Research

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The epidemiology of multimorbidity in primary care:

a retrospective cohort study

Abstract

Background
Multimorbidity places a substantial burden on patients and the healthcare system, but few contemporary epidemiological data are available.

Aim
To describe the epidemiology of multimorbidity in adults in England, and quantify associations between multimorbidity and health service utilisation.

Design and setting
Retrospective cohort study, undertaken in England.

Method
The study used a random sample of 403 985 adult patients (aged ≥18 years), who were registered with a general practice on 1 January 2012 and included in the Clinical Practice Research Datalink. Multimorbidity was defined as having two or more of 36 long-term conditions recorded in patients' medical records, and associations between multimorbidity and health service utilisation (GP consultations, prescriptions, and hospitalisations) over 4 years were quantified.

Results
In total, 27.2% of the patients involved in the study had multimorbidity. The most prevalent conditions were hypertension (18.2%), depression or anxiety (10.3%), and chronic pain (10.1%). The prevalence of multimorbidity was higher in females than males (30.0% versus 24.4% respectively) and among those with lower socioeconomic status (30.0% in the quintile with the greatest levels of deprivation versus 25.8% in that with the lowest). Physical–mental comorbidity constituted a much greater proportion of overall morbidity in both younger patients (18–44 years) and those patients with a lower socioeconomic status. Multimorbidity was strongly associated with health service utilisation. Patients with multimorbidity accounted for 52.9% of GP consultations, 78.7% of prescriptions, and 56.1% of hospital admissions.

Conclusion
Multimorbidity is common, socially patterned, and associated with increased health service utilisation. These findings support the need to improve the quality and efficiency of health services providing care to patients with multimorbidity at both practice and national level.

Keywords
comorbidity; health service utilisation; multimorbidity; primary health care.

INTRODUCTION

Multimorbidity is defined as the coexistence of two or more long-term medical conditions or diseases.[1] Patients with numerous long-term conditions often have complicated medical needs, including understanding and managing multiple illnesses and complex medication regimens.[1] Multimorbidity is challenging for the healthcare system to manage, because patients who have it often require more intensive treatment and monitoring by physicians, nurses, and other healthcare providers.[2] Many studies have shown a positive association between the prevalence of multimorbidity and age[2–5] so, as the population of older individuals in developed nations continues to grow, multimorbidity is likely to become increasingly common.[6]

Multimorbidity has a substantial impact on various health services ranging from general practice to end-of-life care. Much of the management of patients with multimorbidity is undertaken in primary care, placing large demands on GPs, many of whom are already dealing with unsustainable increases in their workload.[7] Describing the relationship and quantifying the associations between multimorbidity and health service utilisation can provide information about overburdened aspects of primary care, identifying areas for increased resource allocation or targets for systems-level restructuring.

In previous studies, patients with multimorbidity have been identified either through self-reporting illnesses[8,9] or, more commonly, by extracting information from electronic health records (EHRs) using lists of diagnostic and prescription codes.[2–4,10,11] These code lists likely differ substantially between studies and, although standardised published lists exist for use in specific contexts — for example, those used to identify conditions as part of the UK pay-for-performance Quality and Outcomes Framework (QOF) — there is currently no single set of codes that has been consistently used to identify patients with a given condition. Many code lists used in multimorbidity studies have varying levels of sensitivity and specificity, and are subjective because their content is at the discretion of the researchers or physicians involved in the study.

A study on 40 long-term conditions by Barnett *et al* based on Scottish general practice data from 2007 described the prevalence of multimorbidity in Scottish primary care.[4] Subsequent work, also in Scotland and based on the same list of morbidities, reported a strong association between multimorbidity and hospitalisation.[12] The list of conditions included in these studies was a pragmatic compromise between smaller lists that have clear, accepted coded definitions (including that used by the QOF), and the far larger, more inclusive Johns

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How this fits in

Multimorbidity is known to be increasingly common in developed countries; in 2007, a large Scottish study found that 23.2% of the population had multimorbidity. The study presented here provides a more up-to-date and comprehensive description of multimorbidity than exists in the current literature, and describes a large English population in 2012. It found a slightly higher rate of multimorbidity at 27.2%, and higher rates of multimorbidity with increased age and greater levels of socioeconomic deprivation. A third of patients with multimorbidity have a mental health condition. The majority of GP consultations, prescriptions, and hospital admissions involve patients with multimorbidity.

Hopkins University Adjusted Clinical Groups Case-Mix Systems (ACG) lists.[4,12] The ACG lists are complex and difficult to implement in research or clinical settings; the QOF lists — although more practical to implement — fail to capture important, common conditions, such as chronic pain, which can have a significant impact on patient care and quality of life. Additionally, the diagnostic and prescribing code lists used in these Scottish studies are not readily available, the methods used to derive the codes are not well described, and the association with service utilisation beyond hospital admission has not been examined. Furthermore, the data are now over 10 years old and considerable changes in both disease prevalence and health service use might be expected over this time period.

The study presented here aimed to provide a comprehensive and more contemporary description of the epidemiology of multimorbidity in England and its association with health service utilisation, using a refined list of long-term conditions based on the work by Barnett *et al*.[4]

METHOD

Patient population and data acquisition

Data for this study were obtained from the Clinical Practice Research Datalink (CPRD). The CPRD provides researchers with anonymised clinical information extracted from consenting general practice EHRs that are uploaded to the CPRD on a monthly basis. The CPRD contains information from approximately 6.9% of the UK population and is representative of the UK general population in terms of age, sex, and ethnicity.[13,14] To ensure records were up to date, patients had to have up-to-standard registration data for at least 1 year prior to the beginning of the study and through its completion.

This study linked CPRD patient-level general practice clinical data to:

- an area-based measure of socioeconomic deprivation (Index of Multiple Deprivation [IMD]); and
- national hospital admissions administrative data (Hospital Episodes Statistics [HES]).

Of the practices that provide patient data to CPRD, 75% participate in this linkage scheme; only patients from practices that participated in this data linkage were eligible for inclusion in the study.

Definition of multimorbidity

Patients with multimorbidity were defined as having two or more currently active long-term conditions out of a list of 36 conditions. The detailed definition for each condition was developed by a group of researchers and GPs from the Primary Care Unit, University of Cambridge. The overall taxonomy drew largely on the previous work by Barnett *et al* in Scotland;[4] the authors of the study presented here used Barnett *et al*'s definition of morbidities, which comprised those conditions:

'... likely to be chronic (defined as having significant impact over at least the most recent year) and with significant impact on patients in terms of need for chronic treatment, reduced function, reduced quality of life, and risk of future morbidity and mortality.'[15]

Information identifying whether patients had current, active morbidities was extracted from patients' primary care medical records in the CPRD, using a list of both Read codes (used by UK GPs to record coded information in the EHR about diagnoses and administrative activity) and product codes (which are unique to the CPRD, and reflect all prescribed pharmacological and non-pharmacological products recorded in the EHR). A detailed description of how each individual condition was defined is available from the authors on request.

In addition to the prevalence of multimorbidity, the association between mental health morbidities and physical morbidities was also examined, with the authors specifically looking at the coexistence of at least one mental morbidity (for example, depression/anxiety) with at
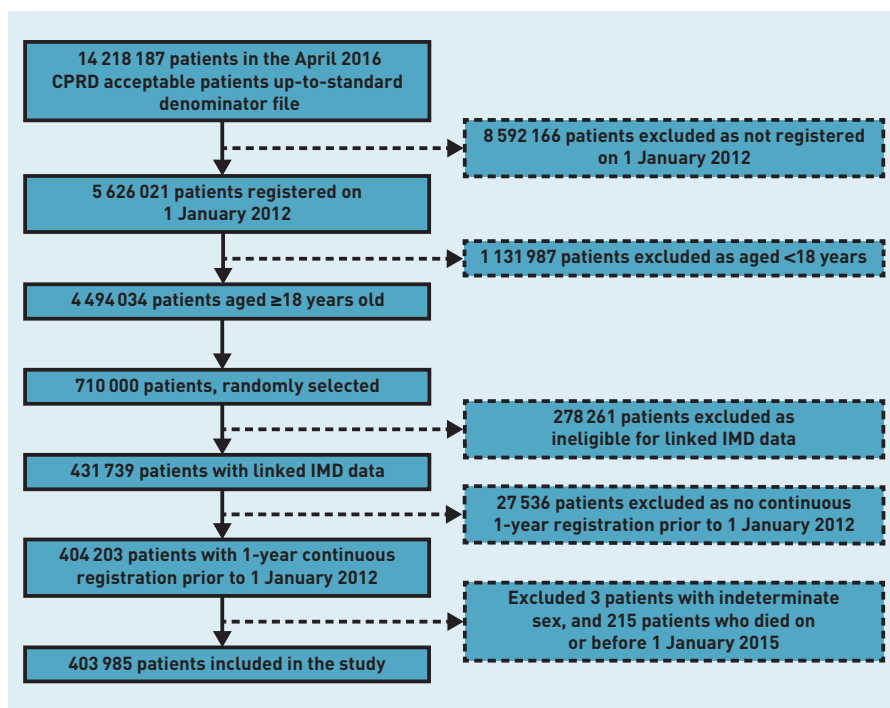
Figure 1. Study inclusion and exclusion criteria.
CPRD = Clinical Practice Research Datalink.
IMD = Index of Multiple Deprivation.

multimorbidity on 1 January 2012 in relation to several covariates:

- sex;
- age; and
- socioeconomic status (SES).

They then assessed health service utilisation over 4 years between 1 January 2012 and 31 December 2015. Utilisation was defined as the number of yearly GP consultations (including face-to-face and telephone consultations), the total number of prescriptions (including pharmaceuticals and non-pharmaceuticals) issued to a patient in a year, and the total number of yearly inpatient hospital admissions. More details about the specific consultation types that were included are available from the authors on request.

Study sample
This study included 403 985 adult patients (aged ≥18 years) who had been registered with a GP in England on 1 January 2012 and who were marked by CPRD as having acceptable patient and up-to-standard practice data in April 2016. Figure 1 shows the inclusion and exclusion criteria for patients in the study.

Analysis
The authors used frequencies and

least one physical morbidity (for example, hypertension).

Study design
In a retrospective cohort study, the authors quantified the cross-sectional prevalence of

Table 1. Patient characteristics and description of multimorbidity

	Patients, *n* (%)	Mean number of morbidities,[a] *n* (SD)	Patients with multimorbidity,[b] % (95% CI)	Patients with physical–mental comorbidity,[b] % (95% CI)	Patients with multimorbidity and physical–mental comorbidity,[b] % (95% CI)
All patients	403 985 (100)	1.11 (1.58)	27.2 (27.1 to 27.3)	9.5 (9.4 to 9.6)	33.8 (33.5 to 34.1)
Sex					
Male	199 096 (49.28)	1.00 (1.52)	24.4 (24.2 to 24.5)	7.0 (6.9 to 7.2)	27.5 (27.1 to 27.9)
Female	204 889 (50.72)	1.21 (1.62)	30.0 (29.8 to 30.2)	11.9 (11.8 to 12.1)	38.8 (38.4 to 39.1)
Age, years					
18–24	39 666 (9.82)	0.26 (0.56)	3.8 (3.6 to 4.0)	2.3 (2.2 to 2.5)	56.5 (54.0 to 59.0)
25–34	63 697 (15.77)	0.36 (0.70)	6.9 (6.7 to 7.1)	4.1 (3.9 to 4.2)	55.7 (54.3 to 57.2)
35–44	73 246 (18.13)	0.53 (0.90)	12.1 (11.9 to 12.4)	6.8 (6.6 to 7.0)	53.8 (52.8 to 54.9)
45–54	75 375 (18.66)	0.80 (1.15)	19.7 (19.4 to 20.0)	9.4 (9.2 to 9.6)	45.8 (45.0 to 46.6)
55–64	61 826 (15.30)	1.31 (1.46)	34.7 (34.4 to 35.1)	12.1 (11.8 to 12.4)	33.7 (33.1 to 34.4)
65–74	47 417 (11.74)	2.06 (1.79)	54.8 (54.4 to 55.3)	13.8 (13.5 to 14.2)	24.5 (24.0 to 25.0)
75–84	29 933 (7.41)	2.97 (2.05)	74.0 (73.4 to 74.4)	18.1 (17.6 to 18.5)	23.7 (23.1 to 24.2)
≥85	12 825 (3.17)	3.65 (2.20)	83.2 (82.5 to 83.8)	27.0 (26.2 to 27.8)	31.7 (30.8 to 32.6)
Socioeconomic status					
1 (least deprivation)	93 788 (23.22)	1.05 (1.51)	25.8 (25.5 to 26.0)	7.5 (7.2 to 7.7)	29.5 (28.9 to 30.0)
2	90 735 (22.46)	1.09 (1.56)	27.0 (26.7 to 27.3)	8.2 (8.1 to 8.4)	30.8 (30.3 to 31.4)
3	84 182 (20.84)	1.12 (1.59)	27.5 (27.2 to 27.8)	9.1 (8.9 to 9.3)	32.8 (32.2 to 33.4)
4	73 865 (18.28)	1.13 (1.63)	27.8 (27.4 to 28.1)	11.0 (10.8 to 11.3)	36.8 (36.1 to 37.4)
5 (greatest deprivation)	61 415 (15.20)	1.22 (1.71)	30.0 (29.6 to 30.4)	14.0 (13.7 to 14.2)	41.2 (40.5 to 41.9)

[a]Statistically significant difference in means (P<0.001) within each variable group based on t-test (sex) and one-way analysis of variance (age group and socioeconomic status).

[b]Statistically significant difference in percentage with multimorbidity (P<0.001) within each variable group based on χ² test. SD = standard deviation.
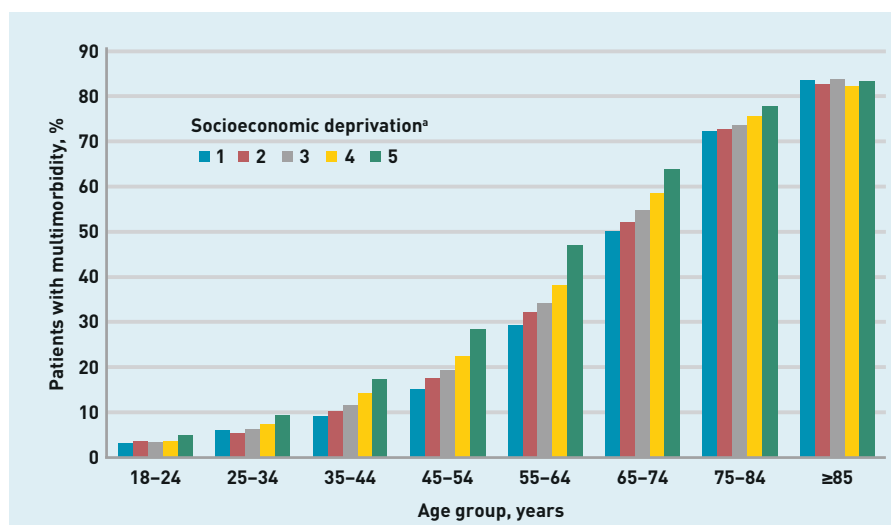
Figure 2. Prevalence of multimorbidity by age and socioeconomic status. [a] 1 is the quintile with the least socioeconomic deprivation, 5 is that with the greatest.

Figure 3. Prevalence of physical–mental comorbidity by age and socioeconomic status. [a] 1 is the quintile with the least socioeconomic deprivation, 5 is that with the greatest.
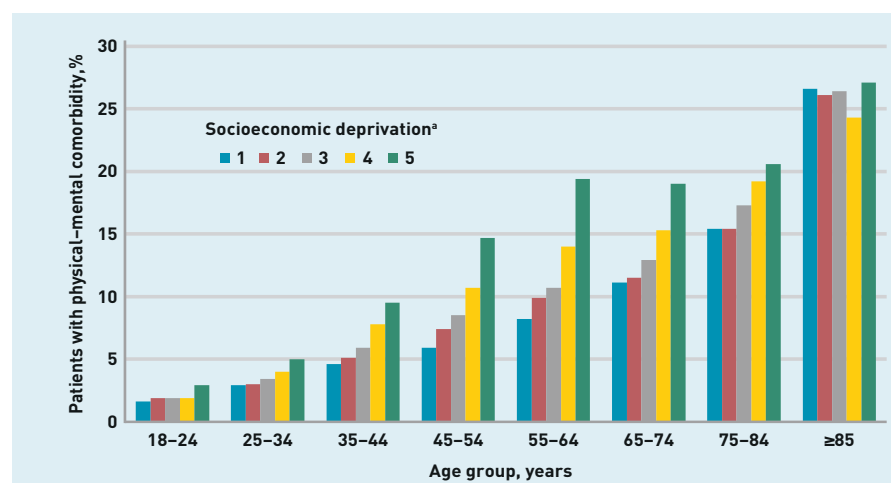

percentages to describe the prevalence of multimorbidity. To assess differences by sex, age, and SES in the percentage of patients with multimorbidity and physical–mental comorbidity, χ^2 tests were used. The number of morbidities in the sample was summarised according to sex, age group (based on 10-year cut-off values), and SES quintile, using mean figures and standard deviations. To assess whether the mean number of morbidities differed by sex, a *t*-test was used. For age group and SES, the authors used one-way analysis of variance to determine whether there was a statistically significant difference in the mean number of morbidities between groups.

Health service utilisation was summarised using median figures and interquartile ranges (IQRs), and the proportions of consultations, prescriptions, and hospital admissions that occurred in patients with multimorbidity were calculated. To account for patients who died or transferred out after 1 January 2012,

yearly counts of health service utilisation were based on total person time (in months) that a participant contributed to the study. Negative binomial regression was used to investigate the association between the presence of multimorbidity and incident rates of GP consultations, prescriptions, and hospital admissions adjusted for sex, age category, SES quintile, and follow-up time (months). To account for similarity of outcome within practices, statistical inference from the negative binomial model was based on cluster-robust standard errors. All analyses were conducted using Stata version 13.1.

RESULTS

Table 1 summarises the demographic characteristics of patients included in the study and reports the mean number of morbidities, prevalence of multimorbidity, and prevalence of physical–mental comorbidity. The prevalence of multimorbidity was 27.2% and females had significantly higher prevalence of multimorbidity than males (30.0% versus 24.4%, *P*<0.001).

Figure 2 shows the prevalence of multimorbidity by age and SES; prevalence was significantly higher with increased age (*P*<0.001 for all age groups). Greater socioeconomic deprivation was associated with significantly higher levels of multimorbidity — 30.0% in the quintile with the greatest levels of deprivation versus 25.8% in that with the lowest (Table 1).

Of patients in the sample, 9.5% had both a physical and a mental morbidity (Table 1). The prevalence of physical–mental comorbidity in patients was highest among females (11.9% versus 7.0%, *P*<0.001; Table 1) and increased with age and greater levels of socioeconomic deprivation (Figure 3). Among patients with multimorbidity, 33.8% had both a physical and a mental morbidity. The majority of patients with multimorbidity in the 18–24- year age group had physical–mental comorbidity (56.5%), compared with 23.7% of their 75–84-year-old counterparts. The proportion of patients with multimorbidity who had a physical–mental comorbidity increased substantially with greater socioeconomic deprivation: 29.5% in the quintile with the lowest levels of deprivation rose to 41.2% in that with the greatest (*P*<0.001) (Table 1).

Table 2 shows the prevalence of the 10 most common individual morbidities, the average number of morbidities associated with these conditions, and the three most frequent comorbidities associated with

Table 2. Ten most prevalent morbidities and associated comorbidities

Morbidity	Prevalence, %	Mean number of comorbidities associated with condition, n	Three most frequently associated comorbidities	
			Condition	Prevalence,[a] %
Hypertension	18.2	3.0	Painful condition	24.3
			Diabetes	19.4
			Hearing loss	16.7
Depression/anxiety	10.3	3.1	Painful condition	32.7
			Hypertension	28.9
			Irritable bowel syndrome	17.2
Chronic pain	10.1	3.7	Hypertension	44.0
			Depression/anxiety	35.5
			Hearing loss	18.4
Hearing loss	9.5	2.8	Hypertension	32.0
			Painful condition	19.4
			Depression/anxiety	14.8
Irritable bowel syndrome	7.9	1.8	Depression/anxiety	22.3
			Hypertension	20.5
			Painful condition	18.4
Diabetes	5.9	3.5	Hypertension	60.1
			Painful condition	26.6
			Depression/anxiety	17.9
Prostate disorders	5.7	3.5	Hypertension	44.1
			Hearing loss	25.3
			Painful condition	20.7
Thyroid disorders	4.7	3.1	Hypertension	37.0
			Painful condition	23.4
			Depression/anxiety	19.7
Coronary heart disease	4.3	4.0	Hypertension	56.5
			Painful condition	30.3
			Diabetes	23.3
Asthma	3.7	3.2	Hypertension	30.3
			Painful condition	26.6
			Depression/anxiety	22.4

[a]Prevalence in male participants only.

each condition. Hypertension (18.2%), depression/anxiety (10.3%), and chronic pain (10.1%) were the three most common individual morbidities. The prevalence of all comorbidities in the sample is available from the authors on request.

Health service utilisation

The majority of GP consultations, prescriptions, and hospital admissions were associated with patients with multimorbidity. Table 3 summarises health service utilisation among patients in the study sample. The proportion of GP consultations devoted to patients with multimorbidity was 52.9%. There was a strong association between multimorbidity and adjusted yearly rate of GP consultations: patients with multimorbidity had 2.56 (95% confidence interval [CI] = 2.48 to 2.64) times as many consultations as patients without multimorbidity.

In total, 78.7% of prescriptions were given to patients with multimorbidity. There was a strong association between multimorbidity and adjusted yearly rate of total prescriptions: patients with multimorbidity had 5.91 (95% CI = 5.71 to 6.12) times as many prescriptions as patients without multimorbidity (Table 3). In the sample, 155 488 patients (38.5%) were admitted to hospital at least once during the 4-year follow-up period; patients with multimorbidity accounted for 56.1% of these admissions (Table 3). There was a strong association between multimorbidity and hospital admissions; patients with multimorbidity had 2.58 (95% CI = 2.48 to 2.69) times as many hospitalisations as patients without multimorbidity. Essentially, one quarter of the population is accounting for more than half of health service utilisation.

DISCUSSION
Summary
This study found that multimorbidity was associated with female sex, increased age, and lower SES. Physical–mental comorbidity made up a substantial proportion of all patients with multimorbidity (33.8%). The proportion of patients with multimorbidity who have a physical–mental comorbidity is higher among females, younger age groups

Table 3. Health service utilisation[a]

Service	Service use attributable to patients with multimorbidity, %	Yearly rate ratio of service use (95% CI) in patients with versus those without multimorbidity[a]	Yearly service utilisation, median (25–75%)		Minimum/maximum yearly service utilisation	
			Multimorbidity[b]	No multimorbidity[c]	Multimorbidity[b]	No multimorbidity[c]
General practice consultations	52.86	2.56 (2.48 to 2.64)	9 (4–16.4)	2 (0–5.25)	0/194	0/156
Prescriptions	78.7	5.91 (5.71 to 6.12)	28.5 (9.25–61)	0.75 (0–2.25)	0/1061	0/132
Hospital admissions	56.14	2.58 (2.48 to 2.69)	0.25 (0–0.75)	0 (0–0.25)	0/156	0/150

[a]Results from the fitted negative binomial model adjusted for sex, age group, and socioeconomic status. [b]≥2 morbidities. [c]0–1 morbidities.

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(patients aged 18–44 years), and groups with greater levels of socioeconomic deprivation.

Additionally, multimorbidity was highly associated with increased rates of GP consultations, prescriptions, and hospitalisations, which highlights the disproportionately large demand that patients with multimorbidity place on the UK's overburdened healthcare system.

Strengths and limitations
A strength of this study was its use of a large, up-to-date data sample that is representative of the English population; there were few missing data.[13] The code lists used to extract information on chronic diseases from the database were evaluated by practising GPs, utilised or improved previously published lists where possible, and are published in full, ultimately improving the reproducibility and transparency of this type of EHR research. A limitation is that, with real clinical data, there may be systematic differences in both the type and frequency of diagnostic labels that GPs and general practice staff document in a patient's medical record. Smaller or less-organised practices are less likely to participate in CPRD, so it is important to be aware that this sample might not be fully representative of all types of GP practices in England.[13]

An additional limitation was that all GP consultations, prescriptions, and hospitalisations were weighted equally as measures of health service utilisation. Accounting for duration of consultation, frequency of prescriptions, and length of hospitalisations would have provided a more complete picture of health service utilisation.

Comparison with existing literature
This study provides an up-to-date and comprehensive description of the epidemiology of multimorbidity and health service utilisation in England. The authors have closely mirrored, but refined where necessary, the definitions of individual multimorbidity categories used by Barnett *et al* in 2012;[4] the specific definition in full for each of these morbidity categories is available from the authors on request to facilitate future research.

The prevalence of multimorbidity in this study in England in 2012 (27.2%) was higher than in previous studies involving similar populations, including Barnett *et al*'s study in Scotland in 2007 (23.2% prevalence)[4] and Salisbury *et al*'s study in the UK in 2008

(16% prevalence), which used only long-term conditions featured in the QOF.[3] The higher prevalence in the study presented here may be attributable to differences in the definitions of multimorbidity and the codes used to identify patients with multimorbidity, as well as to increases in diagnosis and coding within clinical practice. However, it may also suggest that further increases in the prevalence of multimorbidity has occurred in England in recent years.

The study presented here also demonstrates and describes a strong association between multimorbidity and overall health service utilisation, which is consistent with previous studies demonstrating a strong link with prescriptions,[16] consultations,[17] and admissions[12] individually.

Implications for research and practice
How health services are designed to care for patients with multimorbidity should take into consideration demographic factors, such as age and socioeconomic deprivation. This study found that in the younger age groups most of those with multimorbidity had both a physical and mental comorbidity. Similarly, those patients with the greatest levels of socioeconomic deprivation also had higher rates of physical–mental comorbidities. These data suggest that when GPs are caring for younger and poorer patients with multimorbidity, they should think about the intersection between physical and mental health morbidities. By comparison, when caring for older patients with multimorbidity, the sheer number of morbidities is more likely to define those patients' healthcare needs.

The *Five Year Forward View* called for a reorganisation of the NHS to support people with multiple health conditions, not just single diseases.[18] This study has provided yet more evidence of the pressing need to fulfil this ambition at a time when general practice workload,[7] prescribing,[16] and hospital admissions[19] continue to climb at alarmingly rapid rates. As the majority of healthcare encounters are now with patients with multimorbidity, all health professionals must be trained to manage the cumulative effects of more than one chronic condition. Many 'single-disease' services in primary and secondary care will need to be redesigned to treat patients with multiple morbidities.

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