

# BMJ Open What is the impact of multimorbidity on out-of-pocket healthcare expenditure among community-dwelling older adults in Ireland? A cross-sectional study

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## ABSTRACT

**Objectives** Individuals with multimorbidity use more health services and take more medicines. This can lead to high out-of-pocket (OOP) healthcare expenditure. This study, therefore, aimed to assess the association between multimorbidity (two or more chronic conditions) and OOP healthcare expenditure in a nationally representative sample of adults aged 50 years or over.

**Design** Cross-sectional analysis of data collected in 2016 from wave 4 of The Irish Longitudinal Study on Ageing.

**Setting** Ireland.

### Participants

Community-dwelling adults aged 50 years and over.

### Method

A generalised linear model with log-link and gamma distributed errors was fitted to assess the association between multimorbidity and OOP healthcare expenditure (including general practitioner, emergency department, outpatients, specialist consultations, hospital admissions, home care and prescription drugs).

**Results** Overall, 3453 (58.5%) participants had multimorbidity. Among those with any OOP healthcare expenditure, individuals with multimorbidity spent more on average per annum (€806.8 for two conditions, €885.8 for three or more conditions), than individuals with no conditions (€580.3). Pharmacy-dispensed medicine expenditure was the largest component of expenditure. People with multimorbidity on average spent more of their equalised household income on healthcare (7.1% for two conditions, 9.7% for three or more conditions), than people with no conditions (5.0%). A strong positive association was found between number of conditions and OOP healthcare expenditure ( $p < 0.001$ ) and between having private health insurance and OOP healthcare expenditure ( $p < 0.001$ ). A strong negative association was found between eligibility for free primary/hospital care and heavily subsidised medicines and OOP healthcare expenditure ( $p < 0.001$ ).

**Conclusions** This study suggests that having multimorbidity in Ireland increases OOP healthcare expenditure, which is problematic for those with more conditions who have lower incomes. This highlights

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ We conducted multivariate and quantile regressions to assess the association between multimorbidity and out-of-pocket (OOP) healthcare expenditure.
- ⇒ We used data from The Irish Longitudinal Study on Ageing (TILDA), which captures a nationally representative sample of community-dwelling older adults in Ireland.
- ⇒ TILDA only sampled those aged 50 years or over, and therefore, a significant portion of the population, who may have different patterns of multimorbidity and OOP healthcare expenditure were not included.
- ⇒ Household adaptations and travel costs to access healthcare were not included in this analysis meaning that OOP healthcare expenditure is likely to be underestimated.

the need for this financial burden to be considered when designing healthcare/funding systems to address multimorbidity, so that access to essential healthcare can be maximised for those with greatest need.

## INTRODUCTION

Multimorbidity is the co-occurrence of two or more chronic medical conditions in an individual. The prevalence of multimorbidity and its complexity has been increasing in recent decades.<sup>1-4</sup> Its prevalence is estimated to range from 13% to 72% depending on age group and setting.<sup>5</sup> Multimorbidity is a major challenge for individuals and healthcare systems across the world.<sup>6</sup>

Greater healthcare utilisation<sup>7</sup> and polypharmacy (the use of five or more regular medicines),<sup>8</sup> two of the major challenges associated with multimorbidity, are primarily caused by the extra healthcare needs that come with having additional conditions, but also, the additional needs that arise due to the interactions between conditions.<sup>9</sup> High

healthcare utilisation and polypharmacy among people with multimorbidity is also partly caused by the single condition focus of healthcare. This single condition focus manifests itself across healthcare systems, in clinical guidelines, specialty care provision, reimbursement systems and research.<sup>10–13</sup> High healthcare utilisation and polypharmacy lead to high levels of out-of-pocket (OOP) healthcare expenditure for people with multimorbidity.<sup>14 15</sup> Studies from a range of high-income countries<sup>1 16</sup> (HICs) and middle-income countries<sup>17–20</sup> (MICs) have shown a positive association between multimorbidity and OOP healthcare expenditure. Studies in HICs estimate that the expenditure associated with having two or more chronic conditions is multiples of that experienced by those without multimorbidity.<sup>1 16</sup> However, studies<sup>1 16</sup> in HICs have not accounted for healthcare entitlements in their analyses, or conducted analysis across the distribution of expenditure.<sup>1 16</sup> Furthermore, there is a need for up to date research in HICs as OOP healthcare expenditure may be rising due to increases in use of prescription medicines,<sup>21</sup> increased development of expensive drugs,<sup>22</sup> ageing populations<sup>23</sup> and the increasing prevalence of chronic disease<sup>24</sup> and multimorbidity.<sup>1–4</sup>

There are many potential consequences of high OOP healthcare expenditure.<sup>14 15</sup> For example, high OOP healthcare expenditure can lead to people with multimorbidity sacrificing basic necessities, which can have a negative effect on well-being.<sup>25 26</sup> Multimorbidity can also lead to non-adherence to medication and healthcare non-attendance,<sup>14 26 27</sup> which in turn can have negative health consequences.<sup>14 26 28</sup> High OOP healthcare expenditure has the potential to be exacerbated by the strong association between multimorbidity and socioeconomic deprivation.<sup>29 30</sup> Provision of subsidised or free care at the point of delivery may protect against the financial burden caused by chronic conditions.<sup>31</sup>

### Health coverage in Ireland

Health entitlements in Ireland are ‘extremely complex’.<sup>32</sup> Households with incomes below a certain threshold (which varies based on age), or in a small percentage of cases, those with high medical expenses relative to their income, are eligible for a ‘medical card’.<sup>33</sup> For example, a single person aged under 66 years earning €184 a week after taxes and allowable expenses, is entitled to a medical card.<sup>34</sup> There is no clarity around the calculations for discretionary medical cards,<sup>35</sup> which are held by less than 1% of the population.<sup>36</sup> A medical card entitles holders to free primary, community and hospital care, and heavily subsidised prescription medicines.<sup>33</sup> At the time of data collection, medical cardholders paid a prescription charge of €2.50 per item, capped at €25 per month. Households without a medical card, paid the first €144 per month on community-dispensed prescription medicines, up to €750 per annum on inpatient care, €100 per emergency department attendance<sup>37</sup> and an average fee of €50 per general practitioner (GP) consultation.<sup>38</sup> This €50 fee represents one of the highest payments in

Europe for primary care.<sup>39</sup> In 2005, an additional layer of eligibility was introduced and adults with income approximately 50% higher than the medical card threshold were entitled to free GP care through a ‘GP visit card’.<sup>40</sup> Adults aged over 70 are entitled to GP visit cards regardless of income.<sup>40</sup> Other government schemes include the long-term illness scheme which entitles people with certain long-term illnesses or disabilities to obtain medicines associated with that illness free of charge (patients with diabetes represent a majority within the scheme).<sup>41</sup> Further complicating health coverage in Ireland is the high proportion (46%)<sup>42</sup> of people with private health insurance (PHI). In Ireland, the level of voluntary PHI expenditure as a percentage of overall healthcare funding is the second highest in Europe.<sup>43</sup> PHI plans in Ireland are voluntary. Most insurance plans are hospital plans, providing access to private hospitals and/or private rooms in public hospitals.<sup>44</sup> Though these plans often provide limited cover for non-hospital services.<sup>44</sup> Those with PHI are more likely to be older and of higher socioeconomic status.<sup>45</sup>

There is little information on the degree of OOP healthcare expenditure for people with multimorbidity, or how factors such as eligibility for heavily subsidised/free healthcare and PHI may affect financial pressures for people with multimorbidity. These entitlement factors as well as an analysis of the effect of multimorbidity across the distribution of expenditure are not included in other similar studies in HICs.<sup>1 16</sup> Furthermore, OOP healthcare expenditure is likely increasing over time. Therefore, we aimed to explore the association between multimorbidity and OOP healthcare expenditure using multivariate regression and quantile regression analyses which accounted for entitlements (the medical card and PHI) along with demographic and socioeconomic variables.

### METHODS

We used a cross-sectional study design and reported the study according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.<sup>46</sup> Multivariate regression analyses were used to investigate the association between multimorbidity and OOP healthcare expenditure. Data from The Irish Longitudinal Study on Ageing (TILDA) wave 4<sup>47</sup> were used. TILDA is a nationally representative study of community-dwelling adults aged 50 years and over in Ireland.<sup>48</sup> The sampling frame was all residential addresses in the Irish Geodirectory.<sup>49</sup> In wave 4, there were 5977 respondents.<sup>49</sup> Residents from residential care facilities (N=78) were excluded from analysis because their pattern of healthcare utilisation differs from community-dwelling adults. Data collection took place between January and December 2016. Data were collected using computer-aided personal interviewing.

TILDA respondents were provided with a list of 36 conditions and asked if a doctor had diagnosed them with any of them (online supplemental appendix A).

For this study, we developed a multimorbidity count by combining some of the 36 conditions to give 21 broader conditions (online supplemental appendix B) based on data availability and a previous TILDA study.<sup>50</sup> For this analysis, multimorbidity was defined as the presence of two or more of these conditions (online supplemental appendix B).

The primary outcome variable was self-reported OOP healthcare expenditure (details of questions in online supplemental appendix C). OOP healthcare expenditure is expenditure 'borne directly by a patient where insurance does not cover the full cost of the health good or service'.<sup>51</sup> Services and products were considered healthcare if they were in the Health Section of the United Nations Classification of Individual Consumption According to Purpose.<sup>52</sup> We also included social care services that are likely to be required as a result of having a chronic condition, namely home care services (services to support people to remain living on their own). OOP healthcare expenditure was estimated for the following services: GP, emergency department, outpatients, specialist medical consultations, in-patient hospital admissions, home care, prescription drugs and 'other' health expenses. Respondents were asked to exclude payments that were reimbursed by the state or health insurance companies where applicable.

For home care services, participants were asked to recall their expenditure in the previous month, and for prescription drugs it was 'on average' 'per month'. To calculate 12-month expenditure for these two areas, the amounts were multiplied by 12 (further details in online supplemental appendix D). The limitation of this is that it is less likely to accurately capture 12-month expenditure (eg, if someone had no expenses in the last month but a large one off expense 6 months ago, then their expenditure would be underestimated).

PHI premia expenditure represents a significant proportion of household spending in Ireland (approximately 3% on average).<sup>32</sup> In countries where expenditure on PHI is high, it is often included in analysis of OOP healthcare expenditure.<sup>33 53 54</sup> Therefore, PHI premia expenditure was included as a secondary outcome variable. However, PHI premia are not considered an OOP healthcare expenditure by the WHO definition. Therefore, PHI premia expenditure was not included in the regression analyses.

The financial burden of healthcare expenditure was calculated as the percentage of equivalised annual household income spent on healthcare.<sup>16</sup> This measure, and the 20% threshold for high financial burden, were used to allow for comparisons with a similar Australian study.<sup>16</sup> Equivalised household income is an adjusted household income measure based on the OECD-modified equivalence scale for household size<sup>55</sup>; household income is divided by number of people in the household, with a weight of one for the first adult, 0.5 for each additional adult and 0.3 for each child.

Details of how we managed outlying values which were considered likely to be incorrect are in online supplemental appendix E.

### Data analysis

This study used a hurdle model to analyse OOP healthcare expenditure.<sup>56</sup> A hurdle model allowed us to examine the decisions to consume healthcare using OOP healthcare expenditure, as well as the intensity of healthcare expenditure for those who have OOP healthcare expenditure. A probit regression was used to model the binary outcome of any OOP healthcare expenditure or not. A participant was considered to have any OOP healthcare expenditure if they had OOP healthcare expenditure in any of the following areas: GP, medicines, emergency department, outpatients, specialist medical consultations, overnight hospital stay, home care or 'other' healthcare expenditure. Expenditure on PHI premia was excluded from adjusted analysis, but copayments and deductibles were included in all analyses. A generalised linear model (GLM) with log-link and gamma distributed errors was used to model intensity of OOP healthcare expenditure among those with any OOP healthcare expenditure. This model is commonly used for healthcare expenditure data<sup>57 58</sup> and allows us to better fit the long tail of the expenditure distribution. Supplementary analysis using ordinary least squares (OLS) regression with the expenditure variable log transformed was also conducted (online supplemental appendix F eTable 2). Unconditional quantile regressions were conducted to understand the effect of the independent variables on OOP healthcare expenditure at different points of the expenditure distribution. Results across nine quantiles are presented in the quantile regression analysis to allow for comparison with previous studies of multimorbidity and OOP healthcare expenditure.<sup>18 19</sup>

Complete-case analysis was used for all regression models. For both sets of analyses, a series of models were fitted, first including variables for face validity and to meet the aims of the research, followed by two models including interactions, and then a model including additional demographics. In the probit and gamma models, age and household income were included as squared variables, because the authors hypothesised a potential curvilinear relationship between these variables and expenditure. Interactions between number of conditions and medical card, and number of conditions and PHI were included in the probit and gamma models. A supplementary analysis of the interaction between age and number of conditions was also conducted (online supplemental appendix F eTables 4 and 5). To facilitate interpretable coefficients, household income was divided by one thousand for the relevant probit and gamma models.

Multivariate regression analyses controlled for the following covariates: age, sex, cardholder status (medical card or GP visit cardholder), PHI status, education, household income, marital status and geographical region (urban/rural). These covariates were chosen for face



validity and their association with both multimorbidity<sup>5,29</sup> and healthcare utilisation.<sup>59</sup> In line with previous analysis,<sup>60</sup> medical cardholders and GP visit cardholders were collapsed into one group: cardholders, for the purposes of regression analysis. Long-term illness scheme eligibility was not included in analysis, because, given the eligibility criteria, it is likely collinear with multimorbidity. Statistical analysis was conducted using Stata, V.15.

### Patient and public involvement

The research question and the conclusions were developed in consultation with a patient and public involvement panel of people living with multimorbidity.

## RESULTS

There were 5899 eligible respondents aged 50 or over. The average age was 68.4 (SD=9.1) years, 55.7% of respondents were female and 24.1% (N=1421) had a primary school education or less. Overall, 3453 (58.5%) individuals had multimorbidity (2+ conditions). Respondents

with multimorbidity were more likely to be older, female and have lower education attainment. Table 1 provides details of the sample characteristics.

Excluding expenditure on PHI premia, average reported annual OOP healthcare expenditure was higher for individuals with multimorbidity (€806.8 for those with two conditions, €885.8 for those with three or more conditions) than for those with no conditions (€580.3). Those with no conditions reported spending slightly more on average on PHI (€449.1) than individuals with three or more conditions (€363.2), while those with one condition spent the most (€524.3). Table 2 presents annual unadjusted figures on OOP healthcare expenditure and financial burden for all participants.

Expenditure on medicines was the largest component of OOP healthcare expenditure, especially for people with multimorbidity. The mean annual OOP medicine expenditure for those with three or more conditions was €453.5, representing 51% of their overall OOP expenditure. For those with two conditions it was €393.0,

**Table 1** Demographic and entitlement characteristics of sample

	Overall (N=5899) % (N)	Multimorbidity			
		No conditions (N=979) % (N)	One condition (N=1466) % (N)	Two conditions (N=1381) % (N)	Three or more conditions (N=2072) % (N)
Age (years)					
50–59	18.5 (1091)	33.9 (332)	24.4 (357)	15.6 (216)	9.0 (186)
60–69	40.1 (2365)	45.3 (443)	42.2 (618)	41.9 (579)	35.0 (725)
70–79	27.8 (1642)	15.2 (149)	23.7 (348)	30.2 (417)	35.1 (728)
80–89	12.1 (714)	4.9 (48)	8.4 (123)	10.9 (151)	18.9 (391)
90+	1.5 (87)	0.7 (7)	1.4 (20)	1.3 (18)	2.0 (42)
Sex					
Female	55.7 (3285)	47.8 (468)	47.5 (697)	54.9 (758)	65.7 (1361)
Male	44.3 (2614)	52.2 (511)	52.5 (769)	45.1 (623)	34.3 (711)
Education					
Primary/none	24.1 (1421)	15.7 (154)	19.9 (292)	23.6 (326)	31.3 (648)
Secondary	39.4 (2325)	40.7 (398)	40.5 (593)	38.2 (528)	38.9 (806)
Third/higher	36.5 (2153)	43.6 (427)	39.6 (581)	38.2 (527)	29.8 (618)
Location					
Urban	54.3 (3204)	50.5 (494)	53.7 (787)	55.4 (765)	55.8 (1157)
Rural	45.7 (2695)	49.5 (486)	46.3 (679)	44.6 (616)	44.2 (915)
Private health insurance					
Yes	60.1 (3543)	63.8 (624)	64.3 (942)	62.6 (862)	53.7 (1111)
No	39.9 (2353)	36.1 (353)	35.7 (523)	37.5 (516)	46.3 (957)
Healthcare entitlements					
Cardholder	60.1 (3539)	63.9 (624)	64.3 (942)	62.6 (862)	53.7 (1111)
Non-cardholder	39.9 (2349)	36.1 (353)	35.7 (523)	37.5 (516)	46.3 (957)

**Table 2** Annual out of pocket (OOP) healthcare expenditure\* (€) and financial burden by number of conditions for those with any OOP healthcare expenditure

	Multimorbidity			
	No conditions	One condition	Two conditions	Three or more conditions
Percentage with any OOP healthcare expenditure (N)	78.2% (761)	91.0% (1318)	96.5% (1318)	96.6% (1965)
Total OOP expenditure excluding PHI Mean (SD)	€580.3 (1167.3)	€718.5 (1059)	€806.8 (1014.0)	€885.8 (1222.5)
GP Mean (SD)	€61.4 (87.0)	€60.7 (94.6)	€56.7 (111.5)	€45.9 (113.6)
Medicines Mean (SD)	€161.6 (634.0)	€311.8 (720.8)	€393.0 (534.0)	€453.5 (571.8)
Hospital care† Mean (SD)	€70.2 (195.7)	€106.0 (340.5)	€126.4 (317.7)	€139.2 (573.6)
Other healthcare Mean (SD)	€291.6 (913.3)	€237.1 (578.2)	€233.0 (616.6)	€257.3 (634.5)
PHI Mean (SD)	€449.1 (790.8)	€524.3 (950.5)	€411.8 (698.6)	€363.2 (1,031.7)
Equivalised household income Mean (SD)	€17 710 (20 476)	€16 561 (21 517)	€13 735 (10 734)	€12 932 (9131)
Financial Burden‡ Mean (SD)	5.0% (13.7)	6.5% (15.1)	7.1% (15.1)	9.7% (19.4)
Percentage with financial burden >20% (N)	4.2% (25)	5.3% (55)	5.6% (58)	8.6% (131)

\*Median expenditure and IQR for each area can be seen in online supplemental appendix F eTable 1.  
 †Includes OOP expenditure on emergency department, outpatients, consultants, overnight hospital.  
 ‡Percentage of equivalised household income spent on healthcare in previous 12 months.  
 GP, general practitioner; PHI, private health insurance.

representing 49% of their overall OOP expenditure. Individuals with no conditions spent €161.1, representing 28% of their overall OOP healthcare expenditure. Individuals with multimorbidity reported higher OOP expenditure on hospital care. Little difference was seen across condition groups for OOP expenditure on GP and ‘other’ healthcare.

In addition to reporting higher OOP expenditure, individuals with multimorbidity had substantially lower equivalised household income than individuals with no conditions. Consequently, the average financial burden for individuals with multimorbidity was much higher, (7.1% for those with two conditions, 9.7% for those with three or more conditions) than it was for people with no conditions (5.0%).

### Probability of any OOP expenditure

Probit models (table 3) were fitted to examine associations with probability of experiencing any OOP healthcare expenditure. A strong positive association was found between number of chronic conditions and probability of any OOP healthcare expenditure, after adjusting for covariates. Compared with those with no health

conditions, model 1 showed that having two conditions was associated with a 20% increased probability of any OOP healthcare expenditure, and three or more conditions was associated with a 21% increased probability (online supplemental appendix F eFigure 1). Being a cardholder was associated with being 5% less likely to have any OOP healthcare expenditure (model 1), this association was significant. The interaction effects of being a cardholder and number of chronic conditions were statistically significant. This model therefore provides evidence that being a cardholder had a stronger effect on having any OOP healthcare expenditure, the more conditions an individual had. Having PHI was associated with being 6% more likely to have any OOP healthcare expenditure, this association was significant. The interaction effects on having PHI and number of chronic conditions were statistically significant. This model, therefore, provides evidence that having PHI had a stronger effect on having any OOP healthcare expenditure, the more conditions an individual had. Sex, rurality, income and education were not found to have a significant association with probability of any OOP healthcare expenditure.

**Table 3** Probit model assessing associations with any out-of-pocket healthcare expenditure†

	Model 1 (N=5815) Marginal Effect (SE)	Model 2 (N=5815) Marginal Effect (SE)	Model 3 (N=5815) Marginal Effect (SE)	Model 4 (N=4690) Marginal Effect (SE)
No Conditions (comparator: 0 conditions)				
One condition	0.140* (0.016)	0.141* (0.017)	0.141* (0.016)	0.139* (0.018)
Multimorbidity				
Two conditions	0.199* (0.015)	0.198* (0.016)	0.201* (0.015)	0.197* (0.017)
Three or more conditions	0.205* (0.015)	0.204* (0.016)	0.206* (0.015)	0.199* (0.017)
Age	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Age <sup>2</sup>	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Female	0.003 (0.007)	0.003 (0.007)	0.003 (0.007)	0.004 (0.008)
Cardholder	-0.051* (0.008)	-0.051* (0.008)	-0.050* (0.008)	-0.044* (0.009)
Private health insurance	0.060* (0.008)	0.060* (0.008)	0.061* (0.008)	0.056* (0.009)
One condition#cardholder		0.042** (0.019)		
Two conditions#cardholder		0.111* (0.017)		
Three conditions#cardholder		0.123* (0.015)		
One condition#PHI			0.301* (0.026)	
Two conditions#PHI			0.329* (0.026)	
Three conditions#PHI			0.336* (0.026)	
Equivalised household income‡				0.274 (0.445)
Equivalised household income <sup>2</sup>				-0.000** (0.000)
Education (comparator=primary)				
Secondary				0.003 (0.010)
Third level or higher				0.007 (0.011)
Rural (comparator=urban)				-0.002 (0.007)
Marital status (comparator=married)				
Living with partner				-0.032 (0.027)
Single				-0.024 (0.014)
Separated				-0.037 (0.020)
Divorced				0.002 (0.017)
Widowed				-0.015 (0.012)

\*P<0.001, \*\*p<0.05.  
†PHI expenditure is not included in the calculation of any out-of-pocket healthcare expenditure  
‡Scaled variable where coefficient is associated with €1000 change in income.  
PHI, private health insurance.

### Level of OOP expenditure

GLMs with log link and gamma distributed errors (table 4) were fitted to examine associations with the level of OOP healthcare expenditure among those with any OOP healthcare expenditure. A strong positive association was found between number of chronic conditions and OOP healthcare expenditure, after adjusting for covariates. Having three or more conditions was associated with 79% (exp(0.580)) higher OOP healthcare expenditure than people with no conditions (model 1), which in absolute terms is €425 higher annual OOP expenditure (online supplemental appendix F eFigure 2). Having two conditions was associated with 43% (exp(0.356)) higher OOP

healthcare expenditure than people with no conditions, which in absolute terms is €231 higher annual OOP expenditure.

In model 1, being a cardholder was associated with a 48% (exp(-0.647)) reduction in OOP expenditure compared with non-cardholders. The interaction effects on being a cardholder and number of chronic conditions was statistically significant; a greater number of conditions was associated with cardholder status having a stronger negative effect on OOP healthcare expenditure (online supplemental appendix F eFigure 3). Having PHI was associated with a 97% (exp(0.676)) increase in OOP healthcare expenditure compared with individuals

**Table 4** Gamma model assessing associations with out-of-pocket Healthcare expenditure†

	Model 1 (N=5144) Coefficient (SE)	Model 2 (N=5144) Coefficient (SE)	Model 3 (N=5144) Coefficient (SE)	Model 4 (N=4198) Coefficient (SE)
No Conditions (comparator: 0 conditions)				
One condition	0.288* (0.079)	0.287* (0.094)	0.180 (0.130)	0.315* (0.086)
Multimorbidity				
Two conditions	0.356* (0.079)	0.515* (0.100)	-0.096 (0.128)	0.334* (0.086)
Three or more conditions	0.580* (0.576)	0.880* (0.104)	0.236** (0.119)	0.589* (0.083)
Age	0.040 (0.036)	0.030 (0.035)	0.038 (0.034)	0.058 (0.040)
Age <sup>2</sup>	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Female	0.082 (0.049)	0.072 (0.046)	0.082 (0.045)	0.110* (0.054)
Cardholder	-0.647* (0.061)	-0.325* (0.134)	-0.668* (0.057)	-0.661* (0.068)
Private health insurance	0.676* (0.052)	0.690* (0.049)	0.255** (0.128)	0.476* (0.061)
One condition#cardholder		-0.099 (0.157)		
Two conditions#cardholder		-0.410* (0.158)		
Three conditions#cardholder		-0.581* (0.155)		
One condition#PHI			0.161 (0.158)	
Two Conditions#PHI			0.695* (0.157)	
Three conditions#PHI			0.557* (0.146)	
Equivalentised household income‡				9.063** (3.628)
Equivalentised household income <sup>2</sup>				-29.815 (29.909)
Education (comparator=primary)				
Secondary				0.152** (0.070)
Third level or higher				0.242* (0.077)
Rural (comparator=urban)				-0.151* (0.053)
Marital status (comparator=married)				
Living with partner				-0.018 (0.177)
Single				-0.162 (0.092)
Separated				-0.156 (0.131)
Divorced				0.097 (0.142)
Widowed				-0.140 (0.080)
Intercept	4.284* (1.266)	4.508* (1.214)	4.636* (1.191)	3.385* (1.417)

\*p<0.001, \*\*p<0.05.

†Health insurance expenditure is not included in the calculation of out of pocket healthcare expenditure. Results presented as coefficients and can be interpreted as percentage changes by converting to an exponent

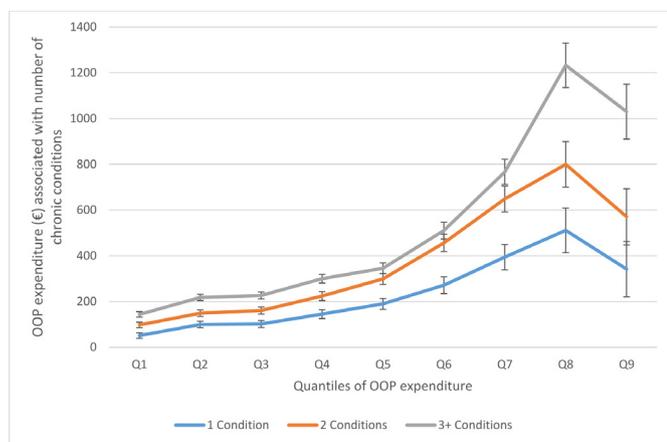
‡Scaled variable where coefficient is associated with €1000 change in income.

PHI, private health insurance.

without PHI (model 1). The interaction effects on having PHI and number of chronic conditions was statistically significant, a greater number of conditions was associated with PHI status having a stronger positive effect on OOP healthcare expenditure (online supplemental appendix F eFigure 4). Higher income, higher educational attainment and living in an urban area were also found to have a positive association with OOP healthcare expenditure. The sensitivity analysis using OLS models (online supplemental appendix F eTable 2) revealed similar results to those found in the gamma models.

### Effect of independent variables at different points of the OOP expenditure distribution

Unconditional quantile regression models were conducted to examine whether the association between number of conditions and OOP healthcare expenditure (among those with any OOP healthcare expenditure) differed across the OOP healthcare expenditure distribution (online supplemental appendix F eTable 3). A strong positive association between multimorbidity and OOP healthcare expenditure was found (figure 1). For example, while three or more conditions was associated with OOP expenditure being €143.52 higher per annum



**Figure 1** Quantile regression coefficients for effect of number of conditions on out-of-pocket (OOP) healthcare expenditure (error bars represent SE).

for individuals in quantile 1, in the highest quantile it was associated with annual OOP expenditure being €1029.98 higher.

## DISCUSSION

This study provides evidence on the differences in OOP healthcare expenditure between those with and those without multimorbidity. The results show that having multimorbidity in Ireland increases an individual's likelihood of having OOP healthcare expenditure by over 20%. The results also show that having multimorbidity is associated with a large absolute increase in OOP healthcare expenditure, even controlling for several sociodemographic factors. Our adjusted analyses found that, on average, people with two chronic conditions spent €771 per annum on OOP healthcare expenditure while those with three or more conditions spent €965. This places a large financial burden (percentage of household income spent on healthcare) on those with multimorbidity. The study identifies a subset of high OOP spenders; 8.6% of people with three or more conditions spent 20% or more of their equivalised household income on healthcare. Using unconditional quantile regressions, when looking at the highest spending quantile, people with multimorbidity spent much more per annum (€570 for those with two conditions and €1030 for those with three or more conditions) than those with no conditions.

To put these results into context, a 2017 study found that people with colorectal cancer had OOP healthcare expenditure of almost €1600 per annum.<sup>61</sup> However, this included indirect costs such as clothing and childcare, which were not accounted for in our analysis. Also, in 2019, across all health and social care, OOP spending equated to €580 per person in the general population.<sup>62</sup> However, this included long-term care costs which make up a substantial proportion of OOP costs in Ireland.<sup>60</sup>

The findings of higher financial burden among people with multimorbidity is particularly concerning.

It is likely caused by the association between multimorbidity and healthcare utilisation,<sup>7</sup> polypharmacy,<sup>8</sup> socioeconomic deprivation<sup>29 30</sup> and having to leave paid employment.<sup>63</sup> An Australian study of older adults with multimorbidity<sup>16</sup> found similar levels of financial burden to those found in this study. This is unsurprising as there are many similarities between the two countries' health systems.<sup>64 65</sup> The association between number of conditions and greater OOP healthcare expenditure is consistent with findings from studies in HICs<sup>1 16</sup> and MICs.<sup>18–20 66</sup> However, the unadjusted results show that multimorbidity (is associated with a less than two-fold increase in OOP healthcare expenditure, compared with those with no conditions. Studies in the USA and Australia showed far greater increases in expenditure associated with multimorbidity.<sup>1 16</sup> The stronger effect in high spenders is consistent with two recent studies conducted in MICs.<sup>18 19</sup> This may be accounted for by specific combinations of conditions associated with high OOP healthcare expenditure,<sup>14</sup> or simply with discordant multimorbidity (conditions that require different management approaches and/or have different aetiology) as opposed to concordant multimorbidity (conditions that require similar management approaches and/or have similar aetiology).<sup>6</sup>

Similarly to the results found in the USA<sup>1</sup> and Australia,<sup>16</sup> our results found that pharmacy-dispensed medicines were the greatest contributor to OOP expenditure, particularly for people with multimorbidity. This is despite many people with multimorbidity being eligible for heavily subsidised or free medicines in Ireland through medical card or long-term illness scheme eligibility (where patients with diabetes represent a majority within the scheme and are entitled to free diabetes-related medicines).<sup>67</sup> However, for those not eligible for these schemes, the high OOP expenditure may be due to the high caps on medicine expenditure. At the time of data collection, individuals who were not eligible for a medical card or the long-term illness scheme were required to pay up to €144 per month per family through the Drugs Payment Scheme.<sup>68</sup> Though it should be noted that the Drugs Payment Scheme cap reduced to €100 per month in January 2022.<sup>69</sup> Current plans for health system reform in Ireland involve a commitment to free (at the point of delivery) GP and hospital care and introducing a different Drugs Payment Scheme threshold for single-headed households of €72.<sup>70</sup> Given that medicines were a large contributor to OOP healthcare expenditure, interventions to reduce unnecessary or inappropriate prescribing should be considered given the positive effects this could have on both OOP healthcare expenditure and health outcomes. These could include clinical guidelines which account for people with multimorbidity,<sup>71</sup> deprescribing interventions<sup>72</sup> or interventions that reduce interactions between the pharmaceutical industry and physicians.<sup>73</sup> Interventions to increase levels of generic prescribing<sup>74</sup> and reduce the costs of medicines<sup>75</sup> would also be beneficial.

The results highlight the contrasting impact of medical cards and PHI on OOP expenditure across the Irish health system. The medical card, which entitles people to free or heavily subsidised healthcare, was found to reduce OOP healthcare expenditure, by 48%. This mitigating effect was found to be stronger for people with multimorbidity. A Chinese study<sup>66</sup> of multimorbidity and OOP healthcare expenditure found a strong association between public entitlements and reduced OOP expenditure. Our study found that PHI was associated with 61% higher OOP healthcare expenditure (excluding expenditure on PHI premia), and strikingly this increase was significantly greater for people with multimorbidity. The strong association between PHI and increased OOP healthcare expenditure likely speaks to the supplementary role PHI plays in Irish healthcare.<sup>76</sup> In a supplementary market, PHI offers access to services covered by public entitlements, but gives the PHI purchaser the choice of a private provider and the ability to skip waiting lists for publicly funded treatments.<sup>76</sup> The supplementary market may be increasing expenditure for people with PHI because of the higher co-payments associated with private care. Though, it is also possible that this relationship is being driven by people with PHI being enabled to afford, use and pay for certain healthcare services, relative to people without PHI.<sup>77</sup> PHI is also thought to play a complementary role in Ireland<sup>76</sup> (covering services not covered by public entitlements and reimbursing some statutory charges) and therefore should offer some financial protection. However, given the strong association between PHI and increased OOP healthcare expenditure, this complementary role seems to be outweighed by the supplementary role.

Given that those on a low income without a medical card or PHI are more likely to report an unmet healthcare need<sup>77</sup> increasing the income threshold for the medical card, which includes free GP and hospital care and heavily subsidised medicines, would likely be beneficial to people with multimorbidity. The benefits of this measure are further emphasised by this study's results that the medical card is associated with a significant reduction in OOP healthcare costs, and that people with multimorbidity have lower incomes and higher expenditure, on average. Another useful measure for people with multimorbidity would be to address known barriers to medical card uptake including 'lack of awareness of entitlement, potential stigma and large administrative burdens'<sup>33</sup> as there is evidence that 31% of those entitled to a medical card are not availing of it.<sup>33</sup> However, reduced OOP costs will not address access issues completely if uncoordinated care<sup>13</sup> and long waiting lists for public services<sup>78</sup> are not addressed.<sup>77</sup>

With regard to future research, a similar study of other groups, for example, those with disabilities who do not have multimorbidity could provide interesting findings as they may have different levels of income and OOP healthcare expenditure. For similar reasons a study of those aged under 50 years, who may also have different patterns

of multimorbidity could provide valuable findings. Future research could stratify the OOP healthcare expenditure analysis by entitlement status. Also, analysis using direct measures of expenditure such as insurance databases or medical records could provide more valid findings. This would address the potential recall bias limitation of this study. This may also help facilitate greater access to data on people with cognitive impairment or people who speak a language other than English. However, the IT infrastructure in Ireland would need to be improved and made more accessible to researchers in order to conduct these types of studies.

### Strengths and limitations

This study has several strengths and limitations. First, a major strength of this study is that TILDA captures a nationally representative sample of community-dwelling adults in Ireland. A limitation of this study is the use of self-reported survey-based data, which can create a recall bias. Specifically, it can result in under-reporting of chronic conditions<sup>79 80</sup> and misreporting of routine healthcare utilisation.<sup>81</sup> This is likely to be more problematic for those with higher expenditure due to the greater volume of information involved. However, a recent study of TILDA data found that patient self-report for healthcare utilisation was accurate for several health services.<sup>82</sup> However, these findings are not directly applicable to expenditure data. Calculating 12-month expenditure for home care services and prescription drugs by multiplying monthly amounts by 12 is also a limitation. Another limitation is that household adaptations, medical devices and travel costs to access healthcare were not included in this analysis meaning that OOP healthcare expenditure is likely to be underestimated. Overall, the regression models are vulnerable to unobserved heterogeneity, and therefore, require cautious interpretation. A measure of the proportion of non-subsistence income (income not spent on subsistence) spent on healthcare, which is not available within TILDA, may have allowed for increased understanding of financial burden.<sup>83 84</sup> Using disease count to represent multimorbidity has both strengths and limitations; its primary limitation is that severity of each condition is not considered.<sup>85</sup> Its primary strength is that it is the only multimorbidity measure associated with all three essential outcomes from the core outcomes set for multimorbidity research: mortality, mental health outcomes and health related quality of life.<sup>85</sup> Finally, the observational nature of this study means it is vulnerable to residual confounding and selection bias.

### CONCLUSION

Multimorbidity is associated with significantly increased OOP healthcare expenditure, particularly for those who spend more on healthcare, and leads to higher financial burden, particularly for those in more socioeconomically disadvantaged groups. High financial burden can have a range of negative effects, which include adverse

clinical outcomes and cost-related non-adherence/non-attendance. Eligibility for free healthcare and heavily subsidised medicines greatly reduces these OOP healthcare costs. Therefore, broader access to free healthcare has the potential to reduce the high financial burden experienced by people with multimorbidity.

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#### REFERENCES

- 1 Paez KA, Zhao L, Hwang W. Rising out-of-pocket spending for chronic conditions: a ten-year trend. *Health Aff* 2009;28:15–25.
- 2 King DE, Xiang J, Pilkerton CS. Multimorbidity trends in United States adults, 1988–2014. *J Am Board Fam Med* 2018;31:503–13.
- 3 Pefoyo AJK, Bronskill SE, Gruneir A, et al. The increasing burden and complexity of multimorbidity. *BMC Public Health* 2015;15:415.
- 4 Uijen AA, van de Lisdonk EH. Multimorbidity in primary care: prevalence and trend over the last 20 years. *Eur J Gen Pract* 2008;14 Suppl 1:28–32.
- 5 Fortin M, Stewart M, Poitras M-E, et al. A systematic review of prevalence studies on multimorbidity: toward a more uniform methodology. *Ann Fam Med* 2012;10:142–51.
- 6 The Academy of Medical Sciences. Multimorbidity: a priority for global health research, 2018. Available: <https://acmedsci.ac.uk/policy/policy-projects/multimorbidity>
- 7 Palladino R, Tayu Lee J, Ashworth M, et al. Associations between multimorbidity, healthcare utilisation and health status: evidence from 16 European countries. *Age Ageing* 2016;45:431–5.
- 8 Vyas A, Pan X, Sambamoorthi U. Chronic condition clusters and polypharmacy among adults. *Int J Family Med* 2012;2012:193168.
- 9 Mercer S, Salisbury C, Fortin M. *ABC of multimorbidity*. John Wiley & Sons, 2014.
- 10 Hughes LD, McMurdo MET, Guthrie B. Guidelines for people not for diseases: the challenges of applying UK clinical guidelines to people with multimorbidity. *Age Ageing* 2013;42:62–9.
- 11 Xu X, Mishra GD, Jones M. Mapping the global research landscape and knowledge gaps on multimorbidity: a bibliometric study. *J Glob Health* 2017;7:010414.
- 12 Boyd CM, Fortin M. Future of multimorbidity research: how should understanding of multimorbidity inform health system design? *Public Health Rev* 2010;32:451–74.
- 13 Salisbury C. Multimorbidity: redesigning health care for people who use it. *The Lancet* 2012;380:7–9.
- 14 Sum G, Hone T, Atun R, et al. Multimorbidity and out-of-pocket expenditure on medicines: a systematic review. *BMJ Glob Health* 2018;3:e000505.
- 15 Wang L, Si L, Cocker F, et al. A systematic review of cost-of-illness studies of multimorbidity. *Appl Health Econ Health Policy* 2018;16:15–29.
- 16 McRae I, Yen L, Jeon Y-H, et al. Multimorbidity is associated with higher out-of-pocket spending: a study of older Australians with multiple chronic conditions. *Aust J Prim Health* 2013;19:144–9.
- 17 Lee JT, Hamid F, Pati S, et al. Impact of noncommunicable disease multimorbidity on healthcare utilisation and out-of-pocket expenditures in middle-income countries: cross sectional analysis. *PLoS One* 2015;10:e0127199.
- 18 Zhao Y, Atun R, Anindya K, et al. Medical costs and out-of-pocket expenditures associated with multimorbidity in China: quantile regression analysis. *BMJ Glob Health* 2021;6.
- 19 Anindya K, Ng N, Atun R, et al. Effect of multimorbidity on utilisation and out-of-pocket expenditure in Indonesia: quantile regression analysis. *BMC Health Serv Res* 2021;21:427.
- 20 Rivera-Almaraz A, Manrique-Espinoza B, Chatterji S, et al. Longitudinal associations of multimorbidity, disability and out-of-pocket health expenditures in households with older adults in Mexico: the study on global AGEing and adult health (SAGE). *Disabil Health J* 2019;12:665–72.
- 21 Kantor ED, Rehm CD, Haas JS, et al. Trends in prescription drug use among adults in the United States from 1999–2012. *JAMA* 2015;314:1818–31.
- 22 Hammel B, Michel MC. Why are new drugs expensive and how can they stay affordable? *Handb Exp Pharmacol* 2019;260:453–66.
- 23 Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the global burden of disease study 2013. *Lancet* 2015;386:743–800.
- 24 World Health Organization. Global status report on noncommunicable diseases 2014; 2014.
- 25 Jeon Y-H, Essue B, Jan S, et al. Economic hardship associated with managing chronic illness: a qualitative inquiry. *BMC Health Serv Res* 2009;9:182.

- 26 Larkin J, Foley L, Smith SM, *et al.* The experience of financial burden for people with multimorbidity: a systematic review of qualitative research. *Health Expect* 2021;24:282–95.
- 27 Sabaté E, Sabaté E. *Adherence to long-term therapies: evidence for action.* World Health Organization, 2003.
- 28 McQueenie R, Ellis DA, McConnachie A, *et al.* Morbidity, mortality and missed appointments in healthcare: a national retrospective data linkage study. *BMC Med* 2019;17:2.
- 29 Barnett K, Mercer SW, Norbury M, *et al.* Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012;380:37–43.
- 30 Khanolkar AR, Chaturvedi N, Kuan V, *et al.* Socioeconomic inequalities in prevalence and development of multimorbidity across adulthood: a longitudinal analysis of the MRC 1946 national survey of health and development in the UK. *PLoS Med* 2021;18:e1003775.
- 31 Jan S, Laba T-L, Essue BM, *et al.* Action to address the household economic burden of non-communicable diseases. *Lancet* 2018;391:2047–58.
- 32 Johnston B, Thomas S, Burke S. Can people afford to pay for health care? new evidence on financial protection in Ireland. *Eurohealth* 2020:1–118.
- 33 Keane C, Regan M, Walsh B. Failure to take-up public healthcare entitlements: evidence from the medical card system in Ireland. *Soc Sci Med* 2021;281:114069.
- 34 Health Service Executive. Medical card means test: aged under 70. Available: [https://www.citizensinformation.ie/en/health/medical\\_cards\\_and\\_gp\\_visit\\_cards/medical\\_card\\_means\\_test\\_under\\_70s.html](https://www.citizensinformation.ie/en/health/medical_cards_and_gp_visit_cards/medical_card_means_test_under_70s.html) [Accessed 09 May, 2022].
- 35 Health Service Executive. Discretionary medical cards. Available: <https://www2.hse.ie/services/medical-cards/discretionary-medical-cards.html> [Accessed 09 May 2022].
- 36 Finn C. Number of discretionary medical cards falls by over 16,000. Available: <https://www.thejournal.ie/discretionary-medical-cards-fall-hse-1485714-May2014/> [Accessed 03 Jun 2022].
- 37 Wren M-A, Connolly S. *Challenges in achieving universal healthcare in Ireland.* Economic and Social Research Institute, 2016.
- 38 whatclinic.com. Cost of a private gp consultation in Ireland is a cross country lottery. Available: <https://www.whatclinic.com/about/press/pdfs/whatclinic-gp-checkups-ireland-july-2014.pdf> [Accessed 22 Nov 2021].
- 39 Kringos D, Boerma W, Bourgueil Y, *et al.* The strength of primary care in Europe: an international comparative study. *Br J Gen Pract* 2013;63:e742–50.
- 40 Citizens Information. Gp visit cards. Available: [https://www.citizensinformation.ie/en/health/medical\\_cards\\_and\\_gp\\_visit\\_cards/gp\\_visit\\_cards.html](https://www.citizensinformation.ie/en/health/medical_cards_and_gp_visit_cards/gp_visit_cards.html) [Accessed 14 Sep 2021].
- 41 Health services Executive. Long term illness scheme. Available: <https://www2.hse.ie/services/long-term-illness-scheme/long-term-illness.html> [Accessed 29 Oct 2020].
- 42 Health Insurance Authority. Market figures, 2020. Available: <https://www.hia.ie/sites/default/files/1%20HIA%20Annual%20Report%202019%20Release%201%2030%20July%202019%20FINAL.pdf> [Accessed 29 Oct 2020].
- 43 OECD, European Commission. *Health at a glance: Europe.* Paris: OECD Publishing, 2016.
- 44 Turner B, Smith S, Thomson S. Uncovering the complex role of private health insurance in Ireland. In: *Private health insurance: history, politics and performance.* 2020: 221–63.
- 45 Kantar. A review of private health insurance in Ireland, 2019. Available: [https://www.hia.ie/sites/default/files/17th%20January%20Kantar%20Report\\_0.pdf](https://www.hia.ie/sites/default/files/17th%20January%20Kantar%20Report_0.pdf) [Accessed 09 May 2022].
- 46 von Elm E, Altman DG, Egger M, *et al.* The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med* 2007;147:573–7.
- 47 Irish Social Science Data Archive. The Irish longitudinal study on ageing (TILDA) wave 4. Available: <https://www.ucd.ie/issda/data/tilda/wave4/> [Accessed 20 Jun 2022].
- 48 Whelan BJ, Savva GM. Design and methodology of the Irish longitudinal study on ageing. *J Am Geriatr Soc* 2013;61 Suppl 2:S265–8.
- 49 Turner N, Donoghue O, Kenny RA. Wellbeing and Health in Ireland's Over 50s 2009–2016. Available: <https://tilda.tcd.ie/publications/reports/W4KeyFindings/index.php> [Accessed 04 Nov 2020].
- 50 Ryan A, Murphy C, Boland F, *et al.* What is the impact of physical activity and physical function on the development of multimorbidity in older adults over time? a population-based cohort study. *J Gerontol A Biol Sci Med Sci* 2018;73:1538–44.
- 51 OECD. Burden of out-of-pocket health expenditure. In: *Health at a glance 2009: OECD indicator.* OECD Publishing, 2009. [https://www.oecd-ilibrary.org/docserver/health\\_glance-2009-62-en.pdf?expires=](https://www.oecd-ilibrary.org/docserver/health_glance-2009-62-en.pdf?expires=1637694275&id=id&accname=guest&checksum=CE83343B69289B21E7C89F2AF6139F48)
- 52 United Nations Statistics Division. Classification of expenditure according to purpose. accessed 09 November, 2020. Available: <https://unstats.un.org/unsd/EconStatKB/KnowledgebaseArticle10189.aspx>
- 53 Bernard DM, Johansson P, Fang Z. Out-Of-Pocket healthcare expenditure burdens among nonelderly adults with hypertension. *Am J Manag Care* 2014;20:406–13.
- 54 Johnston BM, Burke S, Barry S, *et al.* Private health expenditure in Ireland: assessing the affordability of private financing of health care. *Health Policy* 2019;123:963–9.
- 55 Organisation for Economic Cooperation and Development. What are equivalence scales? Available: <https://www.oecd.org/economy/growth/OECD-Note-EquivalenceScales.pdf> [Accessed 22 Sep 2021].
- 56 Cragg JG. *Some statistical models for limited dependent variables with application to the demand for durable goods.* *Econometrica: Journal of the Econometric Society*, 1971: 829–44.
- 57 Mihaylova B, Briggs A, O'Hagan A, *et al.* Review of statistical methods for analysing healthcare resources and costs. *Health Econ* 2011;20:897–916.
- 58 Griswold M, Parmigiani G, Potosky A, *et al.* Analyzing health care costs: a comparison of statistical methods motivated by Medicare colorectal cancer charges. *Biostatistics* 2004;1:1–23.
- 59 Wammes JGG, van der Wees PJ, Tanke MAC, *et al.* Systematic review of high-cost patients' characteristics and healthcare utilisation. *BMJ Open* 2018;8:e023113.
- 60 Walsh B, Keegan C, Brick A. Projections of expenditure for primary, community and long-term care in Ireland, 2019–2035, based on the Hippocrates model. *ESRI Research Series* 2021;126.
- 61 Ó Céilleachair A, Hanly P, Skally M, *et al.* Counting the cost of cancer: out-of-pocket payments made by colorectal cancer survivors. *Support Care Cancer* 2017;25:2733–41.
- 62 Central Statistics Office. System of health accounts, 2019. Available: <https://www.cso.ie/en/releasesandpublications/ep/p-sha/systemofhealthaccounts2019/> [Accessed 04 Nov 2021].
- 63 van Zon SKR, Reijneveld SA, Galaurchi A, *et al.* Multimorbidity and the transition out of full-time paid employment: a longitudinal analysis of the health and retirement study. *J Gerontol B Psychol Sci* 2020;75:705–15.
- 64 Burke S, Barry S, Siersbaek R, *et al.* Sláintecare - A ten-year plan to achieve universal healthcare in Ireland. *Health Policy* 2018;122:1278–82.
- 65 Dixit SK, Sambasivan M. A review of the Australian healthcare system: a policy perspective. *SAGE Open Med* 2018;6:2050312118769211.
- 66 Zhao Y, Zhang P, Oldenburg B, *et al.* The impact of mental and physical multimorbidity on healthcare utilization and health spending in China: a nationwide longitudinal population-based study. *Int J Geriatr Psychiatry* 2021;36:500–10.
- 67 Connors J. Spending review 2017. future sustainability of pharmaceutical expenditure. Department of public expenditure and reform. Available: <https://igees.gov.ie/wp-content/uploads/2015/02/Future-Sustainability-of-Pharmaceutical-Expenditure.pdf> [Accessed 04 Nov 2021].
- 68 Department of Health. Health in Ireland key trends 2019, 2020. Available: <https://assets.gov.ie/45117/6a4f970018d6477bac38f4539f80e927.pdf> [Accessed 27 Oct 2020].
- 69 Citizens Information. Drugs payment scheme. Available: [https://www.citizensinformation.ie/en/health/drugs\\_and\\_medicines/drugs\\_payment\\_scheme.html](https://www.citizensinformation.ie/en/health/drugs_and_medicines/drugs_payment_scheme.html) [Accessed 22 Oct 2021].
- 70 Committee on the Future of Healthcare. Sláintecare report. Available: <https://assets.gov.ie/22609/e68786c13e1b4d7daca89b495c506bb8.pdf> [Accessed 04 Nov 2021].
- 71 Fitzgerald SP, Bean NG. An analysis of the interactions between individual comorbidities and their treatments—implications for guidelines and polypharmacy. *J Am Med Dir Assoc* 2010;11:475–84.
- 72 Scott IA, Hilmer SN, Reeve E, *et al.* Reducing inappropriate polypharmacy: the process of deprescribing. *JAMA Intern Med* 2015;175:827–34.
- 73 Brax H, Fadlallah R, Al-Khaled L, *et al.* Association between physicians' interaction with pharmaceutical companies and their clinical practices: a systematic review and meta-analysis. *PLoS One* 2017;12:e0175493.
- 74 Moe-Byrne T, Chambers D, Harden M, *et al.* Behaviour change interventions to promote prescribing of generic drugs: a rapid evidence synthesis and systematic review. *BMJ Open* 2014;4:e004623.
- 75 Barry M, Boland R, Bradley C, Department of Health and Children. Economies in drug usage in the Irish healthcare setting. Available:



- <https://www.lenus.ie/bitstream/handle/10147/66358/?sequence=1> [Accessed 23 Dec 2021].
- 76 Thomson S, Mossialos E. Private health insurance in the European Union. In: *Studies and reports on health and long-term care*. Brussels: European Commission, 2009.
- 77 Connolly S, Wren M-A. Unmet healthcare needs in Ireland: analysis using the EU-SILC survey. *Health Policy* 2017;121:434–41.
- 78 McGlacken-Byrne D, Parker S, Burke S. Tracking aspects of healthcare activity during the first nine months of COVID-19 in Ireland: a secondary analysis of publicly available data. *HRB Open Res* 2021;4:98.
- 79 Koller KR, Wilson AS, Asay ED, *et al*. Agreement between self-report and medical record prevalence of 16 chronic conditions in the Alaska earth study. *J Prim Care Community Health* 2014;5:160–5.
- 80 Muggah E, Graves E, Bennett C, *et al*. Ascertainment of chronic diseases using population health data: a comparison of health administrative data and patient self-report. *BMC Public Health* 2013;13:16.
- 81 Wolinsky FD, Miller TR, An H, *et al*. Hospital episodes and physician visits: the concordance between self-reports and Medicare claims. *Med Care* 2007;45:300.
- 82 Wallace E, Moriarty F, McGarrigle C, *et al*. Self-Report versus electronic medical record recorded healthcare utilisation in older community-dwelling adults: comparison of two prospective cohort studies. *PLoS One* 2018;13:e0206201.
- 83 Ataguba JE-O. Reassessing catastrophic health-care payments with a Nigerian case study. *Health Econ Policy Law* 2012;7:309–26.
- 84 Xu K, Evans DB, Kawabata K, *et al*. Household catastrophic health expenditure: a multicountry analysis. *Lancet* 2003;362:111–7.
- 85 Lee ES, Koh HL, Ho EQ-Y, *et al*. Systematic review on the instruments used for measuring the association of the level of multimorbidity and clinically important outcomes. *BMJ Open* 2021;11:e041219.

**Appendix A – health conditions (questionnaire)**

(A) Since your last interview, has a doctor ever told you/ that you have any of the [other] conditions on this card?

(B) Has a doctor ever told [you/Rname] that [you/he/she] [have/has] any of the conditions on this card?

**IWER: PROBE - 'WHAT OTHERS?' CODE ALL THAT APPLY.**

- |   |                                      |
|---|--------------------------------------|
| 1. Chronic lung disease such as chronic bronchitis<br>or emphysema                                    | GO TO PH302 [ph301_01]<br>[ph301_02] |
| 2. Asthma   |                                      |
| 3. Arthritis (including osteoarthritis, or rheumatism)  | GO TO PH304 [ph301_03]               |
| 4. Osteoporosis, sometimes called thin or brittle bones   | [ph301_04]                           |
| 5. Cancer or a malignant tumour<br>(including leukaemia or lymphoma but excluding minor skin cancers) | GO TO PH309 [ph301_05]               |
| 6. Parkinson's disease  | GO TO PH314 [ph301_06]               |
| 7. Any emotional, nervous or psychiatric problems,<br>such as depression or anxiety                   | GO TO PH315 [ph301_07]               |
| 9. Alzheimer's disease  | GO TO PH318 [ph301_09]               |
| 10. Dementia, organic brain syndrome, senility  | GO TO PH319 [ph301_10]               |
| 11. Serious memory impairment   | GO TO PH319a [ph301_11]              |
| 12. Stomach ulcers  | [ph301_12]                           |
| 13. Varicose Ulcers (an ulcer due to varicose veins)  | [ph301_13]                           |
| 14. Cirrhosis, or serious liver damage  | [ph301_14]                           |
| 15. Thyroid Problems  | GO TO PH325 [ph301_15]               |
| 16. Alcohol abuse   | GO TO PH320a [ph301_16]              |
| 17. Substance abuse   | GO TO PH320b [ph301_17]              |
| 18. Chronic kidney disease  | GO TO PH327 [ph301_18]               |
| 19. Severe Anaemia  | [ph301_19]                           |
| 20. Epilepsy  | GO TO PH329 [ph301_20]               |
| 95. Other (please specify)  | [ph301_95] [ph301oth]                |
| 96. None of these   | GO TO PH328 [ph301_96]               |
| 98. DK  | GO TO PH328 [ph301_98]               |
| 99. RF  | GO TO PH328 [ph301_99]               |
- (ELSA/ similar question HRS/NSHAP)

**IWER: SHOW CARD PH2 [PAGE #]**

**IF (intstatusW4 = 2, 4, 5), USE WORDING 'B'. ALL OTHERS, USE WORDING 'A'.**

PH201: Please look at card PH2.

(A) Since your last interview, has a doctor ever told you that you have any of the [other] conditions on this card?

(B) Has a doctor ever told [you/Rname] that [you/he/she] [have/has] any of the conditions on this card?

INTERVIEWER: PROBE - 'WHAT OTHERS?' CODE ALL THAT APPLY.

- |   |                      |
|---|----------------------|
| 1. High blood pressure or hypertension  | [ph201_01]           |
| 2. Angina   | [ph201_02]           |
| 3. A heart attack<br>(including myocardial infarction or coronary thrombosis) | [ph201_03]           |
| 4. Congestive heart failure   | [ph201_04]           |
| 5. Diabetes or high blood sugar   | [ph201_05]           |
| 6. A stroke (cerebral vascular disease)                                       | [ph201_06]           |
| 7. Ministroke or TIA  | [ph201_07]           |
| 8. High cholesterol   | [ph201_08]           |
| 9. A heart murmur   | [ph201_09]           |
| 11. Atrial Fibrillation   | [ph201_11]           |
| 12. An abnormal heart rhythm (not atrial fibrillation)                        | [ph201_12]           |
| 95. Any other heart trouble (please specify)                                  | [ph201_95][ph201oth] |
| 96. None of these   | [ph201_96]           |
| 98. DK  | [ph201_98]           |
| 99. RF  | [ph201_99]           |
- (ELSA/ similar questions in HRS/ SHARE)

(A) Since [your] last interview, has a doctor ever told you that you have any of the following [other] eye diseases?

(B) Has a doctor ever told [you/Rname] that [you/he/she] [have/has] any of the following eye diseases? [DISPLAY ALL CONDITIONS]

**IWER: READ OUT. CODE ALL THAT APPLY.**

- |                                     |                       |
|-------------------------------------|-----------------------|
| 1. Cataracts                        | [ph105_01]            |
| 2. Glaucoma                         | [ph105_02]            |
| 3. Age related macular degeneration | [ph105_03]            |
| 95. Other (please specify)          | [ph105_95] [ph105oth] |

**Appendix B: Conditions included in analysis (partly based on Ryan and colleagues)**

1. Cardiac Condition
  - Angina
  - Heart Attack
  - Congestive Heart Failure
  - Heart Murmur
  - Abnormal heart rhythm
  - Atrial fibrillation
  - Any heart trouble
2. Cerebrovascular disease
  - Stroke
  - Transient ischemic attack (TIA)
3. Hypertension (HTN)
4. Diabetes
5. High Cholesterol
6. Chronic respiratory disease
  - Chronic lung disease
  - Asthma
7. Liver disease
  - Alcohol abuse
  - Cirrhosis
  - Liver disease
8. Eye disease
  - Cataracts
  - Glaucoma
  - Age related macular degeneration
  - Other eye disease
9. Cognitive Impairment
  - Alzheimer's
  - Dementia
  - Serious cognitive impairment
10. Arthritis

11. Osteoporosis
12. Cancer
13. Parkinson's disease
14. Emotional /psychological condition including anxiety and depression
15. Substance abuse
16. Gastrointestinal conditions including Stomach Ulcers
17. Varicose veins including varicose ulcers
18. Epilepsy
19. Thyroid Problems
20. Chronic kidney disease
21. Anaemia

**Appendix C – Healthcare Expenditure Questions**

IF HU002 =1,2,3 GO TO HU044

**HU044: Approximately how much was [your/Rname's] latest annual health insurance premium?**

IWER: IF NOT PAID ANNUALLY HELP RESPONDENT WORK OUT ANNUAL PAYMENT ON A CALCULATOR

€0 ... €500,000 GO TO HU046

-98. DK GO TO HU045

-99. RF GO TO HU045

**IWER SHOW CARD HU1 [PAGE #]****HU045: Please look at card HU1. Please select which annual health insurance premium category is most appropriate.**

IWER: CODE THE ONE THAT APPLIES

0 €0 - €400

1 €401 - €800

2 €801 - €1200

3 €1201 - €1600

4 €1601 - €2000

5 €2001 - €2400

6 €2401 - €2800

7 More than €2800

-98. DK

-99. RF

**HU005: In the last 12 months, about how often did [you/he/she] visit [your/his/her] GP?**

IWER: IF RESPONDENT HAS NOT VISITED GP IN THE LAST 12 MONTHS CODE 0

0...200

-98. DK GO TO HU007

-99. RF GO TO HU007

IF (HU005=0, -98,-99) GO TO HU007

IF (HU005&gt;0 AND HU001=1, 2) GO TO HU007

IF (HU005&gt;0 AND HU070= 2) GO TO HU007

IF (HU005&gt;0 AND HU001≠1, 2) GO TO HU006

IF (HU005&gt;0 AND HU070 ≠ 2) GO TO HU006

(SHARE)

**HU006: How much did [you/he/she] pay for [your/his/her] last visit to the GP, after any health insurance reimbursement?**

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE

€0.00 ... €10,000

-98. DK

-99. RF

**HU038: In total, how much did [you/he/she] pay for all of [your/his/her] A&E visit(s) in the last 12 months, after any health insurance reimbursement?'**

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE

€0 ... €10,000

-98. DK

-99. RF

**HU075: In total, how much did [you/he/she] pay for [your/his/her] outpatient/day patient visits in the last 12 months, after any health insurance reimbursement? (May be zero)**

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE

€0 ... €50,000

-98. DK

-99. RF

If HU062=1

**HU039: In total, how much did [you/he/she] pay for [your/his/her] visit(s) to consultant(s) in the last 12 months, after any health insurance reimbursement? (May be zero)**

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE

€0 ... €20,000

-98. DK

-99. RF

**HU040: In total, how much did [you/he/she] pay for [your/his/her] overnight hospital stays(s) in the last 12 months, after any health insurance reimbursement? (May be zero)**

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE

€0 ... €50,000

-98. DK

-99. RF

**HOME CARE****IF HH002=1 GO TO HU076****IF HH002=2, 3 GO TO HU083****HU015\_a4: Not counting costs paid by the HSE/health board, about how much did [you/Rname] (and [your/his/her] [husband/wife/partner]) pay for this home help in the last month? (May be zero)**

€0 ... €10,000

-98. DK

-99. RF

GO TO HU015

**HU015\_b4: Not counting costs paid by the HSE/health board, about how much did [you/Rname] (and [your/his/her] [husband/wife/partner]) pay this personal care attendant in the last month? (May be zero)**

€0 ... €10,000

-98. DK

-99. RF

GO TO HU015

**HU015\_d4: Not counting costs paid by the HSE/health board, about how much did [you/Rname] (and [your/his/her] [husband/wife/partner]) pay for this Home Care Package in the last month? (May be zero)**

€0 ... €10,000

-98. DK

-99. RF

GO TO HU015

**HU035: Not counting health insurance refunds, on average about how much [do/does] [you/he/she] pay out-of-pocket for [your/his/her] prescribed drugs per month?**

IWER: IF RESPONDENT DOES NOT PURCHASE PRESCRIBED DRUGS REGULARLY, ASK FOR TOTAL SPENT IN THE LAST 12 MONTHS IN PRESCRIBED DRUGS AND DIVIDE BY 12.

IWER: IF R CANNOT GIVE EXACT VALUE, ACCEPT APPROXIMATE VALUE VALUE [Allow Responses up to 2 decimal places]

€0.00 ... €5,000.00

-98. DK

-99. RF

NOTE: Include the €2.50 per prescribed item charges for medical card holders.

NOTE: Do not consider expenses for self-medication or drugs not prescribed

NOTE: By 'out of pocket' expenses we mean everything that is not paid by the insurance company. If [you/he/she] first [pay/pays] but later get it refunded, this is not out of pocket expenses.

(SHARE)

**HU036: Not counting any refunds from [your/his/her] health insurance, about how much did [you /he/she] pay (out-of-pocket) for any other health expenses [you/he/she] had in the last 12 months?**

€0 ... and €20,000

-98. DK

-99. RF

**Note:** By other health expenses we mean non-prescription drugs, private physiotherapy, preventive rehabilitative services such as occupational therapy etc.

By 'out of pocket' expenses we mean everything that is not paid by the insurance company. If [you/he/she] first pay/pays] but later [get/gets] it refunded, this is not out of pocket expenses. Prescription drugs should be included in HU035 and not here.

(SHARE)



**Appendix D - Expenditure calculations**

For outpatients, specialist private medical consultations, hospital stays, emergency department and other health expenses, participants were asked to recall their expenditure in the previous 12 months. For GP, participants were asked how much they spent on their last visit and then how many visits they had in the last year. Amount spent on last GP visit was multiplied by number of visits in previous 12 months to calculate 12-month expenditure.

## Appendix E – Outliers

### GP Expenditure

GP expenditure was removed for two respondents; one who said they had 150 GP visits in the last 12 months and one who said the cost of their last visit was €5560

### Medicines Expenditure

We replaced data with missing for anything above €288 (twice the Drug Payment Scheme limit of €144), unless there is other information provided by the participant to suggest it is plausible or a specific error has been made, e.g.

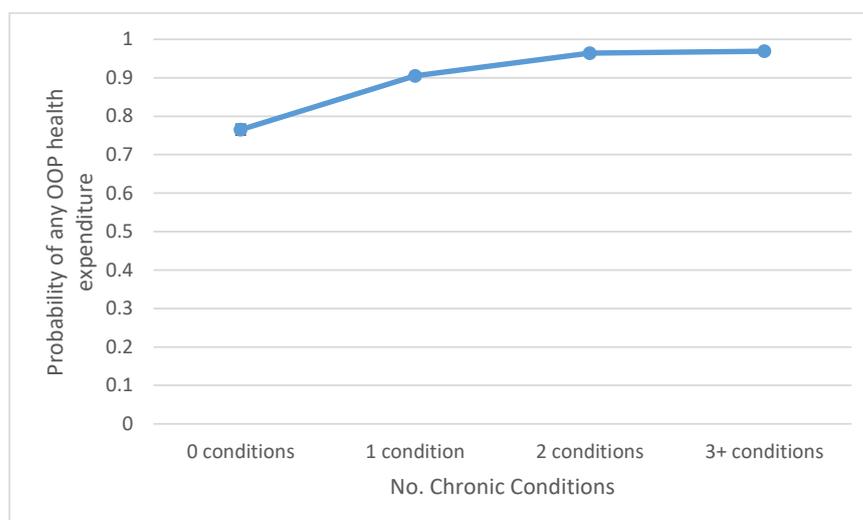
- If they have a medical card, report a multiple of €250, and their number of prescription medicines is equivalent (+/- 1) to the number of medicines that would give that charge (e.g. €1250 and reporting 4-6 meds)
- If not a medical card holder (so likely using Drug Payment Scheme) and report a multiple of 12 (i.e. giving a whole number if dividing by 12), then assume to be an annual rather than monthly report.
- If they remain as an outlier, their response is included if any of the medicines they report are not covered by the Drug Payment Scheme.

**Appendix F - Supplementary Results**

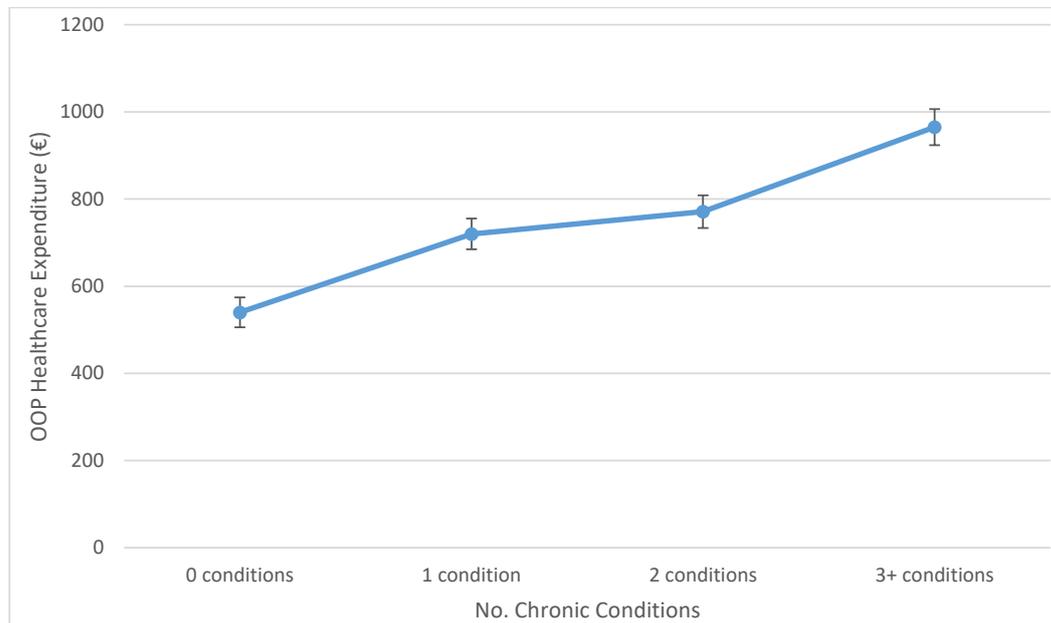
eTable 1. Annual Out of Pocket Healthcare Expenditure (€) and Financial Burden by number of conditions for those with any OOP healthcare expenditure

	Zero conditions	One condition	Two conditions	Three or more conditions
Overall excluding insurance Median (IQR)	€240 (106-600)	€365 (150-887)	€467 (180-1,040)	€420 (220-1,140)
GP Median (IQR)	€45 (0-100)	€0 (0-100)	€0 (0-100)	€0 (0-0)
Medicines Median (IQR)	€0 (0-120)	€120 (24-300)	€180 (84-480)	€240 (120-480)
Hospital care <sup>a</sup> Median (IQR)	€0 (0-1)	€0 (0-100)	€0 (0-120)	€0 (0-120)
Other Healthcare Median (IQR)	€80 (0-250)	€40 (0-220)	€30 (0-250)	€30 (0-250)
PHI Median (IQR)	€875 (0-1,450)	€850 (0-1,429)	€800 (0-1,500)	€0 (0-1,433)
Equivalised Household Income Median (IQR)	€18,980 (12,000-26,667)	€17,333 (10,152-24,267)	€15,000 (10,000-23,500)	€12,050 (8,250-19,600)
Financial Burden <sup>b</sup> Median (IQR)	1.5% (0.6-3.7)	2.4% (1.0-5.5)	3.0% (1.3-6.2)	3.7% (1.9-8.1)

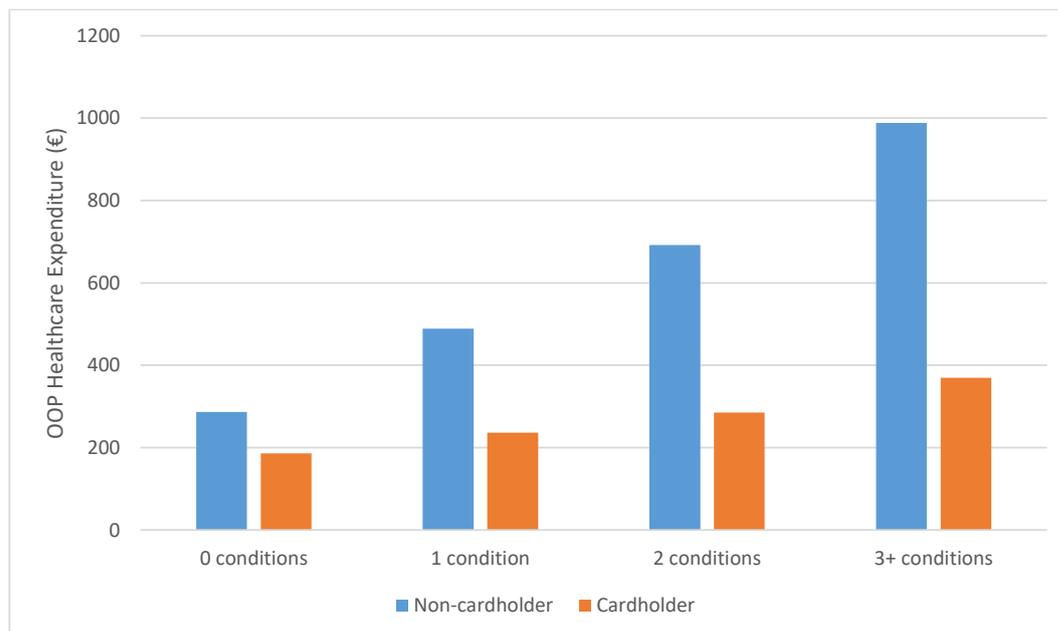
<sup>a</sup>Includes OOP expenditure on emergency department, outpatients, consultants, overnight hospital <sup>b</sup>percentage of equivalised household income spent on healthcare in previous 12 months



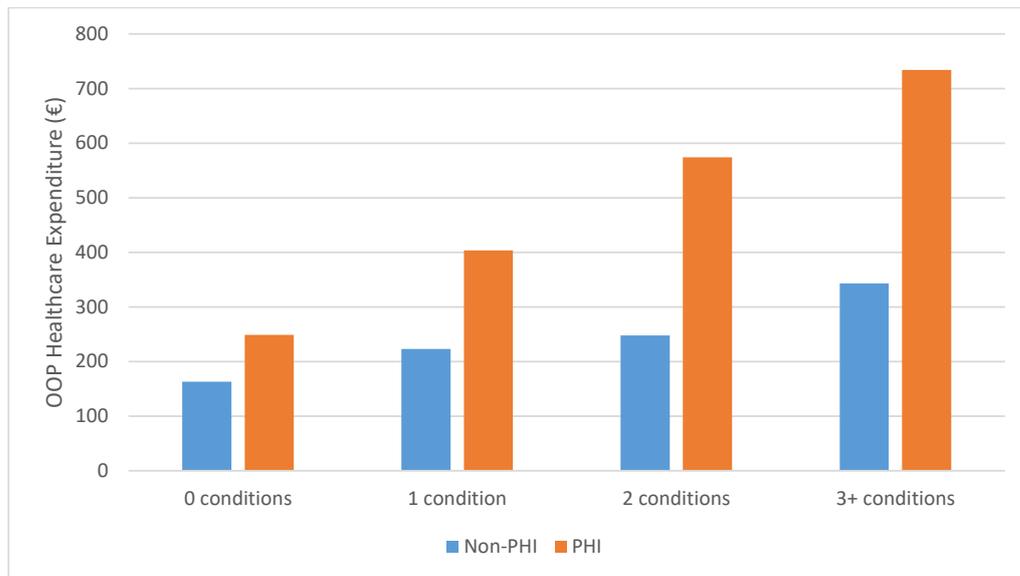
eFigure 1. Number of conditions and probability of any OOP healthcare expenditure



eFigure 2. Number of conditions and Out of Pocket Healthcare Expenditure



eFigure 3. Medical card and OOP healthcare expenditure broken down by number of conditions



eFigure. 4 PHI and OOP healthcare expenditure broken down by number of conditions

eTable 2. Association between multimorbidity, demographic and entitlement factors and log transformed OOP healthcare expenditure excluding insurance (OLS regression)

	Model 1	Model 2	Model 3	Model 4
<b>No. Conditions (comparator: 0 conditions)</b>				
<b>One condition</b>	0.455* (SE= 0.051)	0.532* (SE= 0.064)	0.331* (SE=0.090)	0.448* (SE=0.056)
<b>Two conditions</b>	0.725* (SE=0.051)	0.887* (SE=0.067)	0.438* (SE=0.089)	0.678* (SE=0.056)
<b>Three or more conditions</b>	0.989* (SE=0.050)	1.248* (SE=0.070)	0.750* (SE=0.083)	0.991* (SE=0.055)
<b>Age</b>	0.024 (SE=0.023)	0.018 (SE=0.023)	0.022 (SE=0.023)	0.048 (SE=0.026)
<b>Age<sup>2</sup></b>	-0.000 (SE=0.000)	-0.000 (SE=0.000)	-0.000 (SE=0.000)	-0.000 (SE=0.000)
<b>Female</b>	0.041 (SE=0.031)	0.044 (SE=0.044)	0.044 (SE=0.031)	0.048 (SE=0.048)
<b>Cardholder</b>	-0.795* (SE=0.041)	-0.411* (SE=0.090)	-0.799* (SE=0.041)	-0.757* (SE=0.046)
<b>Private Health Insurance</b>	0.678* (SE=0.034)	0.678* (SE=0.034)	0.391* (SE=0.088)	0.520* (SE=0.041)
<b>One Condition#Medical card</b>		-0.294* (SE=0.106)		
<b>Two Conditions#Medical card</b>		-0.460* (SE=0.106)		
<b>Three Conditions#Medical card</b>		-0.570* (SE=0.104)		
<b>One Condition#PHI</b>			0.173 (SE=0.108)	
<b>Two Conditions#PHI</b>			0.426* (SE=0.108)	
<b>Three Conditions#PHI</b>			0.360* (SE=0.101)	
<b>Household income</b>				0.000* (SE=0.000)
<b>Household income<sup>2</sup></b>				-0.00** (SE=0.000)
<b>Education (comparator=primary)</b>				
<b>Secondary</b>				0.109** (SE=0.046)
<b>Third level or higher</b>				0.232* (SE=0.051)
<b>Rural (comparator=urban)</b>				-0.097* (SE=0.034)
<b>Marital status (Comparator=married)</b>				
<b>Living with Partner</b>				0.019 (SE=0.116)
<b>Single</b>				-0.089 (SE=0.061)
<b>Separated</b>				-0.088 (SE=0.086)
<b>Divorced</b>				-0.093 (SE=0.090)
<b>Widowed</b>				-0.018 (SE=0.051)
<b>Intercept</b>	4.051* (SE=0.808)	4.124* (SE=0.807)	4.302* (SE=0.809)	2.912* (SE=0.915)

\*\* p<.05; \* p<.01

eTable 3. Association between multimorbidity, demographic and entitlements variables with OOP healthcare expenditure (excluding insurance premia) (€)

	Quantile 1	Quantile 2	Quantile 3	Quantile 4	Quantile 5	Quantile 6	Quantile 7	Quantile 8	Quantile 9
No. Conditions (comparator: 0 conditions)									
One condition	51.19* (11.93)	99.66* (13.72)	102.09* (15.25)	144.91* (19.05)	190.00* (23.69)	271.57* (37.00)	394.16* (55.47)	511.26* (97.81)	341.35** (120.74)
Two conditions	97.64* (12.12)	149.36* (13.94)	160.48* (15.50)	223.84* (19.36)	299.02* (24.07)	456.45* (37.59)	648.49* (56.36)	799.74* (99.39)	570.39* (122.68)
Three or more conditions	143.52* (11.85)	218.18* (13.63)	226.40* (15.15)	299.68* (18.93)	345.63* (23.54)	510.32* (36.76)	766.57* (55.12)	1232.81* (97.19)	1029.98* (119.97)
Age	-10.18 (5.44)	2.02 (6.26)	9.12 (6.96)	12.33 (8.69)	17.07 (10.81)	43.93** (16.88)	58.20** (25.30)	40.57 (44.62)	42.49 (55.08)
Age <sup>2</sup>	0.09** (0.04)	0.01 (0.04)	-0.04 (0.05)	-0.06 (0.06)	-0.09 (0.08)	-0.27** (0.12)	-0.34 (0.18)	-0.20 (0.31)	-0.24 (0.39)
Female	8.96 (7.37)	11.70 (8.48)	17.71 (9.42)	20.50 (11.77)	21.89 (14.64)	20.57 (22.86)	-6.78 (34.27)	-46.20 (60.43)	-36.99 (74.60)
Cardholder	-88.57* (9.65)	-132.74* (11.09)	-174.30* (12.33)	-240.06* (15.40)	-348.20* (19.16)	-545.34* (29.91)	-766.30* (44.85)	-1,019.51* (79.09)	-817.09* (97.63)
Private Health Insurance	60.07* (8.06)	103.17* (9.27)	145.05* (10.30)	211.35* (12.87)	325.62* (16.00)	472.67* (24.99)	608.30* (37.47)	901.57* (66.07)	773.11* (81.56)
Intercept	261.61 (190.53)	-182.05 (219.11)	-381.45 (243.56)	-443.89 (304.24)	-596.50 (378.38)	-1,544.55** (590.87)	-2,018** (885.90)	-1,358.43 (1,562.11)	-395.70 (1,928.32)

\*\* p<.05; \* p<.001

eTable 4. Association between multimorbidity, demographic and entitlement factors and probability of any OOP healthcare expenditure (probit regression)

	<b>Model 1</b>
<b>No. Conditions (comparator: 0 conditions)</b>	
<b>One condition</b>	0.676 (SE=0.641)
<b>Two conditions</b>	0.894 (SE=0.653)
<b>Three or more conditions</b>	1.451** (SE=0.610)
<b>Age</b>	0.021** (SE=.008)
<b>Female</b>	0.083 (SE=0.049)
<b>Cardholder</b>	-0.646* (SE=0.061)
<b>Private Health Insurance</b>	0.683* (SE=0.052)
<b>One Condition#Age</b>	-0.006 (SE=0.010)
<b>Two Conditions#Age</b>	-0.008 (SE=0.010)
<b>Three Conditions#Age</b>	-0.013 (SE=0.009)
<b>Intercept</b>	4.674* (SE=0.536)

\*\* p<.05; \* p<.01

eTable 5. Association between multimorbidity, demographic and entitlement factors and OOP healthcare expenditure (gamma regression)

	<b>Model 1</b>
<b>No. Conditions (comparator: 0 conditions)</b>	
<b>One condition</b>	0.676 (SE=0.641)
<b>Two conditions</b>	0.894 (SE=0.653)
<b>Three or more conditions</b>	1.451** (SE=0.610)
<b>Age</b>	0.021** (SE=0.008)
<b>Female</b>	0.083 (SE=0.049)
<b>Cardholder</b>	-0.646* (SE=0.061)
<b>Private Health Insurance</b>	0.683* (SE=0.052)
<b>One Condition#Age</b>	-0.006 (SE=0.010)
<b>Two Conditions#Age</b>	-0.008 (SE=0.010)
<b>Three Conditions#Age</b>	-0.013 (SE=0.009)
<b>Intercept</b>	4.674* (SE=0.537)

\*\* p<.05; \* p<.01