

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

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ABSTRACT

Background: Deprivation increases admission rates; the specific effect of deprivation with regard to weekend admissions is unknown.

Methods: We calculated annual weekend admission rates for each small area population unit and related these to quintiles of Deprivation Index from 2002-2014. Univariate and multivariable risk estimates were calculated using truncated Poisson regression.

Results: There were 30,794 weekend admissions in 16,665 patients. The admission rate was substantially higher for more deprived areas, 12.7 per 1000 (95%CI 9.4, 14.7) vs 4.6 per 1000 (95%CI 3.3, 5.8). More deprived patients admitted at the weekend had a significantly lower 30-day in-hospital mortality (10.3% vs 14.5%, $p < 0.001$).

Conclusion: Deprivation is a powerful determinant of weekend admissions, however these comprise a group of patients with better outcomes.

Keywords

Deprivation Index; Weekend Admission; Weekend Effect.

Key points

- Deprivation substantially increases weekend admission rates
- Weekend admissions from deprived areas have lower 30-day in-hospital mortality than those from less deprived areas.
- Weekend admissions from deprived areas have a shorter hospital length of stay than those from less deprived areas.
- Weekend admissions from deprived areas are significantly younger than those from less deprived areas.
- Weekend admissions from deprived areas have lower illness severity and co-morbidity burdens than those from less deprived areas.

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Introduction

There has been a growing interest in the association between weekend medical emergency admissions and mortality. Mortality has been estimated on average to be 10% higher at the weekend.¹⁻³

It is possible that this may relate to patient or organizational factors.⁴⁻⁶

Social deprivation has been defined by Townsend as a state of “observable and demonstrable disadvantage relative to the local community to which an individual belongs”.⁷ Deprivation describes ‘social circumstances and conditions’ related to ‘poverty’;⁸ resultant exposure to disadvantageous environment factors may have long term adverse health consequences. Socio-economic deprivation has been shown to increase hospital utilization and hence health care costs.⁹ There appears to be an embedded literature proclaiming that the poor use more hospital resources, evidenced as longer hospital stays and increased utilization, leading to an increased cost burden.^{10, 11}

Our institution St James’s Hospital (SJH) has a predominantly inner city catchment area, combining over 50% of patients labeled as deprived and a

largely elderly population; hospitals with such a case-mix face particular resource problems in meeting the needs of the population they serve.¹² We were interested therefore as to how, within our catchment area, deprivation might impact on admission rates and outcomes. We have therefore examined the relationship between Deprivation Index and a weekend admission in relation to objective measures including the annual admission incidence rate, the 30-day in-hospital mortality and the hospital length of stay.

Methods

Background

SJH serves as a secondary care centre for emergency admissions for its local Dublin catchment area of 270,000 adults. All emergency medical admissions are referred to one of nine teams operating a 24 hour on-call roster. The ‘on-call’ system is covered by a ‘physician of the day’ with a post-call review round. Emergency medical patients are admitted from the Emergency Department to an Acute Medical Admission Unit (AMAU) opened in 2003, under

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

the care of the 'on-call' physician (who is certified in General Internal Medicine and a Subspecialty) – the operation and outcome of which have been described elsewhere.^{13, 14} Patient's seen and discharged directly from the Emergency Department were not included in the current study.

Data collection

For audit purposes we employed an anonymous patient database assembling core information about each admission from elements contained on the national hospital in-patient enquiry (HIPE) scheme, the patient electronic record, the emergency room and laboratory systems. HIPE is a national database of coded discharge summaries from acute public hospitals in Ireland.^{15, 16} Ireland used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) for both diagnosis and procedure coding from 1990 to 2005 and ICD-10-CM since then.

Data held on the database includes the unique hospital number, admitting consultant, date of birth, gender, area of residence, principal and up to nine additional secondary diagnoses, principal and up to nine additional secondary procedures, and admission and discharge dates. Additional physiological, haematological and biochemical parameters are recorded at time of admission. Data for the present study was related to all emergency general medical patients admitted to SJH for the years 2002–2014. Analysis of the annual admission incidence rate data was confined to the 73% of admissions who resided in our catchment area – as including those residing elsewhere would make calculations of the annual incidence rates unreliable due to the high possibility of admissions to another institution.

Deprivation Index

The Republic of Ireland census (Central Statistics Office) returns report small area population statistics (SAPS); the reporting unit is the Electoral Division. Of the total of 3409, 74 Electoral Divisions are in our institution's catchment area. The catchment area population, measured in 2006, was 210,443 persons, with a median population per Electoral Division of 2845 (IQR 2020, 3399). The Irish National Deprivation Index uses methodology similar to Townsend⁷ and Carstairs¹⁷ to derive a Deprivation Index based on four indicators, relating to unemployment, social class, type of housing tenure and car ownership.⁸ The assignment of patients to Electoral Divisions used the ArcGIS geographic information system software implementation of the well-known Point-in-Polygon algorithm as outlined by Shimrat.¹⁸ We have described the methodology involved in greater detail previously.¹⁹

The annual incidence rate (rate/1000 population) of emergency weekend medical admissions for our hospital catchment area was calculated by summing weekend admissions for each Electoral Division over 13 years, calculating an average for each Electoral Division (numerator) and dividing by the total population within each Electoral Division (divisor). The Deprivation Index for the 74 Electoral Divisions in our institution's catchment area were obtained from the National Deprivation Index based on the 2006 census. The Dependency Ratio is an age-based measure (those <15 or ≥65 years) of the non-working population as a fraction of the total population within each Electoral Division.

Statistical methods

Descriptive statistics were calculated for demographic data, including means/standard deviations (SD), medians/inter-quartile ranges (IQR), and percentages. Comparisons between categorical variables and mortality were made using chi-square tests.

For hospital admission rates, we employed a truncated Poisson regression model, including previously described predictive outcome variables in the model as a series of indicator variables. The dependent variable of the admission rate is a count variable and restricted to certain values; the predictor variables are therefore regressed against admission rates using the truncated Poisson model. We used robust standard errors for the parameter estimates, as recommended by Cameron and Trivedi.²⁰ The Poisson regression coefficients are the log of the rate ratio: the rate at which events occur is called the incidence rate. Thus, with the truncated Poisson regression model, we can interpret the coefficients in terms of incidence rate ratios (IRR). We used the margins command in Stata 13.1 to estimate and interpret adjusted predictions for sub-groups, while controlling for other variables such as illness severity, using computations of average marginal effects. Margins are statistics calculated from predictions of a previously fitted model at fixed values of some covariates and averaging or otherwise over the remaining covariates. In the multivariable truncated Poisson model, we adjusted univariate estimates of effect, using known outcome predictor variables of 30-day in-hospital mortality; the Acute Illness Severity Score,^{21,22} the Charlson Co-Morbidity Index,²³ the Chronic Disabling Disease Score²⁴ and Sepsis Status.²⁵ The model parameters were stored; post-estimation intra-model and cross-model hypotheses could thereby be tested.

Adjusted odds ratios (OR) and 95% confidence intervals (CI) or incidence rate ratios (IRR) were calculated for those predictors that significantly entered the model ($p < 0.10$). Statistical significance at

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

Table 1. Weekend Admissions (2002 – 2014): Demographics by Deprivation quintile

Factor	Level	QI/III	QIV/V	p-value
N		2338	28456	
Gender	Male	1012 (43.6%)	13834 (48.9%)	<0.001
	Female	1309 (56.4%)	14471 (51.1%)	
Outcome	Alive	2110 (90.9%)	26759 (94.5%)	<0.001
	Died	211 (9.1%)	1546 (5.5%)	
Age, median (IQR)		76.1 (62.0, 83.7)	63.7 (42.5, 78.2)	<0.001
LOS (days)		6.4 (3.1, 16.6)	5.6 (2.9, 12.5)	<0.001
Admission Rate/1000		4.6 (3.3, 5.8)	12.7 (9.4, 14.7)	<0.001
Acute Illness Severity	1	43 (2.0%)	816 (3.1%)	<0.001
	2	93 (4.3%)	1847 (7.1%)	
	3	159 (7.4%)	3172 (12.2%)	
	4	244 (11.3%)	4164 (16.0%)	
	5	415 (19.2%)	4946 (19.0%)	
	6	1204 (55.8%)	11087 (42.6%)	
Charlson Index	0	946 (40.8%)	12534 (44.3%)	0.003
	1	669 (28.8%)	7832 (27.7%)	
	2	706 (30.4%)	7939 (28.0%)	
Disabling Disease	0	183 (7.9%)	3137 (11.1%)	<0.001
	1	491 (21.2%)	6868 (24.3%)	
	2	648 (27.9%)	7992 (28.2%)	
	3	572 (24.6%)	6137 (21.7%)	
	4	427 (18.4%)	4171 (14.7%)	
MDC Respiratory	0	1770 (76.3%)	21002 (74.2%)	0.029
	1	551 (23.7%)	7303 (25.8%)	
MDC Cardiovascular	0	1890 (81.4%)	23832 (84.2%)	<0.001
	1	431 (18.6%)	4473 (15.8%)	
MDC Neurology	0	1828 (78.8%)	23407 (82.7%)	<0.001
	1	493 (21.2%)	4898 (17.3%)	

LOS: length of stay, MDC: Major disease category, IQR: Inter-Quartile Range

P<0.05 was assumed throughout. Stata v.13.1 (Stata Corporation, College Station, Texas) statistical software was used for analysis.

Results

Patient Demographics

A total of 82,368 episodes were recorded in 44,628 patients admitted as medical emergencies over the 13-year study period. There were 30,794 admissions at the weekend in 16,665 persons. These represented all emergency medical admissions, including patients admitted directly into the Intensive Care Unit and High Dependency Unit. The unadjusted 30-day in-hospital mortality of patients admitted at the weekend was not different compared with patients

admitted during the week; calculated by admission, 5.7% vs. 5.5% (p=0.14), or by individual patient, 10.6% vs. 10.1% (p=0.12). The hospital length of stay (LOS) of weekend admissions was similar to weekday admissions; 5.1 days (95%CI 2.8, 10.6) vs 5.4 days (95%CI 2.3, 10.2) (p=0.10).

When studying the quintiles of Deprivation (Quintiles I-III vs. Quintiles IV/V) (Table 1), it was evident that the large majority (92.5%) of weekend admissions were from Electoral Divisions classified as being in the top two quintiles of the National Deprivation Index. The weekend admission incidence rate was substantially higher for more deprived compared with less deprived areas; 12.7/1000 (95%CI 9.4, 14.7) vs 4.6/1000 (95%CI 3.3, 5.8). Patients from more deprived backgrounds

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

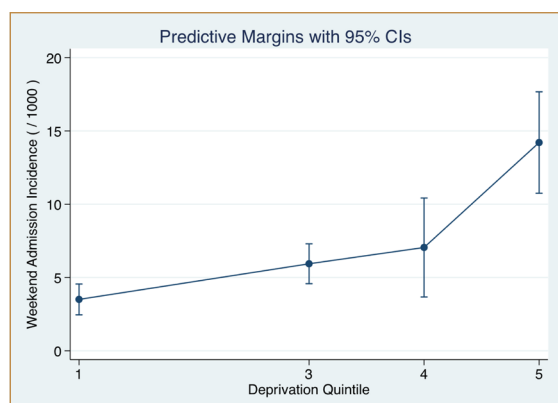


Figure 1. Relationship between Deprivation Index quintile and Weekend Admission Rates (expressed/1000 population). The predicted probabilities for each were derived from the zero truncated Poisson model. We used margins to estimate and interpret adjusted predictions for sub-groups, while controlling for other variables, using computations of average marginal effects.

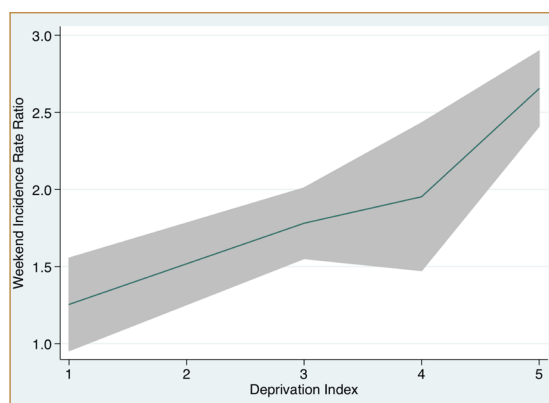


Figure 2. Relationship between Deprivation Index quintile and Incidence Rate Ratios for weekend admissions. The predicted probabilities were derived from the multi-variable truncated Poisson model. We used margins to estimate and interpret adjusted predictions for sub-groups, while controlling for other variables, using computations of average marginal effects.

were substantially younger; 63.7 years (95%CI 42.5, 78.2) vs 76.1 years (95%CI 62.0, 83.7) ($p < 0.001$). These more deprived had a significantly lower 30-day in-hospital mortality when calculated by admission (5.5% vs. 9.1%) or unique patient (10.2% vs. 14.3%) ($p < 0.001$). The LOS was also shorter for patients admitted from the more deprived areas; median 5.6 vs. 6.4 days ($p < 0.001$).

The Acute Illness Severity Score, the Chronic Disabling Disease Score, and the Charlson Co-Morbidity Index were all higher for those from less deprived areas (Table 1).

Social Deprivation Markers and Annual Admission Rate Incidence

There were a total of 74 Electoral Divisions in the catchment area with a population, measured in 2006, of 210,443 persons. The median population per Electoral Division was 2845 (IQR 2020, 3399). We related the National Deprivation Index, within these 74 Districts within our catchment area to the incidence rate of all the emergency medical admissions; fifty-six of these (75.7%) were in the top two quintiles of Deprivation Index (Q4=7, Q5=49). The median (IQR) weighted catchment area annual admission rate/1000 population was 29.2 (13.9, 36.0); the 90th centile being at 55.0. For patients admitted at the weekend, the median (IQR) weighted annual admission rate/1000 population was 10.9 (5.7, 14.0).

Considering weekend admissions, weighted for small area frequency, the small area Deprivation Index strongly correlated with the annual admission rate incidence (Figure 1, Figure 2). By quintile the respective incidence rates (expressed/1000 population) increased as follows: Q1 3.5 (95%CI 2.4, 4.6), Q3 5.9 (95%CI 4.6, 7.2), Q4 7.2 (95%CI

3.7, 10.7) and Q5 14.3 (95%CI 10.8, 17.7). The model annual Incidence Rate Ratios (compared with Quintile 1) were for Q3 1.70 (95%CI 1.15, 2.48), Q4 2.05 (95%CI 1.16, 3.64) and Q5 4.07 (95%CI 2.75, 6.02).

Adjusted Model of Weekend Incidence Rates for Emergency Admissions

We modelled the admission incidence rates of emergency medical patients, with prediction based on the Deprivation Index of each Electoral Division within our catchment area. In the multivariable model we included Deprivation Index and other outcome predictive parameters as previously described the Acute Illness Severity Score,^{21, 22} the Charlson Co-Morbidity Index,²³ Chronic Disabling Disease Score²⁴ and Sepsis status.²⁵ None of the latter were predictive; that is to say, that the levels of these variables were similar in local areas of low or high deprivation and were not factors explaining the difference in the rates of admission between the small area population areas.

We therefore added in the small area dependency (non-working population (<15 and ≥65 year/total population) and unemployment rates into the model. Both of these were predictive (Table 2, Figure 3). In the final model, the rate at which the Deprivation Index related to the weekend annual admission incidence rates (expressed/1000 population) increased as follows: Q1 4.3 (95%CI 2.6, 6.0), Q3 6.8 (95%CI 4.9, 8.8), Q4 11.0 (95%CI 5.8, 16.2) and Q5 13.7 (95%CI 11.6, 15.8) (Table 2).

Discussion

The current work shows that deprivation is a powerful predictor of weekend admission rates, with very high

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

Table 2. Zero Truncated Poisson model of Weekend Admission by Deprivation Index quintile, with multivariable adjustment for other Admission Predictors.

Parameter	Group	IRR	95% CI	p-value
Deprivation	Q III vs. Q I	1.59	1.13, 2.23	0.008
	Q IV vs. Q I	2.55	1.69, 3.87	0.001
	Q V vs. Q I	3.19	2.21, 4.60	0.001
Dependency	Q II vs. Q I	0.82	0.58, 1.17	0.27
	Q III vs. Q I	1.90	1.24, 2.90	0.003
	Q IV vs. Q I	1.29	0.97, 1.72	0.08
Unemployment	Q V vs. Q I	1.52	1.05, 2.22	0.03
	Q IV/V vs. Q I/III	1.48	1.04, 2.10	0.03

The multivariable model estimated coefficients were transformed to incidence-rate ratios. The latter is a hazard rate, based on the rate or incidence of counts.

rates of emergency medical admissions in patients from deprived areas at the weekend. However it also shows that these weekend admissions from more deprived areas are on average younger, with less severe illness and better outcomes. Both hospital length of stay and 30-day in-hospital mortality were significantly lower for patients from more deprived areas admitted at the weekend.

The findings of the current study are in stark contrast to our previous assessment of deprivation index as an outcome predictor in acute medical admissions.¹⁹ We previously demonstrated that deprivation was a powerful outcome predictor with a 31% increase in 30-day in-hospital mortality for patients in the upper half of the deprivation index.¹⁹ This negative predictive effect of deprivation is consistent with the findings of a number of other previous studies.²⁶⁻²⁸ The effects of deprivation are far reaching, interacting, and difficult to fully

quantify accurately. There is a suggestion in our data that weekend admissions are more skewed to the respective ends of the spectrum of admissions in terms of a variety of prognostic factors including disease severity and co-morbidity. A potential explanation for our findings is that the nuances of the Irish healthcare system are resulting in a large proportion of admissions of low acuity patients overwhelming the more typical signal of higher acuity, higher mortality, patients who are admitted at weekends. The current work cannot adequately address these unexpected findings due to the lack of an appropriate control group but this is an important topic which would benefit from further examination.

It is intriguing to speculate on the explanations for the disparity in the effects of deprivation overall and when assessing weekend admissions in particular. Systems factors, either local or national, may be more important than patient factors in this scenario, this may also help to explain the possible differences between our data and other work in this area. Potential explanations include a real or perceived lack of availability of non-hospital medical services in these areas at the weekend leading to an increased utilisation of hospital services. Other factors may include a lack of health education at the individual patient level or a lack of success in the long-term management of existing conditions resulting in more unplanned emergency admissions at the weekend in this group of patients. Reduced staffing and availability of investigations at weekend times may result in the admission of patients with lower acuity who would otherwise be investigated and discharged from the Emergency Department on the day of attendance or referred on to appropriate ambulatory care or outpatient settings as appropriate. A converse explanation is also possible, in which less deprived

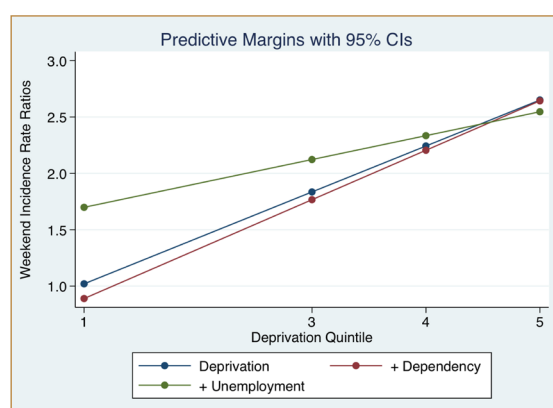


Figure 3. Relationship between a Weekend Admission and Deprivation Index, Dependency Ratio and Unemployment Rates. The probabilities were derived from the multivariable truncated Poisson model and a linear fit of the modelled parameters; the effect is plotted based on the latter prediction.

The Relationship Between Social Deprivation and a Weekend Emergency Medical Admission

individuals postpone required hospital admissions over the weekend resulting in illness progression and presentation with more severe disease at a later date, followed by ultimately better outcomes due to the long term health benefits of their lower underlying deprivation.

The current study explored the specific effect of deprivation on weekend admissions. It was not designed to directly assess disparities in outcomes based on deprivation status between weekday and weekend admissions. This is a crucially important area in which further study is needed. The elucidation of outcome patterns and the contribution of deprivation to these are vital for the appropriate allocation of our limited healthcare resources. Identifying areas in which investment has the greatest potential to improve outcome measures should be a key future priority for policy makers and funders. A study comparing deprivation index between weekday and weekend admissions and exploring the complexities of patient outcomes for various strata of deprivation is needed.

In conclusion the current study demonstrates that deprivation is a powerful determinant of weekend admission rate for emergency medical conditions. However these admissions comprise a group of younger patients with a lower burden of disease and better outcomes.

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Conflict of interest

Nothing to declare.

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