PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (**http://bmjopen.bmj.com/site/about/resources/checklist.pdf)** and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

ARTICLE DETAILS

TITLE (PROVISIONAL)	Comorbidity and healthcare utilisation for individuals with CVD in the Republic of Ireland: a cross-sectional, population-based study
AUTHORS	Morrissey, Karyn

VERSION 1 – REVIEW

REVIEWER	Brendan Walsh Economic and Social Research Institute, Ireland
REVIEW RETURNED	23-Jul-2018

GENERAL COMMENTS	This study examines public and privately-based healthcare utilisation for individuals with Cardiovascular Disease and other comorbidities in Ireland. Furthermore, the study examines the socioeconomic profiles of the population. The analysis uses a relatively small population-based dataset to examines these issues. In line with previous findings, comorbidities are related to higher healthcare utilisation.
	Overall, examining these matters is important, and the study sheds new light on the high utilisation of health services for those with CVD and with CVD and comorbidities. However, there are there key points that the need to be addressed by the authors.
	1) My biggest concern in the study relates to the use of the QNHS Health Module from 2007. These data are now quite dated, and the health system itself has undergone significant changes in the past 11 years. Was there a reason the more recent QNHS Health Module from 2010 was not used? QNHS 2010 provides NACE Economic Sectors and Soccode which may be better proxies for SES.
	Similarly, Healthy Ireland is a more recent dataset, similar to the QNHS, with data from 2015 onwards that also captures comorbidities and healthcare utilisation. Why these more recent datasets were not used must at least be discussed, or alternatively be included in an analysis such as this.
	Furthermore, the agedness of the data becomes more important as there is evidence that cardiovascular outcomes have improved significantly in Ireland, even in the last decade. Between 2007 and 2014, the WHO Mortality Databases shows 1500 less deaths from CVD in Ireland. Therefore, utilisation, comorbidity prevalence etc is also likely to have changed. Using a number of datasets over time may afford the opportunity of examining utilisation over time.
	2) In the paper, public hospital inpatient and private hospital inpatient utilisation are compared. But, significant care needs to be taken when comparing these two sectors. Essentially all complex emergency inpatient care occurs in public hospitals, regardless of

private health insurance status. 80% of all public hospital inpatient episodes are emergency inpatient episodes (see Wren et al, 2017 - https://www.esri.ie/pubs/RS67.pdf). While in private hospitals, virtually all inpatient care is for elective or less severe cases. Comparing public and private in the study therefore is unlikely to be capturing substitutability between public and private care, or between privately insured and non-privately insured.

In the paper it is stated that: "The distinction between public and private hospital utilisation is an important addition to this paper as it provides a mechanism for examining hospital utilisation patterns for individuals with the same disease profile between income groups."
It is not possible to examine this mechanism due to the differences in what is offered between the public and private settings. Also, there is no information on the disease profile of the patient in these data, but rather whether they have self-reported a specific disease or not.

The results section also states that: "Dividing the two hospital utilization variables as such, it is hoped that some of the wealth effect associated with private health insurance is also captured."

Again I do not think that this is possible using these data.

3) Presentation of results. Within the results section, both descriptive statistics and Odds Ratios following logistic regressions are provided. Due to the correlation between CVD/Comorbidities and Age, putting too much emphasis on differences within the descriptive is problematic.

Was region included as control variable? This is specifically likely to affect private hospital use as private hospitals are not distributed evenly across Ireland.

I think count data models may also be more appropriate at showing differences in utilisation rather than logistic regressions with ORs (I think ORs are used in Table 5, but it is not explicitly stated). This would allow for results to be interpreted as actually utilisations/visits, rather than as relative differences across groups, and aid readers in understanding the utilisation differences across groups.

Other points
Background:
While the Andersen's Behavioural Model is a commonly used framework it is difficult to stand over the state that it is the "most frequently employed tool to understand health service utilisation". In some areas, the Grossman model is more prevalent. Though I have no issue with the use of this framework in this study, a rewording here is suggested.

The background includes no information on how Ireland compares internationally regarding CVD prevalence/impact on health. This would allow readers to have a sense of how important this disease is in Ireland.

Page 3, line 33: "(again, divided by public and private utilisation)" – should this be hospital rather than utilisation

Page 3, line 34: The paper states that "Ireland has a complex mix of public and private health care service provision [13, 14], however regardless of income level everyone is entitled to use the public hospital services for free or for a nominal fee". – While the latter point is correct, up to €800 annual costs for public inpatient care and €100 per ED visit may not be seen as a "nominal fee", specifically in comparison to the NHS and other EU health systems.

Page 3: lines 37-39: "This has lead researchers to infer income based socioeconomic status from private insurance status and private health service usage [15, 16]." – I do not think that these papers explicitly state this.

Data:
QNHS Health Module from 2007 is very dated

Page 4, line 43: "Then remainder of the population" – should be 'The remainder'

Page 4, line 47: "nominal fee" – again not sure it is nominal

Page 4, line 56: References 18, and 19 are incorrect, or included in the wrong position of the manuscript.

Page 5: When grouping CVD related morbidities and CVD non-related comorbidities, this this follow an approach used in previous work, or from clinical guidance? Could diabetes also be considered as CVD related comorbidity? A greater discussion of this from the literature would aid the reader.

Results:
Table 3:
How were individuals have with both Private Health Insurance and a Medical Card, and how are they treated in the analysis?

Table 4:
• Greater care needs to be made when compared public and private hospital use.
• Could you also examine PHI v MC for public hospital only?
• Headings are required in the Table
• Should Doctor be "GP"?
• Could the smaller OR for pharmacy simply be a consequence of how long those with CVD receive drugs supply. For example, individuals on ACE inhibitors for hypertension may get a 90-day supply of medications, therefore may only see the pharmacy 4 times per year. Others, which less severe illnesses. may be forced to go monthly as they receive 30-day supply, and therefore be forced to see the pharmacy 12 times per year. Is there information on this?

Table 5
Page 9, line 35: "largest increased risk for GP" – needs rewording
Odds ratios make the results difficult to interpret. Visits following count data models may be better for interpretation.
Does inpatient public and Private relate to nights?

Discussion:

<table>
<tr><td></td><td>Too much emphasis is placed upon the descriptive findings. Findings, after controlling for sex, age, and PHI/MC status are more relevant

P 10, line 50: "The models indicate that respondents with access to private healthcare…" – should this be public healthcare? Also, all individuals have access to private healthcare if they are willing to pay.

P 11, line 1: Lower socioeconomic status is mentioned here, but in effect it is not captured in these data. In terms of discussions of SES inequality, comorbidity/CVD diagnosis may reduce SES and/or result in gaining a Medical Card, and therefore the using Medical Card as the key measure of socioeconomic status in this study is not ideal.

Also, I am unsure that findings from this paper "reinforce the need to concentrate health promotion and healthy policy efforts on reducing social inequalities". But this paper does not attempt examine the issues of health promotion and social inequalities, so I am unsure how this fits into the conclusion.

Limitations:
Data limitation need to be discussed

As with all analysis of individuals with an illness, particularly using survey data, survival bias needs to be mentioned</td></tr>
</table>

VERSION 1 – AUTHOR RESPONSE

Response to reviewers for manuscript ID bmjopen-2018-025305: Empirically Exploring Health Service Utilisation for Individuals with CVD and Comorbidity in Ireland.

The author would like to thank the reviewer for their helpful and pertinent reviews. The author hopes the manuscript now meets both the editorial and reviewer requirements.

Responses to Editorial Requirements:
Please revise your title to indicate the research question, study design, and setting. This is the preferred format of the journal.
Response to Reviewer: The title has now been updated to:

'Comorbidity and healthcare utilisation for individuals with CVD in the Republic of Ireland: a cross-sectional, population-based study'

Please reformat the abstract so that it's following the structured abstract recommended in our Instructions for Authors for research articles
Response to Reviewer: The abstract has been updated to BMJ Open house style.

Can you please include the relevant odds ratios and confidence intervals to support your statements in the results section of the abstract?
Response to Reviewer: Odds ratios and CI are now included in abstract.

Responses to Reviewer 1:

My biggest concern in the study relates to the use of the QNHS Health Module from 2007. These data are now quite dated, and the health system itself has undergone significant changes in the past 11 years. Was there a reason the more recent QNHS Health Module from 2010 was not used? QNHS 2010 provides NACE Economic Sectors and Soccode which may be better proxies for SES. Similarly, Healthy Ireland is a more recent dataset, similar to the QNHS, with data from 2015 onwards that also captures comorbidities and healthcare utilisation. Why these more recent datasets were not used must at least be discussed, or alternatively be included in an analysis such as this. Furthermore, the agedness of the data becomes more important as there is evidence that cardiovascular outcomes have improved significantly in Ireland, even in the last decade. Between 2007 and 2014, the WHO Mortality Databases shows 1500 less deaths from CVD in Ireland. Therefore, utilisation, comorbidity prevalence etc is also likely to have changed. Using a number of datasets over time may afford the opportunity of examining utilisation over time.

Response to reviewer:
Thank you for this important comment on the agedness of the data. Please note that the reason that the author used the 2007 data is that they had full access to all variables, disaggregated or the 2007 paper. The same is not true for the 2010 data, where key variables such as rates of usage of health service usage for each health service and Soccode is not included and the age classifications are provided rather than a continuous age variable. This is because the author lives/works outside Ireland and the ISSDA provides different data aggregations/combinations based on your location. However, to address concerns about the agedness off the data, all analysis has now been updated using the 2010 QNHS. With regard to the results; as the reviewer will see are very much the same, with approximately 5% reporting CVD in both 2007 and 2010. However, it is important to use the most up to date data available. Unfortunately, the author currently does not have access to the Healthy Ireland dataset, but future research in this area will definitely focus on this dataset.

With regard to the reviewers comment that mortality due to CVD is decreasing, it is also important to note that while CVD rates may be decreasing, health utilisation rates are still expected to increase, as more people gain access to services. This is particularly true with regard to comorbidity. Text highlighting this, along with appropriate referencing is now included in the Introduction. See below.

'The World Health Organization (WHO) has projected that cardiovascular disease (CVD) alone will account for nearly a quarter of global deaths by 2030 [1]. While WHO mortality estimates indicate that deaths associated with CVD in Ireland has decreased in the last decade [2], CVD burden comes not only from deaths, but also from those living with the disease (Bhatnagar et al., 2016).'

In the paper, public hospital inpatient and private hospital inpatient utilisation are compared. But, significant care needs to be taken when comparing these two sectors. Essentially all complex emergency inpatient care occurs in public hospitals, regardless of private health insurance status. 80% of all public hospital inpatient episodes are emergency inpatient episodes (see Wren et al, 2017 - https://www.esri.ie/pubs/RS67.pdf). While in private hospitals, virtually all inpatient care is for elective or less severe cases. Comparing public and private in the study therefore is unlikely to be capturing substitutability between public and private care, or between privately insured and non-privately insured. In the paper it is stated that: "The distinction between public and private hospital utilisation is an important addition to this paper as it provides a mechanism for examining hospital utilisation patterns for individuals with the same disease profile between income groups." It is not possible to examine this mechanism due to the differences in what is offered between the public and private settings. Also, there is no information on the disease profile of the patient in these data, but rather whether they have self-reported a specific disease or not. In terms of 80% of all public hospital inpatient episodes are emergency inpatient episodes, this is true but once admitted patients can opt to be treated privately or moved to a private hospital.

The distinction between public and private hospital utilisation is an important addition to this paper as it provides a mechanism for examining hospital utilisation patterns for individuals with the same self-reported doctor diagnosed health conditions across different socio-economic groups. The results section also states that: "Dividing the two hospital utilization variables as such, it is hoped that some of the wealth effect associated with private health insurance is also captured." Again I do not think that this is possible using these data.

Response to the reviewer:
Considering the comments of the reviewer and their concerns regarding public/private hospital usage as a proxy for socio-economic analysis and the request to examine PHI v MC for public hospital use, the author has updated their analysis and removed the analysis by hospital type. Instead, in the absence of socio-economic data, this paper uses health coverage as a *proxy* for socio-economic status. Although a crude indicator, there is a long history of research on health outcomes and health inequalities in Ireland that have used medical card status and/or private health insurance status as a proxy for socio-economic status. Please see literature by:

Tay JB, Kelleher CC, Hope A, Barry M, Gabhainn SN, Sixsmith J. Influence of sociodemographic and neighbourhood factors on self-rated health and quality of life in rural communities: findings from the Agriproject in the Republic of Ireland. Journal of Epidemiology & Community Health. 2004 Nov 1;58(11):904-11.

Morrissey K, Clarke G, Ballas D, Hynes S, O'Donoghue C. Examining access to GP services in rural Ireland using microsimulation analysis. Area. 2008 Sep;40(3):354-64.

Smith S, Normand C. Analysing Equity in Health Care Financing: A Flow of Funds Approach, *Social Science and Medicine*, 2009, 69(3), 379-386.

Keegan C, Smith S. The length of stay of in-patient stroke discharges in Irish acute hospitals. *The Economic and Social Review*. 2013 Sep 26;44(3, Autumn):351-70.

Descriptive statistics on coverage type is now included in Table 3 and coverage type by morbidity category. Table 4 now includes an analysis each 4 health services by coverage type and morbidity category.

Presentation of results.
Within the results section, both descriptive statistics and Odds Ratios following logistic regressions are provided. Due to the correlation between CVD/Comorbidities and Age, putting too much emphasis on differences within the descriptive is problematic.
Response to Reviewer: The focus on differences between age is decreased and it is noted that relationship is to be expected.

Was region included as control variable? This is specifically likely to affect private hospital use as private hospitals are not distributed evenly across Ireland.
Response to Reviewer: Region (NUTS2) was included in all the models as an explanatory variable in initial model runs but was not significant for any of the models presented in Table 5 and was therefore removed.

I think count data models may also be more appropriate at showing differences in utilisation rather than logistic regressions with ORs (I think ORs are used in Table 5, but it is not explicitly stated). This would allow for results to be interpreted as actually utilisations/visits, rather than

as relative differences across groups, and aid readers in understanding the utilisation differences across groups.

Response to Reviewer: The author would have liked to use binomial models rather than logistic models however the data that was supplied to the author did not include number of visits to each service, just if the individual had been to each service in the last year, thus a logistic model was used. Whilst not providing the intensity of usage, logistic models do look at access across different morbidity categories controlling from demographic and socio-economic characteristics.

Other points

Background:

While the Andersen's Behavioural Model is commonly used framework it is difficult to stand over the state that it is the "most frequently employed tool to understand health service utilisation". In some areas, the Grossman model is more prevalent. Though I have no issue with the use of this framework in this study, a rewording here is suggested.

Response to review: Thank you for pointing this out, the text has been updated to note that Andersen's Behavioural Model is a frequently rather than most used framework to examine health care utilisation. Please see text below:

'A frequently employed tool to understand health service utilisation is Andersen's Behavioural Model of Health Service Use (BMHSU)'

The background includes no information on how Ireland compares internationally regarding CVD prevalence/impact on health. This would allow readers to have a sense of how important this disease is in Ireland.

Response to review: Thank you for pointing this out. Text has now been included in the Introduction outlining rates of CVD mortality and DALYs attributable to CVD for Ireland.

'The World Health Organization (WHO) has projected that cardiovascular disease (CVD) alone will account for a quarter of global deaths by 2030 [1]. While WHO mortality estimates indicate that deaths associated with CVD in Ireland has decreased in the last decade [2]and that disability adjusted life-years (DALYs) attributable to CVD are lower in Ireland than the European average [3], CVD burden comes not only from deaths, but also from those living with the disease (Bhatnagar et al., 2016).'

Page 3, line 33: "(again, divided by public and private utilisation)" – should this be hospital rather than utilisation

Response to reviewer: Text has now been updated.

Page 3, line 34: The paper states that "Ireland has a complex mix of public and private health care service provision [13, 14], however regardless of income level everyone is entitled to use the public hospital services for free or for a nominal fee". – While the latter point is correct, up to €800 annual costs for public inpatient care and €100 per ED visit may not be seen as a "nominal fee", specifically in comparison to the NHS and other EU health systems.

Response to reviewer: This is an important point and the text around nominal fee has been changed to 'a heavily subsided fee'.

Page 3: lines 37-39: "This has led researchers to infer income based socioeconomic status from private insurance status and private health service usage [15, 16]." – I do not think that these papers explicitly state this.

Response to reviewer: Actually, these papers do explicitly say this, please see text below from Keegan and Smith (2013) as one example:

'Available data suggest that these entitlement groups can be broadly ranked in terms of socio-economic status from the medical card (lowest), to the noncovered, to the privately insured (highest)'. (Keegan and Smith (2013, p. 357)

Furthermore, published literature on health inequalities in Ireland have a long history of using medical card entitlement as a proxy for socio-economic status. Please see example for example Tay et al., 2004; Morrissey et al., 2008

Tay JB, Kelleher CC, Hope A, Barry M, Gabhainn SN, Sixsmith J. Influence of sociodemographic and neighbourhood factors on self-rated health and quality of life in rural communities: findings from the Agriproject in the Republic of Ireland. Journal of Epidemiology & Community Health. 2004 Nov 1;58(11):904-11.

Morrissey K, Clarke G, Ballas D, Hynes S, O'Donoghue C. Examining access to GP services in rural Ireland using microsimulation analysis. Area. 2008 Sep;40(3):354-64.

Data:
QNHS Health Module from 2007 is very dated
Response to reviewer: The data used has been updated to QNHS 2010. As noted above the author did not have access to the Healthy Ireland Survey.

Page 4, line 43: "Then remainder of the population" – should be 'The remainder'
Response to reviewer: The text has been updated.

Page 4, line 47: "nominal fee" – again not sure it is nominal
Response to reviewer: This is an important point and the text around nominal fee has been changed to 'a heavily subsided fee'.

Page 4, line 56: References 18, and 19 are incorrect, or included in the wrong position of the manuscript.
Response to reviewer: Thank you for pointing this out. The appropriate references have now been inserted (References, 13 and 14).

Page 5: When grouping CVD related morbidities and CVD non-related comorbidities, this this follow an approach used in previous work, or from clinical guidance? Could diabetes also be considered as CVD related comorbidity? A greater discussion of this from the literature would aid   the   reader.
Response to reviewer: The grouping is following an approach used in previous research and is based on the on the system impacted. For CVD groupings, only vascular related morbidities were included as a CVD based morbidity. Text noting this categorization is now included in the text.

'Whilst diabetes often presents as comorbidity with CVD [10, 18], as the health service provision associated with diabetes (metabolic) and CVD (vascular) are typically not integrated across and between different health care service [19], for the purpose of this health service focused paper, diabetes is classified as a non-related comorbidity.'

Results:
Table 3:

How were individuals have with both Private Health Insurance and a Medical Card, and how are they treated in the analysis?

Response to reviewer: The percentage of individuals by health care coverage is now included in Table 3. In terms of the analysis subsequent analysis by the author based on the reviewer's comments means that the breakdown of morbidity category by coverage type (no coverage, medical care, PHI and both MC & PHI) is now included in Table 4. Please see response to reviewer comments regarding Table 4 below.

Table 4:

Greater care needs to be made when compared public and private hospital use.

Could you also examine PHI v MC for public hospital only?

Response to reviewer: Considering the comments of the reviewer and their concerns regarding public/private hospital usage as a proxy for socio-economic analysis and the request to examine PHI v MC for public hospital use, the author has updated their analysis and examined health service usage across the four health care coverage types in Ireland by morbidity category. Please see table below (extended Table 4 in the text).

Following research that has used type of health coverage as a proxy for socioeconomic status noted above, Table 4 indicates that across all 3 CVD morbidity types medical card holders have the highest rate of each health service, with the exception of private health insurance.

GP	77	93	98	97
Pharmacy	40	42	45	44
Inpatient Public	9	27	32	32
Inpatient Private	2	2	6	5
Doctor				
No Coverage	16	10	6	3
Medical Card	33	53	62	60
Private Health Insurance	41	18	13	12
Both Medical Card & Private Health Insurance	9	19	19	25
Pharmacy				
No Coverage	17	12	8	1
Medical Card	32	49	64	68
Private Health Insurance	43	19	11	12
Both Medical Card & Private Health Insurance	8	20	17	19
Inpatient Public				
No Coverage	13	15	5	0
Medical Card	37	38	61	61
Private Health Insurance	37	21	14	14
Both Medical Card & Private Health Insurance	13	27	20	24

Inpatient Private				
No Coverage	3	0	0	0
Medical Card	6	0	3	0
Private Health Insurance	66	50	27	71
Both Medical Card & Private Health Insurance	25	50	69	28

Headings are required in the Table
Response to Reviewer: Headings are now included in Table 4.
Should Doctor be "GP"?
Response to Reviewer: Text has been updated to GP.

Could the smaller OR for pharmacy simply be a consequence of how long those with CVD receive drugs supply. For example, individuals on ACE inhibitors for hypertension may get a 90-day supply of medications, therefore may only see the pharmacy 4 times per year. Others, which less severe illnesses. may be forced to go monthly as they receive 30-day supply, and therefore be forced to see the pharmacy 12 times per year. Is there information on this?
Response to Reviewer: Thank you for this suggestion. In the 2010 data we do not have actual number of visits to each service so unfortunately I cannot answer this.

Table 5
Page 9, line 35: "largest increased risk for GP" – needs rewording
Response to Reviewer: Text has been updated.

Odds ratios make the results difficult to interpret. Visits following count data models may be better for interpretation.
Response to Reviewer: Thank you for this suggestion. As noted above in the responses to the more general comments, the author did not have access (as an overseas user of ISSDA services) to all QNHS data and they did not have access to the number of visits for each service, just whether the individual accessed such a service in the previous 12 months.

Does inpatient public and Private relate to nights?
Response to Reviewer: No, as noted above in the responses to the more general comments, the author did not have access (as an overseas user of ISSDA services) to all QNHS data and they did not have access to the number of nights spent in either public or private hospitals.

Discussion:
Too much emphasis is placed upon the descriptive findings. Findings, after controlling for sex, age, and PHI/MC status are more relevant
Response to Reviewer: Thank you for this comment. The discussion has been updated to reflect all new analysis and more focus has been placed on the results of the regression model

P 10, line 50: "The models indicate that respondents with access to private healthcare…" – should this be public healthcare? Also, all individuals have access to private healthcare if they are willing to pay.
Response to reviewer: Given the updated analysis this text has been removed as it is no longer relevant.

10

P 11, line 1: Lower socioeconomic status is mentioned here, but in effect it is not captured in these data. In terms of discussions of SES inequality, comorbidity/CVD diagnosis may reduce SES and/or result in gaining a Medical Card, and therefore the using Medical Card as the key measure of socioeconomic status in this study is not ideal.

Response to Reviewer: As outlined above, following previous research in Ireland health care coverage type has been used as a proxy for socio-economic status. Given the reviewers concerns about focusing on public/private hospital usage as a proxy for socio-economic status, the analysis has been updated to use health care coverage as a proxy for SES instead used throughout the paper.

Also, I am unsure that findings from this paper "reinforce the need to concentrate health promotion and healthy policy efforts on reducing social inequalities". But this paper does not attempt examine the issues of health promotion and social inequalities, so I am unsure how this fit into the conclusion.

Response to reviewer: Thank you for this comment, this text has now been removed.

Limitations:
Data limitation need to be discussed

As with all analysis of individuals with an illness, particularly using survey data, survival bias needs to be mentioned
Response to reviewer:

Response to reviewer: The limitations Section has been updated to note the age of the data and the need to not survival bias.

'Limitations of the study need to be considered in interpreting the results. First, this study is based on a representative sample of the Irish population, however the data is old and relates to 2009/2010. However, an analysis of this data is still important as while mortality due to CVD is decreasing, the burden of CVD and comorbidity is increasing, thus the data presented here is indicative of an upward trend in the health care service needs of the Irish population. Second, the dependent variables used in this study are based on self-reported doctor diagnosis rather than clinical records. It is important to note that there may be limitations on using a dependent variable that is self-reported, with regard to respondent memory, accuracy of diagnosis, etc. However, this study believed that to understand the health service usage patterns and socioeconomic profile of individuals with a CVD based comorbidity that a dataset with representative sample of the Irish population was more appropriate than a clinical dataset. Third, as with as with all analysis of individuals with an illness using survey data, survival bias needs to be noted.'

VERSION 2 – REVIEW

REVIEWER	Brendan Walsh ESRI, Ireland
REVIEW RETURNED	12-Oct-2018

GENERAL COMMENTS	The authors have responded in a very in-depth fashion to my previous comments. The paper has now been greatly improved upon and it is of publishable quality in its current form.