Impact of socioeconomic geography on outcomes following hospital discharge for people with diabetes

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Abstract

Background: **Socioeconomic factors drive poor diabetes outcomes. Little research has assessed the impact of socioeconomic factors on outcomes when people with diabetes are discharged from hospital. We evaluate the impact of socioeconomic factors on readmission and mortality.**

Methods: **We performed a retrospective evaluation of data extracted from an electronic health record of a large UK hospital for all patients discharged with a diabetes diagnosis over 3 years. Data were extracted for 46,357 distinct discharges and matched at patient level to postcode sector socioeconomic data. Outcomes were evaluated against prespecified diabetes cohorts. Standardised effect sizes were calculated.**

Results: **Socioeconomic status was statistically significantly associated with 14 of 19 socioeconomic variables in relation to 180-day mortality for a type 2 diabetes mellitus (T2DM) patient cohort; no statistically significant association between mortality and socioeconomic variables in a type 1 diabetes mellitus (T1DM) cohort was noted. Socioeconomic status was significantly associated with one of 19 variables for 28-day readmission in T2DM patient cohorts compared with nine statistically significant variables for T1DM cohorts. Effect sizes were strongest for deprivation indices (Cohen's D=0.29) and health-related activity impairment (Cohen's D=0.15).**

Conclusion: **There is a strong association between geographical socioeconomic status and readmission outcomes for patients with T1DM but only a limited association with mortality. In contrast, mortality for T2DM cohorts is strongly associated with socioeconomic status whilst readmission is not.**

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Introduction

The proportion of people in hospital with a diagnosis of diabetes continues to grow at a rapid rate.[1] It is well established that people with a diagnosis of diabetes are at increased risk of longer hospital stays, increased rates of complications and increased inpatient mortality.[2,3] There has been less work on the impact of diabetes on outcomes following hospital discharge.[4] There is, however, increasing evidence that people with diabetes are at an increased risk of poorer outcomes including readmission[5] and mortality[6,7] following discharge from an inpatient hospital admission.

Avoiding excess readmissions is a particular priority for healthcare services, based on an underlying belief that readmission rates reflect the quality of care provided and the potential financial savings associated with reduced readmission rates.[4] Sonmez *et al* showed that, in an urban teaching hospital, the 30-day adjusted readmission rate for patients with diabetes was 15.3% versus 8.4% for patients without diabetes.[8] Excess readmissions for diabetes are estimated to cost the NHS over £99 million annually.[9] Whilst research considering the impact of diabetes on mortality rates following hospital discharge is relatively scarce and typically focused on particular conditions, there is also good evidence that patients with diabetes are at an increased risk of mortality following discharge from hospital compared with those without diabetes.[10,11]

The increased risk of poor outcomes when people are discharged from hospital with diabetes has driven searches to understand both the drivers for these poor outcomes and potential methods to mitigate against them. A recent systematic review acknowledged 48 studies identifying risk factors of readmission when people with diabetes are discharged from hospital.[12] These studies reported 76 distinct statistically significant risk factors for readmission. The most commonly reported risk factors were comorbidity burden, age, race and insurance type.

A relatively small number of studies considered the impact of socioeconomic status on readmission rate, particularly outside small subsets of patients with type 1 diabetes (T1DM).[13] There are no studies within the current research literature assessing the impact of socioeconomic status on mortality following hospital discharge for patients with diabetes. This paucity of research on

the impact of socioeconomic status on patients with diabetes following hospital discharge comes despite there being well-known associations between lower socioeconomic status and diabetes outcomes in general. Lower markers of socioeconomic status have been associated with an increased prevalence of type 2 diabetes mellitus (T2DM),[14] lesser attainment of diabetes treatment goals[15] and increased mortality.[16] The contrast between socioeconomic research for diabetes in general and research considering risk factors at hospital discharge may reflect the data interoperability challenges associated with matching diverse inpatient electronic health record (EHR), primary care and socioeconomic datasets at the individual patient level.

We present the first assessment of the impact of socioeconomic status on the risk of readmission and mortality at the point of discharge from hospital for people with diabetes. This research is essential if we are to personalise healthcare services to meet the needs of individual patients and appropriately design strategies to reduce the excess readmission and mortality risks seen for patients with diabetes when discharged from hospital.

Methods

We performed a retrospective evaluation of data extracted from an EHR of a large tertiary referral centre in the Coventry and Warwickshire region of the UK for all patients discharged with a diagnosis of diabetes over a 3-year period. Outcome variable data were extracted for hospital readmission within 30 days and mortality within 180 days of hospital discharge.

The diagnosis of diabetes was taken from the coding of patients at discharge and, thus, if there was discrepancy in the diagnosis within the record, the latest diagnosis of diabetes at discharge was used. Maternity patients were excluded from the study due to the differing nature of maternity care and readmission patterns. Patients discharged within the last 6 months of the study period were not evaluated as index patients to ensure that all patients had a full period of 6 months follow-up on the EHR, in order to assess for the outcome measures of interest. Patients with a postcode outside the Coventry & Warwickshire region were excluded to ensure accurate capture of readmission rates to the hospital.

Socioeconomic data were extracted from the latest UK Census performed by the Office for National Statistics. The last UK Census was performed in 2011 and published in July 2012. It represents a 'detailed snapshot of the population and its characteristics, and underpins funding allocation to provide public services'; with a 93% coverage rate, it is a unique and invaluable resource considering the characteristics of the UK population.

Socioeconomic data were extracted from the Office of Statistics Nomis Portal relating to the following pre-specified variables: indices of multiple deprivation, adults in employment, ethnicity, language, housing density, activity limitation and provision of unpaid care. Socioeconomic data were extracted and matched to patient postcodes within the EHR at postcode sector level. The 5-digit postcode sector (eg, 'SW1A 2' from the full postcode 'SW1A 2AA') represents the smallest area level within the Census dataset.[17] There are 89 postcode sectors within the Coventry and Warwickshire region, with approximately 9,000 people living in each postcode sector.

The association between socioeconomic status and outcomes of interest was assessed using the Student's t-test for continuous variables, following adequate assessment for skew and kurtosis to ensure normality. Outcomes of interest were readmission and mortality. An absolute skew value larger than 2 or an absolute kurtosis (proper) larger than 7 was used as a reference value for determining substantial non-normality.[18]

A p value of <0.05 was considered significant. Standardised size was evaluated using Cohen's D for continuous variables. Standardised effect size measures offer an important statistical choice for this research question, as outlined by Robbins et al.[19] Effect size statistics are also particularly valuable when looking to make comparisons – for example, between different predictors, cohorts or variables –,and it is primarily in this context that standardised effect sizes have utility in considering risk predictors for negative outcomes.

All statistical testing was performed using Microsoft Excel 2016 (Redmond, WA, USA) and IBM SPSS Version 24 (Armonk, NY, USA).

Ethical approval was granted by the local NHS Trust Research Ethics Committee at University Hospitals Coventry & Warwickshire NHS Trust through the Governance arrangements for Research Ethics Committee Process (study reference: GF0220). Approval was also granted through the University of Warwick's Biomedical & Scientific Research Ethics Committee (study reference: REGO-2017-2114).

The research topic, strategy and approach were informed by direct patient public involvement (PPI). The research topic was identified following engagement with patient representatives through the Diabetes UK 'Diabetes Voices programme' who were sent free-text questionnaires enquiring about their experiences of inpatient hospital stays. The research approach was developed and adapted by working with two PPI ambassadors, who were recruited through the National Institute of Health Research (NIHR) People in Research (https://www.peopleinresearch.org/)

Results

Data were extracted for 24,108 hospital discharges with a diagnosis of diabetes recorded, 2,538 for patients with T1DM and 21,048 for patients with T2DM. Twenty-four percent (N=5,741) of emergency hospital admissions were identified as being readmitted within 30 days for the generalised population of diabetes, 26.7% (n=678) of emergency admissions with T1DM and 23.4% (n=4,981) of emergency admissions with T2DM. Fifteen percent of patients (n=3,718) died within 180 days of hospital discharge in the generalised population of patients with diabetes, 6.9% (n=175) of patients with T1DM and 16% (n=3,460) of patients with T2DM.

Socioeconomic status was significantly associated with one of 19 variables for readmission at 30 days in T2DM patient cohorts compared with nine statistically significant variables for T1DM cohorts ($p<0.05$, Student's t-test). Standardised size mea-

Table 1 Association between socioeconomic status and readmission risk at 30 days

	Readmission all diabetes		Readmission T1DM		Readmission T2DM	
	P value	Cohen's D	P value	Cohen's D	P value	Cohen's D
% not deprived	0.75		0.00*	0.14*	0.25	
% deprived in 1 dimension	0.16		0.00*	–0.29*	0.33	
% deprived in 2 dimensions	0.72		0.09		0.20	
% deprived in 3 dimensions	0.54		0.01*	–0.12*	0.41	
% deprived in 4 dimensions	0.50		0.03*	–0.10*	0.51	
% Adults in employment	0.71		0.11		0.19	
% Ethnic minority race (not English)	0.05*	0.03*	0.01*	0.13*	0.17	
Day-to-day activities limited a little, %	0.01*	0.04*	0.00*	0.16*	0.12	
Day-to-day activities limited a lot, %	0.03*	0.03*	0.05*	0.09*	0.10	
Day-to-day activities not limited, %	0.01*	–0.04*	0.00*	–0.14*	0.08	
Day-to-day activities limited a lot: age 16–64, %	0.04*	0.03*	0.14		0.08	
Day-to-day activities limited a little: age 16–64, %	0.18		0.95		0.11	
Day-to-day activities not limited: age 16–64, %	0.04*	–0.03*	0.63		0.05	
Provides no unpaid care, %	0.49		0.36		0.44	
Provides 1–19 hours unpaid care a week, %	0.86		0.28		0.92	
Provides 20–49 hours unpaid care a week, %	0.27		0.46		0.13	
Provides ≥50 hours unpaid care a week, %	0.06		0.41		0.09	
Main language is not English	0.00*	0.05*	0.02*	0.11*	0.00*	0.05*
Density (number of persons per hectare)	0.93		0.14		0.43	

*p<0.05.

sures were relatively large and strongest for deprivation indices (Cohen's D=0.29) and health-related activity impairment (Cohen's D=0.15).

Socioeconomic status was statistically significantly associated with 14 of 19 socioeconomic variables in relation to 180-day mortality for the T2DM patient cohort (p<0.05, Student's t-test). Standardised effect sizes were relatively small; however, they were strongest for language and activity limitation (both 0.09). There was no statistically significant association between mortality and socioeconomic variables in the T1DM cohort.

Tables 1 and 2 show the association between socioeconomic factors and readmission at 30 days or mortality at 30 days for generalised populations of people with diabetes, T2DM populations and T1DM populations at discharge from hospital. A standardised effect size measure (Cohen's D) is presented for statistically significant associations.[19]

Discussion

There is a strong association between geographical socioeconomic status and readmission outcomes for patients with T1DM. However, there is very limited association between socioeconomic status and mortality outcomes for the T1DM cohort. In direct contrast, socioeconomic status is strongly associated with mortality outcomes following hospital discharge for patients with T2DM, whilst there is very little association with readmission.

This is an important finding as it will help guide and understand how to most appropriately risk stratify these different patient cohorts at discharge from hospital, as well as make suggestions as to the potential design of interventions to reduce readmission or mortality following discharge. The results also go some way to explaining variations in outcomes when patients are discharged from hospital with diabetes, as they suggest that both the geographical socioeconomic status and the type of diabetes may be of significant relevance.

These results clearly demonstrate an association between geographical socioeconomic status and outcomes following hospital discharge; however, they do not provide any information on causation. Further work is clearly needed to understand the possible mechanisms and causes for the findings reported here. There are a wide range of possible explanations for these findings. One may include drivers of readmission related to socioeconomic status in T1DM cohorts being both compliance with treatment and health-seeking behaviour. Drivers of mortality related to socioeconomic status in T2DM cohorts may be related to wider lifestyle choices and cardio-metabolic risk. There are, however, a range of possible hypotheses that would merit further investigation. It is important to note that we have not attempted to control the populations for factors such as age, sex or diabetes control. Whilst we have not controlled for such variables, the results remain useful, in particular for the development of risk stratification tools.

There are a number of strengths and weaknesses with the study described. Foremost among the strengths is that we have used a large sample size over a prolonged period of time (3 years). This is important as previously very few studies, which have looked at the association between socioeconomic status

Table 2 Association between socioeconomic status and mortality risk at 180 days

	Readmission all diabetes		Readmission T1DM		Readmission T2DM	
	P value	Cohen's D	P value	Cohen's D	P value	Cohen's D
% not deprived	0.17		0.49		0.00*	-0.08*
% deprived in 1 dimension	0.12		0.24		0.01*	0.05*
% deprived in 2 dimensions	0.14		0.84		0.00*	0.07*
% deprived in 3 dimensions	0.03*	0.04*	0.36		0.00*	0.08*
% deprived in 4 dimensions	0.02*	0.04*	0.25		0.00*	0.08*
% Adults in employment	0.50		0.74		0.02*	0.04*
% Ethnic minority race (not English)	0.00*	0.05*	0.07		0.00*	0.09*
Day-to-day activities limited a little, %	0.29		0.57		0.95	
Day-to-day activities limited a lot, %	0.00*	–0.08*	0.69		0.01*	-0.05*
Day-to-day activities not limited, %	0.01*	0.05*	0.61		0.25	
Day-to-day activities limited a lot: age 16–64, %	0.04*	0.04*	0.38		0.00*	0.05*
Day-to-day activities limited a little: age 16–64, %	0.23		0.80		0.01*	0.05*
Day-to-day activities not limited: age 16–64, %	0.00*	0.06*	0.72		0.15	
Provides no unpaid care, %	0.01*	0.05*	0.37		0.03*	0.04*
Provides 1–19 hours unpaid care a week, %	0.02*	–0.04*	0.34		0.01*	-0.05*
Provides 20–49 hours unpaid care a week, %	0.78		0.76		0.01*	0.05*
Provides ≥50 hours unpaid care a week, %	0.23		0.76		0.96	
Main language is not English	0.01*	0.04*	0.05		0.00*	0.09*
Density (number of persons per hectare)	0.19		0.87		0.12	

*p<0.05.

and diabetes outcomes, have used sufficiently large sample sizes.[20] Weaknesses of the study include its nature as a retrospective study and that we have only considered a single centre. This was, however, a large tertiary referral centre set within a diverse population representing a mix of affluence, ethnicity and urbanisation. It should be noted that this study is the first of its kind. There are limitations in the statistical methods presented here, with the results not adjusted for factors such as age and co-morbidities, the latter of which is not well recorded within the electronic record system used. Furthermore, the article does not present a Bonferroni correction with respect to the multiple t-tests performed. Such a statistical approach is beyond the initial remit of this work, however, it would be an important element of future larger multicentre studies looking to understand this area in more detail.

The use of postcode sectors, as opposed to full postcodes, also merits discussion. This was necessitated both by the availability of census data provided within the Office of National Statistics datasets and also the need to ensure that patient identity was not inadvertently compromised. From a research perspective, it would of course be interesting to repeat the study with identifiable patients' datasets and full postcodes with an individual assessment of socioeconomic status. However, from a practical perspective, the benefits of such an approach would be limited. The use of postcode sectors and publicly available socioeconomic datasets allows ready and rapid incorporation of such data into risk stratification tools, which could be implemented within hospital discharge processes without significant disruption to the clinical teams and yet provide valuable information. An individual assessment of socioeconomic status at discharge would, of course, be laborious and impractical.

Key messages

- There is a potentially important association between socioeconomic geography and hospital discharge outcomes for people with diabetes
- There may be a different association depending on whether a person has type 1 or type 2 diabetes
- Further work is needed to better understand the impact of socioeconomic geography and work towards risk stratification tools

In summary, we present here the first large-scale assessment of the impact of geographical socioeconomic status collected from publicly available data sources on outcomes for cohorts of patients discharged from hospital with diabetes. We demonstrate clear associations between socioeconomic status and readmission for patients with T1DM and socioeconomic status and mortality for patients with T2DM. These findings can – and we believe should – be readily incorporated into risk stratification tools applied at the point of discharge and thus supporting evidence-based individualised care for patients leaving hospital with diabetes.

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Conflict of interest Nothing to declare.

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