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Proportionate universalism in practice? A quasi-experimental study (GoWell) of a UK neighbourhood renewal programme's impact on health inequalities

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ABSTRACT

Recommendations to reduce health inequalities frequently emphasise improvements to socio-environmental determinants of health. Proponents of 'proportionate universalism' argue that such improvements should be allocated proportionally to population need. We tested whether city-wide investment in urban renewal in Glasgow (UK) was allocated to 'need' and whether this reduced health inequalities. We identified a longitudinal cohort (n = 1006) through data linkage across surveys conducted in 2006 and 2011 in 14 differentially disadvantaged neighbourhoods. Each neighbourhood received renewal investment during that time, allocated on the basis of housing need. We grouped neighbourhoods into those receiving 'higher', 'medium' or 'lower' levels of investment. We compared residents' self-reported physical and mental health between these three groups over time using the SF-12 version 2 instrument. Multiple linear regression adjusted for baseline gender, age, education, household structure, housing tenure, building type, country of birth and clustering. Areas receiving higher investment tended to be most disadvantaged in terms of baseline health, income deprivation and markers of social disadvantage. After five years, mean mental health scores improved in 'higher investment' areas relative to 'lower investment' areas (b = 4.26; 95% CI = 0.29, 8.22; P = 0.036). Similarly, mean physical health scores declined less in high investment compared to low investment areas (b = 3.86; 95% CI = 1.96, 5.76; P < 0.001). Relative improvements for medium investment (compared to lower investment) areas were not statistically significant. Findings suggest that investment in housing-led renewal was allocated according to population need and this led to modest reductions in area-based inequalities in health after five years. Study limitations include a risk of selection bias. This study demonstrates how non-health interventions can, and we believe should, be evaluated to better understand if and how health inequalities can be reduced through strategies of allocating investment in social determinants of health according to need.

1. Introduction

Differences in health status between social groups are frequently recognised as avoidable and unfair (Graham, 2007; Marmot et al., 2010). In the UK, such differences are usually termed health inequalities, whilst elsewhere the term 'health inequities' predominates. Successive national and international public health strategies, including those advanced by the World Health Organisation (WHO), have emphasised the reduction of

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health inequalities by tackling socio-structural and environmental determinants of health (Bambra et al., 2011; Dahlgren and Whitehead, 2006; Graham, 2007; WHO, 2008). An emphasis on these broader determinants of health suggests a need for public health policy to extend its reach beyond the health sector, seeking improvements across a wide range of social domains including homes and neighbourhoods (Braveman et al., 2011; Hunter et al., 2010; Marmot, 2005). Empirical and theoretical research into housing and neighbourhood improvement interventions have indicated a range of pathways by which such interventions may improve the health of residents living in disadvantaged areas (Mehdipanah et al., 2015; Thomson, 2015) but there is relatively little evidence on whether such interventions reduce health inequalities or what mechanisms may drive such reductions (Droomers et al., 2014; Mehdipanah et al., 2014; Stafford et al., 2014).

Reducing health inequalities involves improving health for the most disadvantaged members of the population to a greater degree than for others (Graham, 2007; Macintyre, 2007). Health strategies have considered resource allocation to be an important mechanism for achieving this differential improvement, if resources that benefit health can be allocated in greater quantities to those population sub-groups who are most in need. Commentators such as Graham (2007) and Marmot et al. (2010) have argued that simple targeting of the most disadvantaged populations for intervention is problematic. Such an approach fails to recognise the health needs of other sections of the population, some of whom will also be disadvantaged to some degree even if they are not identified as targets for specific interventions.

The 'Marmot Review' into health inequalities in England argued that resource allocation must benefit all social strata but those benefits should increase according to need: "To reduce the steepness of the social gradient in health, actions must be universal, but with a scale and intensity that is proportional to the level of disadvantage" (Marmot et al., 2010, p.15). However, this strategy of 'proportionate universalism' has potential operational challenges that have not been explored in detail in the public health literature, particularly within the context of improving social determinants of health (Hutt and Gilmour, 2010). We suggest that these challenges include questions of how need or disadvantage is to be defined and measured, the proportion of resource that should be allocated to different need-levels, and the means of ensuring that different allocations of resource reach their intended sub-populations (see also Mackenzie et al., 2012).

Some studies have found that countries, such as Nordic states, with more universal policies tend to have lower rates of inequalities (Eikemo et al., 2008; Niedzwiedz et al., 2014). One argument advanced to explain this holds that universalism destigmatises and increases the acceptability of government spending on health and welfare (McKee and Stuckler, 2011). Whilst all members of society may be potential recipients, the benefits of such entitlements may be felt more according to an individual's level of disadvantage. Benach et al. (2011, 2012) highlight a difference between universal policies that include some additional targeting of deprived populations, and proportionate universalism that increases benefits along the social gradient. They argue that proportionate universalism may include universal policies that lead to a pattern of benefits mirroring the social gradient, or it may result from more prescriptive attempts to allocate resources proportionally across that gradient (Benach et al., 2012, 2011).

One type of resource that can be differentially allocated according to need is investment in housing-led renewal. Renewal is often delivered to selected neighbourhoods and considered a form of Area-Based Intervention (ABI) with the potential to modify structural and environmental determinants of health inequalities (Gibson et al., 2011; Thomson et al., 2006, 2013). Housing-led renewal varies in cost and composition depending on the type and quality of exposed homes and neighbourhoods. For example, implementers may assess houses, streets or neighbourhoods as requiring no additional improvements, minor repairs, substantial home improvement, investment in community organisations, new neighbourhood amenities, environmental neighbourhood improvements or demolitions and rebuilding of entire neighbourhoods (Curl et al., 2014; Durie and Wyatt, 2007; Kearns et al., 2009). The level of investment required to meet these different needs varies greatly. Furthermore, whilst renewal programmes are often not directed at affluent areas, there still remains scope to allocate different levels of investment to differentially deprived neighbourhoods. For example, in the study setting reported here (Glasgow, UK), 42% of the city's neighbourhoods meet the Scottish Government's definitions of 'deprived' (Scottish Government, 2013) but more detailed assessments of deprivation and need influence the targeting of investment in renewal across such areas (Glasgow City Council, 2009).

Renewal programmes such as those taking place in Glasgow reflect increasing international criticism of narrowly targeted intervention strategies that have been a feature of both social policy and public health debates in recent decades. For example, in the 1960's and 1970's, urban renewal projects funded under the UK Urban Programme targeted areas of 'special need' or multiple deprivation (Atkinson and Moon, 1994), an approach which became known as 'worst first'. Calls to move beyond the 'worst first' approach in the 1990's led to a broadening focus on 'at risk' areas, as well as the most deprived (Home, 2010). These developments parallel public health arguments put forward in support of proportionate universalism and 'the need to redirect existing resource from crisis intervention to crisis prevention' (Marmot et al., 2010, p.17). They provide a context for renewal programmes that target many areas with a range of disadvantages, compared to more intensive programmes that focused resources on a smaller number of the areas considered to be most disadvantaged.

As stated above, the impacts on health inequalities of population-level interventions affecting social determinants of health are rarely evaluated (Bambra et al., 2010; Katikireddi et al., 2011) and the hypothesis that reductions in health inequalities should occur if renewal investment is allocated proportionally to need has yet to be tested (Fenwick et al., 2013). It is possible to counter-hypothesise that reductions may not occur within specific timescales (Egan et al., 2013). For example, the most costly housing-renewal interventions (e.g. neighbourhood demolition and rebuild) can take years or decades to complete, leading to social upheaval and adverse consequences (Fullilove, 2004). In comparison, less disadvantaged residents may benefit from small-scale housing improvement without major disruption or delay (Egan et al., 2013).

Specifically, there is a recognised need for better evidence to support frequently stated policy assumptions that housing-led urban renewal contributes to public health goals, particularly given the huge investment in this form of intervention (Kearns et al., 2009). Widely acknowledged difficulties in conducting such robust evaluations are likely to have contributed to the relative dirth of empirical studies (Bond et al., 2013) and may help explain why no previous study has explored the effects of proportionally allocated investment in housing-led renewal on health inequalities.

This study aims to investigate whether calls for 'proportionate universalism' delivered as part of a social determinants of health strategy could be adhered to within urban renewal, with consequent impacts upon health inequalities. Our first objective was to examine the degree to which investment in the programme of housing-led renewal in Glasgow was allocated according to need. We then ask whether differential investment led to changes in self-

reported physical and mental health conducive to a reduction in health inequalities over a five year period amongst adult householders living in these neighbourhoods.

2. Methods

The study is a quasi-experimental evaluation of a natural experiment with a prospective, comparative design (Egan et al., 2010). It uses linked survey data collected for a research programme, GoWell, from which we identified a 5 year longitudinal cohort. The researchers were not responsible for intervention planning, implementation or allocation. GoWell received ethical approval from NHS Scotland B MREC committee in 2005 (05/MRE10/89).

2.1. Study context

This study was conducted in disadvantaged neighbourhoods in the city of Glasgow, Scotland (UK). Publicly owned housing stock was transferred to an independent housing association, Glasgow Housing Association (GHA) in 2003 (Kearns and Lawson, 2009). A £1.4 billion housing-led urban renewal programme was then planned over ten years. Investment was allocated according to surveyor reports, routine data on housing and social issues, stakeholder (including residents') consultations and local knowledge. By 2011, interventions included: 40,000 heating improvements, 36,000 kitchen improvements, 28,000 dwellings over-clad, and 26,000 re-roofings (Glasgow Housing Association, 2010). Homes could receive multiple, single or no improvements within and across investment categories. Eight neighbourhoods were allocated long term (>10 years) programmes of neighbourhood demolition, redesign and new build. GHA also funded 'social programmes' (i.e. interventions addressing residents' social needs, such as debt management services, employment support, playgrounds, anti-social behaviour services/initiatives and support for vulnerable residents).

In consultation with GHA and other stakeholders, we identified 14 study areas with a combined population of 25,790 households (19,431 were GHA owned), where the timetable for intervention delivery was compatible with our planned study period. Each area was considered a 'neighbourhood' by the implementers, although it is recognised that residents vary in their individual opinions about what constitutes their neighbourhood. Housing improvement and social interventions occurred across all the areas. Four areas experienced demolition and two of these were sites for new builds. Of the £271,255,300 investment allocated across the 14 areas during the study period (2006–11), 40% and 29% went to external and internal home improvements respectively; 18% to new homes; 7% to demolition and 6% on social programmes.

2.2. Data collection

Similar to the New Deal for Communities evaluation, the only other major UK study of differential health impacts following neighbourhood renewal (Walthery et al., 2015), this study takes the form of a longitudinal sample identified from participants who took part in a repeat cross-sectional survey of householders (a nested longitudinal sample). Retrospective matching of names, age, gender and addresses were used to identify longitudinal cases embedded in the surveys (see Fig. 1).

We conducted repeated cross-sectional surveys of households situated in 14 neighbourhoods across Glasgow receiving the intervention. Sampled households participated following recruitment based on prior informed consent. The surveys reported here were conducted in 2006 (baseline), and 2011 (follow-up). In randomly sampled addresses in each study area, one consenting adult per household received face-to-face structured interviews. The surveys achieved response rates of 50.2% and 45.8%, respectively. Around a fifth (n = 1006) of baseline participants also took part in surveys of the same neighbourhoods at five years follow-up. The process of matching from two cross-sectional surveys to create the longitudinal sample makes estimates of selective loss to attrition problematic, as not all the baseline participants would be included in the sampling frame for follow-up. Nonetheless we assume that both selective response and attrition occurred (see our Limitations section).

2.3. Outcome health variables

Self-reported mental and physical health were measured using mean component scores derived from SF-12 version 2 (Ware et al., 2005). SF-12v2 scores are computed from responses to twelve questions and range from 0 to 100 with higher scores indicating better health. More details are provided in the online supplemental document.

2.4. Independent variables

2.4.1. Measure of renewal investment

GHA provided area-level data on its investments aggregated across the five year period (2006–2011). The 14 areas were then categorized into three groups according to mean investment per household over the five years: (i) <£5000 ('lower' investment), (ii) £5000–£10,000 ('medium' investment), or (iii) >£10,000 ('higher' investment). These thresholds based on simple (albeit arbitrary) multiples of £5,000, were selected *a priori* to avoid post-hoc selections that might produce multiplier effects upon the outcomes. We have categorised areas for our analysis by the amount of investment they received, not how that investment was spent. The areas received different types and combinations of renewal but these were all part of what implementers and researchers perceived to be the same high level complex intervention: namely, an investment programme in locally tailored, multi-faceted neighbourhood renewal. This approach follows a rationale previously articulated by Hawe et al. (2004) It centres on viewing a complex intervention as having a high level 'function' (in this case, investment in renewal); and a variety of different local 'forms' tailored to contexts to achieve this function (in this case, different combinations of housing improvement, social programme, demolition and new build). So long as 'fidelity' to the high level function is adhered to, it is legitimate to include areas with a variety of different forms into the same analysis.

2.4.2. Other variables

Our main analysis adjusted for characteristics that we previously theorized to be potential confounding variables: gender, age (16–39, 40–64 and >64 years), education (no qualification or some qualification), household structure (adult only, or living with children), housing tenure (owner occupied, rented), and building type (house, low-rise flat, high-rise flat). We also included country of birth (born in the UK, or born outside the UK) as several neighbourhoods included a large migrant sub-group (Egan et al., 2010). All variables were based on participant self-reporting with two exceptions: building type and area of residence were assessed by researchers. Income deprivation and Glasgow deprivation deciles were calculated using the data from the Scottish Index of Multiple Deprivation (SIMD): an index of measures used by the Scottish Government and others as area-level proxies for relative poverty. The process for matching study area boundaries to SIMD data is described elsewhere (Walsh, 2008) and summarised in the

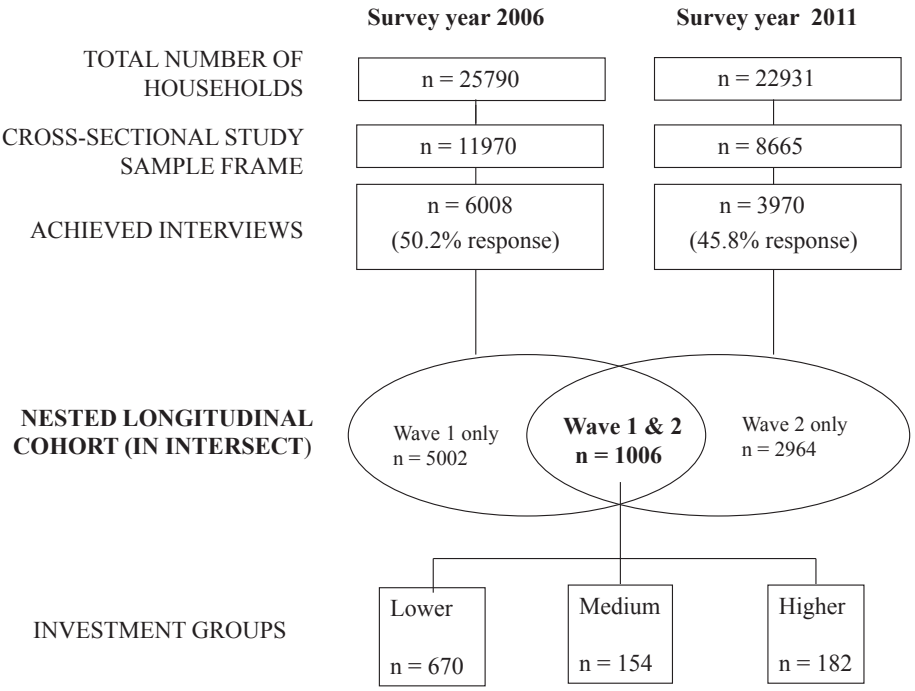

Fig. 1. The study sample. Note: The sample frame includes one adult householder for each sampled household. The respective cross sectional response rates for low, medium and higher investment groups were 50.2% (n = 3617 participants), 53.2% (n = 910), and 48.8% (n = 1481) at 2006 (wave 1) and 46.7% (n = 2308), 45.6% (n = 702) and 44.1% (n = 960) at 2011 (wave 2). The total number of households in the lower, medium and higher investment groups were 18,318, 2803 and 4669 households respectively at wave 1; and 16,910, 2619 and 3402 at wave 2.

supplemental online document. More details on all the study variables are provided in the supplemental online document.

2.5. Analyses

In 2013 an analysis plan was developed to test whether GHA's investment allocation corresponded to area-level baseline income deprivation estimated from government statistics, and SF-12v2 heath scores (using both GoWell's baseline cross-sectional survey and the nested longitudinal cohort).

In 2014 we tested for change in mental and physical health SF-12v2 scores over the five year period, using a difference-in-difference comparative analysis. The lower investment group was the reference group, against which the medium and higher investment groups were compared. We adjusted for potential confounders. Of the 1006 individuals included in the data set, 966 had no missing data. All analyses were carried out using Stata/IC 11.1 on the subset of complete data (Statacorp, 2005). Multiple regression models based on robust standard errors were used to take into account the non-independence of respondents within each of the 14 areas.

Previous GoWell analysis had indicated the possibility that education and country of birth may interact with main effects so we tested for interactions (Egan et al., 2013). We conducted sensitivity analyses that included adjustment for baseline health, and further analyses excluding social renewal investment to test if including the social programme had affected results. As a sensitivity analysis we tested interactions between survey wave and study group using the larger repeat cross-sectional sample: this had higher statistical power compared to the nested longitudinal study, but it included residents who may only have resided in the study areas for part of the study period.

3. Results

3.1. Investment and 'need'

Fig. 1 shows how the nested longitudinal sample divided between the 3 study groups: the lower investment group included 670 longitudinal participants, compared to 154 in the medium investment group and 182 in the higher investment groups.

The supplemental online document contains more details of the areas in each study group. It can be seen that lower investment areas were more likely to be large estates built in the 1930's, 50's and 60's, before Glasgow's high rise construction was fully underway. In contrast, higher investment was often allocated to mass housing estates that included high and low rise buildings constructed in the 1960's and 70's: these were smaller than some of the earlier estates but their higher mean investment per household per area reflected perceptions about the concentrations of structural and social problems that affect some high rise estates. The larger number of participants in the lower investment group reflected the larger total household population for that group.

Table 1 summarises information on the investment, interventions, population, deprivation and self-reported health for each study area. Six areas received relatively low investment (<£5000 investment per household), three received medium investment (£5000–10,000) and five received high investment (>£10,000) over the study period. The investment range per household per area was from £1907 to £29,511 (Table 1). Most (n = 10) areas received funding for the housing improvement and social programmes only. Two areas with relatively high investment received home improvements, the social programme, demolition and new builds. One lower and one medium investment area received investment in housing improvement, social programme and demolition.

The higher investment group consisted of highly deprived areas

Table 1
Investment per household in GoWell areas between 2006 and 11, estimated baseline income deprivation and mean self-reported health per area.

Study area	Investment per household investment per household	Investment type	% Income deprived households	Income deprivat-ion decile	House-holds W1 (n)	Mental health[a]	Physical health[a]
Lower investment group (<£5000 per household)							
1	£1906.88	HI, SP	27.1	6	2633	48.29	46.35
2	£2606.36	HI, SP	39.9	9	2293	51.51	49.39
3	£3406.81	HI, SP	43.2	9	4644	47.30	47.50
4	£3501.26	HI, SP	28.6	7	4159	48.99	48.54
5	£3602.35	HI, SP, D	34.8	8	2518	49.63	50.57
6	£4033.89	HI, SP	29.0	7	2071	52.23	49.76
Medium investment group (£5000–10,000 per household)							
7	£6151.98	HI, SP, D	24.6	6	912	47.98	49.96
8	£7184.60	HI, SP	29.1	7	1281	49.83	46.97
9	£9257.33	HI, SP	42.1	9	610	44.92	45.64
Higher investment group (>£10,000 per household)							
10	£11,905.05	HI, SP	54.1	10	535	46.27	45.03
11	£13,269.89	HI, SP	50.0	10	1109	46.81	43.91
12	£14,002.97	HI, SP, D, NB	52.2	10	1140	45.31	46.23
13	£24,062.80	HI, SP, D, NB	38.8	9	1456	46.94	48.20
14	£29,510.97	HI, SP	42.1	9	429	47.34	47.52

Notes: Investment per household is the average investment per occupied home in each area over the 5 year period, including all the activities listed in the 'Investment Type' column. Investment data provided by Glasgow Housing Association (unpublished data). Income deprivation estimates calculated from data available from Scottish Neighbourhood Statistics (www.sns.gov.uk), with income deprivation decile relative to the city of Glasgow.
HI = housing improvement; SR = social programme; D = demolition; NB = new built homes.
[a] Mean SF-12v2 mental and physical health scores (higher = better) from GoWell cross-sectional survey 2006 (n = 6004).

at baseline whereas the lower and medium investment groups included a broader range of area deprivation (Table 1). For example, city-level income deprivation deciles for areas in the higher investment group ranged from 9 to 10, compared to a range of 6–9 in both the lower and medium investment groups (higher = more deprived).

Mean physical and mental health SF-12v2 scores at baseline tended to be lower (indicating worse health) in the group that received higher levels of investment; and highest (indicating better health) in the lower investment group. This was true for both the cross-sectional and longitudinal samples: mean scores summarised in Table 2.

A supplemental document available online presents several other markers of baseline disadvantage fitting the pattern of lower, medium and higher levels of disadvantage corresponding to the lower, medium and higher investment groups. This pattern was found for the proportion of the population living in high rise flats; living in rented property; and being non-UK-born migrants. The prevalence of residents with educational qualifications did not follow this pattern.

3.2. Change in self-reported health by level of investment

Table 3 shows that between baseline and 5 year follow-up, mean SF-12v2 mental health scores had decreased by 0.09 in the lower investment group and risen by 1.31 and 3.39 in the medium and higher investment groups respectively. The relative increase was only significant for the higher investment group (b = 4.26; 95% CI = 0.29, 8.22; P = 0.036), indicating an improvement in mental health compared with the lower investment group after adjustment.

Between baseline and follow-up, mean SF-12v2 physical health scores fell by 6.61, 5.38 and 4.47 in the lower, medium and higher

Table 3
Difference–in-differences analysis of mean mental and physical SF-12v2 scores in lower, medium and higher investment groups: adjusted regression of longitudinal sample.

Study group	Mean score		b	SE	P value	(95% CI)	
	Year						
	2006	2011					
SF-12v2 mental health score (higher = better)							
Lower investment	*48.98*	*48.89*	*0.00*				
Medium investment	48.03	49.34	1.72	1.43	0.240	−1.21	4.64
Higher investment	47.06	50.45	4.26	1.94	0.036	0.29	8.22
SF-12v2 physical health score (higher = better)							
Lower investment	*48.12*	*41.51*	*0.00*				
Medium investment	47.15	41.77	1.48	1.42	0.307	−1.42	4.37
Higher investment	45.06	40.59	3.86	0.93	<0.001	1.96	5.76

b = beta coefficient; SE = robust standard error; CI = confidence interval.
Notes: Physical and mental health scores were analysed separately based on 966 complete cases. The dependent variable was obtained by subtracting SF-12v2 scores at 2006 from SF-12v2 scores at 2011. Findings adjusted for baseline gender, age, education, household structure, housing tenure, building type and country of birth.

Table 2
Baseline (2006) mean SF-12v2 scores by lower, medium and higher investment groups, for cross-sectional and nested longitudinal samples.

	Lower investment	Medium investment	Higher investment	Lower vs medium investment P	Lower vs higher investment P
Mean SF-12v2 mental health score (higher = better)					
Cross-sectional	49.64	48.05	46.39	<0.001	<0.001
Longitudinal	48.98	48.03	47.06	0.280	0.020
Mean SF-12v2 physical health score (higher = better)					
Cross-sectional	48.70	47.39	46.09	<0.001	<0.001
Longitudinal	48.12	47.15	45.06	0.306	0.001

Notes: SF-12v2 mean scores: higher = better. Lower investment <£5000 per household; medium investment £5–10,000 per household; higher investment >£10,000 per household. GoWell cross-sectional and longitudinal (respectively) achieved samples: lower investment (n = 3617, n = 670); medium investment (n = 910, n = 154); higher investment (n = 1477, n = 182).

investment groups respectively. Again, this difference was only statistically significant for the higher investment group (b = 3.86; 95% CI = 1.96, 5.76; P < 0.001), indicating a lesser decline in physical health compared to the lower investment group after adjustment.

We found no significant interactions between investment groups and either education or country of birth. Adjusting for baseline health did not alter our interpretation of findings. Excluding the social investment made no difference to the grouping of study areas and therefore did not affect the results. As a form of post hoc sensitivity analysis, we explored interactions between study wave and investment groups' mean SF-12v2 scores using the larger repeat cross-sectional sample. Findings were similar to those of the primary longitudinal analysis: after five years, mean mental health scores improved in 'higher investment' areas relative to 'lower investment' areas (b = 2.79; 95% CI = 0.23, 5.35; P = 0.034). Mean physical health scores in high investment areas experienced little change compared to a decline in low investment areas (b = 3.66; 95% CI = 1.65, 5.66; P = 0.001). Findings for medium investment areas were not significantly different from low investment areas: the full repeat cross-sectional findings are tabulated in Appendix D of the supplemental online document.

4. Discussion

We have studied a nested longitudinal cohort within two cross-sectional surveys of householders experiencing housing-led urban renewal in Glasgow (UK). We found that although the renewal investment was based on housing considerations, it also followed a pattern of allocation to needs related to health and area-level deprivation. Furthermore, the 'higher need' group of areas experienced relatively favourable mental and physical health outcomes after receiving higher levels of investment compared to areas of lower need.

Glasgow's renewal includes intersecting housing improvement and neighbourhood improvement characteristics and so we will discuss our findings in relation to previous studies that focus on homes and/or neighbourhoods. Previous research from GoWell (Curl et al., 2014; Egan et al., 2013) and other studies have found evidence of health benefits following housing improvement (Ludwig et al., 2012; Thomson et al., 2013). There is evidence from observational studies that variations in the quality of home (Marsh et al., 2000) and neighbourhood environments (Ellaway et al., 2012) contribute to social inequalities in health. A Cochrane review (Thomson et al., 2013) of housing improvement found the best available evidence of positive health impacts from home heating improvements targeted at households with housing-related health needs (Howden-Chapman et al., 2008). We have suggested elsewhere that a more individually targeted approach in Glasgow may have led to a more effective intervention, potentially enabling greater health gains in lower and medium investment areas, but our current study does not test this (Curl et al., 2014).

A study of a UK urban renewal programme found evidence of reduced inequalities in its educational outcome and inconsistent findings relating to health outcomes (Stafford et al., 2014; Walthery et al., 2015). Another study of area based renewal in Barcelona reported that positive effects on self-rated health were greater amongst residents with relatively low socio-economic status (Mehdipanah et al., 2014). Further, a study of the contents of area-based interventions in the Netherlands found variations in types and 'doses' of intervention suggesting that population health impacts could vary by area (Droomers et al., 2014).

The fact that the current study combined urban renewal investment data with health outcome measures is novel and has rarely been attempted in previous studies. Our assessment of investment per household per area is an advantage due to the varying number of households per area. The only prior UK study concerned with the economics of urban renewal used estimates of the outputs produced by those investments in order to make 'valuation assumptions' about the benefits versus the costs, rather than actually measuring the benefits as we have done here. Furthermore, whilst the previous study recognized that the value of the regeneration benefits might be greater for those people on lower incomes, it did not take this into account in the values generated (Tyler et al., 2010).

Renewal is often associated with gentrification, although in a previous article we outlined reasons why we do not think this is a prevalent process or outcome in the case of Glasgow's renewal areas (Kearns and Mason, 2012). These include a lack of incomers into areas scheduled for demolition, the displacement of deprived households from demolition areas to other renewal areas, an economic recession that dampened Glasgow's private housing market; and the fact that much of the newly developed social housing is occupied by people with local connections and disadvantaged backgrounds.

In terms of our study's outcomes, the contrast between mental and physical health trajectories over time is notable. Self-reported physical health appeared to deteriorate in all three groups but to a lesser extent in the high investment areas: an apparent protective effect. Mental health, however, improved across all study groups with a greater improvement in the higher investment group. This concurs with previous analyses from the study programme whereby ageing appears to be associated with improved mental health scores and with the recent Scottish Health Survey finding that mental wellbeing scores peak for 65–74 year old but decrease again after 75 (Scottish Government, 2015). We speculate that an ageing cohort within a population known for high levels of morbidity could help explain physical health deterioration across our sample.

4.1. Implications for researchers

Studies rarely evaluate social interventions from a health inequalities perspective despite the prominence of concerns about health inequalities within research and policy (Bambra et al., 2010). There are some methodological advantages to evaluating intervention impacts on health inequalities. Whilst many evaluations of complex natural experiments face the problem of identifying comparison groups that closely resemble the intervention group (Craig et al., 2011), in our study the groups being compared do not need to be identical. In fact the hypotheses and study design require that study groups vary by deprivation characteristics and by the 'dose' and form of intervention received. However, a separate 'no-intervention' comparator would have strengthened the findings further and helped rule out the possibility of external socially patterned confounding factors influencing the results.

The impacts of social interventions on health inequalities and the operationalization of strategies for allocating according to need are, in our view, appropriate areas for further research and methodological development. Similar studies set in other cities, including national and international comparative studies of multiple urban renewal projects, could help us better understand the generalizability of findings, and the role of local contextual and compositional factors.

4.2. Implications for policy/practice

The investment strategy we have studied was not explicitly based on proportionate universalism, nor was reducing health inequalities its primary aim. The renewal programme has a range of potential housing, economic and social benefits beyond health.

However, the main social landlord has emphasised that its focus extends to social improvement, including helping resident achieve happier and healthier lives (Glasgow Housing Association, 2007). The landlord manages over 40,000 homes in a city where 40% of the neighbourhoods contain a majority of social housing. This scale of work and the neighbourhood level differences in need can help to explain how the investment took on some of the characteristics of proportionate universalism, without being wholly universal. Because such investments affect social determinants of health, we find that a non-health sector intervention with a housing focus can nonetheless be described as advancing a social determinants strategy for health inequalities reduction.

The lesson we derive from this is that health inequality reductions can potentially be achieved by allocating non-health sector interventions and services according to the needs that are most relevant to those services (in this case, primarily, housing and social needs). In line with calls for 'Health in All Policies' (WHO, 2010) we therefore advocate for social policies that seek to reduce inequalities through differential investment across a broad range of sectors, as a means of achieving public health goals in tandem with other forms of social justice (Katikireddi et al., 2013). Deliverers should engage with researchers to support the approach advocated by Orton et al., who argued for 'upstream' public health and preventative approaches to health to be better prioritized, stating that "it is vital that the effectiveness and cost effectiveness of all new and existing policies and services affecting public health are measured in terms of their impact on the social determinants of health and health inequalities" (Orton et al., 2011, p.9). Whilst the current study focuses on the specific issue of allocation to need, a protocol has been developed to undertake more detailed economic evaluation and assess the value for money of the urban renewal investments, taking into account a wide range of potential intersectoral impacts, health and non-health.

4.3. Limitations

The methodological challenges to evaluating interventions affecting social determinants of health are numerous and have been described elsewhere (Bond et al., 2013). This study explores allocation to need at a population-level based on a relatively large spatial scale (groups of areas) rather than more fine-grain scales: e.g. individual, household, and neighbourhood. We could not identify a counter-factual based on a comparable range of disadvantaged areas guaranteed to receive no interventions over the study period, not least because the national quality standard driving the housing improvement programme was applied to all social housing in Scotland (Bond et al., 2013). Equivalent 'no intervention' control groups would have helped rule out the possibility that heath trends in the most deprived areas receiving higher investment might have improved without the intervention – for example, as a result of alternative health interventions and services being allocated to need at the same time (Barr et al., 2014; Buck and Maguire, 2015). However, we note that neighbourhood demolition was associated with service closures rather than improved services over time so we assume the overall picture with regard to confounders is a complex one.

We support Medical Research Council natural experiment guidance that emphasizes the need to replicate studies like ours to build confidence in findings and better understand their transferability (Craig et al., 2011). In line with this guidance we also support alternative methodologies to tackle related issues and allow for triangulation: the study reported here is just one component of a programme of research that includes quantitative and qualitative explorations of this intervention. Elsewhere, realist approaches have been advocated and conducted (Mehdipanah et al., 2015).

The response rates to the original surveys were approximately 45–50%, which is not unusual for a study of such disadvantaged neighbourhoods but still risks selection bias. We also assume selective attrition occurred even though our longitudinal sample broadly matched the larger cross-sectional samples across a range of measured characteristics and the response rates between study groups were similar. The longitudinal sample was smaller than the cross-sectional samples, thus reducing power to detect small changes, although our sensitivity analysis found that the repeat cross-sectional sample yielded similar findings to the longitudinal sample with respect to this study's primary outcomes.

Our primary analysis, including the categorization of areas by investment group, could have been conducted in multiple ways: we selected one approach in advance and stuck to it to avoid retrospective 'cherry picking' of findings from different analyses. Nonetheless, the likelihood that different approaches could yield different findings is a limitation. The *a priori* decision to focus on self-reported health using SF-12v2 means that other valid outcome measures have not been explored in this study, including outcomes relating to determinants of health such as education, environment, employment and psychosocial outcomes.

We could only access investment data at an aggregate level, per study area, and thus we used average investment levels per household within each study area as our measure of investment or treatment, rather than actual investments per household. Our approach also assumes, correctly in our view, that all residents of an area are affected to some degree by widespread renewal investment.

Social and housing improvement to tackle persistent problems of deprivation is a continual part of Glasgow's history, not neatly contained within the five year study period (Bond et al., 2013). At different time-points, neighbourhoods received (and in fact some were created by) preceding renewal interventions. The five year follow-up, whilst longer than most housing evaluations, means that subsequent intervention and longer term health impacts are missed. The neighbourhoods were located across the city, although three pairs of neighbourhoods bordered one another. The study does not analyse potential spillover effects. In the European context spillover is often said to result in neighbourhood dissatisfaction and the identification of incivilities in neighbourhoods adjacent to renewal areas, although a recent review (Kleinhans and Varady, 2011) found little conclusive evidence on the causal relations involved. Glasgow residents relocate most frequently to neighbouring areas: a process accelerated by demolition and new build programmes (Kearns and Mason, 2012). Residents who relocated within their neighbourhood are included in our longitudinal sample frame: this includes residents relocated temporarily to flats scheduled for later demolition. Those who were relocated out of intervention areas due to the demolition programme were guaranteed homes built or refurbished to the most recent housing standards. We cannot report intention to treat analysis that takes account of impacts on those who moved to other areas either as a consequence of the demolition programme or for other reasons.

4.4. Conclusion

Our findings suggest that investment in housing-led renewal in Glasgow was allocated according to population need and this led to modest reductions in social inequalities in health after five years. This study demonstrates that a non-health sector intervention can be evaluated to better understand its contribution to reductions in health inequalities when allocated according to need. We know no other intervention evaluation that has sought to demonstrate this fundamental public health strategy. This is therefore an area that

needs further evaluation including methodological development to reduce bias and make the case for generalisability. Whilst the 'more evidence required' conclusion has become clichéd within the academic community, it seems to us remarkable that so little evaluative evidence is available to critically examine, inform or support the core public health strategy of allocating resources to need in order to differentially improve social determinants of health inequalities.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2016.01.026.

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