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Complete List of Authors:	Goyder, Elizabeth; The University of Sheffield, Public Health, ScHARR; Maheswaran, Ravi; University of Sheffield, ScHARR Read, Simon; University of Sheffield, ScHARR
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Associations between neighbourhood environmental factors and the uptake and effectiveness of a brief intervention to increase physical activity: findings from deprived urban communities in an English city.

Prof Goyder, E.C., Professor of Public Health, School of Health and Related Research, University of Sheffield[1]

Prof Maheswaran, R., Professor of Epidemiology & Public Health, Public Health GIS Unit, School of Health and Related Research, University of Sheffield[1]

Dr Read, S., Research Associate, Public Health GIS Unit, School of Health and Related Research, University of Sheffield[1]

[1]School of Health and Related Research, University of Sheffield, Regent Court, 30 Regent Street, Sheffield, S1 4DA, UK

On behalf of the BOOSTER Study team

*Corresponding author. E-mail: e.goyder@sheffield.ac.uk

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Abstract

Background: Evidence suggests behavioural interventions may exacerbate health inequalities, potentially due to differences in uptake or effectiveness. We used a physical activity intervention targeting deprived communities to identify neighbourhood-level factors that might explain differences in programme impact.

Methods: Individuals aged 40 to 65 were sent a postal invitation offering a brief intervention to increase physical activity. We used postcodes linkage to determine whether neighbourhood indicators of deprivation, housing, crime and proximity to green spaces and leisure facilities predicted uptake of the initial invitation or an increase in physical activity level in those receiving the brief intervention.

Results: 4134 (6.8%) individuals responded to the initial invitation and of those receiving the intervention and contactable after three months, 486 (51.6%) reported an increase in physical activity. Area deprivation scores linked to postcodes predicted intervention uptake, but not intervention effectiveness. Neighbourhood indicators did not predict either uptake or intervention effectiveness.

Conclusions: The main barrier to using brief intervention invitations to increase physical activity in deprived, middle aged populations was the low uptake of an intervention requiring significant time and motivation from participants. Once individuals have taken up the intervention offer, neighbourhood characteristics did not appear to be significant barriers to successful lifestyle change.

(200 words)

Introduction

There are clear socioeconomic gradients in physical activity levels and cardiovascular mortality, with lower physical activity levels and higher cardiovascular and all-cause mortality rates in more deprived areas.[1,2] There is also a growing body of evidence suggesting environmental and neighbourhood characteristics may explain some of the variations in physical activity related to socioeconomic circumstances. [3]

Whilst there is evidence that brief interventions increase physical activity levels in the short term[4], it is less clear to what extent these interventions might reduce or exacerbate individual or neighbourhood inequalities in physical activity levels. Modelling suggests that this may be a crucial issue in determining cost effectiveness but, as Gulliford et al acknowledge, there is a lack of empirical data about exactly how and why specific interventions might reduce or exacerbate inequalities due to differences in participation or to differences in the efficacy of the intervention for different population groups or in different settings or neighbourhoods.[5]

We therefore used the evaluation of a brief intervention programme delivered in deprived communities in the English city of Sheffield (undertaken as part of a larger project which included a subsequent randomised trial [6]) to address this question. The intervention included a motivational DVD sent by post, information on local leisure facilities and activity programmes, such as Health Walks. and two follow up phone calls at monthly intervals, to check they had received the DVD, to answer and questions and to encourage them to use the DVD and local information. [6]

The aim was to investigate if there were neighbourhood-level factors for which local data were available and which could potentially influence uptake and effectiveness of a brief intervention to increase physical activity. [7,8] We selected two types of factors for which there was a plausible potential causal relationship with increases in physical activity levels: firstly the proximity of relevant leisure facilities or green spaces which might facilitate active pursuits[9], and secondly the general quality of the local environment (as reflected by crime and housing indicators) which might be a barrier to individuals being more active in their neighbourhood[10].

The overall aim was to examine if the overall degree of deprivation or these two types of more specific neighbourhood level factors (access to green spaces, gyms and swimming pools or housing and crime rates) were associated with either uptake or effectiveness of a brief intervention offered by postal invitation in relatively socioeconomically deprived neighbourhoods.

Methods

There is a striking West-East gradient in area level deprivation across Sheffield, with deprived areas situated to the east of the city. [11] As mailouts, described further below, were sent out to postcodes in deprived neighbourhoods, we used postcodes as the geographical unit of analysis in this study.

The design of the study is shown in the Consort diagram (Figure 1). Initially a mailout was sent to all people aged 40-64 years living in deprived neighbourhoods in Sheffield. More deprived neighbourhoods were selected on the basis of having an above average Index of Multiple Deprivation (IMD) score, a widely used national indicator of deprivation in England.[12] This mailout was done in six rounds in 2009-10, including an initial pilot round targeting only one neighbourhood in order to test the feasibility of the approach and estimate the likely response rate and five rounds each targeting a different group of neighbourhoods. Although the total mailout was in excess of 70 000, the last round was incompletely mailed out. For this analysis, we therefore limited the data used to the first five mailouts, which totalled 60 429. Prepaid envelopes were enclosed with the mailouts. People who sent in the replies accepting the invitation to participate were then contacted and provided with the initial brief intervention, as described in detail in the full report, if they were deemed eligible.[6]The main reason for ineligibility was currently being physical active (and just wanting support for activities), since the intervention was targeting currently sedentary individuals.

Self-reported physical activity was collected at recruitment, and then re-assessed three months after sending the DVD, using the Scottish Physical Activity Questionnaire (SPAQ), to see if they had increased their physical activity. We used an increase from pre-intervention activity levels of at least 30 minutes a week as an

indicator of effective change. This was a pragmatic choice based on what was considered feasible for previously sedentary participants and chosen to reflect whether it was likely the intervention had led to a clinically significant change.

We used the IMD income domain from 2010 as the indicator of socioeconomic deprivation at the small area level. [12] The Income Domain score was available at the lower super-output area (LSOA) level. We assigned the LSOA score to all postcodes within each LSOA. On average, there were approximately 25 residential postcodes per LSOA (representing about 1500 individuals).

With regard to access to green space for physical activity, we used municipal green spaces managed by Sheffield City Council. We only included green spaces that were open to the public for use for physical activity. We also considered green spaces surrounding Sheffield and included a park managed by Rotherham Borough Council as this was accessible to residents to the east of Sheffield.

With regard to access to gyms and swimming pools, we included all such facilities that were open to the public. The detailed specification of green space, gym and swimming pool facilities included, and the rationale for selection of these spaces and facilities, have been provided elsewhere. [6]

We used two indicators of housing from 2010 that were provided by Sheffield City Council at the postcode level. These were the percentage of vacant domestic properties in each postcode and the percentage of households that were classed as being in multiple occupancy in each postcode. Both these indicators were used locally as indicators of the housing environment.

We obtained geo-referenced data on crime and anti-social behaviour from the national police website (http://police.uk). We calculated the total number of crimes reported (which exclude anti-social behaviour) and the number of anti-social behaviour incidents recorded within a 1km radius of each postcode centroid in 2011.

Access to green space, gyms and swimming pools was calculated using pedestrian network information within a GIS. The shortest distance along the network from a

postcode centroid to the edge of a green space or the geo-location of a leisure facility was calculated. [6]

Uptake was assessed in relation to the response to the initial postal invitation, which is one relatively common way of inviting participation in public health programmes targeted at specific geographical areas. Effectiveness was assessed in relation to the self-reported change in physical activity, three months after the "brief intervention" which is an outcome previously used to assess effectiveness of brief interventions[4].

Statistical analysis was carried out using logistic regression, modelling the odds of a positive response at each stage of the multiphase study. IMD income, distances to the nearest green space, gym and swimming pool, and crime and anti-social behaviour incident rates were entered as continuous variables. Because of the very small percentage of postcodes which had one or more vacant properties and households in multiple occupancy, these were entered as dichotomous variables (>0 vs 0). Although in some phases, a positive response was not likely to be potentially associated with all the predictors, for consistency we assessed associations with all predictors in all phases. As response rates varied by mailout, the five mailouts were included as categorical variables in the analysis to adjust for this variation. For the continuous variables, the odds ratios are expressed per inter-quartile range (IQR) increase in the predictor variable.

Results

The positive response counts at each stage of the study are given in Figure 1. Of the 60 429 invitations sent, only 4164 people responded to this initial invitation by mail, giving a response rate of 7%. Only 54% of these individuals were contactable by phone and of these only 77% were sufficiently sedentary to be considered eligible for the brief intervention. Of the 941 individuals who could be contacted three months after receiving the DVD, 486 (52%) had managed to increase their level of physical activity.

Table 1 shows the distribution of the postcode level predictor variables used in the analysis, while Table 2 shows the adjusted odds ratios for associations between each of the predictor variables and a positive response at each stage.

Initial response rates varied by mailout from 6% to 9%. Statistical analyses were therefore adjusted for mailout round to take into account this variation.

There was a significant association between the level of deprivation and response to the mailout. The odds ratio for a positive response for an IQR increase in deprivation was 0.92 (95% CI 0.87-0.96, p=0.0006). There was also a significant association between the level of deprivation and the odds of managing to contact those who had responded to the mailout (0.85, 95% CI 0.77-0.94, p=0.001), indicating that both using postal invitations for initial contact and telephone for subsequent follow up may exacerbate inequalities in uptake of similar interventions in relatively deprived communities. In contrast, there were no significant associations between deprivation and the odds of response from those successfully recruited to receive the brief intervention.

With regard to the other variables, there were generally no significant associations apart from two relatively weak associations between being contactable three months after the intervention and distance to a gym or houses in multiple occupancy (Table 2). These are of questionable relevance, as these variables did not predict either response to the initial invitation or intervention effectiveness.

We also examined whether there were any seasonal effects on uptake or effectiveness of the intervention, as this might have influenced results but no significant association was identified.

Discussion

Summary of main findings

The response to initial postal invitation to participate in an intervention to increase physical exercise sent to people aged 40-64 years living in deprived areas was very low, with only 7% responding to the invitation. The finding that more than half of those contacted after receiving the intervention reported an increase in physical

activity after three months, suggests that these were a highly selected group of individuals already motivated to make relevant lifestyle changes.

Only area level deprivation showed a clear association with response to the initial invitation, with lower response rates in more deprived areas, with this association seen even within the range of deprivation observed in this analysis. The association with deprivation was largely apparent only in the initial response to the postal invitation, with no significant effect of deprivation on effectiveness in those receiving the intervention and contactable after three months. We also found no evidence linking access to green space and leisure facilities, or to neighbourhood crime rates or housing indicators with uptake or effectiveness.

What is already known

Evidence from the NHS Health Check programme suggests both that socioeconomic status may influence uptake of preventive programmes and that mode of invitation is a significant predictor of uptake, with postal invitation showing lower uptake than telephone or verbal invitations. [13,14]

Deprivation and uptake of physical activity interventions: Gidlow et al examined uptake at different stages of the referral process for exercise referral schemes[13] and also found that uptake was lower with increasing area level deprivation at the area level in the initial stages of referral. Deprivation was a predictor of uptake but not of completion rates, consistent with our findings. In contrast, Harrison et al found that area level deprivation did not influence attendance following referral to exercise referral schemes[15] and Sowden et al found that uptake of such schemes and completion rates were not associated with deprivation status. [16]

Environmental factors and physical activity: With regard to neighbourhood level environmental factors, Bauman et al found in a review that physical activity levels were generally correlated with proximity to recreation facilities and with environmental aesthetics, including greenness. [8] However, they found no consistent evidence of correlation in older adults. Humpel et al, in another review[9], found that

high neighbourhood crime levels and fear of crime were associated with decreased physical activity in some studies but not several others.

A related issue is the equity of access to leisure facilities. Hillsdon et al[10] examined the geographical distribution of leisure facilities, using a database of all public access indoor exercise facilities in England .They found that the availability of these facilities, which included gyms and swimming pools, declined with increasing levels of area-level deprivation. They used the IMD score at LSOA level as their indicator of socioeconomic deprivation.

Spatial autocorrelation, that is the tendency for spatial units close to each other to have similar characteristics, may complicate statistical analysis. We have previously carried out methodological analysis to examine this aspect using data from the initial phase of the study .[17] We found that the association with deprivation held after a complex Bayesian spatial model was used to taken account of spatial autocorrelation.

What this study adds

Whilst there are a number of reasons why interventions to promote physical activity might have lower uptake and be less effective in more deprived communities, the empirical evidence is sparse and inconsistent. The large scale mailing across a large number of urban neighbourhoods provided a unique opportunity to examine whether, and to what extent, neighbourhood characteristics which might be barriers or facilitators to physical activity, would predict uptake, and subsequently the effectiveness, of a brief intervention.

We found that even within the deprived areas targeted in this study, there was an association between deprivation and uptake. However, we found no strong evidence to indicate that proximity to leisure facilities and green space or that neighbourhood crime rates and housing indicators were important determinants of uptake.

Of practical relevance to those delivering similar programmes, are the very low response rates using postal invitations with telephone follow up in relatively deprived

urban neighbourhoods. This proved to be a very inefficient way of recruiting the target group of sedentary middle-aged residents.

These findings also have important implications for ensuring interventions to promote physical activity do not exacerbate health inequalities. This may be a particular concern when using postal invitations, since even when relatively deprived urban areas are targeted for an intervention, the more deprived the neighbourhood, the lower the response to a postal invitation.

The findings also suggest that the major challenge may lie in getting sufficient uptake for an individual level intervention to have an impact in deprived neighbourhoods. However if individuals are sufficiently motivated to take up an intervention in deprived areas, access to facilities or other characteristics of the local environment do not seem to have an additional impact on success, presumably because these are relatively highly motivated respondents and the individual support helps to overcome the environment factors that might otherwise encourage less active lifestyles.

Limitations

A number of potential limitations to our study need to be considered. We used an ecological study design and this is susceptible to ecological bias that is the situation in which associations at the area level may not be representative of associations which exist at the individual level. However, we used the deprivation index at a small-area level and used postcode level data for all the other variables. Use of very small geographical units overcomes several of the limitation of traditional ecological studies as explanatory factors tend to be more homogenous in small geographical areas. We did not specifically address spatial autocorrelation in our analysis. However, in our previous work, residual spatial autocorrelation was not a significant problem once explanatory factors were taken into account. [17]

We did not take quality of green space, which may have influenced use of green space, into account. The database of facilities we used may have contained some inaccuracies. We only took into account physical access in terms of network walking distances, and other dimensions of access (e.g. cost, access for people with

disabilities, opening times) could have influenced use of these facilities. Other means of transport e.g. private cars and public transport could have been used to access leisure facilities and green spaces. Multiple occupancy could also be due to student accommodation but the areas included in our study did not have large resident student populations. Whilst vacant properties were used as a proxy for run down areas, new housing estates would also have been captured by this indicator. Crimes may have been under-recorded and there may have been geo-location errors regarding where these crimes were recorded as having occurred. Also, fear of crime rather than actual crime rates may exert a stronger influence on behaviour. Give the potential limitations of our analysis the results need to be interpreted with caution.

Conclusions

We found that uptake of a brief intervention was significantly lower in more deprived areas but there was no strong evidence to indicate that other environmental factors such as access to gyms, swimming pools and green space and neighbourhood crime rates and housing deprivation influenced uptake. There was also no evidence that socioeconomic and neighbourhood characteristics had a significant impact on the effectiveness of the intervention. These findings suggest that the main reason that individual brief interventions will have a limited impact on inequalities in the domain of physical activity is the lower levels of uptake, rather than specific neighbourhood characteristics and further research should consider how to more effectively target and recruit sedentary individuals to programmes of proven effectiveness.

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Figure 1: CONSORT diagram for brief intervention uptake showing overall number of participants at each stage

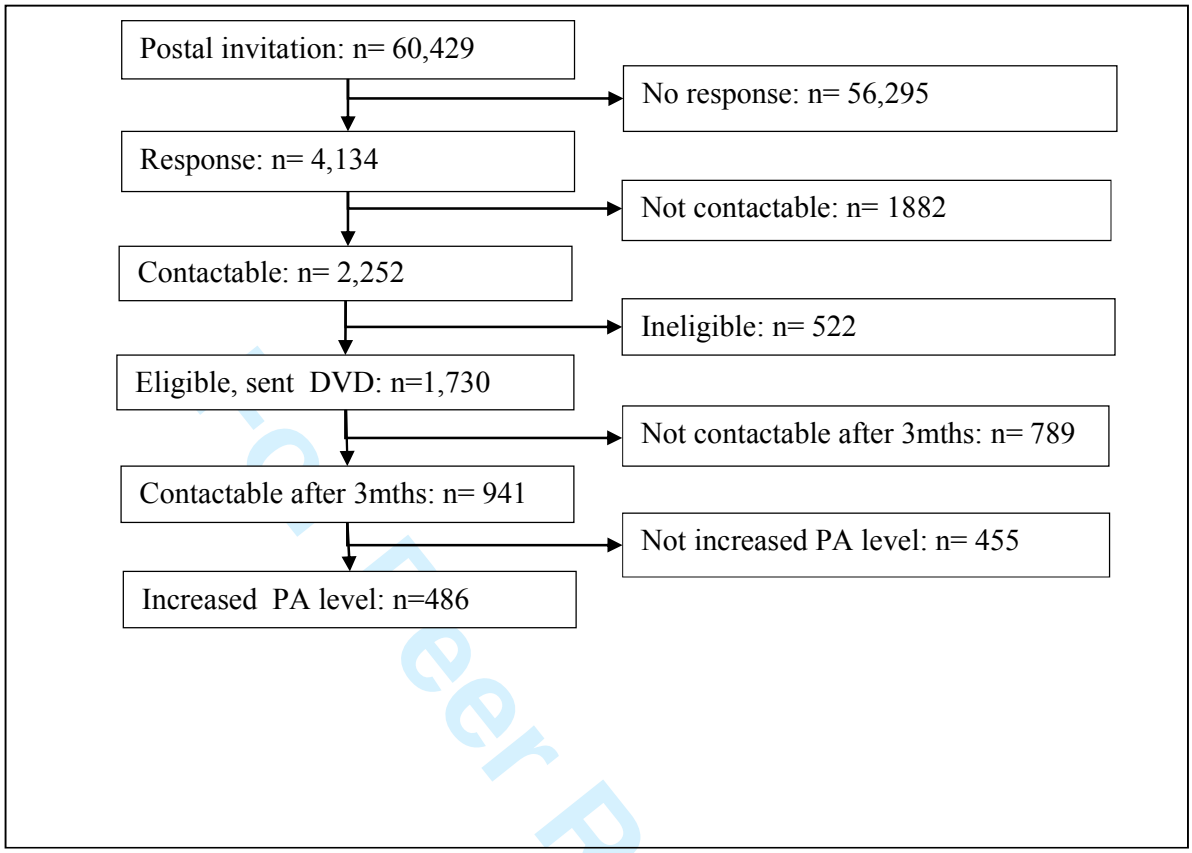

Table 1. Distribution of postcode level variables in the dataset of 3662 postcodes used in this analysis of uptake and effectiveness

Variables	Distribution	
IMD 2010 Income Domain score (Percentage of population who are classified as income deprived)	Median (IQR)	0.30 (0.21 - 0.36)
Walking distance to nearest gym from postcode centroid (km)	Median (IQR)	1.09 (0.67 - 1.59)
Walking distance to nearest swimming pool from postcode centroid (km)	Median (IQR)	1.70 (1.00 - 2.36)
Walking distance to nearest municipal green space from postcode centroid (km)	Median (IQR)	0.60 (0.31 - 0.91)
Percentage of postcodes containing one or more vacant domestic properties	Percentage	39%
Percentage of postcodes containing one or more households in multiple occupation	Percentage	5%
Crime incidents recorded within a 1km radius of the postcode centroid in one year	Median (IQR)	1232 (897 – 1633)
Antisocial behaviour incidents recorded within a 1km radius of the postcode centroid in one year	Median (IQR)	1583 (1188 – 1931)

Table 2: Association of socioeconomic and environmental factors with uptake and effectiveness of the brief intervention

Variable	Odds ratio (95% CI) for an IQR increase (except where indicated otherwise)				
	Respondents (4134) vs. non-respondents (56295)	**Contactable respondents (2252) vs. non-contactable (1882)**	**Eligible (1730) vs. non-eligible (522)**	**Contactable three months later: yes (941) vs. no (789)**	**Increased physical activity (486) vs. did not increase physical activity (455)**
IMD 2010	0.92 (0.87 - 0.96) p=0.0006	0.85 (0.77 - 0.94) p=0.001	1.02 (0.87 - 1.20)	0.97 (0.83 - 1.13)	0.91 (0.74 - 1.12)
Walking distance to nearest gym	1.06 (0.99 - 1.13)	1.078 (0.94 - 1.23)	0.87 (0.70 - 1.08)	0.81 (0.66 – 1.00) p=0.04	1.02 (0.77 - 1.36)
Walking distance to nearest swimming pool	0.94 (0.88 - 1.00)	1.01 (0.89 - 1.14)	1.12 (0.91 - 1.39)	1.11 (0.92 - 1.35)	0.95 (0.73- 1.24)
Walking distance to nearest municipal green space	1.00 (0.95 - 1.05)	1.04 (0.93 - 1.16)	1.02 (0.87 - 1.19)	1.04 (0.89 - 1.22)	0.92 (0.74 - 1.13)
Vacant domestic properties (Odds ratio for >0%(1) vs 0% (0)	0.95 (0.89 - 1.01)	0.99 (0.87 - 1.13)	1.17 (0.96 - 1.43)	1.09 (0.90 - 1.32)	1.30 (1.00 - 1.70)
Domestic properties in multiple occupancy (Odds ratio for >0%(1) vs 0% (0)	1.07 (0.91 - 1.25)	0.76 (0.55 - 1.04)	0.79 (0.46 - 1.34)	0.52 (0.30 - 0.88) p=0.02	1.49 (0.66 - 3.36)

Crimes reported within a 1km radius of postcode centroid	0.97 (0.89 - 1.06)	0.88 0.74 - 1.05)	0.89 (0.66 - 1.21)	0.80 (0.60 - 1.07)	1.04 (0.68 - 1.58)
Antisocial behaviour incidents recorded within a 1km radius of postcode centroid	1.05 (0.94 - 1.18)	1.14 (0.91 - 1.44)	1.20 (0.82 - 1.75)	1.38 (0.96 - 1.99)	0.97 (0.58 - 1.63)

Mailout round was included as a categorical variable in all analyses above.