Evaluation of the health impact of an urban regeneration policy: Neighborhood Renewal in Northern Ireland

Document Version:
Peer reviewed version

TITLE PAGE

Title:

Evaluation of the health impact of an urban regeneration policy: Neighbourhood Renewal in Northern Ireland

Authors:
Gretta Mohan,[a,b,c] Alberto Longo[b,c,d] Frank Kee,[a,b]

Author Affiliations:
[a] Centre for Public Health, Queen's School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, Institute of Clinical Sciences, Grosvenor Road, Royal Victoria Hospital, Belfast, BT12 6BA, UK.
[b] UK Clinical Research Collaboration (UKCRC) Centre of Excellence for Public Health Northern Ireland, Queen's University Belfast, Institute of Clinical Sciences, Grosvenor Road, Royal Victoria Hospital, Belfast, BT12 6BA, UK.
[c] Gibson Institute, Institute for Global Food Security, School of Biological Sciences, Queen's University, Room 01.409, Medical Biology Centre, Lisburn Road, Belfast, BT9 7BL, UK.
[d] Basque Centre for Climate Change (BC3), Sede Building 1, 1st floor Scientific Campus of the University of the Basque Country, 48940 Leioa Bilbao, Spain.

Corresponding author:
Gretta Mohan, gmohan03@qub.ac.uk
Permanent address:
UK Clinical Research Collaboration (UKCRC) Centre of Excellence for Public Health Northern Ireland, Queen's University Belfast, Institute of Clinical Sciences, Grosvenor Road, Royal Victoria Hospital, Belfast, BT12 6BA, UK.
Telephone: +44 (0)28 9097 6430

Word count:
3,690 words

TITLE

Evaluation of the health impact of an urban regeneration policy: Neighbourhood Renewal in Northern Ireland

ABSTRACT

Background
Neighbourhood Renewal (NR) was launched in Northern Ireland (NI) in 2003 to revive the social, economic and physical fabric of thirty-six deprived communities, characterised by a legacy of sectarian conflict. This study evaluates the impact of the policy on health over a decade.

Methods
A merged panel of secondary data from the British Household Panel Survey (2001-2008) and Understanding Society (2009-2012) yields longitudinal information on respondents for twelve years. We conducted a controlled before and after investigation for NR intervention areas (NRAs) and three control groups – two groups of comparably deprived areas that did not receive assistance and the rest of NI. Linear difference-in-difference regression was used to identify the impact of NR on mental health, self-rated health, life satisfaction, smoking and exercise. Subgroup analysis was conducted for males and females, higher and lower educated, retired, unemployed and home owner groups.

Results
NR did not have a discernible impact on mental distress. A small, non-significant, trend towards a reduction in the gap of good self-rated health and life satisfaction between NRAs and controls was observed. A 10% increase in probability of rating life as satisfying was uncovered for retirees in NRAs compared to the rest of NI. Smoking in NRAs declined on par with people from control areas so a NR influence was not obvious. A steady rise in undertaking weekly exercise in NRAs compared to controls was not statistically significant.

Conclusions
Area-based initiatives may not achieve health gains beyond mainstream service provision, though they may safeguard against widening of health disparities.

What is already known on this subject

- Residents of communities characterised by social, economic and physical deprivation tend to experience poorer health, mental wellbeing and choose unhealthy lifestyles.
- Evaluations of urban regeneration policies have found limited evidence of health improvement at the target population level. Where gains have been uncovered, these have been limited to distinct subgroups of the population, or have depended on the active agency of residents, or have relied on especially intensive assistance.
- A government-commissioned evaluation of Neighbourhood Renewal found that gentrified areas continued to underperform based on administrative health statistics despite £194 million investment, equal to £75 per capita for residents of intervention areas per annum.

What this study adds

- A rich longitudinal panel survey covering aspects of health and wellbeing for the same respondents spanning twelve years in intervention and three control areas was assessed before and for the duration of Neighbourhood Renewal in Northern Ireland.
- Robust multiply-adjusted analysis demonstrates that respondents' mental health, self-rated health, life satisfaction, smoking and exercise habits were not found to be significantly associated with change as a result of the policy. At best, further widening of inequalities was prevented during a challenging economic period.

INTRODUCTION

A growing body of UK and international evidence examining the health effects of urban regeneration has emerged since the 1990s. Despite this, clear and consistent support for the effectiveness of area based initiatives (ABIs) on health has not materialised.

This paper assesses the health impacts of a major urban regeneration policy, Neighbourhood Renewal (NR) in Northern Ireland (NI)[1]. NI is a unique study setting as the region is marked by the legacy of thirty years of conflict (1968-1998). The scars of an era of chronic unemployment[2], scant inward investment[3,4] and psychological trauma[5–9] are thought to have left a legacy of poor health[10,11] in some balkanised communities.

NR was launched in 2003 as a devolved response to the Blair government's National Strategy for Neighbourhood Renewal[12], analogous to England's New Deal for Communities (NDC). Originally designed to roll out over 7–10 years, the Strategy provided intensive community-led assistance to thirty-six neighbourhoods suffering the highest levels of deprivation, accommodating one in six NI residents (280,000 persons)[13]. Intervention neighbourhoods were selected because they fell in the ten-percent most deprived urban wards in NI, identified by the 2001 Noble Multiple Deprivation Measure[14]. The total of thirty-six areas was determined through public and statutory consultation[i].

NR partnership boards in each of the NRAs comprised of local stakeholders, representatives from key delivery agencies and residents. The partnerships created Vision Statements and three year Action Plans which outlined the priorities for their area and guided the allocation of funds[1]. The NR Investment Fund subsidized community, economic, social and physical renewal investments. Health featured as one of the social renewal objectives. Annual reports from NRA partnerships reveal that the prioritisation of health varied considerably across NRAs and a kaleidoscope of health projects were implemented[15]. Common themes included physical activity promotion and weight management, nutrition and food poverty, mental wellbeing and suicide prevention, drug and alcohol awareness, smoking cessation, disability and elderly social inclusion, sexual health, fuel poverty mitigation and health condition specific groups. The policy also recognised that health could be affected by other renewal themes attending to upstream determinants of health such as employment, education and the physical environment. Examples included the provision of accredited skills, employability and educational courses, crime prevention initiatives, installation of security measures, improved housing, traffic calming schemes, land developed for green space and enhanced public realm[15].

In the period 2003/4-2012/13, £194 million was invested in NR, approximately £75 per capita per annum for residents of NRAs[16]. Due to a lack of clear financial accounting in the Strategy's infancy, the total budget spend on health was undefined. However, data for 2012/13 states that 27% of funds were allocated to the social renewal stream[16], and individual NRA reports suggest that circa 10-15% of an area's budget was typically disbursed on health schemes[15].

The NI government commissioned mid-term and final evaluations of NR[14,16]. The final evaluation assessed the impact of NR on health by comparing available administrative statistics for NRAs with non NRAs. Indicators were only compared for the years 2004/05 and 2010/11. The evaluators

uncovered a 12% increase in the gap between NRAs and non NRAs on premature mortality rates (deaths under the age of 75) between 2005 and 2010, a 0.3% widening in the gap on suicides, no change in the gap in the proportion of deaths due to drugs and alcohol, and a 3.7% reduction in the gap of births to teenage mothers. It is not statistically rigorous to attribute the change in these health indicators to NR using this 'gap analysis' approach, meriting a more comprehensive and robust investigation. The evaluation also does not capture resident's own views of their health. Moreover, academic studies of England's NDC found conclusions somewhat different from government commissioned evaluations[17–20].

METHODS

Data

Two major longitudinal household surveys, the Northern Ireland Household Panel Survey (NIHPS) and Understanding Society (US) were merged to provide a twelve year panel of the original sample of households from 2001-2012. US replaced NIHPS in 2008 as a new, more extensive survey.

Annual face-to-face interviews were carried out with all household members in survey households aged sixteen and over. A single household questionnaire was completed for the household and each adult was interviewed with an individual adult questionnaire. An adult self-completion questionnaire was also issued, containing more sensitive questions concerning mental health and attitudes. Sample members were followed as they move address.

The first wave of the NIHPS was carried out in 2001 as an extension of the longer running British Household Panel Survey (BHPS) (1991-2008), and comprised an unclustered sample of the population in private households. Approximately 2,000 households and 3,500 individuals were interviewed in the first wave. The household response rate was 69% and individual response rate was 89%[21]. The NIHPS involved eight waves, with the final wave in 2008-2009 surveying 1,300 of the original respondents. Participating households of the NIHPS were invited to continue being surveyed under US and a further 1,300 new NI households were recruited for US. Four waves of US data were available at the time of undertaking this research (2009-2012).

Study design and study population

By means of a special access licence[ii] from the UK Data Service, the addresses of survey respondents indicated by a geographic indicator, super output areas (soas)[iii], were retrieved. Respondents living in NRAs and non NRAs were distinguished, permitting the construction of control groups for statistical analysis.

Control groups

All respondents living in non NRAs in NI were identified as a control group, *Non NRAs*. Two further control groups comprising respondents living in the most deprived areas in NI as ranked according to the 2005 Multiple Deprivation Measure which were not NRAs were also fashioned[22]. The first deprived control group contained respondents living in the 25% most deprived soas, *Control 1*. The

second deprived control group was slightly wider and contained those living in the 30% most deprived soas, *Control 2*.

Health measures

The NIHPS and US surveys use the twelve item General Health Questionnaire (GHQ) to measure mental distress. This measure is constructed from responses to twelve questions which cover hedonic and eudemonic aspects of wellbeing and functioning - feelings of happiness/depression, enjoyment of day-to-day activities, confidence, self-worth, ability to face problems, overcome difficulties, levels of strain faced, capacity to make decisions, feelings of ability to play a useful role, and ability to sleep and concentrate. Responses were given on a four point Likert scale ranging from 'better than usual' to 'much less than usual'. Answers were then converted to a single scale from 0 (least distressed) to 36 (most distressed).

Self-rated health was measured slightly differently between the NIHPS and US surveys but could be reconciled with health ratings grouped into the categories of 'very poor or poor', 'fair', 'good or very good', and 'excellent' (see Supplementary Figure 1 of the accompanying supplementary file). Self-rated health was dichotomised (1/0) where one represents 'good or better' self-rated health.

Life satisfaction was asked from wave two of the survey and measured on a seven point scale with the options ranging 'completely', 'mostly', 'somewhat' and 'neither' dissatisfied/satisfied. Life satisfaction was dichotomised where one represents 'somewhat satisfied or better' levels of satisfaction.

Frequency of physical activity was harmonised between the two surveys and a dichotomous variable 'exercise at least once a week' could be constructed, though this was only asked in five out of the twelve survey waves, with one pre-intervention wave. Smoking behaviour was asked in ten waves and the dichotomous variable 'smoker' was used. Greater details on the outcome measures exploited and a discussion of validity are provided in the supplementary material.

Demographic and socioeconomic confounders

The merged survey yields demographic and socioeconomic information on respondents including gender, age, education, employment status, household income and other sources of income, marital status, number of children, housing tenure and subjective financial status.

Statistical analyses

Linear[iv] regression difference-in-difference (DD) modelling was employed to estimate the effect of NR, offering a quasi-experimental research design with observational study data[23–25]. The effect of an intervention is inferred by comparing the pre and post intervention change in an outcome for NRAs relative to the control group(s). The performance of the control group gives an implied counterfactual – an indication of what would have happened in NRAs in the absence of NR. DD relies on the 'parallel trends' assumption where trends over time, be that in health or wellbeing, are assumed to be equivalent in both the NRA and control group in the absence of NR.

The dependent variable, Y_{it}, is the health of individual i at time t. The DD regression equation to be estimated is:

$$Y_{it} = \beta_0 + \beta_1 NR_i + \beta_2 S_t + \beta_3(NR_i S_t) + \beta_4 X_{it} + \varepsilon_{it}$$

$$NR_i = \begin{cases} 0 & Control\ group \\ 1 & NRA \end{cases}$$

$$S_t = \begin{cases} 0 & Before\ NR\ Strategy \\ 1 & After\ NR\ Strategy \end{cases}$$

The intervention variable, NR_i, is a dummy variable indicating whether a survey respondent lived in a NRA or not at the time of interview. The dummy S_t denotes whether the data was collected before or after the beginning of the NR intervention. Pre-NR data cover two years, 2001-2002, and post-intervention data span for ten years, 2003-2012. The DD estimate, β_3, is given by the interaction of NR_i and S_t and is the main variable of interest. It indicates the impact of being in a NRA during the intervention period when both dummies equal one. Unadjusted crude effect estimates are presented, and adjustment for potential confounders arising from the demographic and socioeconomic characteristics of respondents, X_{it}, is represented by β_4. Cluster-robust standard errors account for clustering at the soa level.

Panel data methods were used and respondents who migrate in or out of NRAs over the course of the sample were excluded to prevent contamination[v]. The analysis was also stratified by subgroups of the population to compare trends between groups: male/female, low/higher educational qualifications[vi], unemployed/not unemployed, retired/not retired and owner occupier/renting or other tenure. A discussion of the choice of subgroups is included in the supplementary material.

The results presented are for complete cases, for respondents with complete information on outcome and sociodemographic adjustment variables. Sample sizes for outcomes differ because some outcomes were not asked in every survey wave. Multiple imputation methods were also used as a robustness check, to compare the results generated from the raw data with a simulated dataset that replaces missing entries with predicted values, calculated using existing values from other observed variables (methods and missingness are documented in the supplementary file; Supplementary Table 4 and Supplementary Table 7). Unweighted DD results for complete cases were also compared with inverse probability weighted DD models, which adjust for sample attrition in the panel resulting from observable characteristics among respondents (detailed in the supplementary file; Supplementary Table 1, Supplementary Table 2, Supplementary Figure 2, Supplementary Table 3 and Supplementary Table 6). The analysis was carried out using STATA 13.1[26].

RESULTS

NRA respondents differed in education, employment status, household income and other sources of income, marital status, number of children, tenure and financial status compared to respondents in Non NRAs (Table 1). The statistically significant differences between NRAs and Control 1 and 2 were few, though NRAs had more renters compared to both deprived controls, and had slightly lower

household income and higher benefits than Control 1 (difference tests obtainable in Supplementary Table 5).

Time trends of the outcome variables are presented in Figure 1. Mean GHQ scores for NRAs and controls were quite closely matched in the early years of the survey but a positive gap developed over time with mean GHQ scores in the control areas declining slightly, while scores in NRAs were broadly static. Over time, in both NRAs and Non NRAs there was a rise in the number of respondents reporting good or better health. The proportions reporting life as satisfying were lower in NRAs and there was not much change in life satisfaction in either NRAs or controls. Smoking rates were much higher in NRAs than all other groups but a similar decline in smoking was witnessed for each over time. The percentage of respondents exercising at least once a week steadily increased in NRAs and deprived controls while for Non NRAs little change was observed.

The DD models were unable to detect an effect of NR on health and wellbeing or health behaviours for the NRA target population as a whole, shown in Table 2. Selected results for sub groups are presented in Table 3.

At baseline, before NR, GHQ in the unadjusted model was significantly higher among respondents in NRAs than Non NRAs. However, when demographic, socioeconomic characteristics and self-rated health of respondents were accounted for, this effect was attenuated and non-significant. At follow-up, during the implementation of NR, the disparity in mental distress scores for respondents in NRAs and Non NRAs remained, and was slightly wider but not significant for the adjusted models. However, the DD estimate of the impact of NR on distress was null at 0.03 (95% CI -0.42 to 0.48). Subgroup analysis comparing NRAs and Control 1 reveals that distress among more highly educated respondents rose during the policy operation and for females GHQ scores trended towards an increase.

While the prevalence of reported good self-rated health increased in NRAs, the results did not demonstrate that NR buoyed the probability of good health for the target population beyond the improved trends witnessed for other controls. However, probability of good self-rated health increased by 9% for owner occupiers in NRAs compared to Control 1 and 6% compared to Control 2, associated with NR.

The results also demonstrate that life satisfaction was uninfluenced by NR for the target population as a whole. However, a comparison of retirees in NRAs and Non NRAs reveals that NR was associated with a 10% uplift in the probability of reporting life as satisfying among retirees (p<0.05).

The probability of smoking in NRAs declined over the Strategy period, in accordance with trends for the rest of NI and other groups. The estimated DD coefficient of -0.003 (95% CI -0.04 to 0.03) implies that NR supported a reduction in the probability of smoking when compared to Non NRAs, but this did not attain statistical significance. Panel modelling indicates a 12% gap in smoking rates persisted between NRAs and Non NRAs in the unadjusted model (p<0.001), although this gap attenuated to 4% in the adjusted models (p<0.1).

Figure 1 shows that the percentage of respondents undertaking weekly exercise in NRAs increased from 56% in wave two to 70% in wave twelve, while control groups did not experience a

corresponding upsurge. However, modelling indicates that the changes between NRAs and Non NRAs over the decade were not statistically significant.

The results generated to account for attrition and missingness did not significantly differ from those presented (see Supplementary Table 6 and Supplementary Table 7).

Table 1: Sociodemographic and outcome characteristics of study population at wave one[†]

Characteristics		NRA	Non NRA	Control 1	Control 2
N		596	2,217	204	305
Female (%)		60.7	57.4	57.4	58.7
Age (mean)		44.6	45.7	43.1	46.0
Education	Degree	6.2	12.2	4.4	4.6
(%)	Other higher	9.1	15.5	14.2	12.1
	A Levels	10.1	11.8	10.3	10.5
	GCSE	20.8	20.3	20.6	18.7
	Other qualification	9.1	10.9	8.3	8.9
	No qualifications	44.8	29.2	42.2	45.3
Jobs status	Self-employed/employed	37.6	55.6	41.7	41.0
(%)	Unemployed	8.7	3.9	7.8	6.2
	Retired	19.8	19.0	15.7	21.0
	Family care	15.8	10.3	17.2	15.7
	Full time student	4.0	4.6	5.9	4.3
	Long term sick	10.7	5.5	11.3	10.8
	Non-paid employment	3.4	1.2	0.5	1.0
Household income (£ monthly) (mean)		1,794	2,397	1,974	1,876
Benefits (%)		68.0	55.1	59.8	64.3
Pension (%)		10.6	13.5	9.8	11.8
Investment income (%)		13.9	25.4	14.7	15.1
Marital	Single	29.5	24.7	36.8	33.4
status	Married/Civil partner	50.2	60.8	43.6	46.6
(%)	Separated	5.9	3.2	5.9	4.6
	Divorced	6.2	3.8	5.4	6.2
	Widowed	8.2	7.5	8.3	9.2
Number of children (mean)		0.8	0.6	0.7	0.6
Tenure	Owner occupier	54.5	80.5	65.7	66.6
(%)	Social rent	34.6	11.6	27.9	26.6
	Private rent	10.7	7.7	6.4	6.9
	Other tenure	0.2	0.2	0.0	0.0
Subjective	Living comfortably	22.0	33.3	21.6	23.6
financial	Doing alright	33.2	35.9	34.8	35.4
status	Getting by	34.6	24.0	31.9	30.2
(%)	Quite difficult	7.4	4.8	6.4	6.9
	Very difficult	2.9	2.0	5.4	3.9
GHQ score (mean)		12.5	11.3	11.8	11.8
Good or better self-rated health (%)		57.7	70.0	60.3	61.6
Life somewhat satisfying or better[‡] (%)		69.6	80.4	73.2	74.1
Smoker (%)		40.6	25.0	31.4	34.1
Exercise once a week[‡] (%)		55.8	57.6	48.2	51.0

[†]Sample used in modelling, excludes residents who migrate in/out of NRAs and observations with missing values.
[‡]Wave two since question was not asked in wave one.

Figure 1: Time trends of outcomes by study groups over period 2001 (wave 1) - 2012 (wave 12)

[See Figure 1: Images 1-5 attached as image files]

Table 2: DD modelling results - slope estimate comparison of outcomes with NRAs, whole sample

	N	Unadjusted			Adjusted (demographics & socioeconomics[Π])			Adjusted (demographics, socioeconomics & health[ΠΠ])		
		Pre-NR 2001-2002	NR 2003-2012	DD (95% CI)	Pre-NR 2001-2002	NR 2003-2012	DD (95% CI)	Pre-NR 2001-2002	NR 2003-2012	DD (95% CI)
Mental distress GHQ score										
Non NRAs	21,462	1.12***	1.04***	-0.08 (-0.61 to 0.45)	0.36	0.37	0.01 (-0.47 to 0.50)	0.27	0.30	0.03 (-0.42 to 0.48)
Control 1	5,707	0.48	0.83§	0.35 (-0.61 to 1.30)	0.32	0.56	0.24 (-0.58 to 1.05)	0.27	0.63§	0.36 (-0.43 to 1.15)
Control 2	6,450	0.54	0.70§	0.16 (-0.62 to 0.94)	0.40	0.43	0.03 (-0.69 to 0.76)	0.32	0.46	0.14 (-0.55 to 0.83)
Good self-rated health[⊥]										
Non NRAs	21,462	-0.12***	-0.10***	0.02 (-0.02 to 0.06)	-0.03	-0.02	0.007 (-0.03 to 0.04)	-0.03	-0.02	0.007 (-0.03 to 0.04)
Control 1	5,707	-0.05	-0.02	0.03 (-0.04 to 0.10)	-0.02	0.02	0.04 (-0.02 to 0.10)	-0.02	0.02	0.04 (-0.02 to 0.10)
Control 2	6,450	-0.04	-0.02	0.02 (-0.04 to 0.09)	-0.03	0.007	0.03 (-0.02 to 0.09)	-0.03	0.01	0.03 (-0.02 to 0.09)
Satisfied with life[⊥]										
Non NRAs	18,544	-0.11***	-0.08***	0.03 (-0.02 to 0.07)	-0.05*	-0.03§	0.02 (-0.02 to 0.06)	-0.04§	-0.01	0.03 (-0.02 to 0.07)
Control 1	4,886	-0.04	-0.03	0.006 (-0.07 to 0.08)	-0.02	-0.01	0.009 (-0.07 to 0.08)	-0.02	-0.01	0.008 (-0.06 to 0.08)
Control 2	5,524	-0.05	-0.04	0.007 (-0.06 to 0.07)	-0.04	-0.02	0.02 (-0.04 to 0.08)	-0.04	-0.02	0.02 (-0.04 to 0.08)
Smoker[⊥]										
Non NRAs	18,803	0.14***	0.12***	-0.02 (-0.06 to 0.03)	0.04*	0.04§	-0.003 (-0.04 to 0.03)	0.04*	0.04§	-0.003 (-0.04 to 0.03)
Control 1	5,021	0.06	0.06	-0.004 (-0.07 to 0.07)	0.05	0.05	-0.004 (-0.07 to 0.06)	0.05	0.05	-0.003 (-0.07 to 0.06)
Control 2	5,692	0.05	0.06	0.009 (-0.05 to 0.07)	0.02	0.04	0.01 (-0.04 to 0.07)	0.02	0.04	0.01 (-0.04 to 0.07)
Exercise at least once per week[⊥]										
Non NRAs	7,273	-0.02	-0.02	-0.0004 (-0.06 to 0.06)	0.01	0.003	-0.008 (-0.07 to 0.05)	0.02	0.004	-0.01 (-0.08 to 0.05)
Control 1	1,883	0.08	0.05	-0.03 (-0.14 to 0.08)	0.09	0.07§	-0.02 (-0.13 to 0.08)	0.09§	0.06§	-0.03 (-0.14 to 0.07)
Control 2	2,134	0.05	0.008	-0.04 (-0.13 to 0.05)	0.05	0.01	-0.03 (-0.12 to 0.06)	0.05	0.005	-0.04 (-0.14 to 0.05)

Pre-NR: difference between NRA and control prior to NR, NR: difference between NRA and control for the roll out of NR, DD (95% CI): difference in the difference between NRA and control pre and post launch of NR (95% confidence interval).

[⊥]Probability of reporting.

§Significant at p 0.1; * at p .05; ** at p 0.01; *** at p 0.001. Clustered standard errors on super output area geographical unit.

[Π]Included demographic and socioeconomic covariates: gender, age, age^2, education (degree, other tertiary, A Level, GCSE, other qualification: base - no qualifications), employment status (unemployed, retired, family care, full time student, long term sick, non-paid employment: base - self-employed/employed), marital status (married, separated/divorced, widowed: base - single), number of children, tenure (social rent, private rent, other tenure: base - owner occupier) natural logarithm of household income, receipt of a pension, receipt of welfare benefits, have investment income, subjective financial situation (living comfortably, doing alright, getting by, quite difficult: base - very difficult).

[ΠΠ] Where they are not already itemised as dependent variables, the models are adjusted for good self-rated health and dichotomised GHQ (GHQ threshold score of ≥24=1, GHQ score <24=0; this threshold is used as the cut off to indicate presence of a psychiatric illness[27,28]).

Table 3: Selected results for subgroups (only those demonstrating statistically significant relationships) - slope estimate comparison of outcomes with NRAs

	N	Unadjusted			Adjusted (demographics & socioeconomics$^{\Pi}$)			Adjusted (demographics, socioeconomics & health$^{\Pi}$)		
		Pre-NR 2001-2002	NR 2003-2012	DD (95% CI)	Pre-NR 2001—2002	NR 2003-2012	DD (95% CI)	Pre-NR 2001-2002	NR 2003-2012	DD (95% CI)
Mental distress GHQ score										
Females										
Control 1	3,381	0.48	1.31*	0.83 (-0.47 to 2.13)	0.08	0.93*	0.84 (-0.21 to 1.90)	0.07	0.96*	0.90§ (-0.13 to 1.92)
Higher educated										
Control 1	1,937	-0.22	1.04§	1.25§ (-0.15 to 2.65)	-0.27	0.92§	1.19§ (-0.19 to 2.63)	-0.35	1.06*	1.41* (0.08 to 2.78)
Good self-rated health$^{\perp}$										
Owner occupiers										
Control 1	3,616	-0.02	0.08§	0.09* (0.004 to 0.18)	-0.04	0.05	0.08* (0.005 to 0.16)	-0.04	0.05§	0.09* (0.009 to 0.16)
Control 2	4,093	-0.01	0.06	0.07§ (-0.008 to 0.15)	-0.05	0.01	0.06§ (-0.006 to 0.13)	-0.04	0.02	0.06§ (-0.005 to 0.13)
Renters										
Control 1	2,091	-0.02	-0.15**	-0.13§ (-0.26 to 0.004)	0.01	-0.08§	-0.09 (-0.20 to 0.03)	0.008	-0.08§	-0.09 (-0.20 to 0.03)
Control 2	2,357	-0.02	-0.11*	-0.09 (-0.21 to 0.03)	0.002	-0.04	-0.05 (-0.15 to 0.06)	0.004	-0.05	-0.05 (-0.15 to 0.06)
Satisfied with life$^{\perp}$										
Retirees										
Non NRAs	3,706	-0.11*	-0.007	0.11* (0.01 to 0.20)	-0.09§	0.01	0.10* (0.009 to 0.20)	-0.08	0.03	0.11* (0.01 to 0.20)

Pre-NR: difference NRA and control prior to NR, NR: difference NRA and control for roll out of NR, DD: difference in the difference between NRA and control pre and post launch of NR.

$^{\perp}$Probability of reporting.

§Significant at p 0.1; * at p .05; ** at p 0.01; *** at p 0.001. Clustered standard errors on super output area.

$^{\Pi}$Included demographic and socioeconomic covariates are the same as in Table 2, except for the subgroup variable which is dropped as an explanatory variable e.g. for the retiree subgroup - the whole group of 'employment status' is dropped as an explanatory variable.

DISCUSSION

Explaining the lack of neighbourhood-wide improvement

NR failed to generate material or consistent health gains in NRAs over and above control areas. At best, we speculate that NR prevented widening of health inequalities over the Strategy period. NR may have had a role in supporting and safeguarding the results of mainstream provision of public services in areas that typically trail behind progress made in the rest of the country. The various NR projects may have been beneficial for the health of some individual participants, but at the population level our modelling did not detect salutary improvements to indicators of health as a result of NR. The findings of this research are consistent with previous NR evaluations[14,16]. Several other studies of ABIs show that, by and large, urban regeneration programmes have not secured affirmative health impacts at the aggregate level[18–20,29–34].

Within the NRAs, healthy lifestyle initiatives, as well as actions to improve neighbourhood environments, services and amenities, may not have been delivered in adequate dose or duration to stimulate or support lifestyle changes or impact on significant proportions of the populations served. The concept of "dose" is more complex for public health interventions than it is, for example, for pharmaceutical interventions. It must embrace both *reach* (the fraction of the population affected) and implementation *strength* (which may be measured differently according to the type of intervention e.g. frequency and duration of intervention components). The concept of dose is further complicated where an intervention acts at different socio-ecological levels that have multiple different mechanisms of action[35,36]. The evaluation of GoWell housing regeneration in Glasgow found that reductions in health inequalities were confined to 'higher investment areas'[37]. Mental health improvements achieved through the Dutch District Approach were limited to districts that implemented more intensive programmes[31]. The Well London initiative only found tentative evidence of progress on some health outcomes in 'higher exposure areas'[33,38]. Moreover, the NDC policy in England was much more heavily resourced than NR[16] but nonetheless there was limited and conflicting evidence of benefit. The government commissioned evaluation found a significant mental health uplift, however, subsequent academic evidence did not find a statistically robust impact on mental health[18,20].

The effect of NR interventions on health may differ from one NRA to the next. Since decision making was devolved to local partnerships, for some areas, health was a top priority, while for others it did not feature highly in annual reports[15]. Therefore, pooling all NRAs into a single entity, to conserve statistical power may mask different effects in diverse NRAs. Stakeholders' views expressed in the statutory evaluation of NR also revealed that the partnership model underpinning NR took time to establish in some areas, which previously had little experience of working between voluntary and community sectors and statutory bodies[16]. NR-sponsored interventions were not implemented instantaneously with the policy launch in 2003[14] and so lead-in times may also result in a lag for results to be realised.

Many factors that affect people's health and wellbeing accumulate over the life course. Early childhood experiences affect later life behaviours and health. It may be unrealistic to expect that having greater access to healthy lifestyle classes would significantly alter lifetime diet and physical

activity habits. The surveys used for the present research were not designed to measure individual exposure or participation in any one component of the interventions. If anything, misclassification of individual level exposures might bias putative effects towards the null. Where interventions do lead to the adoption of healthier lifestyles, the benefits of changes may also take a long time to manifest. Additionally, any enhanced educational, developmental and environmental opportunities for children and adolescents in NRAs, as well as the initiatives tackling workless-ness and improving training opportunities for adults in NRAs, may only pay health dividends in the longer term.

Strengths and limitations of the current study

Compared to several other ABI evaluations, this quasi-experimental study of a complex real-world intervention offers a longer follow-up than most, with twelve year longitudinal data. The investigation benefits from a substantial sample size, however, power was limited for subgroups and eroded somewhat by attrition. We concede that subgroup analysis is best reserved for hypothesis generation and is typically underpowered[39]. The small effect sizes are comparable to results in parallel studies[19,29,40].

Contamination of controls by NR spillover effects cannot be completely excluded. This cannot be tested, since we do not know whether respondents outside NRAs participated in NR health initiatives. However, the views of stakeholders documented in the statutory NR evaluation indicate there was an active effort to minimise spillovers and keep interventions targeted[16].

The research employs evaluation methods advocated by Medical Research Council natural experiment guidance[41,42] and can be replicated. The rich dataset permits adjustment to control for multiple demographic and socioeconomic factors that change over time, though unmeasured confounders may still prevail. The nature of secondary data did not permit measurement of NR participation; however, small household surveys carried out by the NI Housing Executive in NRAs indicated fairly low levels of awareness and involvement in NR[43].

This research expands and complements an existing government-commissioned evaluation[14,16]. The outcome measures of this study offer a superior signal of NR influence on health than mortality statistics which the government uses to inform judgement, since there is a long lagged effect on mortality and many more contributing causes.

While we had insufficient access to local financial information on how NR investments were focussed, we acknowledge that a return on investment appraisal would be a valuable addition to ABI evaluation.

Furthermore, since local government did not prescribe detailed reporting of the types of intervention and the components of NR, it proved impossible for us to gauge intensity of the different elements, making it difficult to discern what was effective and where. Whitehead proposed a typology of interventions to reduce inequalities: those that strengthen individuals; those that strengthen communities; those that improve living conditions and physical environments; and those that change macro-level policies[44,45]. It is likely that NR included, to varying extents, elements of the first three types and the approach was more 'universal', than targeted within the NRAs. Whitehead's typology, however, does not explicate distinct mechanisms to combat inequalities. Some interventions may span different socioecological levels. Interventions which notionally act at the

level of the population, such as the changing of social norms, ultimately affect individual behaviours but for people whose sensitivities to norms are different, the change in norms (its magnitude or "dose") may need to be different[46]. Area-based policy by itself may not be sufficient to tackle inequalities and policymakers might consider blended approaches to target the most disadvantaged individuals or groups, while still retaining certain population wide measures, borne out by recent modelling studies[47–49]. We speculate that securing health impacts through ABIs requires a higher dose of intervention delivery than NR in NI, and within intervention areas it may be appropriate to focus resources on selected vulnerable groups.

CONCLUSION

This study does not find a material health impact from an extensive area-based urban regeneration policy in NI. In the UK and several European countries long term ABIs have been phased out, which may be justified given the results presented here and elsewhere. However, since we have no access to the counterfactual, it is possible that without NR, health inequalities might have further increased. More research is required to judge what and how particular groups within disadvantaged areas may benefit from such initiatives. It may also be interesting to investigate whether the phasing out of ABIs will affect health inequalities in areas that previously benefited from regeneration policies.

OTHER INFORMATION

Contributors
GM, AL and FK designed the study. GM collated the data and conducted data analysis; GM drafted the paper; all authors contributed to interpreting results, revised the draft and approved the final version.

Licence for Publication
The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non-exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd to permit this article (if accepted) to be published in JECH and any other BMJPGL products and sub licences such use and exploit all subsidiary rights, as set out in our licence (http://group.bmj.com/products/journals/instructions-for-authors/licence-forms).

Competing Interest
None declared.

Ethics approval
Ethical approval for this research project was given by Queen's University Belfast School of Biology Ethics Committee.

Provenance and peer review
Not commissioned; externally peer reviewed.

Data sharing statement
The data used in this study are available through the UK Data Archive (http://data-archive.ac.uk/).

REFERENCES

1. Department for Social Development. *Neighbourhood Renewal - People and Place*. Belfast: Department for Social Development; 2003.
2. The Portland Trust. *Economics in Peacemaking: Lessons from Northern Ireland*. London: The Portland Trust; 2007.
3. O'Hearn D. Peace Dividend, Foreign Investment, and Economic Regeneration: The Northern Irish Case. *Soc Probl*. 2000;47(2):180-200.
4. O'Hearn D. How has Peace Changed the Northern Irish Political Economy? *Ethnopolitics*. 2008;7(1):101-118.
5. Bunting B, Ferry F, Murphy S, O'Neill SM, Bolton D. Trauma Associated With Civil Conflict and Posttraumatic Stress Disorder: Evidence From the Northern Ireland Study of Health and Stress. *J Trauma Stress*. 2013;26:134-142.
6. Ferry F, Bolton D, Bunting B, Devine B, McCann S, Murphy S. *Trauma, Health and Conflict in Northern Ireland*. Omagh: The Northern Ireland Centre for Trauma and Transformation; 2008.
7. Muldoon OT, Downes C. Social identification and post-traumatic stress symptoms in post-conflict Northern Ireland. *Br J Psychiatry*. 2007;191:146-149.
8. O'Reilly D, Stevenson M. Mental health in Northern Ireland: have "the Troubles" made it worse? *J Epidemiol Community Health*. 2003;57(7):488-492.
9. Tomlinson MW. War, peace and suicide: The case of Northern Ireland. *Int Sociol*. 2012;27(4):464-482.
10. Bell J. *Voice for All*. Belfast: Institute for Conflict Research; 2008.
11. Morrissey M, Smyth M. *Northern Ireland after the Good Friday Agreement: Victims, Grievance and Blame*. London: Pluto Press; 2002.
12. Social Exclusion Unit. *A New Commitment to Neighbourhood Renewal: National Strategy Action Plan*. London: Social Exclusion Unit; 2001.
13. Northern Ireland Statistics and Research Agency. Northern Ireland Census 2001. http://www.ninis2.nisra.gov.uk/public/Theme.aspx?themeNumber=-3&themeName=Neighbourhood+Renewal. Accessed April 30, 2017.
14. Department for Social Development. *People and Place Renewal Mid–Term Review*. Belfast: Department for Social Development; 2011.
15. Department for Communities, Neighbourhood Renewal Partnerships. Neighbourhood Renewal Annual Reports. 2013. https://www.communities-ni.gov.uk/articles/resources-neighbourhood-renewal-partnerships. Accessed April 27, 2017.
16. RSM McClurre Waters. *Neighbourhood Renewal A Final Evaluation*. Belfast: Department for Social Development; 2014.
17. Department for Communities and Local Government. *The New Deal for Communities Experience: A Final Assessment*. London: Department for Communities and Local Government; 2010.
18. Popay J, Whitehead M, Carr-hill R, et al. The impact on health inequalities of approaches to community engagement in the New Deal for Communities regeneration initiative: a mixed-methods evaluation. *Public Heal Res*. 2015;3(12).
19. Stafford M, Badland H, Nazroo J, et al. Evaluating the health inequalities impact of area-based initiatives across the socioeconomic spectrum: a controlled intervention study of the New Deal for Communities, 2002-2008. *J Epidemiol Community Health*. 2014;68(10):979-986.
20. Walthery P, Stafford M, Nazroo J, et al. Health trajectories in regeneration areas in England: the impact of the New Deal for Communities intervention. *J Epidemiol Community Health*. 2015;69(8):762-768.
21. Access Research Knowledge. ARK Northern Ireland NIHPS training workshop. 2003. http://www.ark.ac.uk/nihps/NIHPS_ws_1.ppt. Accessed April 27, 2017.
22. Northern Ireland Statistics and Research Agency. *Multiple Deprivation Measure 2005*. Belfast:

Northern Ireland Statistics and Research Agency; 2005.

23. Lechner M. The Estimation of Causal Effects by Difference-in-Difference Methods. *Found Trends Econom*. 2011;4(3):165-224.

24. Karaca-Mandic P, Norton EC, Dowd B. Interaction Terms in Nonlinear Models. *Health Serv Res*. 2012;47(1):255-274.

25. Athey S, Imbens G. Identification and inference in nonlinear difference-in-differences models. *Econometrica*. 2006;74(2):431-497.

26. Villa JM. *Simplifying the Estimation of Difference in Differences Treatment Effects with Stata*. University Library of Munich, Germany; 2013.

27. Madden D. Mental stress in Ireland, 1994-2000: a stochastic dominance approach. *Health Econ*. 2009;18(10):1202-1217.

28. Goldberg DP, Oldehinkel T, Ormel J. Why GHQ threshold varies from one place to another. *Psychol Med*. 1998;28(4):915-921.

29. Droomers M, Jongeneel-Grimen B, Kramer D, et al. The impact of intervening in green space in Dutch deprived neighbourhoods on physical activity and general health: results from the quasi-experimental URBAN40 study. *J Epidemiol Community Heal*. 2016;70:147-154.

30. Jalaludin B, Maxwell M, Saddik B, et al. A pre-and-post study of an urban renewal program in a socially disadvantaged neighbourhood in Sydney, Australia. *BMC Public Health*. 2012;12(1):521.

31. Jongeneel-grimen B, Droomers M, Kramer D, et al. Impact of a Dutch urban regeneration programme on mental health trends: a quasi-experimental study. *J Epidemiol Community Heal*. 2016;70:967-973.

32. Kelaher M, Warr DJ, Tacticos T. Evaluating health impacts: Results from the neighbourhood renewal stratgey in Victoria, Australia. *Heal Place*. 2010;16(5):861-867.

33. Phillips G, Bottomley C, Schmidt E, et al. Measures of exposure to the Well London Phase-1 intervention and their association with health well-being and social outcomes. *J Epidemiol Community Heal*. 2014;68(7):597-605.

34. Ruijsbroek A, Wong A, Kunst AE, Brink C Van Den. The impact of urban regeneration programmes on health and health-related behaviour: Evaluation of the Dutch District Approach 6 . 5 years from the start. *PLoS One*. 2017;12(5):1-13.

35. Center for Community Health and Evaluation, Kaiser Permanente. Healthy Dose: A toolkit for boosting the impact of community health strategies. 2015;(August):1-30. https://share.kaiserpermanente.org/wp-content/uploads/2016/04/DoseToolkitVersion1.1-1.pdf.

36. Schwartz P, Rauzon S, Cheadle A, Permanente K. *Dose Matters: An Approach to Strengthening Community Health Strategies to Achieve Greater Impact*. Washington, D.C.; 2015.

37. Egan M, Kearns A, Katikireddi S V, Curl A, Lawson K, Tannahill C. Proportionate universalism in practice? A quasi-experimental study (GoWell) of a UK neighbourhood renewal programme's impact on health inequalities. *Soc Sci Med*. 2016;152:41-49.

38. Phillips G, Bottomley C, Schmidt E, et al. Well London Phase-1: results among adults of a cluster-randomised trial of a community engagement approach to improving health behaviours and mental well-being in deprived inner-city neighbourhoods. *J Epidemiol Community Heal*. 2014;68(7):606-614.

39. Egan M, Kearns A, Mason P, et al. Protocol for a mixed methods study investigating the impact of investment in housing, regeneration and neighbourhood renewal on the health and wellbeing of residents: the GoWell programme. *BMC Med Res Methodol*. 2010;10:41.

40. Kramer D, Jongeneel-Grimen B, Stronks K, Droomers M, Kunst AE. Are area-based initiatives able to improve area safety in deprived areas? A quasi-experimental evaluation of the Dutch District Approach. *BMC Public Health*. 2015;15(1):711.

41. Craig P, Manager P, Cooper C, et al. *Using Natural Experiments to Evaluate Population Health Interventions: Guidance for Producers and Users of Evidence*. London: Medical Research

Council; 2008.

42. Craig P, Cooper C, Gunnell D, et al. Using natural experiments to evaluate population health interventions: New Medical Research Council guidance. *J Epidemiol Community Health*. 2012;66(12):1182-1186.

43. Northern Ireland Housing Executive. Northern Ireland Housing Executive Neighbourhood Renewal Surveys. http://www.nihe.gov.uk/search?q=neighbourhood renewal. Accessed April 27, 2017.

44. Bambra C, Hillier F, Cairns J, Kasim A, Moore H, Summerbell C. How effective are interventions at reducing socioeconomic inequalities in obesity among children and adults? Two systematic reviews. *Public Heal Res*. 2015;3(1).

45. Whitehead M. A typology of actions to tackle social inequalities in health. *J Epidemiol Community Health*. 2007;61(6):473-478.

46. Kimbrough EO, Vostroknutov A. *Norms Make Preferences Social*. Burnaby; 2013. http://www.sfu.ca/econ-research/RePEc/sfu/sfudps/dp13-01.pdf.

47. Kypridemos C, Allen K, Hickey GL, et al. Cardiovascular screening to reduce the burden from cardiovascular disease: microsimulation study to quantify policy options. *BMJ*. 2016;353(14):i2793.

48. Spruijt-Metz D, Hekler E, Saranummi N, et al. Building new computational models to support health behavior change and maintenance: new opportunities in behavioral research. *Transl Behav Med*. 2015;5(3):335-346.

49. Winston FK, Puzino K, Romer D. Precision prevention: time to move beyond universal interventions. *Inj Prev*. 2016;22(2):87-91.

---

[i] It is worth noting that while the thirty-six NR areas (NRAs) were ranked similarly on deprivation measures, individually these areas differed in their community characteristics, socio-economic conditions and population size. For example, in 2001, the average population across NRAs was 7,700 persons, but the largest NRA, Inner East Belfast (20,500 persons), had a population twenty-six times that of the smallest NRA, Dungannon (780 persons).

[ii] Usage number 83566.

[iii] The coding for the geographic indicator of super output areas (soas) in NI does not follow the same 'two layer' coding as in England and Wales of lower super output areas (lsoas) and middle layer super output areas (msoas). The 'soas' created by the Northern Ireland Statistics Agency in 2001 were based on electoral wards and the soas were constructed on ward-by-ward basis, accounting for measures of population size and mutual proximity. In NI there is only a single 'super output area' (soa) layer. Soas have an average population of 2,000 (range 900 to 4,200).

[iv] Linear models are used because of the difficulty interpreting interaction terms in non-linear models, documented difference-in-difference methods literature[24,25].

[v] As a sensitivity check we also included those who migrate in/out of NRAs over the study and found the results did not substantially change. These results are available on request from the corresponding author.

[vi] Low educated: GCSE qualifications (mandatory secondary education in the UK) or lower (includes qualifications lower than GCSE level and no qualifications).