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Rates and estimated cost of primary care consultations in people diagnosed with type 2 diabetes and comorbidities: A retrospective analysis of 8.9 million consultations

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Appendix: Supplementary Tables 4; STROBE checklist; ISAC protocol

Keywords

Comorbidity; Physicians, Primary Care; Diabetes Mellitus, Type 2; Primary health care; electronic health records; health care costs

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KEY MESSAGES

What is already known on this topic

- Management of patients with type 2 diabetes requires significant primary care resources
- Most people with type 2 diabetes have comorbidities
- The extent to which comorbidities in people with type 2 diabetes affect primary care utilization is not known

Key question

- Do the rate and cost of primary care consultations differ by the number of comorbidities in people with type 2 diabetes?

New findings

- Our study found that patients with type 2 diabetes and comorbidities have an increased rate of consultations in primary care compared to patients with type 2 diabetes and no other comorbidities and that this results in a quantifiable increase in healthcare costs

Impact on clinical practice

- These findings support that patients with type 2 diabetes and comorbidities may require a different model of service delivery that involves less frequent, more comprehensive consultations with a primary care provider.

ABSTRACT

Aims

To determine whether telephone and face to face primary care consultation rates, costs, and temporal trends during 2000-2018 differed by the number of comorbidities in people with type 2 diabetes (T2DM).

Methods

120,409 adults with newly diagnosed T2DM from 2000-2018 were classified by the number of prevalent and incident comorbidities. Face to face and telephone primary care consultations with a nurse or physician were obtained. Crude and sex-age adjusted annual consultation rates and associated costs were calculated based on the number of comorbidities at the time of consultation.

Results

The crude rate of face to face primary care consultations for patients without comorbidities was 10.3 (95% CI 10.3-10.4) per person year, 12.7 (12.7-12.7) for 1 comorbidity, 15.1 (15.1-15.2) for 2 comorbidities, and 18.7 (18.7-18.8) for 3 or more comorbidities. The mean annual inflation-adjusted cost for face to face consultations was £412.70 per patient without comorbidities, £516.80 for 1 comorbidity, £620.75 for 2 comorbidities, and £778.83 for 3 or more comorbidities. The age-sex adjusted face to face consultation rate changed an average of -3.3% (95% CI -4.4% to -2.3%) per year from 2000 to 2018 for patients without comorbidities, -2.7% (-4.0% to -1.3%) for 1 comorbidity, -2.2% (-3.3% to -1.2%) for 2 comorbidities, and -4.3% (-8.7% to +0.3%) for 3 or more comorbidities.

Conclusions

Though consultation rates for all patients decreased from 2000-2018, there was a significant disparity between the rate for patients with and without comorbidities. Patients with T2DM but and comorbidities may require different models of service delivery.

INTRODUCTION

Due to the aetiology of type 2 diabetes (T2DM), patients with this disease often have comorbidity. Approximately 85% have at least one comorbidity, while 68-70% have more than two comorbidities.(1-3) T2DM patients aged 75 years and older had nearly four times the odds of having three or more comorbidities compared to those younger than 50 years of age.(4) Comorbidity in people with T2DM is associated with poor glycaemic control in addition to an increased risk of adverse events and mortality.(5, 6) Therefore, it is important to identify which T2DM patients are at risk for comorbidity and determine future healthcare resources needed to manage these patients.

Existing healthcare infrastructure is primarily designed for management of single diseases. However, management of T2DM with comorbidity requires more complex clinical interventions and pharmacotherapy.(7) Within the United Kingdom, most long-term conditions, including T2DM, are managed in primary care.(8, 9) From a healthcare resource planning perspective, expenditure for managing patients with comorbidities is not necessarily equivalent to the sum of the costs for managing each individual condition. As health care systems determine the most cost efficient model of care moving forward for management of patients with comorbidities, there is a wealth of existing real world evidence that can be used to understand past trends and predict future needs.

Within the UK, patients with T2DM have historically been frequent healthcare service users.(10) Additionally, patients with T2DM often have comorbidities.(11) It remains unknown whether increased healthcare usage in patients with T2DM is primarily due to the subset with comorbidities. Although patterns of comorbidity in patients with T2DM have been described, the degree to which comorbidities affect primary care utilization in this patient group remains unquantified.(12) In this study we address these research gaps by: (1) describing primary care consultation rates during 2000-2018; and (2) determining whether the rate and cost of primary care consultations differed by the number of comorbidities.

METHODS

Study population

The Clinical Practice Research Datalink (CPRD) GOLD includes anonymized primary care electronic health records for over 11.3 million UK patients, approximately 6.9% of the UK population.(13) The CPRD is broadly representative of the age, sex and ethnicity of the UK general population. Because linkage to Hospital Episode Statistics (HES) admitted patient care database is possible only for patients registered in England, patients from Northern Ireland, Scotland, and Wales were excluded. This observational retrospective study included an open cohort of patients without incident or prevalent gestational or type 1 diabetes, who had a first diagnosis of type 2 diabetes (T2DM) during January 1, 2000 to December 31, 2018, were age 18 years old or older, and were registered at a GP practice contributing to the CPRD. The index date was the date of T2DM diagnosis. Person years of observation were calculated beginning at the index date until death, the last data collection from practice, or when the patient transferred out of the practice. All patients had availability of linkage to the Office of National Statistics (ONS) death registration, belonged to an "up to standard" practice at the index date, and were determined by CPRD to be of acceptable research standards.

Comorbidity

Comorbidities were obtained from in-hospital primary diagnoses (from HES) and during routine primary care (from CRPD), excluding records dated before January 1, 1990 as records before this date are not well coded. Comorbidity was quantified using comorbidities included in the Charlson Comorbidity Index .(14) Diabetes and diabetes with end organ damage were both excluded, as all patients in the study had T2DM. Comorbidities included: cerebrovascular disease, chronic pulmonary disease, cancer (any malignancy including leukaemia and lymphoma), congestive heart disease, dementia, hemiplegia and paraplegia, HIV/AIDS, metastatic solid tumour, liver disease (mild or moderate), myocardial infarction, peptic ulcer disease, peripheral vascular disease, rheumatological disease, and renal disease.

At the index date, patients were grouped by the number of prevalent comorbidities: T2DM only (without comorbidities), T2DM+1 comorbidity, T2DM+2 comorbidities, T2DM+3 or more comorbidities. Incident comorbidities diagnosed during follow-up were also obtained.

Included consultations

A consultation is recorded in CPRD each time a patient's clinical record is open and is coded according to the type of contact and the role of the staff member attending. Consultations for this study were

restricted to: (1) face to face consultations, i.e. those involving direct contact between a patient and a primary care physician (general practitioner, GP) or nurse within the primary care setting; (2) telephone consultations, i.e. those involving telephone contact between a patient and GP or nurse within the primary care setting (**Supplementary Table 1**). Patients could have multiple face to face and/or telephone consultations on a given date, which were each counted separately. All qualifying consultations after the index date to the end of follow up were included. The index consultation where T2DM was diagnosed was excluded, as it was assumed all patients had a consultation when initially diagnosed with T2DM.

Estimated cost for face to face consultations

Although information on the duration of consultation is available in CPRD, at data exploratory stage we observed significant implausible (i.e., 23.9% ≤1 minute) and missing data, suggesting that consultation duration is inaccurately collected in CPRD. Therefore, we used estimated unit costs from the Personal Social Services Research Unit for face to face consultations.(15) The GP face to face consultation cost estimates were for a qualified GP and included direct care staff costs. From 2000-2006, unit costs were reported for a face to face clinical consultation lasting 12.6 minutes. Starting in 2007, unit costs were reported for face to face patient contact lasting 17.2 minutes. Beginning in 2016, unit costs were reported for contact lasting 9.2 minutes. These represent changes in the length of face to face consultation appointments over nearly two decades.(16) From 2000-2010, face to face consultation costs were reported for a qualified practice nurse. Beginning in 2011, costs for practice nurses were no longer reported per consultation and were, instead, reported per hour. From 2000-2010, the cost of a nurse consultation increased an average of 3.4% each year. Using the reported 2010 cost as a baseline, we estimated the unit cost for a nurse consultation from 2011-2018 assuming a 3.4% annual percentage increase. This annual percentage increase was comparable to GP consultations, for which consultation unit cost were available for all years. Costs were then adjusted for inflation to 2018 based on the Office for National Statistics' (ONS) composite price index.(17)

Statistical analysis

Age was calculated at the index date and for each year thereafter for age standardisation. The frequency of each type of comorbidity and the timing relative to T2DM diagnosis (prevalent and incident) was obtained. For each year, we determined the total number of consultations, stratified by the number of comorbidities and age at the time of the consultation. Total person-years of follow up were determined for each calendar year, stratified by the number of comorbidities and age at the time of the consultation. Patients alive and registered for the whole year contributed one person year

of follow up. Patients transitioned comorbidity groups when diagnosed with an additional comorbidity during follow up. For example, a patient with 2 comorbidities at the index date would contribute consultations and person-time to this group. When diagnosed with an additional comorbidity during follow-up, they would transition to the 3 or more comorbidities group and contribute consultations and person-time to this group beginning on the diagnosis date of the additional comorbidity. Patients who died or unregistered from their GP practice within a calendar year contributed person-time until the date of death or unregistration.

Crude face to face consultation rates were calculated as the number of consultations per patient per year (p-y) for nurse, GP, and in total for each comorbidity group. Using the crude consultation rates and the estimated cost per consultation based on the staff type attending, the annual inflation-adjusted cost per patient was calculated based on the number of comorbidities at the time of consultation. Excess face to face consultations using patients without comorbidities as the reference group were estimated as rate ratios.

To compare face to face consultation rates across years, crude consultation rates were age-sex standardised to the 2018 mid-year English adult population using the following age groups: 18–54, 55-64, 65-74, and 75 years and older. Joinpoint regression analysis was used to model changes in annual face to face standardized consultation rates from 2000 to 2018 by the number of comorbidities at the time of consultation.(18)

Additionally, a secondary analysis was carried out on telephone consultations. Crude telephone consultation rates were calculated as the number of telephone consultations per p-y. The percentage of GPs compared to nurses attending the telephone consultation was calculated. Excess consultations using patients without comorbidities as the reference group were estimated as rate ratios.

All analyses were performed in Stata/IC 15.1 and SAS v9.4; results are reported with 95% confidence interval (CI) when applicable and nominal statistical significance was defined at $p<0.05$. Joinpoint analysis was performed using the Joinpoint Trend Analysis Software Version 4.7.0.0.(18)

Patient and public involvement

A patient and public involvement group made up of members of the public was involved in refining the research question and protocol.

RESULTS

Cohort characteristics

The cohort comprised 120,409 patients newly diagnosed with T2DM; 65,294 (54.2%) males and 55,115 (45.8%) females (**Table 1**). Most patients were White (91.8%), followed by South Asian (5.0%), Black (2.2%), and 1.1% were of other ethnic backgrounds. Including both prevalent and incident comorbidities, the most common was chronic pulmonary disease (22.4%), followed by renal disease (20.2%), cancer (17.6%), cerebrovascular disease (11.1%), and myocardial infarction (9.8%, **Supplementary Table 2**).

Total face to face consultations

During 679,704 person years of follow up (mean 5.6 [95% CI 5.2-5.7], range 1 day-19 years), 8,334,371 face to face consultations were included, resulting in a crude rate of 12.3 (12.3-12.3) per p-y (**Table 2**). In most instances, patients had one or two face to face consultations on a given date. The crude consultation rate increased with the number of comorbidities. The total crude rate of consultations for patients without comorbidities was 10.3 (10.3-10.4) per p-y, compared to 12.7 (12.7-12.7) for 1 comorbidity, 15.1 (15.1-15.2) for 2 comorbidities, 18.7 (18.7-18.8) for 3 or more comorbidities. Patients with 3 or more comorbidities had 81% (81%-82%) more face to face consultations than patients without comorbidities.

Nurse face to face consultations

In total, 3,258,223 consultations (39.1% of face to face consultations) were with a nurse at a rate of 4.8 (4.8-4.8) per p-y. Nurse consultations were typically with a practice nurse, comprising 92.9% of face to face nurse consultations, followed by a community nurse (5.5% of face to face nurse consultations, **Supplementary Table 1**). The crude rate of nurse consultations increased as the number of comorbidities increased. The rate was 4.2 (4.2-4.2) per p-y for patients with T2DM, compared to 4.9 (4.9-4.9) for 1 comorbidity, 5.7 (5.6-5.7) for 2 comorbidities, and 6.7 (6.7-6.7) for 3 or more comorbidities. Patients with 3 or more comorbidities had 58% (58%-59%) more face to face nurse consultations than patients without comorbidities.

GP face to face consultations

In total, 5,076,148 consultations (60.9% of face to face consultations) were with a GP at a rate of 7.5 (7.5-7.5) per p-y. Patients with more comorbidities were more likely to see a GP than a nurse; 59.2% of face to face consultations for patients without comorbidities were with a GP, compared to 61.2% for 1 comorbidity, 62.6% for 2 comorbidities; and 64.3% for 3 or more comorbidities. The crude rate

of face to face GP consultations increased as the number of comorbidities increased; 6.1 (6.1-6.1) per p-y for patients without comorbidities, compared to 7.8 (7.8-7.8) for patients with 1 comorbidity, 9.5 (9.5-9.5) for 2 comorbidities, 12.0 (12.0-12.1) for 3 or more comorbidities. Patients with 3 or more comorbidities had 97% (96%-97%) more face to face GP consultations than patients without comorbidities.

Temporal trends in face to face consultations

Adjusting for age and sex, the annual face to face consultation rate decreased for all comorbidity groups. The adjusted consultation rate changed by an average -3.3% (-4.4% to -2.3%) per year from 2000 to 2018 for patients without comorbidities, compared to -2.7% (-4.0% to -1.3%) for 1 comorbidity, -2.2% (-3.3% to -1.2%) for 2 comorbidities, and -4.3% (-8.7% to +0.3%) for 3 or more comorbidities (**Figure 1**).

The age-sex adjusted consultation rate was unstable for patients with 3 or more comorbidities during 2000. This is primarily due to the small amount of person-time in one of the age-sex strata (females age 55-64, **Supplementary Table 4**).

Estimated costs for face to face consultations

The mean annual inflation-adjusted cost for face to face consultations was £412.70 per patient without comorbidities, compared to £516.80 for 1 comorbidity, £620.75 for 2 comorbidities, and £778.83 for 3 or more comorbidities (**Table 3**). Because costs were reported for different lengths of consultations depending on year, the face to face consultation costs increased from 2006-2007 and decreased from 2015-2016.

Telephone consultations

There were a total of 557,004 telephone consultations included, resulting in a total crude rate of 0.8 (0.8-0.8) telephone consultations per p-y. The most common type of telephone consultation was a call to the patient (65.3% of telephone consultations) followed by a call from the patient (34.5% of telephone consultations). The crude telephone consultation rate increased with the number of comorbidities. The rate for patients without comorbidities was 0.6 (0.6-0.6) per p-y, compared to 0.9 (0.9-0.9) for 1 comorbidity, 1.2 (1.2-1.2) for 2 comorbidities, and 1.7 (1.7-1.8) for 3 or more comorbidities. The majority of telephone consultations were with a GP (83.6% of telephone consultations). Similar to face to face consultations, patients with more comorbidities had more consultations with a GP than a nurse; 80.6% of telephone consultations for patients without

comorbidities were with a GP, compared to 83.8% for 1 comorbidity, 85.7% for 2 comorbidities, and 87.4% for 3 or more comorbidities. Patients with 3 or more comorbidities had telephone consultations at three times the rate of patients without comorbidities (rate ratio 3.05 [3.02-3.08]). While the annual crude rate of face to face consultations decreased over time for the entire cohort, the annual crude rate of telephone consultations increased 51%, from 0.6 (0.6-0.7) per p-y in 2000 to 0.9 (0.9-0.9) per p-y in 2018.

CONCLUSION

This study highlights the high burden of comorbidities in patients with T2DM, with implications for health service delivery and utilization. Patients with T2DM and comorbidity had an increased rate of face to face primary care consultations compared to patients without comorbidities. Patients with 3 or more comorbidities had 18.7 face to face and 1.7 telephone consultations annually. In comparison, patients without comorbidities had 10.3 face to face and 0.6 telephone consultations annually. From a patient perspective, the increased consultation rate for comorbidities represents a major burden that includes missing work and other commitments, increased likelihood of missed appointments, interruption to continuity of care, greater susceptibility to failures of coordination, and adds to diabetes-related distress.(19-21) From a healthcare cost perspective, the annual consultation cost for a patient with 3 or more comorbidities is 1.9 times higher than that for a patient without comorbidities. Additionally, patients with more comorbidities were more likely to see a GP than a nurse, which is more costly per consultation. This study also indicates that as of 2018 telephone consultations are becoming a common means to consult with a nurse or GP. Further, during the recent COVID-19 pandemic, the rate of telephone consultations eclipsed face to face consultations, a trend we expect will continue moving forward. To our knowledge, this study represents the first large-scale quantification of primary care utilization in relation to comorbidities in this patient group. Additionally, utilization estimates are contemporary and reflect the changing profile of T2DM patients from 2000 to present. T2DM patients are presenting more frequently with multiple conditions. Further research is necessary to determine the most cost effective and efficient modality to manage patients with T2DM and comorbidities.

Struijs *et al*. showed in patients with diabetes, comorbidities increased medical care utilization, including primary care, specialty care, hospital admission, as well as prescriptions (22). The findings from Struijs *et al*. combined with our study challenge the single-disease framework used for the majority of healthcare planning, delivery, and research to date.(23) Due to workload issues, many GPs restrict consultations to a single healthcare issue.(24) While this may be effective for most patients, the result is fragmented, costly, and ineffective care for patients with T2DM and comorbidities. In order to provide comprehensive care, patients may need to be seen less often for larger blocks of time. Evidence from this study indicates that primary care services may be already adapting to this model. We found that the rate of consultations for all T2DM patients decreased significantly from 2000 to 2018. This mirrors a finding from a study among commercially insured adults in the United States that found primary care visits decreased 24.2% between 2008 and 2016.(25) Further research

is needed on the structure and length of these less frequent consultations to determine if they are meeting patient needs.

In most primary care centres in the UK, the process management of most chronic diseases on the Quality and Outcomes Framework, the UK pay-for-performance scheme in primary care, is led by nurses.(26) A comprehensive whole-patient-oriented nurse review in longer consultation periods could address comorbidities and risk factor management in addition to T2DM. In a study in Australia with a median follow up of over 2 years, a nurse led consultation in primary care resulted in significant decreases in HbA1c, LDL and systolic blood pressure levels and this remained low in the last half year of follow up.(27) An increase in GP, ophthalmologist and dietician visits in this study calls for a primary care model for managing T2DM that utilises multidisciplinary teams in order to maintain sustained cost effective outcomes.

There is no current standard set of conditions, diseases, or criteria to identify comorbidities, though a number have been proposed.(7, 22, 28-30) Therefore, the first step to developing an evidence base for care of patients affected by concurrent chronic conditions is establishing a standard measure of comorbidities. Our analysis of a large, nationally representative primary care dataset shows that the risk profile for comorbidities in people with T2DM must be revised. While it was previously thought that the number of comorbidities was closely related to old age, our study found that approximately 1 in 4 patients younger than 40 and 1 in 3 patients younger than 65 had comorbidity at the time they were diagnosed with T2DM.(4, 7) This supports that comorbidity risk should be assessed in all patients with T2DM, regardless of age.

This study has several limitations and strengths. Because we used routinely collected primary care data, some comorbidities may be under-recorded. However, the majority of comorbidities in this study are included in the Quality Outcomes Framework incentive programme, so it is likely that comorbidities were comprehensively recorded.(31) This study used a count of comorbidities, weighting all equally, though the severity and combinations of comorbidities likely varied. Several assumptions were made for this study as there were challenges with data quality surrounding the way consultations are recorded in the CPRD. Since consultation length is not well recorded, we are unable to calculate costs based on duration. Therefore, we had to rely on reported unit costs based on mean consultation time, which fluctuated over the course of the study. The estimated costs are for nurse and GP face to face consultations only and do not take into account secondary and tertiary care

resources and other healthcare costs like prescriptions, tests, or procedures. Additionally, more than 10 million face to face non-nurse and non-GP consultations were excluded from this study. The majority of these consultations were with administrative staff, but some included healthcare professionals such as pharmacist, dietician, or phlebotomist. Therefore, costs are most certainly an underestimate. Finally, unit costs were not available for nurse telephone consultations or GP telephone consultations from 2015-2018. Therefore, only costs for face to face consultations were estimated. However, telephone consultations comprised a relatively small proportion of total consultations (<6.3%). This study also has several strengths. It includes a large representative cohort with sufficient follow up to examine changes in clinical practice over two decades. Additionally, the long-term follow up and statistical methods used allowed examination of changes in consultation rates in real time as patients developed additional comorbidities.

Self-management is an emergent topic in modern diabetes care.(32) Primary care providers are no longer the only source for information on management of T2DM. The proliferation of online resources and the increased sophistication and accessibility of health testing technology—including condition specific metrics such as blood-glucose tests and other more general measurements of personal health—have empowered patients to become informed about their disease and take a more active role in its management.(33) Additionally, structured education programmes have the potential to allow patients to effectively self-manage T2DM and reduce consultation rates.(34) This could reduce the economic impact of the disease on the healthcare system, which was estimated to be £11.94 billion annually and increasing.(35) A 2017 study found that since 2012, costs for diabetes have increased in part to increased prevalence, but also due to a 13% increase in the cost per patient. Restructuring how patients with uncomplicated T2DM are managed could combat this rise in per-patient costs.(36) Though, management of T2DM is progressively more complex where comorbidities and polypharmacy are present.

The findings from our study indicate that although consultation rates for all T2DM patients decreased during the last two decades, patients with T2DM and comorbidities are still seeing their primary care provider more frequently than their counterparts with T2DM without comorbidities. In order to reduce costly in person consultations with GPs, support should be provided for self-management of T2DM and comorbidities, complemented by telephone consultations and in person consultations with practice nurses. When a patient is diagnosed with T2DM, the primary care team members delivering care should develop a personalised management plan that undergoes ongoing review based on new

diagnoses and includes a compressive annual or semi-annual review with the GP with day to day monitoring provided by nurses and patients themselves.

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Declarations

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Conflicts of interest/Competing interests

BC received funding from Novo Nordisk for this study. FZ is a speaker for Napp Pharmaceuticals. SS reports personal fees from NAPP, AMGEN, ASTRA ZENECA, LILLY, Merck Sharp & Dohme, Novartis, Novo Nordisk, Roche, Boehringer Ingelheim, Sanofi-Aventis, and grants from AstraZeneca, Sanofi-Aventis, Servier and Janssen, outside the submitted work. CLG has none. MJD has acted as consultant, advisory board member and speaker for Novo Nordisk, Sanofi-Aventis, Lilly, Merck Sharp & Dohme, Boehringer Ingelheim, AstraZeneca and Janssen, an advisory board member for Servier and Gilead Sciences Ltd and as a speaker for NAPP, Mitsubishi Tanabe Pharma Corporation and Takeda Pharmaceuticals International Inc. MJD has received grants in support of investigator and investigator initiated trials from Novo Nordisk, Sanofi-Aventis, Lilly, Boehringer Ingelheim, Astrazeneca and Janssen. CH is a paid employee of Novo Nordisk. KK has received funds for a research programme on multimorbidities. KK is the National Lead for multimorbidities for National Institute for Health Research Applied Research Collaboration.

Ethics approval

This research was approved by the Independent Scientific Advisory Committee (ISAC) for Medicines and Healthcare products Regulatory Agency Database Research (protocol 19_175).

Consent to participate

Generic ethical approval for observational research using the CPRD with approval from ISAC has been granted by a Health Research Authority (HRA) Research Ethics Committee. Individual patient consent is not required.

Consent for publication

All authors have approved this manuscript for publication.

Availability of data and material

Patient-level electronic health records obtained from CPRD cannot be shared. However, the authors will share aggregate statistics if requested.

Code availability

The authors will share programming code if requested. The following code sets are available at https://github.com/bc188/TherapeuticInertia.git: medcodes for type 2 diabetes, pre-existing type 1 diabetes and gestational diabetes; ICD-10 codes and medcodes for comorbidities. Codes identifying face to face and telephone consultations are available in **Supplementary Table 1**. Role codes are available in **Supplementary Table 3**. Unit costs are available in **Table 3**.

Authors' contributions

Conceptualization: BC, KK, FZ, CH; funding acquisition and methodology: BC, FZ; data curation, analysis, visualiation, writing- original draft: BC; writing- review: KK, FZ, CH, MJD, SS, CG.

Table 1. Descriptive characteristics of the cohort at the time of type 2 diabetes diagnosis.

Characteristic	Patients
Sex	
Male	65,294 (54.2%)
Female	55,115 (45.8%)
Ethnicity	
Black	2,633 (2.2%)
Other	1,314 (1.1%)
South Asian	5,963 (5.0%)
White	110,499 (91.8%)
Deprivation quintile	
1 (least deprived)	22,256 (18.5%)
2	26,978 (22.4%)
3	24,551 (20.4%)
4	25,733 (21.4%)
5 (most deprived)	20,891 (17.4%)
Lifestyle	
Current smoker	15,953 (13.2%)
Current alcohol user	28,979 (24.1%)
Age (years)	63.5 (13.4)

N=120,409. Age is shown as mean (SD). All other characteristics are shown as number (%).

Table 2. Crude rates of face to face and telephone consultations with a physician or nurse by the number of comorbidities at the time of consultation.

Face to face											
Number of comorbidities	**Nurse**				**GP**				**Total**		
	n	**Rate (95% CI)**	**%**	**RR (95% CI)**	**n**	**Rate (95% CI)**	**%**	**RR (95% CI)**	**n**	**Rate (95% CI)**	**RR (95% CI)**
T2DM only	1,356,492	4.22 (4.21-4.22)	40.8%	Reference	1,969,508	6.12 (6.11-6.13)	59.2%	Reference	3,326,000	10.34 (10.33-10.35)	Reference
+1	1,130,835	4.94 (4.93-4.95)	38.8%	1.17 (1.17-1.17)	1,782,381	7.78 (7.77-7.79)	61.2%	1.27 (1.27-1.27)	2,913,216	12.72 (12.70-12.73)	1.23 (1.23-1.23)
+2	505,077	5.66 (5.65-5.68)	37.4%	1.34 (1.34-1.35)	844,859	9.47 (9.45-9.49)	62.6%	1.55 (1.54-1.55)	1,349,936	15.13 (15.11-15.16)	1.46 (1.46-1.47)
+3 or more	265,819	6.68 (6.65-6.71)	35.7%	1.58 (1.58-1.59)	479,400	12.05 (12.01-12.08)	64.3%	1.97 (1.96-1.97)	745,219	18.73 (18.69-18.77)	1.81 (1.81-1.82)
Total	3,258,223	4.79 (4.79-4.80)	39.1%	-	5,076,148	7.47 (7.46-7.47)	60.9%	-	8,334,371	12.26 (12.25-12.27)	-
Telephone											
Number of comorbidities	**Nurse**				**GP**				**Total**		
	n	**Rate (95% CI)**	**%**	**RR (95% CI)**	**n**	**Rate (95% CI)**	**%**	**RR (95% CI)**	**n**	**Rate (95% CI)**	**RR (95% CI)**
T2DM only	35,471	0.11 (0.11-0.11)	19.4%	Reference	147,824	0.46 (0.46-0.46)	80.6%	Reference	183,295	0.57 (0.57-0.57)	Reference
+1	31,670	0.14 (0.14-0.14)	16.2%	1.25 (1.23-1.27)	164,376	0.72 (0.71-0.72)	83.8%	1.56 (1.55-1.57)	196,046	0.86 (0.85-0.86)	1.50 (1.49-1.51)
+2	15,566	0.17 (0.17-0.18)	14.3%	1.58 (1.55-1.61)	92,928	1.04 (1.04-1.05)	85.7%	2.27 (2.25-2.29)	108,494	1.22 (1.21-1.22)	2.13 (2.12-2.15)
+3 or more	8,695	0.22 (0.21-0.22)	12.6%	1.98 (1.94-2.03)	60,474	1.52 (1.51-1.53)	87.4%	3.31 (3.28-3.34)	69,169	1.74 (1.73-1.75)	3.05 (3.02-3.08)
Total	91,402	0.13 (0.13-0.14)	16.4%	-	465,602	0.69 (0.68-0.69)	83.6%	-	557,004	0.82 (0.82-0.82)	-

Rates are consultations per person year. GP= general practitioner. RR= rate ratio.

Table 3. Annual inflation-adjusted cost per patient for face to face consultations with a physician or nurse by number of comorbidities at time of consultation, 2000-2018.

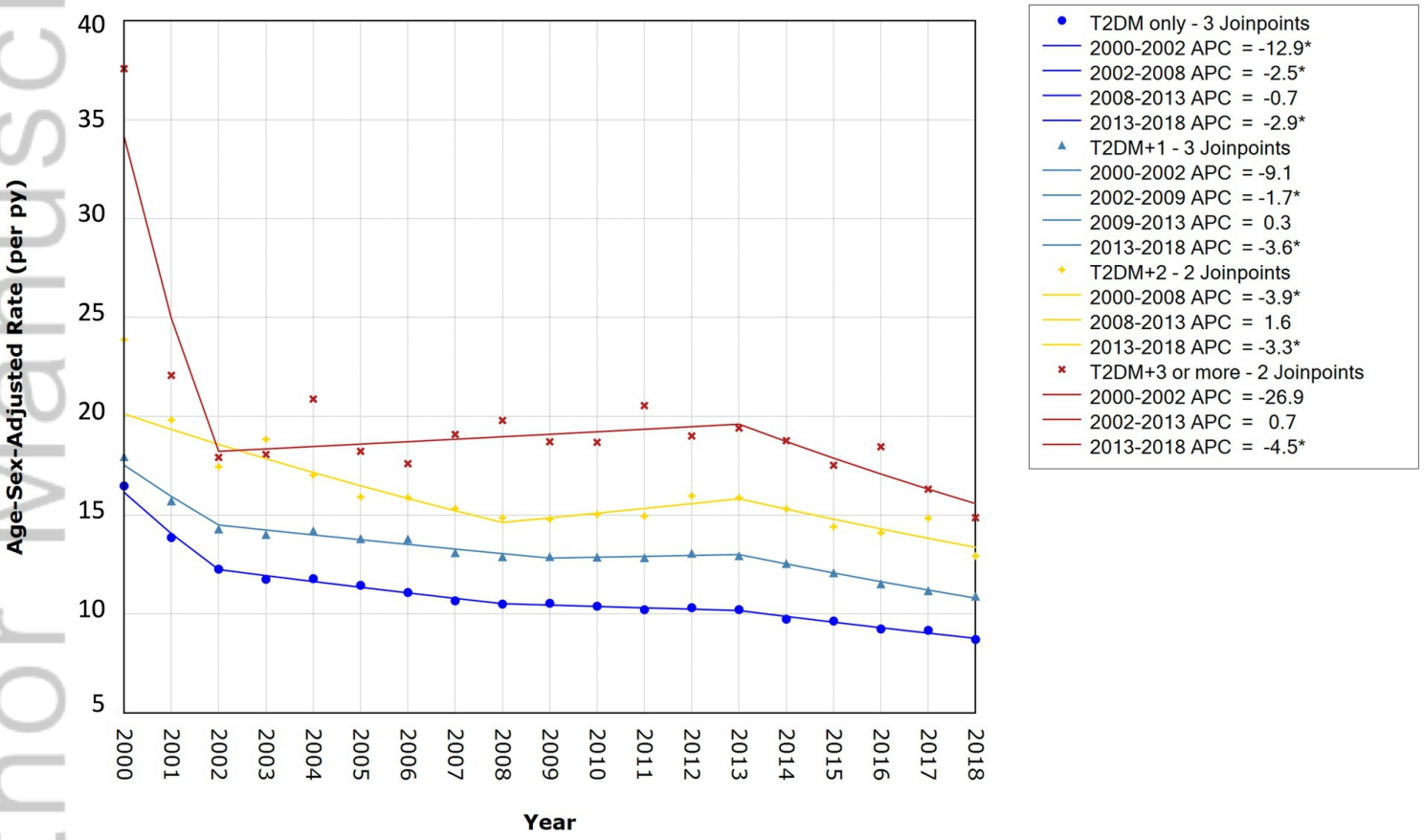
		Cost per consultation		Number of comorbidities											
				T2DM only			+1			+2			+3 or more		
Year	2018 Inflation multiplier	GP	Nurse	GP rate	Nurse rate	Annual cost	GP rate	Nurse rate	Annual cost	GP rate	Nurse rate	Annual cost	GP rate	Nurse rate	Annual cost
2000	1.65	£25.00	£9.00	10.50	6.01	£522.27	12.25	5.90	£593.11	13.70	6.26	£658.16	19.24	6.69	£892.89
2001	1.60	£26.00	£10.00	8.92	4.89	£449.31	10.74	5.22	£530.21	12.16	5.51	£594.15	15.10	6.27	£728.48
2002	1.57	£27.00	£10.00	7.47	4.70	£390.38	9.24	5.09	£471.58	10.98	5.57	£552.98	12.19	6.86	£624.46
2003	1.55	£26.00	£10.00	7.06	4.65	£356.73	8.89	5.20	£438.71	10.74	5.87	£523.65	12.42	6.27	£597.68
2004	1.50	£28.00	£9.00	6.97	4.72	£356.73	8.88	5.44	£446.17	10.67	6.01	£529.50	13.03	7.22	£644.69
2005	1.46	£30.00	£10.00	6.67	4.67	£360.26	8.43	5.41	£448.30	10.47	6.01	£546.09	12.52	7.01	£650.83
2006	1.42	£31.00	£10.00	6.45	4.50	£347.98	8.24	5.41	£439.51	10.17	5.89	£531.46	12.51	7.33	£654.91
2007	1.38	£50.00	£9.00	6.02	4.41	£470.08	7.63	5.11	£589.79	9.47	5.79	£725.53	11.69	7.10	£894.77
2008	1.32	£52.00	£11.00	5.98	4.30	£473.01	7.61	5.01	£595.31	9.12	5.73	£709.08	11.62	6.88	£897.61
2009	1.27	£52.00	£11.00	5.97	4.36	£455.45	7.52	5.04	£566.70	9.17	5.73	£685.57	11.69	6.65	£864.65
2010	1.28	£53.00	£12.00	6.02	4.19	£472.82	7.58	4.93	£589.79	9.15	5.65	£707.49	11.70	6.66	£896.33
2011	1.22	£53.00	£12.41	5.86	4.20	£442.58	7.53	4.93	£561.41	9.11	5.84	£677.44	11.72	6.99	£863.35
2012	1.16	£63.00	£12.83	5.93	4.25	£496.33	7.72	5.11	£640.14	9.47	5.89	£780.08	11.97	6.99	£979.06
2013	1.12	£66.00	£13.27	5.99	4.13	£504.04	7.83	5.02	£653.29	9.74	5.98	£808.90	12.62	7.12	£1,038.65
2014	1.09	£67.00	£13.72	5.82	3.85	£482.50	7.77	4.75	£638.39	9.50	5.59	£777.53	12.72	6.54	£1,026.38
2015	1.07	£65.00	£14.18	5.64	3.96	£452.10	7.32	4.77	£581.61	9.13	5.64	£720.40	11.81	6.54	£920.60
2016	1.05	£36.00	£14.67	5.59	3.60	£266.83	7.32	4.24	£342.07	9.11	4.97	£421.04	12.09	5.73	£545.13
2017	1.04	£38.00	£15.16	5.84	3.31	£283.14	7.53	3.96	£360.06	9.53	4.62	£449.68	12.32	5.14	£567.77
2018	1.00	£37.40	£15.68	5.62	3.11	£258.75	7.28	3.88	£333.08	8.79	4.25	£395.48	11.53	4.99	£509.54

GP= general practitioner. Crude rates are per patient per year. Annual costs are the estimated cost per patient per year. GP costs per consultation were estimated based on a face to face clinic consultation lasting 12.6 minutes from 2000-2006, 17.2 minutes from 2007-2015, and 9.2 minutes from 2016-2018.

Figure caption

Fig 1 Temporal trends of age-sex-adjusted face to face consultation rate with a physician or nurse by number of comorbidities at time of type 2 diabetes diagnosis

*Indicates that the Annual Percent Change (APC) for spline is significantly different from zero at alpha level 0.05.



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