Research: Complications

Cardiovascular disease prevalence and risk factor prevalence in Type 2 diabetes: a contemporary analysis

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Abstract

Aims   To describe the prevalence of major cardiovascular disease (CVD) and risk factor control in a contemporary population with Type 2 diabetes.

Methods   We used data from the national registry in Scotland, Scottish Care Information-Diabetes, linked to hospital admissions. Using descriptive statistics and logistic regression we described associations of risk factors with CVD. CVD was defined based on diagnostic codes in primary or secondary care data for ischaemic heart disease, cerebrovascular disease peripheral arterial disease, heart failure, cardiac arrhythmia, hypertensive heart disease and revascularization procedures.

Results   Among 248 400 people with Type 2 diabetes with a median age of 67.5 years (IQR 58.2, 76.1) and median diabetes duration of 7.8 years (3.8, 13.0), 32% had prior CVD (35% of men, 29% of women). Median HbA_{1c} overall was 55 mmol/mol (7.2%), median SBP was 132 mmHg, median total cholesterol was 4.1 mmol/l and mean BMI was 32 kg/m^2. Overall two-thirds (65% of men, 68% of women) have two or more of the following CVD risk factor thresholds: $HbA_{1c} \geq 53$ mmol/mol (7%), SBP > 130 mmHg or DBP > 80 mmHg, total cholesterol ≥ 5 mmol/l or BMI ≥ 30 kg/m^2, or were currently smoking. Overall 84% were taking anti-hypertensives and 75% a statin. Use of metformin was common at 58%, but other diabetes drugs that reduce CVD were rarely used.

Conclusions   There continues to be a high prevalence of CVD among people with Type 2 diabetes and a high level of unmet need for risk factor control. This implies substantial scope for reducing the excess risk of CVD in diabetes through improved management of known risk factors.

Introduction

Total mortality rates are currently 40% higher in men and 50% higher in women with Type 2 diabetes mellitus compared with the background population [1]. Cardiovascular disease (CVD) remains the leading cause of loss of life expectancy in Type 2 diabetes and rates remain elevated compared with those without diabetes. Ongoing elevations in risk have been reported in recent data from Scotland [2], Sweden and the USA [3,4].

Key aspects of the prevention of primary and secondary CVD in diabetes include smoking prevention, weight control, blood pressure reduction, cholesterol lowering and glycaemic control. With regards to glycaemic control, evidence of vascular benefit has been demonstrated for metformin with respect to myocardial infarction and pioglitazone with respect to CVD; by contrast heart failure is increased [5–7]. For newer drugs, major cardiovascular outcome trials have been conducted in recent years [8]. In four drugs from two anti-diabetes drug classes, sodium glucose co-transporter 2 inhibitors (SGLT2i) and glucagon-like peptide 1 receptor agonists (GLP-1RA), evidence of reduced risk of major CVD events has been demonstrated. These four drugs are canagliflozin (SGLT2i), empagliflozin (SGLT2i), liraglutide

> **What's new?**
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> - There have been substantial advances in the management and prevention of cardiovascular disease in diabetes. To understand where unmet needs lie, it is important to understand the current burden of cardiovascular disease and the levels of treated and untreated risk factors.
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> - In this paper, we show that there continues to be a high prevalence of cardiovascular disease among people with Type 2 diabetes and a high level of unmet need for risk factor control. This implies substantial scope for reducing the excess risk of cardiovascular disease in diabetes through improved management of known risk factors.

(GLP-1RA) and semaglutide (GLP-1RA). Drug labels and clinical guidelines are being updated accordingly [9–16], and it is hoped that the target of lowering HbA_{1c} in Type 2 diabetes and the major goal of lowering the cause of excess death will be increasingly achieved. For medical service planning and to understand current standards of care, it is important to quantify the unmet treatment needs of people with Type 2 diabetes, including the prevalence of established CVD and current drug treatment regimens in a broad and representative Type 2 diabetes population. Accordingly, we aimed to establish the current prevalence of established CVD in a typical contemporary population with Type 2 diabetes. Further, we wanted to investigate the scope for CVD reduction through known risk factor control by identifying the proportion of people having two, three, four or more risk factors for CVD in the Scottish population with Type 2 diabetes. These data are timely given that the European Association for the Study of Diabetes/American Diabetes Association (EASD/ADA) are currently revising their joint recommendations on hyperglycaemia management and because these guidelines are apparently going to highlight 'the need to consider the patient's important comorbidities, particularly cardiovascular disease or high cardiovascular risk, in selecting glucose-lowering therapy' [17].

Methods

Data sources

The Scottish Care Information-Diabetes (SCI-Diabetes) is a register and database that covers almost all (> 99%) of those in Scotland with a diagnosis of diabetes. It has been described in detail previously [18]. It captures data from clinical episodes and laboratory data in primary care, National Health Service (NHS) hospital diabetes clinics, community care and the national retinopathy screening programme. Using the unique health service identifier, it has been linked to hospital admissions data (Scottish Morbidity Record 01)

and to death data from the National Records of Scotland. Availability of risk factor data was generally high, being ≥ 94% for HbA_{1c}, total cholesterol, eGFR, smoking status, blood pressure and retinopathy status. Availability was lower for albuminuria (82%), BMI (80%), triglycerides (79%), weight (72%) and LDL cholesterol (56%). However, there was no difference in missingness for those with and without CVD.

Participants

We defined the study cohort here as all people who were alive, > 18 years of age and with a clinical diagnosis of Type 2 diabetes as of 1 January 2016.

Outcomes

To obtain information on CVD status we selected the Scottish Morbidity Records inpatient and day case procedure records (SMR01) which use the World Health Organization (WHO) International Classification of Disease version 10 (ICD-10) for diagnosis (in earlier years version 9), and we use the Classification of Interventions and Procedures (OPCS-4) [19]. Each person's records were queried for a look-back period of 10 years.

CVD history was defined as having codes for main cause of admission for any of chronic ischaemic heart disease (ICD-10: I20–I25), cerebrovascular disease including transient ischaemic attack (ICD-10: I60–I69 and G45), peripheral arterial disease (ICD-10: I70.2 and I73.9), heart failure (III.0, I13 I50), cardiac arrhythmia (I48, I49), hypertensive heart disease (I13.0, I15.0) or procedure codes for revascularization procedures of coronary, carotid or lower limb arteries. Primary care records were also queried for corresponding Read codes for coronary heart disease (CHD), cerebrovascular disease and revascularization procedures, peripheral vascular disease and atrial fibrillation [20].

Other risk factor and covariate data were obtained from SCI-Diabetes on retinopathy screening status, HbA_{1c}, bodyweight, BMI, blood pressure, estimated GFR (eGFR), plasma total cholesterol, triglycerides and urinary albumin–creatinine ratio. The value for these variables nearest in time to 1 January 2016 was used, with a maximum look-back period of 2 years. The most recent of the observational records in the 2-year period was selected for each individual. Age was calculated at 1 January 2016.

Statistical analysis

Simple summary statistics were used to describe the prevalence and distributions of disease and risk factors. We counted the number of the following risk factor thresholds each person had: HbA_{1c} ≥ 53 mmol/mol (7%), SBP > 130 mmHg or DBP > 80 mmHg, total cholesterol ≥ 5 mmol/l or BMI ≥ 30 kg/m^2, or current smoking. For HbA_{1c}

and blood pressure, these thresholds were chosen to reflect typical clinical guideline intervention levels [5,21]; BMI and total cholesterol were chosen to reflect more extreme lack of control, because most people with Type 2 diabetes require interventions for BMI and warrant lipid-lowering therapy. Because for some people, target BP is < 140/80 mmHg, we also report these data using this threshold. Logistic regression was used to quantify the differences in risk factors in those with and without prior CVD.

Results

Some 248 400 people with Type 2 diabetes were included. Almost a third (32%) of those with Type 2 diabetes had established CVD, the prevalence being 29% (31 635/ 108 259) in women and 35% in men (48 962/140 141) (Table 1). The prevalence rose from 15% (11 249/72 894) in those aged < 60 years to 53% (19 987/38 096) in those aged ≥ 80 years. In this cross-sectional analysis, those with

Table 1 Demographic characteristics and risk factor levels by cardiovascular disease (CVD) status in people with Type 2 diabetes

Variable	Established CVD	No CVD	Total
Total included	80 597 (32.45)	167 803 (67.55)	248 400 (100)
Gender			
Male	48 962 (60.4)	91 179 (54.3)	140 141 (56.4)
Female	31 635 (39.3)	76 624 (45.7)	108 259 (43.6)
Age			
< 60	11 249 (14.0)	61 645 (36.7)	72 894 (29.3)
60–69	21 647 (26.9)	50 246 (29.9)	71 893 (28.9)
70–79	27 714 (34.4)	37 803 (22.5)	65 517 (26.4)
80+	19 987 (24.8)	18 109 (10.8)	38 096 (15.3)
Age at study day (years)*	72.8 (65.1, 80.0)	64.7 (55.6, 73.3)	67.5 (58.2, 76.1)
Age at diabetes diagnosis (years)*	61.9 (53.5, 69.7)	56.0 (47.4, 64.6)	58.0 (49.2, 66.5)
Diabetes duration (years)*	9.5 (4.8, 15.0)	7.1 (3.4, 12.0)	7.8 (3.8, 13.0)
HbA$_{1c}$ (mmol/mol)*	54 (47, 66)	55 (47, 67)	55 (47, 66)
HbA$_{1c}$ (%)*	7.1 (6.5, 8.2)	7.2 (6.5, 8.3)	7.2 (6.5, 8.2)
Systolic BP (mmHg)*	132 (122, 140)	133 (124, 140)	132 (124, 140)
Diastolic BP (mmHg)*	73 (67, 80)	77 (70, 80)	76 (70, 80)
MDRD eGFR (ml min^{-1} 1.73 m^{-2})*	68.5 (53.0, 84.3)	79.0 (65.2, 93.4)	75.8 (61.0, 90.9)
CKDEpi eGFR (ml min^{-1} 1.73 m^{-2})*	70.1 (52.9, 85.9)	83.6 (67.6, 95.8)	79.7 (62.3, 93.1)
BMI (kg/m^2)*	30.6 (27.3, 34.6)	31.3 (27.7, 35.8)	31.1 (27.6, 35.4)
Weight (kg)*	88.0 (76.0, 100.0)	89.5 (77.3, 103.0)	89.0 (77.0, 102.0)
Total cholesterol (mmol/l)*	3.9 (3.3, 4.6)	4.2 (3.6, 5.0)	4.1 (3.5, 4.9)
LDL cholesterol (mmol/l)*	1.9 (1.4, 2.4)	2.1 (1.6, 2.7)	2.0 (1.5, 2.6)
Triglycerides (mmol/l)*	1.8 (1.3, 2.5)	1.7 (1.2, 2.5)	1.7 (1.3, 2.5)
Albuminuric status			
Normoalbuminuric	46 288 (69.3)	111 602 (81.3)	157 890 (77.4)
Microalbuminuric	16 916 (25.3)	22 805 (16.6)	39 721 (19.5)
Macroalbuminuric	3562 (5.3)	2924 (2.1)	6486 (3.2)
Renal status			
CKD-EPI CKD Stage 1	14 214 (18.1)	60 156 (37.1)	74 370 (30.9)
CKD-EPI CKD Stage 2	37 090 (47.3)	75 436 (46.5)	112 526 (46.8)
CKD-EPI CKD Stage 3	23 635 (30.2)	24 524 (15.1)	48 159 (20.0)
CKD-EPI CKD Stage 4/5	3423 (4.4)	2074 (1.3)	5497 (2.3)
MDRD CKD Stage 1	14 112 (18.0)	49 088 (30.3)	63 200 (26.3)
MDRD CKD Stage 2	36 656 (46.8)	84 104 (51.9)	120 760 (50.2)
MDRD CKD Stage 3	24 609 (31.4)	27 164 (16.7)	51 773 (21.5)
MDRD CKD Stage 4/5	2985 (3.8)	1834 (1.1)	4819 (2.0)
eGFR < 60 ml min^{-1} 1.73 m^{-2}	28 402 (35.2)	29 682 (17.7)	58 084 (23.4)
Receiving renal replacement therapy	946 (1.2)	582 (0.3)	1528 (0.6)
Retinopathy status			
None	55 588 (73.3)	121 389 (77.4)	176 977 (76.1)
Mild or moderate	15 137 (19.9)	27 293 (17.4)	42 430 (18.2)
Pre-proliferative or worse	5159 (6.8)	8065 (5.1)	13 224 (5.7)
Current smoker	14 371 (17.9)	28 640 (17.1)	43 011 (17.4)
HbA$_{1c}$ ≥ 53 mmol/mol	43 890 (55.8)	92 976 (57.3)	136 866 (56.8)
HbA$_{1c}$ ≥ 58 mmol/mol	32 185 (40.9)	68 374 (42.1)	100 559 (41.7)
SBP >130 mmHg or DBP >80 mmHg	43 715 (54.2)	100 228 (59.7)	143 943 (57.9)
SBP >140 mmHg or DBP >80 mmHg	23 183 (28.8)	56 659 (33.8)	79 842 (32.1)
Total cholesterol ≥ 5 mmol/l	130 66 (16.9)	40 708 (25.5)	53 774 (22.7)
Currently prescribed a statin	67 378 (83.6)	119 381 (71.1)	186 759 (75.2)
BMI ≥ 30 kg/m2	34 227 (42.5)	81 190 (48.4)	115 417 (46.5)
Currently on anti-hypertensives	77 936 (96.7)	129 737 (77.3)	207 673 (83.6)

Values are given as N (%) unless indicated otherwise; *values are median (IQR). CKD, chronic kidney disease; CKD-EPI, Chronic Kidney Disease Epidemiology.

established CVD were older, more likely to be male and had longer diabetes duration (Table 1). Adjusted for age, sex and diabetes duration, those with CVD had significantly ($P < 0.01$) higher BMI, higher HbA_{1c}, were more likely to have albuminuria and currently smoking, and had lower eGFR. Those with CVD had lower age, diabetes duration and sex-adjusted achieved SBP ($P < 0.01$) and lower cholesterol levels ($P < 0.01$) compared with those without a prior history of CVD, on a background of significantly more anti-hypertensive and statin therapy (both $P < 0.01$). Overall, 58% had a SBP > 130 mmHg or a DBP > 80 mmHg, with this prevalence being 54% in those with CVD and 60% in those without CVD. Overall, almost all (97%) of those with CVD were taking at least one anti-hypertensive drug compared with 77% of those without CVD (Table 1). Of those with CVD, 2% were hypertensive and not prescribed any blood pressure drug, whereas among those without CVD, 11% were hypertensive and not taking any anti-hypertensive drug (Fig. 1). Overall, 75% were currently prescribed a

statin. Overall 23% (17% of those with CVD and 26% of those without) had a total cholesterol ≥ 5 mmol/l (Table 1). Among those with CVD, 6% had a total cholesterol ≥ 5 mmol/l and were not taking a statin. Among those without CVD, 11% had a total cholesterol ≥ 5 mmol/l and were not taking a statin (Fig. 1).

We counted the number of the following risk factor thresholds exceeded by each person; HbA_{1c} ≥ 53 mmol/mol, SBP > 130 mmHg or DBP > 80 mmHg, total cholesterol ≥ 5 mmol/l or BMI > 30 kg/m^2, or current smoking. Overall, 65% of men and 68% of women with Type 2 diabetes have two or more of these risk factor thresholds (Table 2; Table S1). Among those with CVD, 62% had at least two risk factors; in those without CVD, the value was 69%. At all ages and in both sexes, the proportions exceeding these thresholds were high (Table 2; Table S1). In the oldest group, aged ≥ 80 years, the proportions were lowest at 45% of men and 52% of women exceeding two or more thresholds. This reflected significantly lower proportions exceeding the HbA_{1c}
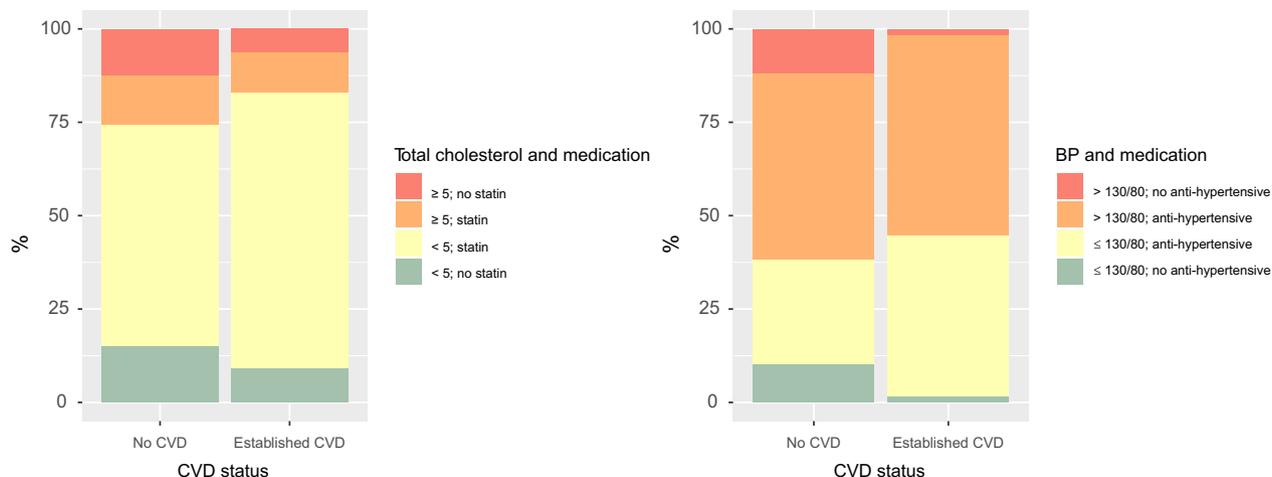
FIGURE 1 Statin and anti-hypertensive use by risk factor threshold and cardiovascular disease (CVD) status.

Table 2 Number of risk factor thresholds exceeded by cardiovascular disease (CVD) status

Number of risk factors	0	1	2	3	4	5	Total
Established and no CVD							
All	21 308 (8.6)	62 376 (25.1)	85 308 (34.3)	59 609 (24.0)	17 803 (7.2)	1996 (0.8)	248 400 (100)
Male	12 605 (9.0)	36 273 (25.9)	48 695 (34.7)	32 583 (23.3)	9016 (6.4)	969 (0.7)	140 141 (56.4)
Female	8703 (8.0)	26 103 (24.1)	36 613 (33.8)	27 026 (25.0)	8787 (8.1)	1027 (0.9)	108 259 (43.6)
Established CVD							
All	8231 (10.2)	22 658 (28.1)	27 866 (34.6)	16 945 (21.0)	4441 (5.5)	456 (0.6)	80 597 (100)
Male	5152 (10.5)	14 182 (29.0)	17 026 (34.8)	10 037 (20.5)	2342 (4.8)	223 (0.5)	48 962 (60.7)
Female	3079 (9.7)	8476 (26.8)	10 840 (34.3)	6908 (21.8)	2099 (6.6)	233 (0.7)	31 635 (39.3)
No CVD							
All	13 077 (7.8)	39 718 (23.7)	57 442 (34.2)	42 664 (25.4)	13 362 (8.0)	1540 (0.9)	167 803 (100)
Male	7453 (8.2)	22 091 (24.2)	31 669 (34.7)	22 546 (24.7)	6674 (7.3)	746 (0.8)	91 179 (54.3)
Female	5624 (7.3)	17 627 (23.0)	25 773 (33.6)	20 118 (26.3)	6688 (8.7)	794 (1.0)	76 624 (45.7)

Values are given as N (%).
The following risk factor thresholds were used: SBP > 130 mmHg or DBP > 80 mmHg; HbA_{1c} ≥ 53 mmol/mol (7%); BMI ≥ 30 kg/m^2; total cholesterol ≥ 5 mmol/l; current smoker.

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and BMI thresholds, and less smoking compared with younger age groups (Fig. S1; *P* < 0.01 for comparison with the youngest group adjusted for sex and diabetes duration). There was more hypertension and more current anti-hypertensive therapy in the older age group (*P* < 0.01 compared with the youngest age group). The proportions with total cholesterol ≥ 5 mmol/l fell from 35% in those aged < 50 years to 16% in those aged ≥ 80 years (*P* < 0.01 compared with those aged < 50 years). Statins were prescribed in 55% of those aged < 50 years, 80% in those aged 50–79 years and 70% in those aged ≥ 80 years. As expected, albuminuria and low eGFR were more common at older ages (data not shown). When a cut-off of 140 mmHg rather than 130 mmHg was used for SBP the prevalence of those exceeding two or more thresholds was 57% overall.

The number of diabetes drugs used was highest in the 50–70-year age groups, falling off thereafter (Table 3; Table S2). The number of diabetes drugs used was similar in those with and without CVD, but the use of insulin was higher in those with CVD compared with those without. Metformin and pioglitazone use (99% of the thiazolidinedione/other category shown in Table 4 comprised pioglitazone) was slightly lower in those with than without CVD (Table 4). Overall just 2.4% of those with CVD and 2.9% of those without were on a GLP-1 agonist and just 1.4% and 2.2% of those

with and without CVD respectively were on an SGLT2 inhibitor.

Discussion

In this study, we find a high prevalence of established CVD in people with Type 2 diabetes, with a third of those with diabetes having had prior CVD. In both those with and those without a history of CVD there remain high levels of unmet need with regard to risk factor control. Overall, 65% of men and 68% of women with Type 2 diabetes have two or more of these risk factor thresholds. At present, HbA$_{1c}$ targets < 58 mmol/l are set for most people with Type 2 diabetes and targets < 53 mmol/l, where safely achievable, are set in US and UK guidelines [5]. However, as shown here, just over half achieve the 58 mmol/l target. Approximately one-third of people already receive two or more diabetes drugs, but these HbA$_{1c}$ levels suggest that there is scope, at least in some, for intensification of therapy or switching to different drug classes where existing therapy is not achieving targets. Metformin and pioglitazone, for which there are data showing a reduction in CVD, were slightly less commonly used in those with CVD than in those without, and the prevalence of use of pioglitazone was very low at < 5%. Of note, the least utilized anti-diabetes drug classes for people

Table 3 Number of diabetes drugs by cardiovascular (CVD) status

Number of diabetes drugs	0	1	2	3+	Total
Established and no CVD					
All	75 648 (30.5)	89 571 (36.1)	57 464 (23.1)	25 717 (10.4)	248 400 (100)
Male	40 244 (28.7)	49 640 (35.4)	33 844 (24.1)	16 413 (11.7)	140 141 (56.4)
Female	35 404 (32.7)	39 931 (36.9)	23 620 (21.8)	9304 (8.6)	108 259 (43.6)
Established CVD					
All	24 605 (30.5)	29 625 (36.8)	18 693 (23.2)	7674 (9.5)	80 597 (100)
Male	13 956 (28.5)	17 654 (36.1)	11 957 (24.4)	5395 (11.0)	48 962 (60.7)
Female	10 649 (33.7)	11 971 (37.8)	6736 (21.3)	2279 (7.2)	31 635 (39.3)
No CVD					
All	51 043 (30.4)	59 946 (35.7)	38 771 (23.1)	18 043 (10.8)	167 803 (100)
Male	26 288 (28.8)	31 986 (35.1)	21 887 (24.0)	11 018 (12.1)	91 179 (54.3)
Female	24 755 (32.3)	27 960 (36.5)	16 884 (22.0)	7025 (9.2)	76 624 (45.7)

Values are given as *N* (%).

Table 4 Use of diabetes drugs by cardiovascular disease (CVD) status

Drug	Established CVD	No CVD	Total
Insulin	12 203 (15.1)	14 842 (8.8)	27 045 (10.9)
Metformin	42 641 (52.9)	100 178 (59.7)	142 819 (57.5)
Sulphonylurea	21 842 (27.1)	43 476 (25.9)	65 318 (26.3)
DPP-4 inhibitor	8024 (10.0)	17 054 (10.2)	25 078 (10.1)
GLP-1 agonist	1952 (2.4)	4866 (2.9)	6818(2.7)
SGLT2 inhibitor	1158 (1.4)	3741 (2.2)	4899(2.0)
TZD/other	2852 (3.5)	9076 (5.4)	11 928 (4.8)

Values are given as *N* (%). DPP-4, dipeptidyl peptidase-4; GLP-1, glucagon-like peptide 1; SGLT2, sodium glucose co-transporter 2; TZD, thiazolidinediones.

with Type 2 diabetes in Scotland at the time of the study (2016) were the SGLT2i and GLP-1 agonists. Because anti-diabetes drugs in these classes have been shown to reduce CVD risk and CVD mortality, and this is now influencing guidelines, the pattern should change in the future. In the guidelines, BP targets are set at 130–140 mmHg for SBP and 80–90 mmHg for DBP, depending on CVD history. However, fewer than half are achieving the target of < 130/80 mmHg and two-thirds the target of < 140/80 mmHg [5–7]. This is despite the vast majority of people with Type 2 diabetes being on anti-hypertensive therapy. So, recognizing the need for treatment is not the challenge, rather there may be scope for further intensification where this is tolerated. Similarly, most people are receiving statin therapy, yet total cholesterol levels are high at a mean of 4.1 mmol/l, with 21% exceeding 5 mmol/l. This also suggests scope for more intensive lipid-lowering therapy where this is tolerated. Guidelines also suggest intervention for obesity, but more than half of the people in this study remain obese. Furthermore, a sizeable proportion are current smokers, suggesting scope for more intensive support for smoking cessation. The proportions exceeding risk factor thresholds for HbA_{1c}, BMI, total cholesterol and smoking were lowest in those with an attained age of 80 years or more. This could reflect a survivor effect, or that some who develop diabetes in later age have less-aggressive diabetes phenotypes, as recently discussed [22]. We cannot discern which of these phenomena may underlie this lower risk factor prevalence at older ages, but we note that in contrast to anti-hypertensive usage the intensity of diabetes drug use and statin fell in the older age bands, indicating treatment rates do not explain the HbA_{1c} and lower cholesterol. We cannot comment with these data on the appropriateness of these lower treatment rates at older ages, but they may reflect the emphasis in national guidelines that diabetes care be tailored to the person's individual needs 'taking into account their personal preferences, comorbidities, risks from polypharmacy, and their ability to benefit from long-term interventions because of reduced life expectancy' [5].

That further scope for narrowing the gap in life expectancy associated with Type 2 diabetes may be achievable by more intensified clinical management of this disease is emphasized by a recent analysis from the USA, which found that those with diabetes who met modest treatment goals for HbA_{1c}, non-HDL cholesterol and blood pressure had a 37% lower mortality than those who did not [23]. In that analysis, almost half of those with Type 2 diabetes had HbA_{1c} > 53 mmol/mol (7%) and 14% had an HbA_{1c} of ≥ 75 mmol/mol (9%). In a recent survey from Denmark of people with Type 2 diabetes being cared for in primary care, the risk factor data are overall very similar to these data from Scotland [24]. Specifically, mean age was 4 years higher (72 years), smoking prevalence was similar (17%), mean HbA_{1c} was slightly (3 mmol/mol) lower, SBP was 2 mmHg lower, DBP was the same, and total cholesterol was just

0.1 mmol/l lower, whereas rates of lipid-lowering drug and anti-hypertensive use were very similar. The main difference in current diabetes drugs use was that in Denmark fewer people (8% compared with 26%) were using sulphonylureas and more (19% compared with 11%) were on insulin therapy. Compared with a summary from the US NHANES survey data for 2014 for all types of diabetes combined, the risk factor levels are broadly similar, with mean BMI being ~ 3 kg/m^2 higher in the USA, blood pressure ~ 9 mmHg lower and total cholesterol ~ 0.7 mmol/l higher in their 2014 survey compared with these data from Scotland [25]. Surprisingly, reported use of anti-hypertensive (58%) and lipid-lowering drugs (50%) was much lower in that study than in Scotland. In NHANES, 57% were achieving an HbA_{1c} < 53 mmol/mol (7%) compared with 43% in Scotland. There were 15% current smokers compared with 17% in Scotland [25].

Our definition of CVD was wide, capturing not just CHD and cerebrovascular disease, but also cardiac arrhythmia, peripheral arterial disease and related revascularizations. Restricting the definition to prior CHD or cerebrovascular disease or coronary revascularization procedures or heart failure would yield a prevalence of 28%. On the other hand, if we define CVD based on the entry criteria in the LEADER trial, then 44% of our population met this definition [12]. Clearly, the burden of established CVD is large under any definition used.

Our data are of substantial interest in understanding what percentage of people with diabetes have unmet need for CVD prevention therapies. In particular, although new diabetes drugs are being licensed based on efficacy for HbA_{1c} and lack of harm for CVD, there is now evidence of cardiovascular benefit for some. New diabetes therapies that have shown benefit with regard to CVD reduction offer scope for simultaneous improvement in HbA_{1c} while lowering CVD risk. For the SGLT2 inhibitor empagliflozin the hazard ratio (HR) for CVD was 0.86 (95% CI 0.74 to 0.99) [9] and for canagliflozin it was 0.86 (0.75 to 0.97) [10]. For the GLP-1 agonist semaglutide vs. placebo the HR was 0.74 (0.58 to 0.95) for CVD [11] and for liraglutide vs. placebo the HR was 0.87 (0.78 to 0.97) [12]; for lixisenatide vs. placebo the HR was 1.02 (0.89 to 1.17) [13]. Trials of the DPP-4 inhibitors sitagliptin [14], alogliptin [15] and saxagliptin [16] have not shown these reductions. Further large cardiovascular outcome trials will report in the next 2 years [8,26]. These data from 2016 predate changes in guidelines and licencing for many of the new diabetes drugs and show very low rates of use of diabetes drugs with evidence of CVD prevention other than metformin.

This study aimed to give a brief contemporary snapshot of Type 2 diabetes and its management. Limitations are that for some risk factors data were incomplete. However, the similarity in missingness between CVD status groups and the fact that the sample size with available data is large in all strata, means that imputation is not needed, and our

estimates have precision and are free of missing data bias or confounding. Another limitation is that we do not have data on why those with elevated risk factors seem to be insufficiently treated based on their risk factors – i.e. whether this is under-prescribing, non-adherence or side-effect issues. A key aspect of our study is that the sample is large and representative of the Scottish population.

Conclusion

We found that there continues to be a high prevalence (32%) of CVD among people with diabetes and a high level of unmet need with regard to risk factor control. This implies substantial scope for further reduction in the relative risk of CVD associated with diabetes through adherence to healthy lifestyles and use of drugs that reduce CVD and control of known risk factors, including but not restricted to HbA_{1c}.

Competing interests

HMC received research support, travel expenses and honorarium and is also a member of the advisory panels and speaker's bureaus for Sanofi Aventis, Regeneron, and Eli Lilly. HMC is a member of the Advisory Panel and receives institutional fees from Novartis Pharmaceuticals. HMC receives or has recently received research support from Roche Pharmaceuticals, Pfizer Inc., Boehringer Ingelheim and AstraZeneca LP. HMC receives research support, travel expenses and is on the Steering Committee for Novo Nordisk. HMC is a shareholder of Roche Pharmaceuticals and Bayer. HMC has received speaker fees from Pfizer. NS reports personal fees from Boehringer Ingelheim, NovoNordisk, Eli Lilly, Janssen, Sanofi and Amgen. He has received research grants from Boehringer Ingelheim. RJM is on the advisory board for Novo Nordisk and the advisory board and honoraria for educational lectures for Sanofi. SW attended a Novo Nordisk conference and received associated expenses from Novo Nordisk. Emina Mocevic and Ulrik Haagen Panton are employed at Novo Nordisk A/S, Søborg, Denmark. All other authors declare no conflicts of interest.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1 Risk factors by age.
Table S1 Number of risk factor thresholds exceeded by CVD status.
Table S2 Number of diabetes drugs by CVD status.