LTAD (Table 3); adjusted HR 1.45 (95% CI 1.31–1.60).

New diagnosis of non-diabetic hyperglycaemia

Non-diabetic hyperglycaemia diagnosis within 12 months was not significantly associated with SMI (Table 4). People on LTAD were more likely to be diagnosed with non-diabetic hyperglycaemia: adjusted HR 1.36 (95% CI 1.16–1.59) (Table 4).

New diagnosis of CKD

People with SMI were more likely to be diagnosed with CKD at or in the 12 months following the NHS Health Check; 8.6/1000 in attendees with SMI compared with 7.1/1000 for those without SMI (Table 3); adjusted HR 1.23 (95% CI 1.12–1.34) (Table 4). Attendees on LTAD also had a higher rate of CKD diagnosis 10.8/1000, compared with 7.0/1000 for those not prescribed LTAD (Table 3) which was significant; adjusted HR 1.55 (95% CI 1.42–1.70) (Table 4).

New diagnosis of familial hypercholesterolemia

New diagnosis of familial hypercholesterolemia was similar between attendees with SMI and without SMI. In the adjusted analysis, 1.1/1000 of eligible people with SMI attended an NHS Health Check in comparison to 0.9/1000 of those without SMI (Table 3); HR 1.14 (95% CI 0.88–1.47) (Table 4). People on LTAD had a higher rate of newly diagnosed familial hypercholesterolemia 1.4/1000 compared with 0.8/1000 for those on LTAD (Table 3) adjusted HR 1.47 (95% CI 1.14–1.90).

New diagnosis of atrial fibrillation

In attendees aged 65 years and older with SMI, new diagnosis of atrial fibrillation was 3.5/1000 compared to those without SMI, 4.9/1000 (Table 3). There was no significant difference in the analysis (Table 4).

In attendees aged 65 or older on LTAD, new diagnosis of atrial fibrillation was 3.0/1000 compared to 4.9/1000 in those not on LTAD (Table 3). However, there was no significant difference between groups (Table 4).

Table 1. NHS Health Check 2013–2017

		Non-SMI	SMI	Non-LTAD	LTAD
		n (%)	*n* (%)	*n* (%)	*n* (%)
Count of patients recorded	Total	3 162 131	330 685	3 262 314	230 502
	Attended an NHS Health Check	524 728 (16.6)	65 490 (19.8)	543 781 (16.7)	46 437 (20.1)
****ATTENDEES****					
Sex	Women	285 238 (54.4)	44 232 (67.5)	295 884 (54.4)	33 586 (72.3)
	Men	239 490 (45.6)	21 258 (32.5)	247 897 (45.6)	12 851 (27.7)
Age-band (years)	40 to 49	252 840 (48.2)	33 719 (51.5)	263 565 (48.5)	22 994 (49.5)
	50 to 59	157 174 (30.0)	20 453 (31.2)	163 067 (30.0)	14 560 (31.4)
	60 to 69	96 945 (18.5)	9831 (15.0)	99 175 (18.2)	7601 (16.4)
	70 to 74	17 769 (3.4)	1487 (2.3)	17 974 (3.3)	1282 (2.8)
Ethnic category	White	424 795 (81.0)	56 409 (86.1)	439 655 (80.9)	41 549 (89.5)
	Indian	13 313 (2.5)	797 (1.2)	13 722 (2.5)	388 (0.8)
	Pakistani	8336 (1.6)	715 (1.1)	8591 (1.6)	460 (1.0)
	Bangladeshi	6701 (1.3)	520 (0.8)	6863 (1.3)	358 (0.8)
	Other Asian	8233 (1.6)	524 (0.8)	8482 (1.6)	275 (0.6)
	Caribbean	6982 (1.3)	841 (1.3)	7583 (1.4)	240 (0.5)
	Black African	12 068 (2.3)	849 (1.3)	12 600 (2.3)	317 (0.7)
	Chinese	3498 (0.7)	141 (0.2)	3590 (0.7)	49 (0.1)
	Other	14 134 (2.7)	1626 (2.5)	14 958 (2.8)	802 (1.7)
	ethnicity not stated or recorded	26 668 (5.1)	3068 (4.7)	27 737 (5.1)	1999 (4.3)
Townsend index of deprivation (quintiles)	1 (most affluent)	121 861 (23.2)	11 632 (17.8)	124 959 (23.0)	8534 (18.4)
	2	118 721 (22.6)	12 818 (19.6)	122 121 (22.5)	9418 (20.3)
	3	104 977 (20.0)	13 261 (20.2)	108 791 (20.0)	9447 (20.3)
	4	90 086 (17.2)	13 483 (20.6)	94 023 (17.3)	9546 (20.6)
	5 (most deprived)	88 627 (16.9)	14 214 (21.7)	93 413 (17.2)	9428 (20.3)
	Townsend not stated or recorded	456 (0.1)	82 (0.1)	474 (0.1)	64 (0.1)
Geographical regions (England)	East Midlands	24 930 (4.8)	2975 (4.5)	25 433 (4.7)	2472 (5.3)
	East of England	34 858 (6.6)	3834 (5.9)	35 651 (6.6)	3041 (6.5)
	London	108 302 (20.6)	12 359 (18.9)	113 874 (20.9)	6787 (14.6)
	North East	15 663 (3.0)	2744 (4.2)	16 404 (3.0)	2003 (4.3)
	North West	81 962 (15.6)	11 842 (18.1)	84 190 (15.5)	9614 (20.7)
	South Central	70 662 (13.5)	8596 (13.1)	73 356 (13.5)	5902 (12.7)
	South East	40 637 (7.7)	4578 (7.0)	41 943 (7.7)	3272 (7.0)
	South West	57 871 (11.0)	7233 (11.0)	60 151 (11.1)	4953 (10.7)
	West Midlands	63 800 (12.2)	8239 (12.6)	66 362 (12.2)	5677 (12.2)
	Yorkshire & Humber	26 043 (5.0)	3090 (4.7)	26 417 (4.9)	2716 (5.8)

SMI, severe mental illness; LTAD, long-term antidepressants; NHS, national health services.
People with SMI in comparison to those without SMI. People prescribed a LTAD *v.* non-LTAD. *n* (%), number and proportion (%).

New diagnosis of dementia

In attendees aged 65 years and older with and without SMI, rates for new dementia diagnosis within 12 months were 2.6/1000 and 1.7/1000, respectively (Table 3) and differences were not significant (Table 4). Attendees aged 65 or older on LTAD were more likely to be diagnosed with dementia within 12 months after NHS Health Check compared to those not on LTAD; 4.3/1000 and 1.5/1000, respectively (Table 3); adjusted HR 3.25 (95% CI 1.96–5.38) (Table 4).

Table 2. NHS Health Check attendance

	Eligible for NHS Health Checks (*N* = 3 492 816)								
	Unadjusted analysis			Adjusted analysis - SMI exposure			Adjusted analysis – LTAD exposure		
	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)
Exposure variables									
SMI	**1.24**	**[1.20–1.29]**	**<0.001**	**1.05**	**[1.02–1.08]**	**0.001**			
LTAD	**1.19**	**[1.16–1.22]**	**<0.001**				**1.10**	**[1.08–1.13]**	**<0.001**
Risk factors									
Sex									
Women	1.00	–	–	1.00	–	–	1.00	–	–
Men	**0.79**	**[0.78–0.80]**	**<0.001**	**0.87**	**[0.86–0.88]**	**<0.001**	**0.87**	**[0.86–0.89]**	**<0.001**
Age band (years)									
40–49	1.00	–	–	1.00	–	–	1.00	–	–
50–59	**1.07**	**[1.05–1.10]**	**<0.001**	**1.19**	**[1.17–1.21]**	**<0.001**	**1.19**	**[1.17–1.21]**	**<0.001**
60–69	**1.26**	**[1.21–1.32]**	**<0.001**	**1.48**	**[1.43–1.53]**	**<0.001**	**1.48**	**[1.43–1.53]**	**<0.001**
70–74	1.06	[1.00–1.13]	0.058	**1.35**	**[1.28–1.42]**	**<0.001**	**1.34**	**[1.28–1.42]**	**<0.001**
Ethnicity									
White	1.00	–	–	1.00	–	–	1.00	–	–
Indian	**1.23**	**[1.11–1.37]**	**<0.001**	**1.26**	**[1.14–1.39]**	**<0.001**	**1.26**	**[1.14–1.39]**	**<0.001**
Pakistani	**1.31**	**[1.12–1.52]**	**0.001**	**1.42**	**[1.23–1.65]**	**<0.001**	**1.42**	**[1.23–1.65]**	**<0.001**
Bangladeshi	**2.30**	**[2.02–2.63]**	**<0.001**	**2.57**	**[2.26–2.91]**	**<0.001**	**2.57**	**[2.26–2.91]**	**<0.001**
other Asian	1.03	[0.92–1.16]	0.584	1.10	[0.99–1.22]	0.080	1.10	[0.99–1.22]	0.074
Caribbean	1.11	[0.99–1.24]	0.078	**1.16**	**[1.05–1.28]**	**0.003**	**1.16**	**[1.05–1.29]**	**0.003**
black African	1.10	[0.98–1.23]	0.093	**1.21**	**[1.11–1.32]**	**<0.001**	**1.21**	**[1.11–1.32]**	**<0.001**
Chinese	0.98	[0.92–1.06]	0.671	1.03	[0.97–1.10]	0.307	1.03	[0.97–1.10]	0.270
other	0.98	[0.92–1.05]	0.617	1.06	[1.01–1.12]	0.020	1.06	[1.01–1.12]	0.016
not stated or recorded	**0.10**	**[0.09–0.12]**	**<0.001**	**0.10**	**[0.09–0.12]**	**<0.001**	**0.10**	**[0.09–0.12]**	**<0.001**
Townsend index of deprivation (quintiles)									
1 (most affluent)	1.00	–	–	1.00	–	–	1.00	–	–
2	1.04	[1.00–1.09]	0.042	1.02	[0.99–1.05]	0.260	1.02	[0.99–1.05]	0.269
3	0.99	[0.93–1.05]	0.676	0.94	[0.90–0.99]	0.013	0.94	[0.90–0.99]	0.012
4	0.96	[0.89–1.04]	0.340	**0.87**	**[0.82–0.93]**	**<0.001**	**0.87**	**[0.82–0.93]**	**<0.001**
5 (most deprived)	1.12	[1.00–1.25]	0.048	**0.89**	**[0.82–0.97]**	**0.008**	**0.89**	**[0.81–0.97]**	**0.007**
not stated or recorded	**0.66**	**[0.54–0.80]**	**<0.001**	0.90	[0.81–1.01]	0.088	0.90	[0.81–1.01]	0.085
Geographical regions									
East Midlands	1.00	–	–	1.00	–	–	1.00	–	–
East of England	1.16	[0.77–1.76]	0.466	0.96	[0.66–1.40]	0.840	0.96	[0.66–1.40]	0.839
London	1.45	[1.01–2.07]	0.042	1.11	[0.81–1.53]	0.520	1.11	[0.81–1.54]	0.511

(*Continued*)

Table 2. (*Continued.*)

	Eligible for NHS Health Checks (*N* = 3 492 816)								
	Unadjusted analysis			Adjusted analysis - SMI exposure			Adjusted analysis – LTAD exposure		
	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)
North East	0.99	[0.61–1.59]	0.960	0.96	[0.64–1.45]	0.854	0.96	[0.64–1.45]	0.852
North West	1.21	[0.85–1.72]	0.297	1.06	[0.77–1.46]	0.730	1.06	[0.77–1.46]	0.733
South Central	1.21	[0.84–1.74]	0.297	1.06	[0.77–1.47]	0.703	1.07	[0.77–1.47]	0.699
South East	1.00	[0.67–1.49]	0.998	0.87	[0.62–1.24]	0.456	0.88	[0.62–1.24]	0.459
South West	1.07	[0.74–1.56]	0.706	1.01	[0.73–1.41]	0.938	1.01	[0.73–1.41]	0.935
West Midlands	1.38	[0.95–2.00]	0.091	1.18	[0.85–1.64]	0.325	1.18	[0.85–1.64]	0.321
Yorkshire & Humber	1.20	[0.77–1.87]	0.410	1.02	[0.68–1.52]	0.935	1.02	[0.68–1.52]	0.939

SMI, severe mental illness; LTAD, long-term antidepressants; NHS, national health services; CI, confidence intervals.
SMI in comparison to no SMI and LTAD in comparison to no LTAD. Association with demographic factors using unadjusted and adjusted hazard ratios. Bold font identifies statistical significance <0.01.

New treatments with statins

More people with SMI were prescribed a statin at the NHS health Check or in the 12 months following (29/1000) compared to 26/1000 without SMI (Table 3), adjusted HR 1.31 (95% CI 1.25–1.38) (Table 4). Statins were prescribed to 6.5/1000 attendees with SMI at age 40–49 years and 3.9/1000 without SMI; 50–59 years 16/1000 *v.* 12/1000; 60–69 years 34/1000 *v.* 28/1000 and 70 −74 years 47/1000 *v.* 44/1000.

Attendees on LTAD were more likely to start statins compared to those not on LTAD (41/1000 and 25/1000, respectively) (Table 3); adjusted HR 1.91 (95% CI 1.82–2.01) (Table 4).

New treatments with antihypertensives

Attendees with SMI were prescribed antihypertensives in 32/1000 NHS Health Check attendances or subsequent 12 months compared to 30/1000 for those without SMI (Table 3). This was not significant in the adjusted analysis (Table 4). Attendees on LTAD had higher prescription of new antihypertensive medication 27/1000 than those not on LTAD 24/1000. (Table 3). This was significant in the adjusted analysis; HR 1.21 (95% CI 1.14–1.29) (Table 4).

Discussion

There was higher attendance at NHS Health Checks in people with SMI or on LTAD than in people without those conditions. Men were less likely to attend an NHS Health Check than women. In people with SMI or LTAD, women were also more likely to attend than men. People with SMI and those on LTAD were significantly more likely to be newly prescribed statins within the 12 months following an NHS Health Check in comparison to people without these conditions. Antihypertensive prescribing was similar in those with and without SMI but higher in patients on LTAD than those not on LTAD.

At the NHS Health Check or within the following 12 months, attendees with SMI and LTAD were more likely to be identified with new diagnoses of CKD and type 2 diabetes than attendees without these conditions. People with SMI had a similar likelihood of a new diagnosis of hypertension, CVD, non-diabetic hyperglycaemia and familial hypercholesterolemia compared with people without SMI. Patients on LTAD were more likely to be newly diagnosed with hypertension, CVD, non-diabetic hyperglycaemia and familial hypercholesterolemia at the NHS Health Check or within the following 12 months. People with SMI or LTAD aged 65–74 years had a similar likelihood of a new diagnosis of atrial fibrillation in comparison to those without these conditions but dementia was more likely to be diagnosed in those on LTAD; numbers however were small (19 LTAD patients with dementia *v.* 95 non-LTAD patients with dementia). The association of dementia with antidepressant therapy has been reported in a systematic review of five studies from North America and Asia involving a total of 53 955 participants (Wang *et al.*, 2018).

Our study is large and distributed across the regions of England and likely to be nationally representative of people with SMI and those on LTAD prescription. The definitions of SMI and those on LTAD do not take account of people who have resolution or episodic remissions of their mental health condition nor the duration or intermittence of antidepressant medication prescriptions, which may reduce the associations that we found by our inclusive case definition.

There is evidence that antipsychotics are associated with acute kidney injury (Jiang *et al.*, 2017) and that people with schizophrenia or bipolar disorder have higher levels of CKD (Smith *et al.*, 2013*b*). It is likely that people with SMI and those on LTAD prescription may also be taking other medications known to be associated with CKD including lithium (Iwagami *et al.*, 2018). There may be other factors such as impaired glucose tolerance and

Table 3. Eligible population for NHS Health Check with or without SMI and LTAD by recorded risk factor and outcome

	Non-SMI *n* (%)	SMI *n* (%)	Non-LTAD *n* (%)	LTAD *n* (%)
Count of patients recorded	3 162 131	330 685	3 262 314	230 502
Patients with an NHS Health Check	524 728 (16.6)	65 490 (19.8)	543 781 (16.7)	46 437 (20.1)
Patients aged 65–74 with an NHS Health Check	60 452 (1.9)	5411 (1.6)	61 476 (1.9)	4387 (1.9)
Risk factor recording				
BMI recorded	520 424 (99.2)	65 021 (99.3)	539 353 (99.2)	46 092 (99.3)
SBP recorded	523 685 (99.8)	65 444 (99.9)	542 724 (99.8)	46 405 (99.9)
Cholesterol recorded	496 656 (94.7)	62 326 (95.2)	514 579 (94.6)	44 403 (95.6)
Cholesterol/HDL recorded	460 290 (87.7)	58 185 (88.8)	476 952 (87.7)	41 523 (89.4)
Positive family history CHD	104 231 (19.9)	15 244 (23.3)	108 269 (19.9)	11 206 (24.1)
Categories of continuous measures (up to NHSHC or index date)				
Obese	112 752 (21.5)	17 962 (27.4)	116 278 (21.4)	14 436 (31.1)
SBP > 140 mmHg	83 242 (15.9)	8230 (12.6)	85 773 (15.8)	5699 (12.3)
DBP > 90 mmHg	46 480 (8.9)	5093 (7.8)	47 876 (8.8)	3697 (8.0)
Hypercholesterolemia (>7.5 mmol/l)	9895 (1.9)	1510 (2.3)	9937 (1.8)	1468 (3.2)
Outcomes (after NHSHC or index date until 12 months)				
Hypertension	13 089 (2.49)	1527 (2.33)	13 431 (2.47)	1185 (2.55)
Cardiovascular disease	1486 (0.28)	179 (0.27)	1489 (0.27)	176 (0.38)
Type 2 diabetes	4051 (0.77)	504 (0.77)	4133 (0.76)	422 (0.91)
Non-diabetic hyperglycaemia	1908 (0.36)	249 (0.38)	1935 (0.36)	222 (0.48)
Chronic kidney disease	3725 (0.71)	561 (0.86)	3785 (0.70)	501 (1.08)
Familial hypercholesterolemia	457 (0.09)	71 (0.11)	462 (0.08)	66 (0.14)
Atrial fibrillation 65 + *	296 (0.49)	19 (0.35)	302 (0.49)	13 (0.30)
Dementia 65 + *	100 (0.17)	14 (0.26)	95 (0.15)	19 (0.43)
Statin prescription	13 565 (2.61)	1905 (2.93)	13 549 (2.49)	1921 (4.14)
Antihypertensive prescription	15 619 (2.98)	2090 (3.19)	13 199 (2.43)	1262 (2.72)

SMI, severe mental illness; LTAD, long-term antidepressants; NHS, national health services; BMI, body mass index; SBP, systolic blood pressure; HDL, high-density lipoproteins; CHD, coronary heart disease; NHSHC, NHS Health Checks; DBP, diastolic blood pressure. * The denominator used for the calculation of the rate considered attendees aged 65–74 years old. This denominator is displayed in the third row labelled as 'Patients age ⩾ 65 with an NHS Health Check'.
n (%), number and proportion (%).

metabolic syndrome that also contribute to renal impairment in people with SMI. These issues have been considered by Iwagami *et al.*, concluding that CKD is identified more commonly among patients with SMI than in the general population (Iwagami *et al.*, 2018).

Like ours, other studies did not find a higher level of hypertension in people with SMI and most also report higher levels of type 2 diabetes in association with anti-psychotic medication and obesity (Smith *et al.*, 2013*a*). It is notable that the association between type 2 diabetes diagnosis and SMI in our study was not stronger. One explanation could be that identification of type 2 diabetes was part of the national Quality and Outcomes Framework from 2012/2013 to 2016/2017 and GPs were incentivised to monitor blood glucose and cholesterol levels for people with SMI. This may have reduced the numbers of new diagnoses of type 2 diabetes found at NHS Health Checks in people with SMI during this period because people already diagnosed with type 2 diabetes are excluded from NHS Health Check programme.

In studies prior to the NHS Health Checks programme, statin usage in people with pre-existing CVD was lower in people with SMI than in those without SMI (Hippisley-Cox *et al.*, 2007). In a more recent study 2006–2015, statin initiation in people with SMI without pre-existing CVD aged under 60 years, was 2−3 times higher than in people without SMI; in older people aged 60–74 years statin prescribing was similar in the two groups whilst statin prescribing was lower in those over 75 years with SMI, though these differences declined over time (Blackburn *et al.*, 2018). Our study showed similarly higher prescribing of statins in people aged 40–69 years with SMI compared to those without SMI.

The relationship between antidepressant prescription and CVD has previously been assessed by several studies (Oh *et al.*, 2014; Coupland *et al.*, 2016) which found no association between SSRIs and ischaemic heart disease, albeit with some limited evidence of an increase with tricyclic antidepressants. There was no association of CVD with SMI, but there was for people on LTAD. The association of CVD outcomes with LTAD prescription is subject to possible sources of bias. Our study did not record CVD deaths, hence outcomes are limited to CVD survivors leading to possible differential under-reporting of events. In people on LTAD, the greater likelihood of diagnosis of familial

Table 4. New diagnoses and prescribed treatments within 12 months after NHS Health Check unadjusted and adjusted hazard ratios for people with SMI and LTAD

	Unadjusted analysis			Adjusted analysis – SMI			Adjusted analysis – LTAD		
	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)	Hazard ratio	95% CI	*p* value (Wald test)
Hypertension									
SMI	0.94	[0.89–1.00]	0.039	1.02	[0.96–1.09]	0.506			
LTAD	1.03	[0.97–1.10]	0.321				**1.12**	**[1.05–1.20]**	**0.001**
Cardiovascular disease									
SMI	0.97	[0.83–1.13]	0.671	1.15	[0.99–1.33]	0.074			
LTAD	**1.39**	**[1.19–1.63]**	**<0.001**				**1.66**	**[1.41–1.94]**	**<0.001**
Type 2 diabetes									
SMI	1.00	[0.91–1.10]	0.962	**1.14**	**[1.03–1.25]**	**0.009**			
LTAD	**1.20**	**[1.08–1.33]**	**<0.001**				**1.45**	**[1.31–1.60]**	**<0.001**
Non-diabetic hyperglycaemia									
SMI	1.05	[0.91–1.22]	0.490	1.09	[0.94–1.26]	0.276			
LTAD	**1.35**	**[1.15–1.58]**	**<0.001**				**1.36**	**[1.16–1.59]**	**<0.001**
Chronic kidney disease									
SMI	**1.21**	**[1.11–1.33]**	**<0.001**	**1.23**	**[1.12–1.34]**	**<0.001**			
LTAD	**1.56**	**[1.42–1.71]**	**<0.001**				**1.55**	**[1.42–1.70]**	**<0.001**
Familial hypercholesterolemia									
SMI	1.25	[0.97–1.62]	0.082	1.14	[0.88–1.47]	0.323			
LTAD	**1.68**	**[1.30–2.16]**	**<0.001**				**1.47**	**[1.14–1.90]**	**0.003**
Atrial fibrillation 65 +									
SMI	0.72	[0.45–1.17]	0.185	0.83	[0.51–1.34]	0.438			
LTAD	0.60	[0.35–1.04]	0.069				0.74	[0.43–1.28]	0.282
Dementia 65 +									
SMI	1.58	[0.91–2.73]	0.102	1.70	[0.97–3.00]	0.066			
LTAD	**2.82**	**[1.73–4.60]**	**<0.001**				**3.25**	**[1.96–5.38]**	**<0.001**
Statins									
SMI	**1.13**	**[1.08–1.19]**	**<0.001**	**1.31**	**[1.25–1.38]**	**<0.001**			
LTAD	**1.68**	**[1.60–1.76]**	**<0.001**				**1.91**	**[1.82–2.01]**	**<0.001**
Antihypertensives									
SMI	0.96	[0.91–1.01]	0.137	1.04	[0.98–1.09]	0.228			
LTAD	**1.12**	**[1.06–1.19]**	**<0.001**				**1.21**	**[1.14–1.29]**	**<0.001**

SMI, severe mental illness; LTAD, long-term antidepressants. Bold font identifies statistical significance <0.01.

hypercholesterolemia may also be due to confounding as this condition is often poorly defined. For dementia, the differences were contingent on small numbers of diagnoses and the further possibility of confounding by indication as antidepressants are widely used in people with cognitive impairment. The risk of hypertension has been shown to be associated with antidepressant usage (Licht *et al.*, 2009).

Limitations

This study included a large representative sample of people aged 40–74 years old from the general English population. All eligible patients were included, so no bias due to non-response was present. We limited selection bias due to loss to follow up by using a short time of follow up. Patients were followed up for a maximum of 4 years for the main outcome (uptake of an NHS Health Check) and just 1 year for the outcomes of new diagnoses and new treatments. Regression analysis allowed for differences in population demographic factors between those with and without SMI/LTAD although it is possible that residual confounding may contribute to the differences between groups.

We grouped psychosis, schizophrenia and bipolar affective disease as SMI. They are different conditions which in separate analysis may show some variability in the estimated effect for the

analysed outcomes. However, previous studies have detected a common direction of the effect with lower levels of recorded physical diseases and drug prescription (De Hert *et al.*, 2009; Vinogradova *et al.*, 2010; Mitchell *et al.*, 2012; Smith *et al.*, 2013*a*; Reilly *et al.*, 2015; Foguet-Boreu *et al.*, 2016; Blackburn *et al.*, 2018; Iwagami *et al.*, 2018; Osborn *et al.*, 2018; Public Health England, 2018; Cunningham *et al.*, 2019).

Conclusion

People with SMI or on LTAD were 5–10% more likely to attend NHS Health Checks than people without these conditions. People with SMI or on LTAD were more likely to be identified with CKD and type 2 diabetes at the NHS Health Check or in the 12 months after and people on LTAD were more likely to have new diagnosis of hypertension, non-diabetic hyperglycaemia, familial hypercholesterolemia and over age 65 years, of dementia, than people not on LTAD treatment.

People with SMI or on LTAD were more likely to be prescribed statins, and antihypertensives were more likely to be prescribed to people on LTAD than those not on LTAD. The uptake of NHS Health Checks is associated with earlier identification of co-morbidities and earlier initiation of preventive treatments. Hence, NHS Health Checks may reduce the gap in adverse cardiovascular events for people with mental ill-health.

Data. Data is not available for sharing. The study protocol is available from the corresponding author.

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Conflict of interest. All authors have completed the Unified Competing Interests form at http://www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). JR and CG have no interests to declare. JH-C was the director of ClinRisk Ltd which produces open and closed source software to ensure the reliable and updatable implementation of clinical risk algorithms (including QRisk2) within clinical computer systems to help improve patient care. CC is an associate professor of Medical Statistics at the University of Nottingham and a consultant statistician for ClinRisk Ltd. The NIHR grant which funded this project provided funds to JR, JH-C, CC and CG for their contribution to the study.

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