A comparison, for older people with diabetes, of health and health care utilisation in two different health systems on the island of Ireland

CURRENT STATUS: UNDER REVIEW

Tom Pierse
National University of Ireland Galway

ORCiD: 0000-0002-2154-271X

Luke Barry
National University of Ireland Galway

Liam Glynn
University of Limerick

Andrew Murphy
National University of Ireland Galway

Sharon Cruise
Queen's University Belfast

Ciaran O’Neill
Queens University Belfast

Send correspondence to

ciaran.oneill@qub.ac.uk

DOI:
10.21203/rs.3.rs-16311/v1

SUBJECT AREAS

Health Policy Infectious Diseases

KEYWORDS
Diabetes, Complications, Health Care Utilisation, Quality and Outcomes Framework
Abstract

Background Primary care policies for diabetes have differed between Northern Ireland (NI) and the Republic of Ireland (ROI). In NI, the Quality and Outcomes Framework (QOF) system was adopted in 2004. In ROI, prior to the Cycle of Care programme being established in 2015 specific financial support for GPs providing diabetic primary care was not available. The aims of this study are to compare health and healthcare utilisation among people with diabetes in the NI and ROI.

Methods Large scale comparable surveys of people over 50 years of age in Northern Ireland (NICOLA) and the Republic of Ireland (TILDA) are used to compare people with diabetes (Type I and Type II) in the two jurisdictions. The combined data set comprises 1,536 people with diabetes. A coarsened exact matching approach is used to compare health care utilisation among people with diabetes in NI and ROI with equivalent demographic, lifestyle and illness characteristics.

Results The overall prevalence in the 50 to 84 years old age group is 3.4 percentage points higher in NI (11.1% in NI, 7.7% ROI, p-value < 0.01). The diabetic population in NI also appear sicker – with more diabetic complications and more chronic illnesses. Comparing people with diabetes in the two jurisdictions with similar levels of illness we find that there are no statistically significant differences in GP, outpatient or A&E utilisation.

Conclusion There are a range of factors that influence the quality of primary care for people with diabetes. While the QOF system in Northern Ireland is likely to have improved some aspects of care by providing financial incentives for identification and management, unless accompanied by improved access to care their ability to impact on outcomes may be compromised.
1. Introduction

In Northern Ireland (NI), based on registry data, 5.6% of the population aged 18 and over are registered with diabetes (1). While in the Republic of Ireland (ROI) a similar register does not exist, it has been estimated that 5.2 per cent of those aged 18 and over have diabetes (2). Diabetic care is a substantial driver of overall health care utilisation and costs. In Europe and North America, the proportion of healthcare expenditure on diabetes in 2010 ranges from 6 to 14 per cent (3). An earlier study estimated the cost of Type II diabetes in ROI to be 6.4 per cent of the total healthcare budget (4). In addition to direct healthcare costs, diabetes significantly impacts on mortality rates, quality of life and labour market productivity (5, 6).

Healthcare utilisation and healthcare costs among those with diabetes are strongly related to diabetic complications; in the UK, 80 per cent of diabetic healthcare costs are due to complications (7, 8). The direct healthcare cost of complications in the UK include: cardiovascular diseases related to diabetes (36% of the overall healthcare cost) and foot ulcers and amputations (13%) (7). Predicative factors for the development of complications include duration of diabetes and glycaemic control (9, 10).

The risk of diabetic complications can be reduced by self-management of the disease as well as appropriate management by healthcare practitioners. In the 2016 Scottish Diabetes Survey, 45 per cent of patients had a HbA1c of more than 58 mmol/mol (7.5% DCCT), suggesting substantial scope for improved glycaemic control and management of diabetic care. A combination of diet, exercise and medication are typically advised for people with diabetes to achieve good glycaemic control. In addition to accessibility to quality health care, social, cultural and economic factors play an important role in an individual’s capacity to manage their diabetes (11). Factors that have been shown to be associated with poor glycaemic control include younger age, number of years of
education, longer duration of diabetes, insulin treatment and poor self-management behaviours (12, 13).

The GP is the primary point of contact between the health service and people with diabetes. There are substantial differences in the way that GP services are delivered in NI and ROI. In NI practices provide publicly funded care, free at the point of use, to a defined list of patients on a universal basis. The Quality Outcomes Framework (QOF) system, in place from 2004, provides financial incentives for GPs to maintain disease registers and meet quality indicators. The QOF system resulted in three simultaneous changes: better data collection by GPs, public information on the quality of care, and pay for performance (14). For diabetes, GPs are paid on the basis of having higher proportions of patients with biomarkers such as blood pressure, lipids and blood sugar in specified ranges as well as records of screening/examinations (15). However, beyond the upper thresholds of each QOF indicator, GPs had no financial incentives to improve care (16). In ROI, GPs have a mix of publicly funded and private fee paying patients. The mixed nature of GP care in ROI means that GPs who work longer hours can earn more revenue from private patients which may incentivize them to provide easier access through, for example, extended working hours. In contrast in NI, the revenue that a GP practice earns is largely determined by the list size. In ROI, prior to the Cycle of Care programme, established in 2015, there was no specific financial support for GPs providing primary care to patients with diabetes.

Diabetic care was unstructured and record keeping by many GPs was poor (17). However, structured reviews and record keeping are only one component of quality primary care. Access and quality of interaction in GP consultations, continuity of care, and access to practice nurses are important components of care quality (11, 18, 19). The supply of GPs has been shown internationally to be associated with improved outcomes, such as reduced mortality (20). In this context it is notable that there are fewer GPs in NI per capita than in
ROI; the average GP list size was 1,620 in NI in 2014 (21) and 1,175 in ROI (1,335 based on WTE), based on total number (head count) of GPs for 2014 and population numbers (22). While we do not have working time equivalent (WTE) values for GPs in NI, even if all GPs were working on a full time basis in NI, there would still be more supply in ROI. Differences in the supply of GPs may result in shorter consultation durations (23, 24) and longer waiting times for non-emergency consultations in NI, as in the rest of the UK (25, 26). Practice nurses play an increasingly important role in the provision of primary care (27). As with GPs there are more practice nurses per capita in ROI. In ROI there are 0.26 practice nurses per 1,000, this compares with an average of 0.2 in NI (22, 28, 29). Cost has been shown to be an important factor in the demand for GP care (30). While GP care is free at the point of use for patients in Northern Ireland, a substantial minority (31.5%) of people in ROI with diabetes are not covered by the medical card or GP visit card schemes and will have to pay for their GP care (31). For those who have to pay out of pocket for a GP consultation, the cost of a consultation is in the region of €50, which may represent a significant deterrent to attending (32, 33). While the cost of attending the GP may be a deterrent for some people it may, by reducing demand, reduce capacity constraints that permit easier access for others (34). The higher cost of inpatient services and longer waiting times in ROI (in 2014) may also increase the proportion of services delivered though primary care (35, 36).

A number of demand side factors, other that need, are also likely to influence differences in the utilisation of GP services under the two systems including cost, geographic accessibility and time cost (37). NI has a population density of just under twice that of ROI, which may lead to differences in transport times to GPs in the two jurisdictions. However, while significant differences in the transportation times and cost for urban and rural patients have been shown in ROI; these have not been shown to translate into
differences in utilisation (38). Employment status may also be related to the utilisation of
GP care, both as a covariate of need and also by increasing the opportunity cost of
attending the GP; however, there is little variation (36% vs 35%) in the employment rates
of the over 50s age group between the two jurisdictions (39, 40).
In this study, we examine, for patients aged 50 and over with diabetes, differences
between NI and ROI in the number and type of health care contacts and clinical outcomes.

2. Methods
The TILDA and NICOLA surveys, used in this study, are based on interviews and health
assessments with approximately 8,000 people representative of the population aged 50
and over in both ROI and NI (see (41) and (42) for further details of the TILDA and NICOLA
studies, including design, methodology, and assessments carried out). The health
assessment comprised of a physical examination and a blood test carried out by a nurse
at a health centre. Older people are the main population of interest for examining
healthcare utilisation by people with diabetes given this is where the disease is most
prevalent - based on the Scottish Diabetes register 84 per cent of people with diabetes
(Type I and Type II) are over the age of 50 (43).
The TILDA and NICOLA surveys are ideally designed for comparison with each other due to
the similarity in the two surveys. Each survey consists of computer-assisted personal
interviewing (CAPI) surveys containing identical questions on diabetes diagnosis and
complications. Self-reported doctor diagnosed diabetes, directly comparable across the
two surveys, is used in this study. Survey work for TILDA was carried out in 2011 (Wave
1), survey work for NICOLA was carried out in 2014–2016 (Wave 1).
Matching is a method for rebalancing observational data (44). A key advantage of
matching over regression analysis is a reduced dependence on assumptions about
functional form (45). A Coarsened Exact Matching (CEM) approach is used here to match
treatment and control observations. CEM is a type of matching process that involves the temporary coarsening of continuous variables followed by a direct matching between the treated and untreated groups. The CEM method involves categorising coarsened continuous variables into user defined groups. A stratum is created for each unique observation in the data set. Observations are dropped that do not have at least one treatment and control in the stratum. Thus, the CEM process involves pruning both treated and control units (46). This method was chosen over the Mahalanobis distance method of matching as we wish to match on a combination of continuous and dichotomous variables (47).

In this study the treatment is the healthcare system in which individuals receive care for their condition. Matching is done based on the presence and severity of health needs. The key outcomes of interest are the levels and types of healthcare use. Health needs are captured in age, sex, education, current smoking status, self-reported health, the number of chronic illnesses and the number of diabetic complications reported. Diabetic complications are defined here as heart attack, stroke, leg ulcers, kidney disease, neuropathy, retinopathy and nephropathy. These matching variables were selected based on previous findings from TILDA of the covariates of healthcare utilisation (48). A count of the number of diabetic complications is included as this has been shown to correlate with hospital utilisation (49). Body Mass Index (BMI), glycosylated haemoglobin (HbA1c) and other biometric markers are not included in the analysis of health care utilisation as they are only available for the subsample that attended the health assessment. Observations with missing data in the variables used for matching were omitted.

3. Results

3.1 Prevalence of Diabetes

Figure 1 shows the percentage of individuals who report having received a diagnosis of
diabetes from their doctor by sex and age group in NI and ROI. The prevalence rates for NI are higher across all age groups and genders. The overall prevalence in the 50 to 84 years old age group is 3.4 percentage points higher in NI (11.1% in NI, 7.7% ROI, p-value < 0.01). There are no observations in ROI for those in the over 85 years age group. The rates of diabetes shown here for ROI are in line with previous studies for ROI (50-52). Based on TILDA estimates of the prevalence of diabetes by age group and gender and 2016 census data, there are 106,207 people over the age of 50 in ROI with diabetes. The rates of diabetes shown in the NICOLA data are consistent with the total number of cases of diabetes registered in Northern Ireland (1). The estimated number of people over 50 with diabetes based on the NICOLA prevalence rates was 67,941 in 2014. This represents 83 per cent of the 81,867 people in NI with a diagnosis of diabetes in the same year on the diabetes register. This is in line with the proportion of people with diabetes who are over 50 on the Scottish Diabetes register (43). In both jurisdictions rates are higher among men than women. There is no indication from the data available that the higher prevalence rates in NI are due to higher case ascertainment. Among those for whom HbA1c data were available, the rates of undiagnosed diabetes (HbA1c > 48 mmol/mol (6.5 %) and no report of a diabetes diagnosis) are also higher in NI(0.8% in ROI vs 4.4% in NI). While alternative data sources for the rates of undiagnosed diabetes in ROI show substantially higher rates compared to TILDA they are still lower than in NI (53).

3.2 Health of People with Diabetes

Table 1 shows the demographic and health status of the samples of people with diabetes in ROI and NI. There are no differences (p > 0.05) in the gender and current smoking status of the two samples, the sample from NI is slightly older. As previously reported, people in the NI have significantly lower levels of self-reported good health status and
higher rates of education (54). People with diabetes in NI have substantially more complications related to diabetes; the proportion of people with diabetes with two or more complication is 8.9 percentage points higher (p<0.001) in NI. Rates of stroke, kidney disease and neuropathy are all significantly higher in NI. The number of other chronic diseases that people with diabetes have is also higher in NI; the proportion of people with diabetes, with three or more other chronic conditions is 9.4 percentage points higher (p<0.001) in NI. Chronic lung disease, asthma, arthritis, alcohol or substance abuse, emotional, nervous or psychiatric problems, hypertension and angina are all significantly higher in NI (p < 0.05). In summary, the sample of people with diabetes in NI appear substantially “sicker” than the sample from ROI.

Table 1. Summary Statistics (Before Matching)

|                        | ROI (TILDA) | NI (NICOLA) | p-value |
|------------------------|-------------|-------------|---------|
| Number of People Surveyed | 8469        | 8212        |         |
| Number of People with Diabetes | 634         | 902         |         |
| Age (Mean)             | 66.4        | 67.5        | 0.018   |
| Male (%)               | 58%         | 56%         | 0.430   |
| Primary Education Only | 41%         | 35%         | 0.014   |
| Current Smoker         | 17%         | 16%         | 0.685   |
| Good Self Related Health | 50%        | 38%         | <0.001  |
| Diabetic Complications |             |             |         |
| None                   | 64%         | 53%         | <0.001  |
| One                    | 26%         | 28%         | 0.58    |
| Two +                  | 10%         | 19%         | <0.001  |
| Heart Attack (%)       | 11.5%       | 14.1%       | 0.142   |
| Stroke (%)             | 6.3%        | 9.6%        | 0.020   |
| Leg ulcers (%)         | 3.8%        | 4.3%        | 0.601   |
| Kidney disease (%)     | 6.5%        | 14.3%       | <0.001  |
| Neuropathy (Nerve Endings) (%) | 14.2% | 19.2% | 0.011 |
| Retinopathy (%)        | 7.4%        | 9.2%        | 0.215   |
| Nephropathy (Kidney) (%) | 3.6%     | 8.2%        | <0.001  |
| Treatment | Insulin (%) | Tablets (%) | Other Chronic diseases |
|-----------|-------------|-------------|------------------------|
|           | 78.5%       | 75.2%       | None                   |
|           | 16.9%       | 20.5%       | One                    |
|           | 34%         | 31%         | Two                    |
|           | 0.124       | 0.074       | Three+                 |
|           | 19%         | 28%         | Chronic lung disease (%) |
|           | 18%         | 12%         | 4.7%                   |
|           | 16.9%       | 20.5%       | Asthma (%)             |
|           | 34%         | 31%         | 11.4%                  |
|           | 30%         | 29%         | Arthritis (%)          |
|           | 32.2%       | 42.4%       | 32.2%                  |
|           | 5.4%        | 6.9%        | Osteoporosis (%)       |
|           | 7.3%        | 9.3%        | Cancer (%)             |
|           | 9.9%        | 15.7%       | Any emotional, nervous or psychiatric problems (%) |
|           | 2.2%        | 4.1%        | Alcohol or substance abuse (%) |
|           | 7.4%        | 1.1%        | Stomach ulcers (%)     |
|           | 3.8%        | 5.9%        | Varicose Ulcers (%)    |
|           | 61.5%       | 66.7%       | High blood pressure or hypertension (%) |
|           | 11.4%       | 15.9%       | Angina (%)             |

3.3 Health Care Utilisation

Table 2 shows the healthcare utilisation of people with diabetes in NI and ROI before and after matching. Matching is carried out based on age, sex, education, smoking status, self-related health, number of diabetic complications and number of chronic illnesses. As can be seen from the table, after the matching process, which mainly pruned off high need cases in NI, the healthcare utilisation of the NI group reduced in all areas of utilisation. The between group differences in primary care increased, the between group differences in secondary care utilisation reduced, and in most cases cease to be statistically significant. In the case of inpatient nights however, NI patients continue to consume
significantly more care. Interestingly substantially more people in NI with diabetes reported not having attended their GP in the last year (ROI 4.5%, NI 9.3%, p-value = 0.006).

Table 2. Healthcare utilisation in the last 12 months

|                               | Before Matching | After Matching |
|-------------------------------|-----------------|----------------|
|                               | ROI (TILDA)     | NI (NICOLA)    | p-value | ROI (TILDA) | NI (NICOLA) |
| Observations                  | 634             | 902            |         | 420         | 486         |
| GP Visits (Mean)              | 5.7             | 5.6            | 0.668   | 5.6         | 5.0         |
| GP Visits: None               | 4.2%            | 7.9%           | 0.004   | 4.5%        | 9.3%        |
| Outpatient Visits (Mean)      | 2.1             | 3.6            | <0.001  | 2.1         | 3.2         |
| A&E Visits (Mean)             | 0.3             | 0.5            | 0.010   | 0.3         | 0.4         |
| Hospital Nights (Mean)        | 1.2             | 2.1            | <0.00   | 1.2         | 1.8         |

4. Discussion

In this study we compare the health and patterns of healthcare use among two representative surveys of older people with diabetes on the island of Ireland. Despite their proximity the surveys highlight that there are substantial differences in the health of the older population in general, and people with diabetes in particular, between NI and ROI. On an age and gender adjusted basis there is a substantially higher prevalence of diabetes in NI. It is not likely that this difference can be explained by the differences in the healthcare system between the two jurisdictions or simply enhanced case ascertainment. Broader societal factors, that may include attitudes to diet physical exercise, other diseases or possibly cumulative lifetime stress may explain the difference in the prevalence rates.

Our results also show that among people with diabetes, those in NI have more
complications and more chronic illnesses in general than people with diabetes in ROI. A range of factors will play a role in the extent to which people are able to manage their diabetes and remain complication free. We are not able to distinguish between these causal factors. The differences in societal factors, indicated by the different prevalence rates, might also explain higher complication rates.

It is notable there is a higher prevalence among people with diabetes in NI of non-attendance at the GP in the past 12 months. As the cut points (proportion of people with diabetes on a practices register) for payments, however, are currently set there are no financial incentives to seek out the people who do not attend once the practice reaches a certain cut off point. This may contribute to poorer disease management and in part explain the greater use of hospital services in Northern Ireland. Higher levels of hospital utilisation in Northern Ireland may also be due to higher levels of supply (55).

People with diabetes typically have other chronic conditions (56). By adjusting for the “sickness” of the people with diabetes in NI and ROI through matching we show that healthcare utilisation with the exception of inpatient care is similar in both jurisdictions despite significant differences in healthcare systems. This is similar to previous findings based on different data sources (52). However, the previous study did not have detailed information on diabetic complications and other chronic illnesses. While not statistically significant, the results point towards a more primary care focused service in ROI, with more frequent GP visits and less frequent secondary care visits.

This finding highlights that there are multiple aspects to quality primary care. The record keeping and pay for performance that were incentivised by the QOF system are only one aspect of quality primary care. Other aspects, such as the amount of consultation time and appointment waiting time of GPs are driven by the number of full time operating GPs. While direct financial incentives were not in place at the time in ROI for diabetes care,
there were substantially more GPs per capita which has been shown to improve outcomes (20). This may have contributed to improved care quality perhaps through longer consultation time or increased continuity of care.

The Cycle of Care policy was introduced in ROI in 2015, subsequent to the TILDA data used in this paper. This policy incentivises GPs to provide structured annual reviews and improved records. While this may improve patient care in ROI any decline in the availability of GPs may counteract any positive benefits.

5. Limitations

The data used in this study are based on two large representative cross sectional surveys. The presence of diabetes, complications, and healthcare utilisation are all self-reported, running the risk of recall bias. However, there is no reason to believe that this would apply differentially across jurisdictions. The severity of reported health conditions is not available in the data; the variation in health care needs may not be fully captured by the number of chronic illnesses or the number of diabetic complications. The age and gender adjusted prevalence rates of diabetes and diabetic complications are compared at two time points over three years apart; a comparison of these rates on the same year may reduce or increase the scale of the differences depending on the relative difference in the incidence of diabetes and complications in that three year period.

6. Conclusion

This study shows that the prevalence and severity of diabetes, among those aged 50 and over, is higher in Northern Ireland than in the Republic of Ireland. The study shows that for cohorts with comparable health care needs, with the exception of inpatients nights, there is no significant difference in patterns of healthcare use. The lack of difference in GP utilisation, despite greater severity, combined with higher rates of GP non-attendance in
NI suggest a closer examination of primary care is worthy of investigation. While during the period of study GPs in ROI were not incentivised in the same way to register and manage diabetes, in NI a lower supply of GPs and perversities in the QOF system may have served to undermine the delivery of quality, an issue that warrants closer examination.

7. Abbreviations

BMI
Body Mass Index

CEM
Coarsened Exact Matching

GP
General practitioner

QOF
Quality and Outcomes framework

NI
Northern Ireland

ROI
Republic of Ireland

8. Declarations

Ethical Approval

Ethical approval for the study was obtained from the School of Medicine, Dentistry and Biomedical Sciences Ethics Committee, Queen’s University Belfast.

Consent for publication

Consent for publication received by data collectors: TILDA and NICOLA.

Availability of data and materials

The data that support the findings of this study are available on request from TILDA (https://www.ucd.ie/issda/data/tilda/) and NICOLA (https://www.qub.ac.uk/sites/NICOLA/).
Competing interests
The authors declare no competing interests

Funding
This project was funded by a grant from the Irish Health Research Board.

Authors' contributions
CON, TP and LB contributed to all stages of the study from conception to drafting; AM, LG and SC contributed to the drafting of the manuscript. All authors read and approved the final manuscript.

Acknowledgments
We are grateful to all the participants of the NICOLA Study, and the whole NICOLA team, which includes nursing staff, research scientists, clerical staff, computer and laboratory technicians, managers and receptionists. The Atlantic Philanthropies, the Economic and Social Research Council, the UKCRC Centre of Excellence for Public Health Northern Ireland, the Centre for Ageing Research and Development in Ireland, the Office of the First Minister and Deputy First Minister, the Health and Social Care Research and Development Division of the Public Health Agency, the Wellcome Trust/Wolfson Foundation and Queen’s University Belfast provide core financial support for NICOLA. The authors alone are responsible for the interpretation of the data and any views or opinions presented are solely those of the authors and do not necessarily represent those of the NICOLA Study team. We are grateful to all the participants of the TILDA Study, and the whole TILDA team, which includes nursing staff, research scientists, clerical staff, computer and laboratory technicians, managers and receptionists. TILDA data may accessed from the following site: Irish Social Science Data Archive (ISSDA) at University College Dublin www.ucd.ie/issda”. This study has been supported by funding Health Research Board RL/2013/16 for the study’s conduct.
References

1. **QOF.** 2017/18 raw disease prevalence trend data for Northern Ireland. 2018.

2. Tracey ML, Gilmartin M, O’Neill K, Fitzgerald AP, McHugh SM, Buckley CM, et al. Epidemiology of diabetes and complications among adults in the Republic of Ireland 1998-2015: a systematic review and meta-analysis. BMC public health. 2015;16(1):132.

3. Zhang P, Zhang X, Brown J, Vistisen D, Sicree R, Shaw J, et al. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes research and clinical practice. 2010;87(3):293-301.

4. Nolan J, O’Halloran D, McKenna T, Firth R, Redmond S. The cost of treating type 2 diabetes (CODEIRE). Irish medical journal. 2006;99(10):307-10.

5. Kanavos P, Aardweg Svd, Schurer W. Diabetes expenditure, burden of disease and management in 5 EU countries. LSE Health, London School of Economics, 2012.

6. Read SH, Kerssens JJ, McAllister DA, Colhoun HM, Fischbacher CM, Lindsay RS, et al. Trends in type 2 diabetes incidence and mortality in Scotland between 2004 and 2013. Diabetologia. 2016;59(10):2106-13.

7. Hex N, Bartlett C, Wright D, Taylor M, Varley D. Estimating the current and future costs of Type 1 and Type 2 diabetes in the UK, including direct health costs and indirect societal and productivity costs. Diabetic Medicine. 2012;29(7):855-62.

8. Sortsoe C, Green A, Jensen PB, Emneus M. Societal costs of diabetes mellitus in Denmark. Diabetic Medicine. 2016;33(7):877-85.

9. Maghbooli Z, Pasalar P, Keshtkar A, Farzadfar F, Larijani B. Predictive factors of diabetic complications: a possible link between family history of
diabetes and diabetic retinopathy. Journal of Diabetes & Metabolic Disorders. 2014;13(1):55.

10. Zoungas S, Woodward M, Li Q, Cooper ME, Hamet P, Harrap S, et al. Impact of age, age at diagnosis and duration of diabetes on the risk of macrovascular and microvascular complications and death in type 2 diabetes. Diabetologia. 2014;57(12):2465-74.

11. Wilkinson A, Whitehead L, Ritchie L. Factors influencing the ability to self-manage diabetes for adults living with type 1 or 2 diabetes. International journal of nursing studies. 2014;51(1):111-22.

12. Chiu C-J, Wray LA. Peer Reviewed: Factors Predicting Glycemic Control in Middle-Aged and Older Adults With Type 2 Diabetes. Preventing chronic disease. 2010;7(1).

13. Rogvi S, Tapager I, Almdal T, Schiøtz M, Willaing I. Patient factors and glycaemic control-associations and explanatory power. Diabetic Medicine. 2012;29(10):e382-e9.

14. Roland M, Guthrie B. Quality and Outcomes Framework: what have we learnt? BMJ. 2016;354:i4060.

15. Dept of Health NI. Quality and Outcomes Framework. Belfast: Department of Health NI,, 2017.

16. Gravelle H, Sutton M, Ma A. Doctor behaviour under a pay for performance contract: further evidence from the quality and outcomes framework. 2008.

17. Gettings JV, O’Connor R, O’Doherty J, Hannigan A, Cullen W, Hickey L, et al. A snapshot of type two diabetes mellitus management in general practice prior to the introduction of diabetes Cycle of Care. Irish Journal of Medical Science (1971-). 2018:1-5.
18. Rushforth B, McCrorie C, Glidewell L, Midgley E, Foy R. Barriers to effective management of type 2 diabetes in primary care: qualitative systematic review. Br J Gen Pract. 2016;66(643):e114-e27.

19. Wolters R, Braspenning J, Wensing M. Impact of primary care on hospital admission rates for diabetes patients: a systematic review. Diabetes research and clinical practice. 2017;129:182-96.

20. Basu S, Berkowitz SA, Phillips RL, Bitton A, Landon BE, Phillips RS. Association of primary care physician supply with population mortality in the United States, 2005-2015. JAMA internal medicine. 2019.

21. NINIS. Belfast: Northern Ireland Neighbourhood Information Service 2018 [cited 2019 03 July]. Available from: http://www.ninis2.nisra.gov.uk/Download/Health%20and%20Social%20Care/GPs,%20Practices%20and%20Registered%20Patients%20(administrative%20geographies).ods.

22. HSE. Medical Workforce Planning: Future Demand for General Practitioners 2015-2025. Dublin: Health Service Executive, 2015.

23. O'Kelly M, Teljeur C, O'Kelly F, Ni Shuilleabhain A, O'Dowd T. Structure of General Practice in Ireland. 2015.

24. Hobbs FR, Bankhead C, Mukhtar T, Stevens S, Perera-Salazar R, Holt T, et al. Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007-14. The Lancet. 2016;387(10035):2323-30.

25. Pulse. GP Waiting Times Survey 2017 [08-05-19]. Available from: http://www.pulsetoday.co.uk/your-practice/practice-topics/access/average-gp-waiting-times-remain-at-two-weeks-despite-rescue-measures/20034534.article.
26. **NAGP.** NAGP Survey: Patient Waiting Times Continue to Increase Due to Under Resourcing 2016. Available from: https://nagp.ie/nagp-survey-patient-waiting-times-continue-to-increase-due-to-under-resourcing/.

27. Maier CB, Aiken LH. Task shifting from physicians to nurses in primary care in 39 countries: a cross-country comparative study. European Journal of Public Health. 2016;26(6):927-34.

28. Teljeur C, Tyrrell E, Kelly A, O'Dowd T, Thomas S. Getting a handle on the general practice workforce in Ireland. Irish journal of medical science. 2014;183(2):207-13.

29. **PHA.** Northern Ireland General Practice Nursing Workforce Survey Report 2016. Belfast: 2016.

30. Gorecki PK. The Impact of Free GP Care on GP Utilisation in Ireland. The Economic and Social Review. 2018;49(2, Summer):201-15.

31. O'Neill KN, McHugh SM, Kearney PM. Cycle of Care for people with diabetes: an equitable initiative? HRB Open Research. 2019;2.

32. Drummond FJ, O'Leary E, O'Neill C, Burns R, Sharp L. “Bird in the hand” cash was more effective than prize draws in increasing physician questionnaire response. Journal of clinical epidemiology. 2014;67(2):228-31.

33. O'Reilly D, O'Dowd T, Galway KJ, Murphy AW, O'Neill C, Shryane E, et al. Consultation charges in Ireland deter a large proportion of patients from seeing the GP: results of a cross-sectional survey. The European journal of general practice. 2007;13(4):231-6.

34. Galway K, Murphy A, O'Reilly D, O'Dowd T, O'Neill C, Shryane E, et al. Perceived and reported access to the general practitioner: an international comparison of universal access and mixed private/public systems. Irish
medical journal. 2007;100(6):494-7.

35. Foster C, McColgan K, Fulton R. Northern Ireland Waiting Time Statistics: Inpatient Waiting Times Quarter Ending December 2014. Belfast: 2015.

36. NTPF. Inpatient/Day Case National by Group/Hospital as at 23/12/2014 Dublin2019 [cited 2019 29 November]. Available from: https://www.ntpf.ie/home/inpatient.htm.

37. Nolan AaBN. The Utilisation of GP Services. In: Nolan B, editor. The Provision and Use of Health Services, Health Inequalities and Health and Social Gain,. Dublin: The Economic and Social Research Institute; 2007. p. pp. 35-62.

38. Teljeur C, O’Dowd T, Thomas S, Kelly A. The distribution of GPs in Ireland in relation to deprivation. Health & Place. 2010 2010/11/01/;16(6):1077-83.

39. Cruise S, Kee F. Early key findings from a study of older people in Northern Ireland The NICOLA Study. Belfast: Queens University, 2017.

40. Barrett A, Burke H, Cronin H, Hickey A, Kamiya Y, Kenny RA, et al. Fifty plus in Ireland 2011: First results from The Irish Longitudinal Study on Ageing (TILDA). Dublin: Trinity College Dublin, 2011.

41. Donoghue OA, McGarrigle CA, Kenny RA. The Irish Longitudinal Study on Ageing. In: Gu D, Dupre ME, editors. Encyclopedia of Gerontology and Population Aging. Cham: Springer International Publishing; 2019. p. 1-7.

42. Neville CE, Cruise SM, Burns F. The Northern Ireland Cohort for the Longitudinal Study of Ageing (NICOLA). In: Gu D, Dupre ME, editors. Encyclopedia of Gerontology and Population Aging. Cham: Springer International Publishing; 2019. p. 1-5.

43. NHS Scotland. Scottish Diabetes Survey 2016. Scotland: NHS Scotland,, 2016.
44. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate behavioral research. 2011;46(3):399-424.

45. Ho DE, Imai K, King G, Stuart EA. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. Political analysis. 2007;15(3):199-236.

46. Blackwell M, Iacus S, King G, Porro G. cem: Coarsened exact matching in Stata. The Stata Journal. 2009;9(4):524-46.

47. King G, Nielsen R. Why propensity scores should not be used for matching. Political Analysis. 2016:1-20.

48. McNamara A, Normand C, Whelan B. Patterns and determinants of health care utilisation in Ireland. 2013.

49. Chang H-Y, Weiner JP, Richards TM, Bleich SN, Segal JB. Validating the adapted diabetes complications severity index in claims data. The American journal of managed care. 2012;18(11):721-6.

50. Leahy S, O’Halloran A, O’Leary N, Healy M, McCormack M, Kenny R, et al. Prevalence and correlates of diagnosed and undiagnosed type 2 diabetes mellitus and pre-diabetes in older adults: Findings from the Irish Longitudinal Study on Ageing (TILDA). Diabetes research and clinical practice. 2015;110(3):241-9.

51. Balanda KP, Buckley CM, Barron SJ, Fahy LE, Madden JM, Harrington JM, et al. Prevalence of diabetes in the Republic of Ireland: results from the National Health Survey (SLAN) 2007. PloS one. 2013;8(10):e78406.

52. Gallagher N, Bennett K, Smith SM, O’Reilly D. Impact of two different health systems on the burden of type 2 diabetes. Journal of health services
research & policy. 2014;19(2):69-76.

53. Connor JM, Millar SR, Buckley CM, Kearney PM, Perry IJ. The prevalence and determinants of undiagnosed and diagnosed type 2 diabetes in middle-aged irish adults. PloS one. 2013;8(11):e80504.

54. Cupples ME, Byrne MC, Smith SM, Leatham CS, Murphy AW. Secondary prevention of cardiovascular disease in different primary healthcare systems with and without pay-for-performance. Heart. 2008;94(12):1594-600.

55. Bengoa R, Stout A, Scott B, McAlinden M, Taylor MA. SYSTEMS, NOT STRUCTURES: CHANGING HEALTH & SOCIAL CARE. Belfast: Expert Panel Report, 2016.

56. Teljeur C, Smith SM, Paul G, Kelly A, O’Dowd T. Multimorbidity in a cohort of patients with type 2 diabetes. The European journal of general practice. 2013;19(1):17-22.

Figures
Figure 1

Prevalence of diabetes by gender and age category