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The prevalence of multimorbidity in primary care and its effect on health care utilization and cost

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Introduction. Multimorbidity is common among the heterogeneous primary care population, but little data exist on its association with health care utilization or cost.

Objective. The aim of this observational study was to examine the prevalence and associated health care utilization and cost of patients with multimorbidity.

Methods. All patients >50 years of age were eligible for the study which took place in three primary care practices in the West of Ireland. Chronic medical conditions and associated health care utilization in primary and secondary care were identified through patient record review.

Results. In a sample of 3309 patients in the community, the prevalence of multimorbidity was 66.2% (95% CI: 64.5–67.8) in those >50 years of age. Health care utilization and cost was significantly increased among patients with multimorbidity ($P < 0.001$). After multivariate adjustment for age, gender and free medical care eligibility, the addition of each chronic condition led to an associated increase in primary care consultations ($P = 0.001$) (11.9 versus 3.7 for >4 conditions versus 0 conditions); hospital out-patient visits ($P = 0.001$) (3.6 versus 0.6 for >4 conditions versus 0 conditions); hospital admissions ($P = 0.01$) [adjusted odds ratio (OR) of 4.51 for >4 conditions versus 0 conditions] and total health care costs ($P < 0.001$) (€4,096.86 versus €760.20 for >4 conditions versus 0 conditions) over the previous 12 months.

Conclusions. Multimorbidity is very common in primary care and in a system with strong gatekeeping is associated with high health care utilization and cost across the health care system. Interventions to address quality and cost associated with multimorbidity must focus on primary as well as secondary care.

Keywords. Cost, health care utiliszation, multimorbidity, prevalence, primary care.

Introduction

Multimorbidity—the simultaneous coexistence of more than one chronic condition in a single individual—is common, particularly in older adults with prevalence estimates of 65–98% for those >65 years of age.[1–3] The treatment of such chronic conditions accounts for up to 75% of all health care expenditure in the USA. In Europe, chronic conditions are estimated to account for 70–80% of health care expenses in countries such as Denmark and comprise 8 of the top 11 causes of hospital admission in the UK.[4] However, published prevalence data on multimorbidity vary greatly as do the various data collection methods used which have included administrative[1,5,6] and primary care[7] databases as well as various surveys.[2,8] Study setting and sources of patient data have an important influence on the outcome of multimorbidity studies[9] and the prevalence of multimorbidity appears to be substantially lower when estimated in a general population than in a family practice-based sample.[10,11] It has been suggested that patient record review is the best way to collect information about multimorbidity prevalence[3] as it is not reliant on coding and data entry but rather gathers data from the entire patient record. To date, only a single large study in primary care has used this methodology in which the prevalence of multimorbidity was 69% in 18–44 year olds, 93% in 45–64 year olds and 98% in those aged >65 years.[3] However, data in this study was collected from consecutive patients attending primary care physicians which as a result may overestimate the true prevalence

of multimorbidity in the community. In addition to age, other factors such as socio-economic status and gender can affect not only the prevalence of multimorbidity[3,7] but also health care utilization in primary and secondary care. With the exception of relatively uncommon conditions, the majority of visits for care for both an indicator condition and any co-existing conditions are made to primary care physicians, not specialists.[12] Although it has been shown that a high morbidity burden leads to greater use of specialist physicians, it has been suggested in a study from the USA that this may not be true of primary care services even for patients with common diagnoses not generally considered to require specialist care.[5] However in the USA, the primary care physician does not play the gatekeeping role seen in many European countries.[13] This gatekeeping role as part of an effective primary care system is known to improve quality and decrease cost in health care systems throughout the world.[14]

In this paper, we examined a block sample of patients'medical records in a primary care system with a strong gatekeeping role to ascertain the prevalence of multimorbidity in a primary care population and to explore the relationship between level of multimorbidity and health care utilization and cost in primary and secondary care.

Methods

Irish health system

Primary care and medications are available free at the point of delivery to that one-third (approximately) of the population of the Republic of Ireland with the lowest income and therefore 'free medical care eligibility' is a direct measure of socio-economic status at the level of the individual. These individuals are registered to a single GP. The other two-thirds, whose income is above a certain level (in 2009: €184/week for a single person aged up to 65 years who is living alone), are not eligible for free medical care, are responsible for their own primary health care costs including out of hours care and are largely but not universally registered to a single general practitioner. The Irish Medical Council is unambiguous regarding the gatekeeping role of family doctors: 'It is in the best interests of the patient that a general practitioner supervises and guides the overall management of their health …. Normally, consultants will see patients following referral from their family doctor or other treating doctor'.[15]

Study population

The study population consisted of all patients from three family practices (10 primary care physicians) from a mixed urban/rural setting in the West of Ireland. These practices are part of a university-affiliated general practice research network which has been shown to be representative of the national profile.[16] We deliberately did not set an upper age limit. Data were collected by a manual search of each patient record within general practice by one of two trained researchers. Practices were paperless and fully computerized and used the same method of patient data recording in that all patient primary and secondary care data were routinely typed or scanned into each patient file. All practices used the International Classification for Primary Care (ICPC-2) coding of chronic diseases. This provided a reference population of 18 941 patients and all active (two or more consultations in the previous 2 years) patients >50 years of age were included the study. In this way, patients (e.g. visitors, patients who had moved away or practice inter-referrals) who attended a practice only once in the previous 2 years were excluded. Patients >50 years of age were included as this is the group with whom most of the morbidity burden rests in the community and thus whom any interventions in this area will inevitably be directed.

Study variables

Chronic medical conditions and multimorbidity. We defined and counted chronic medical conditions according to the World Health Organization definition of chronic conditions as 'health problems that require ongoing management over a period of years or decades'.[17] Multimorbidity was defined as two or more chronic medical conditions occurring simultaneously[3] and present at the time of data collection. The number of chronic medical conditions was recorded from a complete manual search of the patient medical record which included ICPC-2 coding,[18] consultation notes and correspondence from other health care professionals. The ICPC-2 coding system provides a subset of codes (147 of a total of 686) which are defined as chronic medical conditions in primary care.[19]

Health services utilization. Health care utilization was measured in terms of primary care consultations (GP or practice nurse), hospital out-patient visits and hospital admissions in the previous 12 months.

Covariates

Age and gender were also obtained from the medical records. 'Free Medical Care eligibility', due to its means tested basis, was a binary variable directly measuring individual socio-economic status.

Health care costs

Unit cost data for primary care consultations, hospital out-patient visits and hospital admissions were obtained from national data sources and applied to each component of health care utilization to estimate the total cost of care. The cost per primary care

consultation was obtained from the Office of the Revenue Commissioner and the costs per out-patient consultation and hospital admission were obtained from the Health Service Executive. The national average cost per case was adopted with respect to hospital care as we did not have sufficient data to cost each case individually. The unit costs adopted in the analysis, presented in euros (€), were €50.00, €160.00 and €5030 for primary care consultations, hospital out-patient visits and hospital admissions, respectively.

Statistical analysis

To examine the relationship between multimorbidity and demographic characteristics, patients were classified according to the presence or absence of multimorbidity defined as the presence of two or more chronic medical conditions. A binary logistic regression model was then used to examine the relationship between multimorbidity (dependent variable) and age (continuous), gender (male/female) and free medical care eligibility (yes/no) (independent variables). Multivariate analysis was then used to determine the impact of the number of chronic conditions (independent variable), categorized as '0', '1', '2', '3', '4' and '>4' on health care utilization and cost (dependent variables) while adjusting for age, gender and free medical care eligibility. In these multilevel analyses, patient's practice cluster was incorporated as a random effect to model patient heterogeneity within practices. For health care utilization, two of the response variables were discrete ('primary care consultations' and 'hospital out-patient visits') but had sufficiently large ranges to be treated as continuous variables while the third (hospital admissions') was re-categorized as '0' or '1 or more'. This binary variable was created as the majority of data responses for the 12-month period of interest recorded under these variables tended to be '0, 1 or 2'. Poisson regression models were used to model the relationship between the discrete response variables ('primary care consultations' and 'hospital out-patient visits') and the explanatory variables. The classical Poisson regression model for continuous data is often of limited use due to over-dispersion (the variance in the data exceeds that proposed under the Poisson model) and this was indeed the case in this analysis. In order to adjust for over-dispersion, a Quasi-Poisson model[20] was used. Binary Logistic regression was then used to model the odds of increased 'hospital admissions' as a function of the explanatory variables. Finally, a linear test for trends was carried out across the increasing number of chronic conditions for the three health care utilization response variables. For health care costs, a generalized linear multilevel model with a log-link function and gamma error distribution was used to identify the relationship between number of chronic conditions and costs after controlling for age, gender, free medical card eligibility and cluster effect. In all analyses, main effects, –two-way and three-way interactions were considered and the most parsimonious model identified. Model suitability was based on examination of goodness of fit statistics and suitable residual plots. All analyses were carried out using R and SPSS 17.0 statistical software.

Results

Study sample

Of 18941 patients in the reference population, 5150 (27%) were >50 years of age and 3309 patients had two or more consultations in the previous 24 months (Figure 1). The study sample was representative of the population of the Republic of Ireland >50 years of age[21] with 49.1% being male, 51.8% eligible for free medical care and in terms of age: 39.6% were aged 50–59 years; 29.5% were aged 60–69 years; 19.0% were aged 70–79 years and 12.0% were aged ⩾80 years.

Prevalence of multimorbidity

The prevalence of multimorbidity—the simultaneous coexistence of more than one chronic condition in a single individual—in the study sample was 66.2%

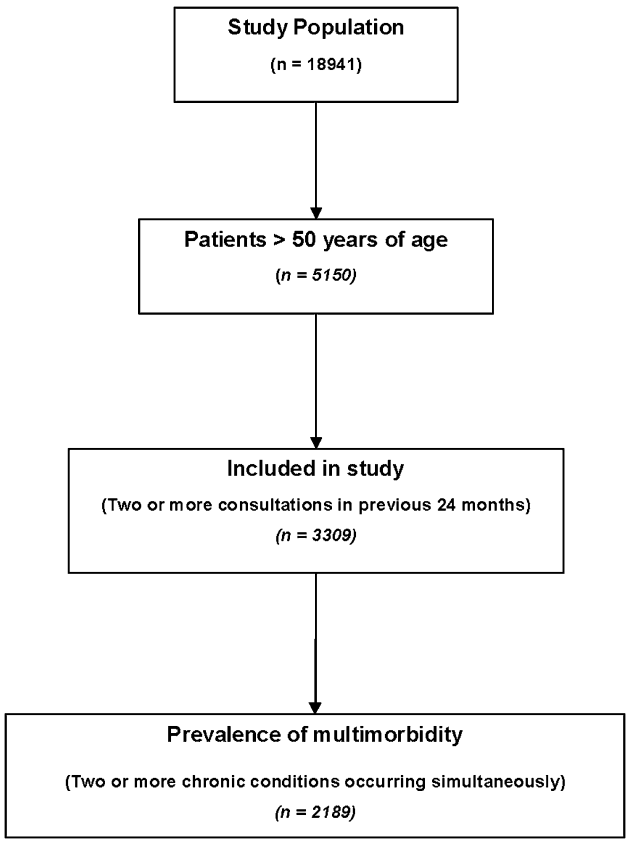

FIGURE 1 *Flow diagram for participants in the study*

(Figure 2), while 11% had more than four chronic conditions. The mean number of chronic conditions and prevalence of multimorbidity stratified for age, gender and free medical care eligibility is described in Table 1. The binary logistic regression model used to examine the relationship between multimorbidity (dependent variable) and age, gender and free medical care eligibility (independent variables) demonstrated that the risk of having multimorbidity increased significantly with increasing age [OR = 1.06, 95% (confidence interval) CI: 1.05–1.07] and being eligible for free medical care (OR = 1.75, 95% CI: 1.45–2.09), while gender had no significant effect.

Health care utilization

Unadjusted data for health care utilization in primary and secondary care according to number of chronic conditions is illustrated in Figure 3, while Table 2 presents the estimates of health services utilization (mean number and 95% CI) according to number of chronic conditions while adjusting for explanatory variables (gender, free medical care eligibility and cluster) and fixing the model at an age covariate value of 65 years. A linear test for trends for the three health care utilization response variables across the increasing number of chronic conditions confirms that there is evidence of a linear trend for primary care consultations ($P < 0.001$) and hospital admissions ($P < 0.001$), while a quadratic trend exists for hospital outpatient visits ($P = 0.008$).

The mean number of primary care consultations increased significantly with increasing number of chronic conditions ($P < 0.001$ for each level compared to baseline 0), eligibility for free medical care

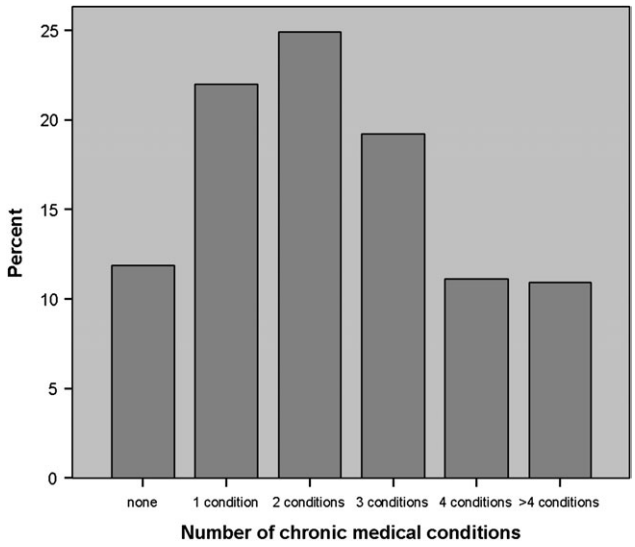

FIGURE 2 *Total morbidity burden in patients > 50 years age in primary care.*

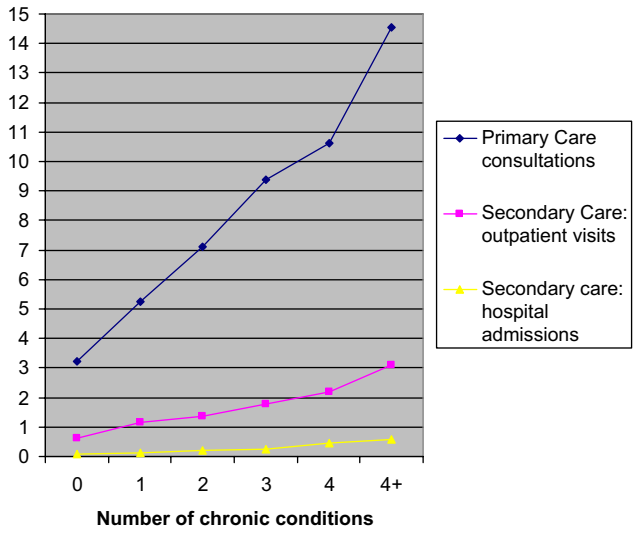

FIGURE 3 *Mean number of primary care consultations, hospital outpatient visits and hospital admissions in previous twelve 12 months according to number of chronic conditions (Uunadjusted).*

TABLE 1 *Mean number of chronic conditions and prevalence of multimorbidity stratified for age, gender and free medical care eligibility (n = 3309)*

	Age	*n*	Mean number of chronic conditions (95% CI)	Multimorbidity prevalence (%)
Gender				
Males	50–59	639	1.61 (1.51–1.72)	46.8
	60–69	517	2.41 (2.25–2.56)	66.2
	70–79	307	3.10 (2.89–3.31)	82.4
	⩾80	161	3.50 (3.23–3.77)	88.2
Females	50–59	670	1.80 (1.69–1.91)	53.0
	60–69	458	2.37 (2.22–2.52)	69.4
	70–79	321	3.07 (2.89–3.24)	84.1
	⩾80	236	3.50 (3.25–3.74)	89.0
Free medical care				
Eligible		1714	2.95 (2.86–3.04)	78.8
Ineligible		1595	1.78 (1.71–1.85)	52.5
Total		3309	2.38 (2.32–2.44)	66.2

TABLE 2 *[a]Adjusted mean estimates for 'primary care consultations' and 'hospital out-patient visits' and [a]adjusted odd ratios for 'hospital admissions' according to number of chronic conditions*

Number of chronic conditions	Primary care consultations Adjusted mean difference (95% CI)	Hospital outpatient visits Adjusted mean difference (95% CI)	Hospital admissions Adjusted OR (95% CI)
0	3.72 (3.28–4.15)	0.63 (0.52–0.73)	Reference group
1	5.56 (5.11–6.01)	1.17 (1.04–1.30)	1.16 (0.71–1.89)
2	6.88 (6.38–7.39)	1.43 (1.29–1.57)	1.86 (1.18–2.94)
3	8.58 (7.87–9.29)	1.92 (1.71–2.12)	2.12 (1.33–3.38)
4	9.36 (8.34–10.38)	2.42 (2.10–2.75)	3.80 (2.35–6.12)
>4	11.86 (10.54–13.18)	3.58 (3.11–4.06)	4.51 (2.79–7.29)

[a]The statistical models used in the above analysis adjusted for explanatory variables (gender, free medical care eligibility) and are fixed at an age covariate value of 65 years.

($P < 0.001$); being female ($P = 0.01$) and with increasing age ($P < 0.001$). There was a significant interaction between age and gender ($P = 0.02$) where the effect of age on the increase in mean number of primary care consultations was larger in females compared to males. Table 2 presents the adjusted mean estimates for the number of primary care consultations (and 95% CI) for the different number of chronic conditions considered while adjusting for explanatory variables (gender, free medical care eligibility and cluster) and fixing the model at an age covariate value of 65 years.

The mean number of hospital out-patient visits also increased significantly with increasing number of chronic conditions ($P < 0.001$ for each level of multimorbidity compared to baseline 0), eligibility for free medical care ($P = 0.016$), being female ($P < 0.001$) and with increasing age ($P < 0.001$). As before, there were significant interactions not only between age and gender ($P < 0.001$) but also between age and eligibility for free medical care ($P = 0.013$). The effect of age on the increase in mean number of hospital out-patient visits was larger in females compared to males ($P < 0.001$) and for those eligible for free medical care compared to those who were not ($P < 0.001$).

In relation to hospital admissions, the most suitable binary logistics regression model identified significant main effects due to all factors except gender with no higher order interactions identified. Increased odds of one or more hospital admissions in the previous 12 months was associated with increasing number of chronic conditions for all comparisons to baseline ($P < 0.01$ in each case) except for those patients with one chronic condition ($P = 0.55$). The odds of one or more hospital admissions increased significantly with increasing age (OR 1.02, 95% CI: 1.01–1.03) and being eligible for free medical care (OR 1.90, 95% CI 1.42–2.37).

Health care costs

In Table 3, unadjusted data for health care costs in primary and secondary care are described in addition to estimates of total health care costs (mean costs and 95% CI) for the different number of chronic conditions considered while adjusting for explanatory variables (gender, free medical care eligibility and practice cluster) and fixing the model at an age covariate value of 65 years. Total health care costs increased significantly with increasing number of chronic conditions ($P < 0.001$) and eligibility for free medical care ($P < 0.001$). Pairwise comparisons showed that mean total cost increased significantly for patients with increasing number of chronic conditions compared to those with no chronic conditions ($P = 0.026$ for one chronic condition; $P = 0.002$ for two chronic conditions; $P = 0.001$ for three chronic conditions; $P = 0.000$ for four chronic conditions and $p = 0.000$ for more than four chronic conditions all compared to baseline of no chronic conditions). There were no significant impacts for gender ($P = 0.692$) or age ($P = 0.057$). The equivalent figures for per capita health care costs in the USA[22] are also shown for comparison purposes in Table 3.

Discussion

Summary of main findings

This study presents the first primary care prevalence data for multimorbidity in the Republic of Ireland and is one of the first to estimate prevalence by patient record review. Among patients >50 years of age in primary care, over two-thirds (66.2%) have multimorbidity. Health care utilization and cost in primary and in secondary care is significantly increased among patients with multimorbidity and increases with increasing number of chronic conditions. This effect on primary care consultations, hospital out-patient visits, hospital admissions and total health care costs occurs independently of age, gender and socio-economic status.

Comparison with existing literature

The prevalence of multimorbidity in primary care has been previously reported and prevalence rates vary greatly between studies. A significant part of this variation is probably linked to problems with defining multimorbidity and the variety of data collection methods used with survey[2,8] and medical insurance database[1] methodologies being particularly criticized due to the tendency to under-report co-morbidities.[3] The definitions used in this study follow the constructs which underpin the co-occurrence of distinct diseases (co-morbidity of an index disease, multimorbidity, morbidity burden and patient complexity) recently elucidated.[23] Following recent recommendations, which show how different constructs might best be applied to research, we have used explicit definitions in order to enhance both the precision and generalizability of findings, leading to improved understanding of the causes of multimorbidity and their consequences for health service providers and planners.[23] It has been suggested that patientrecord review, the method used in the current study, is the most accurate method of data collection for multimorbidity. The single large Canadian study using this method previously was limited by the fact that data were collected from consecutive patients attending family physicians. It reported a multimorbidity prevalence for patients aged >65 years of 98% and may be an overestimation of true prevalence of multimorbidity. The prevalence rate of 81.6% found in the current study for patients aged >65 years is comparable to more recent studies that have used primary care computerized databases

TABLE 3 *Unadjusted mean cost and [a]adjusted mean cost estimates per patient for 'primary care consultations', 'hospital outpatient visits', 'hospital admissions' and [b]'total healthcare cost' in previous 12 months according to the number of chronic conditions*

Health care costs	Number of chronic medical conditions					
	0 (n = 393)	1 (n = 727)	2 (n = 824)	3 (n = 636)	4 (n = 367)	>4 (n = 362)
			Mean cost, € (SD)			
Primary care consultations	161.20 (140.80)	262.38 (215.19)	355.28 (292.42)	469.42 (347.49)	530.25 (395.88)	727.07 (570.42)
Hospital out-patient visits	98.12 (221.49)	183.77 (325.57)	220.00 (347.81)	283.02 (364.69)	347.03 (386.48)	497.24 (559.15)
Hospital admissions	319.98 (1229.20)	422.05 (1395.52)	732.52 (1775.34)	893.70 (1924.17)	1466.51 (2289.14)	1820.25 (2420.48)
[b]Total health care cost	579.29 (1377.43)	868.20 (1593.93)	1307.80 (2025.75)	1646.13 (2170.36)	2343.79 (2619.19)	3044.56 (2843.36)
			Mean cost estimate, € (95% CI)			
[a]Adjusted mean cost estimate for [b]total health care cost	562.07 (549.33–574.81)	888.22 (871.82–904.61)	1320.14 (1296.62–1343.66)	1631.82 (1600.03–1663.62)	2339.01 (2283.36–2394.65)	3029.11 (2970.95–3087.27)
			Mean cost, $			
[c]Total health care cost (US data)	850	2241	4256	6178	8518	12 699

[a]The statistical model (Generalized Liner Model, assuming Gamma variance log link) used in the above analysis adjusted for explanatory variables (gender, free medical care eligibility and practice cluster) and is fixed at an age covariate value of 65 years.
[b]Total health care cost = primary care consultations + hospital outpatient visits + hospital admissions.
[c]Johns Hopkins University. Medical expenditure panel survey, partnership for solutions. Baltimore: Johns Hopkins University, 2001.

(75% for 65–74 year olds and 83% for those >75 years in Australia in 2008[24]) but is higher than some of those studies using other methods such as survey (63% for those >65 years in Canada in 2000[8] and 69% for those >65 years in the USA in 1987[2]) and administrative databases (ranging from 54% for those 65–70 years to 73% in those aged >80 years in the USA in 1999[1]).

Prevalence of multimorbidity was not affected by gender, a finding consistent with other studies.[7,24] However, the current study confirmed the significant effect of increasing age and lower socio-economic status on prevalence of multimorbidity also seen in other studies.[3,7,24,25] There is limited data, however, on the effect of multimorbidity on health care utilization and cost. These data have emerged largely from the USA and demonstrates that a high morbidity burden in the elderly leads to greater use of specialist physicians.[5] Hospital acquired data reveal some evidence that patients with multimorbidity are more likely to be admitted, readmitted at 30 and 365 days to hospital, have greater length of stays and in-hospital mortality.[26] In patients >65 years of age, the risk of an avoidable hospital admission or a preventable complication in an inpatient setting increases dramatically with the number of chronic conditions.[1] There has been little examination of the workload associated with multimorbidity in primary care. One Irish study examined younger patients in a deprived setting and demonstrated a high degree of polypharmacy and a significantly increased workload in the management of these patients in primary care.[27] The current study confirms that increasing level of multimorbidity leads to increased hospital admissions but also shows that in a primary care context with a strong gatekeeping role, utilization of primary health care is also significantly increased. It may be that such increased primary care utilization attenuates associated secondary care use but further comparative work is required to clarify this association. It has already been established that the quality of care, measured according to whether patients were offered recommended services, increases as a patient's number of chronic conditions increases.[28] The current study may support these data by demonstrating an increase in health care utilization across primary and secondary care associated with increasing level of multimorbidity even when controlling for age, gender and social status.

The effect of gender on health care ultilization was noteworthy in that, while females appeared to make more elective visits to primary and secondary care in terms of out-patient visits, this did not translate into a greater number of hospital admissions. In addition, the effect of age on the increase in primary and secondary care consultations was larger in females compared to males. It is not surprising that free medical care eligibility in this study was associated with increased health care utilization across the health care system. We already know that cost is a significant deterrent to seeking health care for those without access to free medical care[29] and in addition those with free medical care eligibility represents the lowest socio-economic groups who have already been shown

to have a higher level of morbidity.[7,27,30] In relation to cost, there are a many studies on the individual cost of chronic conditions but little European data on the aggregated cost of multiple conditions. In the USA, the equivalent figures for per capita health care costs[22] are shown in Table 3 and as expected, the figures for the USA are larger as they include direct and indirect costs. However, the trend is entirely consistent with the results of the current study with a significant increase in health care spending with increasing number of chronic conditions.

Strengths and limitations of this study

This study represents one of the first detailed descriptions of the effect of multimorbidity on primary and secondary health care utilization and attempts to describe a true prevalence of multimorbidity in those >50 years of age in primary care. The study population was representative of the national population >50 years of age in terms of age, gender and free medical care eligibility. The method used for data collection in this study was patient record review which has been suggested to be superior to other methods used in determination of morbidity levels in primary care. Although variation does exist in practices for the recording of information from the specialist sector[27], we ensured that all practices in the study were fully computerized and used the same method of patient data recording. In addition, this study adds to the knowledge base by using the ICPC-2 classification system, as has been recently recommended.[31] Our study had a number of additional limitations. Firstly, the study sample although novel is relatively small and the study sample was predominantly Caucasian (99%) which may underestimate the prevalence of certain common chronic conditions such as diabetes and chronic kidney disease in comparison to other ethnic groups, particularly those of Afro-Caribbean and Asian descent. Secondly, data come from just three practice centres, so it was important in the statistical analysis to incorporate each practice cluster as a random effect to model patient heterogeneity within practices. Thirdly, only active (two or more consultations in the previous 2 years) patients were included in the study. This was done to exclude patients such as visitors, patients who had moved to a different practice or practice inter-referrals and was necessary as approximately two-thirds of the population of the Republic of Ireland are not universally registered to a single GP. However, this may have led to an overestimation of the prevalence of multimorbidity or an underestimation of health care costs as some patients may have received care from more than a single practice. Thirdly, the cost analysis is limited in that we excluded a range of direct (e.g. cost of prescription medications) and indirect (e.g. out-of-pocket expenses to patients and their families, productivity losses, costs of informal care) costs due to lack of data. However, we believe the omission of these cost items, while not insignificant will not alter the nature of our final results. Indeed, our final estimates will be conservative in that they are likely to underestimate the difference in cost across different levels of multimorbidity as patients with multimorbidity may not only use services more frequently but are also likely to have a higher cost per unit. Furthermore, the process of conducting cost analysis in Ireland is limited by the lack of a national health care unit cost database. As a result, best estimates for the unit costs of primary care and secondary care services were obtained from government departments and episodes were costed on the basis of a national average unit cost. Finally, we have information about the number of visits, but not about their duration and there is evidence that patients with multimorbidity require not only more visits but also longer ones[30] and indeed benefit from such extended clinical encounters.[32] This issue could not be addressed with the available data.

Implications for future research and clinical practice

Definitions in relation to multimorbidity measurement and outcomes are complex[31] and as such have led to the widely varying prevalence rates reported above and have impeded the research agenda particular in terms of experimental studies. However, it remains clear that the number and diversity of studies available on multimorbidity are insufficient to provide a strong scientific basis for evidence-based care of patients affected by multiple concurrent chronic medical conditions.[33] It is vital, therefore, to increase the quality and the methodological variety of multimorbidity research taking place in an effort to gain a better understanding of this common and important phenomenon. This study has shown that patients with multimorbidity have high levels of health care utilization and cost across primary and secondary care and in the process are often attending multiple health care professionals. The impact of gatekeeping on health care utilization merits further consideration. In order to increase the quality of care delivered to such patients and reduce spiralling health care costs, there is a need to focus on coordinating and connecting the patient's care journey through the health care system while also promoting 'self-management' among all patients with chronic disease. Primary care is the ideal setting for such a process to take place.

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Declaration

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Ethical approval: Approval Ethical approval was granted by the research ethics committee of the Irish College of General Practitioners (Protocol No: REC08-01).

Conflict of interest: AWM has received funding from Pfizer to support educational meetings for GPs who teach medical students from the Department of General Practice at NUI, Galway. LG has received an honorarium from Roche laboratories for contribution to the development of chronic kidney disease guidelines for primary care. Other authors declare no conflict of interest.

Contributors: LG (guarantor), JMV, JN, PG and AWM contributed to study conception and design. LG, PH and EB were responsible for the acquisition of data while LG, JMV, PG and JN analyzed the data. LG, JMV, PG and JN drafted the article and all authors revised the article and granted final approval to the version submitted for publication.

References

[1] Wolff J, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med* 2002; **62:** 2269–76.

[2] Hoffman C, Rice D, Sung HY. Persons with chronic conditions. Their prevalence and costs. *JAMA* 1996; **276:** 1473–79.

[3] Fortin M, Bravo G, Hudon C, Vanasse A, Lapointe L. Prevalence of multimorbidity among adults seen in family practice. *Ann Fam Med* 2005; **3:** 223–28.

[4] World Health Organisation. *Tackling Europe's Major Diseases: The Challenges and the Solutions.* Fact sheet EURO/03/06. Copenhagen, Denmark: World Health Organisation, Europe, 2006.

[5] Starfield B, Lemke KW, Herbert R, Pavlovich WD, Anderson G. Comorbidity and the use of primary care and specialist care in the elderly. *Ann Fam Med* 2005; **3:** 215–22.

[6] Laux G, Kuehlein T, Rosemann T, Szecsenyi J. Co- and multimorbidity patterns in primary care based on episodes of care: results from the German CONTENT project. *BMC Health Serv Res* 2008; **8:** 14.

[7] Van den Akker M, Buntinx F, Metsemakers JFM, Roos S, Knottnerus JA. Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. *J Clin Epidemiol* 1998; **51:** 367–75.

[8] Daveluy C, Pica L, Audet N *et al*. *Enquête Sociale et de Santé 1998*, 2nd edn. Québec: Institut de la statistique du Québec, 2001.

[9] Schram M, Frijters D, Lisdonk E *et al*. Setting and registry characteristics affect the prevalence and nature of multimorbidity in the elderly. *J Clin Epidemiol* 2008; **61:** 1104–12.

[10] Valderas JM, Glynn L, Ferrer-Menduina X, Johnson R, Salisbury C. Diseases that come in multiples: a systematic review of multi-morbidity profiles. *Fam Med* 2011; **43** (suppl 1).

[11] Fortin M, Hudon C, Haggerty J, Akker M, Almirall J. Prevalence estimates of multimorbidity: a comparative study of two sources. *BMC Health Serv Res* 2010; **10:** 111.

[12] Starfield B. Threads and yarns: weaving the tapestry of comorbidity. *Ann Fam Med* 2006; **4:** 101–03.

[13] Saltman R, Rico A, Boerma W (eds). Primary Care in the Driver's Seat?. Maidenhead: Open University Press, 2006.

[14] Starfield B. Is primary care essential? *Lancet* 1994; **344:** 1129–33.

[15] Irish Medical Council. *The Guide to Professional Conduct and Ethics for Registered Medical Practitioners*, 7th edn. Dublin, Ireland: Irish Medical Council, 2009.

[16] Kavanagh K, O'Brien N, Glynn L, Vellinga A, Murphy A. WestREN: a description of an Irish academic general practice research network. *BMC Fam Pract* 2010; **11:** 74.

[17] World Health Organisation. *Innovative Care for Chronic Conditions: Building Blocks for Action: Global Report.* Geneva, Switzerland: World Health Organisation, 2002.

[18] Classification Committee of the World Organization of Family Doctors. *ICPC-2: International Classification of Primary Care*, 2nd edn. Oxford: Oxford University Press, 1998.

[19] O'Halloran J, Miller GC, Britt H. Defining chronic conditions for primary care with ICPC 2. *Fam Pract* 2004; **21:** 381–86.

[20] Wedderburn RWM. Quasi-likelihood functions, generalized linear models, and the Gauss Newton method. *Biometrika* 1974; **61:** 439–47.

[2] Central Statistics Office. *Census 2006.* Cork, Ireland: Central Statistics Office, 2006.

[22] Johns Hopkins University. *Medical Expenditure Panel Survey Partnership for Solutions.* Baltimore, MD: Johns Hopkins University, 2001.

[23] Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M. Defining comorbidity: implications for understanding health and health services. *Ann Fam Med* 2009; **7:** 357–63.

[24] Britt HC, Harrison CM, Miller GC, Knox SA. Prevalence and patterns of multimorbidity in Australia. *Med J Aust* 2008; **189:** 72–77.

[25] Metsemakers JF, Höppener P, Knottnerus JA, Kocken RJ, Limonard CB. Computerized health information in The Netherlands: a registration network of family practices. *Br J Gen Pract* 1992; **42:** 102–6.

[26] Librero J, Peiró S, Ordiñana R. Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. *J Clin Epidemiol* 1999; **52:** 171–79.

[27] Smith S, Ferede A, O'Dowd T. Multimorbidity in younger deprived patients: an exploratory study of research and service implications in general practice. *BMC Fam Pract* 2008; **9:** 6.

[28] Higashi T, Wenger NS, Adams JL *et al*. Relationship between number of medical conditions and quality of care. *N Engl J Med* 2007; **356:** 2496–504.

[29] O'Reilly D, O'Dowd T, Galway KJ *et al*. Consultation charges in Ireland deter a large proportion of patients from seeing the GP: results of a cross-sectional survey. *EJGP* 2007; **13:** 231–36.

[30] Mercer SW, Watt GCM. The inverse care law: clinical primary care encounters in deprived and affluent areas of Scotland. *Ann Fam Med* 2007; **5:** 503–10.

[31] Valderas JM, Starfield B, Salisbury C, Sibbald B, Roland M. Defining comorbidity: implications for the understanding and provision of health services and health. *Ann Fam Med* 2009; **7:** 357–63.

[32] Mercer SW, Fitzpatrick B, Gourlay G, Vojt G, McConnachie A, Watt GC. More. time for complex consultations in a high-deprivation practice is associated with increased patient enablement. *BJGP* 2007; **57:** 960–66.

[33] Fortin M, Lapointe L, Hudon C, Vanasse A. Multimorbidity is common to family practice Is it commonly researched? *Can Fam Physician* 2005; **51:** 245.