Dadansoddi ar gyfer Polisi
YMCHWIL GYMDEITHASOL Y LLYWODRAETH
GSR
GOVERNMENT SOCIAL RESEARCH
Analysis for Policy

Llywodraeth Cymru
Welsh Government

SOCIAL RESEARCH NUMBER: 17/2017
PUBLICATION DATE: 04/04/2017

The Fuel Poverty Data Linking Project Findings Report No.1: Initial Findings on the Impact on Health of the Warm Homes Nest Scheme

In Wales, a household is considered to be in fuel poverty if it needs to spend more than 10% of its net income on all household fuel use to maintain a satisfactory heating regime. Fuel poverty is particularly challenging in Wales due to the poor housing stock in many areas and the rural nature of much of Wales. Living in a cold or damp home increases the risk of adverse health events.

As part of its strategy to reduce fuel poverty in Wales, the Welsh Government implemented a demand-led fuel poverty scheme called Nest to improve the energy efficiency of homes.

This bulletin reports the first findings of a project that is using data linking techniques to explore the impact of the Warm Homes Nest scheme on health outcomes.

In order to inform potential future demand-led fuel poverty schemes in Wales, this study examines the impact of the current scheme on hospital admissions and general health for recipients of home energy efficiency measures.

Key Points

Administrative data for the Warm Homes Nest scheme was anonymously and securely linked to routine health records for analysis purposes. Levels of health service use were compared for 16,353 recipients of home energy efficiency measures and a control group of 24,895 people who were eligible but who had not yet received measures. Key points are:

- The data shows a significant positive effect on respiratory health for recipients of Warm Homes Nest measures. For those people for whom a respiratory GP Event was recorded there was a 3.9% decrease in the average number of respiratory GP Events. This is a statistically significant difference when compared with a 9.8% increase in the average number of respiratory GP Events for the control group.
- The same statistically significant pattern was found for asthma events, with a 6.5% decrease in the recipient group and a 12.5% increase in the control group. As would be expected, no difference was found in prescribing for asthma medications.
- The data suggests a 'protective effect' for infection, with a smaller increase in the average number of prescriptions for infection in the recipient group compared with the control group (an increase of 4.0% and 6.1% respectively for recipients and controls). Due to large numbers of both recipients and controls having very small numbers of events the overall difference did not reach the level of statistical significance.
- The data suggests a positive impact on emergency hospital admissions for both cardiovascular and respiratory conditions. Numbers were small so the effect did not reach the level of statistical significance, however:
  - for cardiovascular admissions: we found a smaller increase in the recipient group compared with the control group; and
  - for respiratory admissions: we found a decrease in the recipient group compared with an increase in the control group.
- There was no significant difference by age group in the patterns of health events reported above.
- The fact that the number of GP Events was higher for the recipient group than the control group before measures were installed may reflect successful early targeting of the Scheme at households in the greatest need.

Background

1. In Wales, a household is considered to be in fuel poverty if it needs to spend more than 10% of its net income on all household fuel use to maintain a satisfactory heating regime.
2. Fuel poverty is particularly challenging in Wales due to the poor housing stock in many areas and the rural nature of much of Wales. Estimated levels of Fuel Poverty in Wales were 29% in 2012 and are projected to be 23% in 2016. The predicted national levels of fuel poverty for Wales are higher than in England but lower than in Scotland or Northern Ireland (as a percentage of all households).[1]
3. The World Health Organisation (2007)[2] recommends a minimum indoor temperature of 18 degrees and recognises that living in a cold and/or damp house may be harmful to health.
4. As part of its strategy to reduce fuel poverty in Wales, the Welsh Government developed a demand-led all-Wales fuel poverty scheme called Warm Homes Nest to improve the energy efficiency of homes. Nest has provided home efficiency improvements to those most likely to be in fuel poverty, including low income and vulnerable households since 2011.
5. The measures provided by Nest include insulation and heating upgrades, such as a more efficient boiler; some include newer technologies like air source heat pumps and external wall insulation.
6. The Project was carried out by a full-time researcher attached to the ESRC[3] funded Administrative Data Research Centre for Wales (ADRC-W), which is supported by the Welsh Government core-funded SAIL (Secure Anonymised Information Linkage) Databank at Swansea University[4,5]. The researcher was jointly funded by the Welsh Government and the ESRC. The project was conducted within the information governance, information security and ethical framework of the ESRC-funded UK Administrative Data Research Network[6].

Aims and Objectives

7. The overall aim of the programme of work within which this project falls is to use linked administrative data to examine the health and broader well-being impacts of Welsh Government funded home energy efficiency improvement schemes for low income households. Within this aim, the objectives of this project were to:
    - Identify the health risks likely to be associated with living in fuel poverty.
    - Identify a robust control group[7] for analysis purposes.
    - Investigate the impact of the scheme on the health of recipients.
    - Investigate the relative impact of the scheme on recipients in different age categories.

Methods

8. This study conducted a Rapid Evidence Assessment of the literature on the health risks of living in fuel poverty or in an inadequately heated house in order to identify the most appropriate health outcomes for analysis.
9. The Warm Homes Nest scheme provided access to anonymised data relating to individual applications to the scheme and the measures installed.
10. The scheme data was anonymously linked to routine health records in order to examine the health service use of the recipients of home energy efficiency measures.
11. Data Linking is a technique for creating links between data sources so that anonymised information that is thought to relate to the same person, family, place or event can be connected for research purposes.
12. Health service use e.g. GP events, prescriptions and hospital admissions, were examined for the winter before and the winter after each measure was installed.
13. A control group was created using individuals who had applied for measures and later received them; they were therefore known to be both eligible and in need of measures but had not yet received measures.
14. For the recipient group: the analysis examined how the number of health events had changed between the winter period prior to the household receiving a home energy improvement measure and the winter after. The analysis was focused on individuals who had experienced the entire winter before without the installation and the entire winter after with the installation i.e. individuals who received a measure partway through either the ‘before’ or ‘after’ winter were excluded.
15. For the control group: the analysis examined how the number of health events had changed between the same two winters, both without the home energy improvement measure.

16. It should be noted that factors external to the study may have influenced the health of recipients and controls. A certain amount of variation in the number of health events from winter to winter would be expected e.g. due to milder or more severe weather or the presence of healthcare initiatives; the health of both groups would also be expected to deteriorate over time as recipients and controls age. As part of the analysis, we constructed a recipient and control group separately for each year of the study. In this way, we are comparing any changes in the health of each recipient with changes for controls over the same two winters, meaning that both the recipient and control groups are likely to have been exposed to similar external factors. The analysis combined all 'pairs' of winters (i.e. the winters before and winters after installation) for November 2010 to February 2015, allowing us to control for different weather conditions. We are therefore confident that any differences observed between the recipient and control groups over time can be attributed to the Warm Home Nest scheme.
17. We examined the health events in two main ways:
    - we compared the **proportion** of people **for whom an event was recorded** for the recipient and control groups;
    - for those people for whom an event **was** recorded, we compared the average **number of those events** for people in the recipient and control groups.

    What we were seeking to examine, then, was whether there was a significant difference between the recipient group and the control group in the proportion of people who had health events in the first place as well as whether, for those who **did** have those events, there was a significant difference in the average number of those events.
18. We first present raw counts of the numbers of people who had health events and the numbers of health events experienced by the recipient and control groups in the winters before and after installation (see Tables 1 to 6, below). Please note that these figures are for descriptive purposes only and simple comparisons between the raw figures should not be made due to the fact that the base numbers are different in the four groups (recipient group and control group for the winter before and the winter after). We then applied complex statistical techniques to compare the differences between groups in how their health events changed between the two winters.[8]
19. We checked whether any differences we found were big enough for us to be confident they did not happen purely by chance – such changes are referred to as 'statistically significant' or 'significant'. Other findings where a difference was observed but where due to small numbers the effect was not big enough to reach the level of statistical significance, are nevertheless worthy of note so are reported using the phrase 'the data suggests' and should therefore be interpreted with caution.
20. The analysis was conducted on people who lived at the property for a minimum duration of the winter before the installation to the winter after i.e. from November 1st of the winter before to February 28th for the winter after the installation for each study year. We plan to include those experiencing only part of the winter with the intervention in the next stage of the analysis.
21. The key quality information relating to the study can be found on Page 9 of this Report.

Findings

Sample characteristics

22. The Warm Homes Nest scheme provided around 21,000 home energy efficiency measures to around 18,000 homes in Wales between April 2011 and March 2015.
23. The data from the Warm Homes Nest scheme was provided at the dwelling level. The dwelling-level data was linked to routine health records for all of the individuals who were living in those homes during the study period, resulting in a recipient group of 16,353 residents receiving a home energy efficiency measure and a control group of 24,895 individuals who were eligible but who had not yet received measures.
24. The recipient group contained individuals of all ages including 4.1% aged less than 5 years, 23.8% aged between 5 and 24 years, 42.6% aged between 25 and 59 years, 6.9% aged between 60 and 64 years, 11.8% aged between 65 and 74 years and 10.9% aged 75 years or over.

The health risks associated with living in fuel poverty

25. From a Rapid Evidence Assessment of the literature the following key health risks associated with living in fuel poverty were identified:

- *General health:* A range of health impacts have been demonstrated to be associated with inadequate heating, e.g. gastric and duodenal ulcers[9], colds and sore throats, frequent headaches, and eczema[10].
- *Cardiovascular health:* The research literature identifies an association between coronary events[11] and cold weather; those living in cold homes also have an increased risk of high blood pressure[12].
- *Respiratory health:* Studies show a 30-50% increase in a variety of respiratory symptoms[13] and an increase in hospitalisations due to respiratory causes[14] for people living in damp and/or cold homes.

The impact on general health

26. Routine GP Event data consists of all entries made by primary care services regarding the individual patient; this may include information gathered during consultations, test results, referrals or prescribing. A count of GP Events is a simple proxy indicator of general health, with a higher count representing a greater level of interaction with primary care.[15]
27. The following GP Event data was examined:
    - The number of respiratory GP Events (excluding prescriptions).
    - The number of asthma GP Events (excluding prescriptions) – this is a subset of the number of respiratory GP Events.
    - The number of prescriptions for asthma medication.
    - The number of prescriptions related to infection e.g. respiratory infection, ear infection, fungal infection.
28. Raw counts of the numbers of people who had health events and the numbers of health events experienced by the recipient and control groups in the winters before and after installation are shown in Tables 1 to 4, below. As noted above, these figures are for descriptive purposes only and simple comparisons between the raw figures should not be made. The findings of the complex statistical techniques applied to compare the differences between groups are discussed in the following paragraphs.
29. Thinking firstly about the proportion of people who had GP Events in the first place, no significant difference was found between the recipient and control groups for any of the GP Events listed above.
30. The data was then examined for those people for whom one or more event was recorded.

Table 1 Number of GP Respiratory Events

GP Events	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	499	1,601	3.21	652	1,889	2.90
Winter After	477	1,470	3.08	723	2,301	3.18

** Number of people with at least one GP Event recorded*
*** The total number of GP Event recorded*
‡ *Average number of GP Event recorded per person*

Table 2 Number of GP Asthma Events

GP Events	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	324	1,239	3.82	402	1,367	3.40
Winter After	315	1,126	3.57	467	1,786	3.82

** Number of people with at least one GP Events recorded*
*** The total number of GP Events recorded*
‡ *Average number of GP Events recorded per person*

Table 3 Number of prescriptions for Asthma medication

GP Events	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	1,635	8,554	5.23	2,414	12,003	4.97
Winter After	1,674	9,049	5.41	2,468	12,786	5.18

** Number of people with at least one GP Events recorded*

*** The total number of GP Events recorded*

‡ *Average number of GP Events recorded per person*

Table 4 Number of prescriptions for Infection

GP Events	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	2,742	5,182	1.89	4,089	7,382	1.81
Winter After	2,639	5,186	1.97	4,091	7,833	1.91

** Number of people with at least one GP Events recorded*

*** The total number of GP Events recorded*

‡ *Average number of GP Events recorded per person*

31. For those individuals for whom a respiratory GP Event was recorded there was a 3.9% decrease in the average number of respiratory GP Events between the winter before and the winter after for the recipient group. This is a statistically significant difference ($p<0.01$) when compared with a 9.8% increase in the average number of respiratory GP Events for the control group over the same period (see Chart 1, below).
32. For asthma GP Events (see Chart 2, below) there was a 6.5% decrease in the average number of Events between the winter before and the winter after for the recipient group. This is a statistically significant difference ($p<0.01$) when compared with a 12.5% increase in the average number of asthma Events for the control group over the same period.
33. No difference between the recipient and control groups was found in prescribing for asthma medications. This finding is as would be expected because most prescribing for asthma is preventative and would be expected to continue regardless of the number of acute episodes experienced by an individual.
34. For Warm Homes Nest recipients, the data suggests a 'protective effect' for infection. For those with an infection prescribing Event, an increase was found in the average number of prescriptions issued to both the recipient group and the control group for the winter after when compared with the winter before measures were installed, however the increase was smaller for the recipient group at 4.0% than for the control group at 6.1%. The difference was not statistically significant using the statistical modelling method used in this report. However, this was because a large proportion of both recipients and controls had a single prescribing event for infection either in the winter before or the winter after or both. Very small numbers of events that change very little and that are found for large numbers of individuals will dilute any differences that exist for those with greater numbers of events; this will lead to the overall effect not reaching the level of statistical significance. Future analysis will examine the relationship between receipt of a Warm Homes Nest measure and prescribing for infection focusing specifically on individuals who had more than one prescription for infection.
35. The GP Event indicators listed above were analysed to examine whether there were any significant differences in the observed patterns for the recipient and control groups by age group. There was no significant difference in the observed patterns by age group.
36. For each of the health events examined, the number of recorded events was higher for the recipient group than the control group at baseline i.e. the winter before measures were installed. The Warm Homes Nest Scheme directed its marketing, in partnership with appropriate local and community organisations, towards those households believed to be most

in need. Successful targeting of the scheme towards households in most need i.e. those in poorer health, may explain the differences in the numbers of health events at baseline between recipients and controls. However, further analysis would be required before this effect could be attributed to the successful targeting of Warm Homes Nest.

37. The results summarised above suggest a positive impact of the Warm Homes Nest scheme on the general health of recipients, particularly with respect to respiratory health. Where there are many more GP Events that could be used as indicators of general health, further analysis is planned to explore the potential impact of the Warm Homes Nest scheme on additional health conditions (see Next Steps).

Chart 1 The average number of respiratory GP Events per person for people with at least one event in the winter months before and winter months after installation: recipient group compared with control group

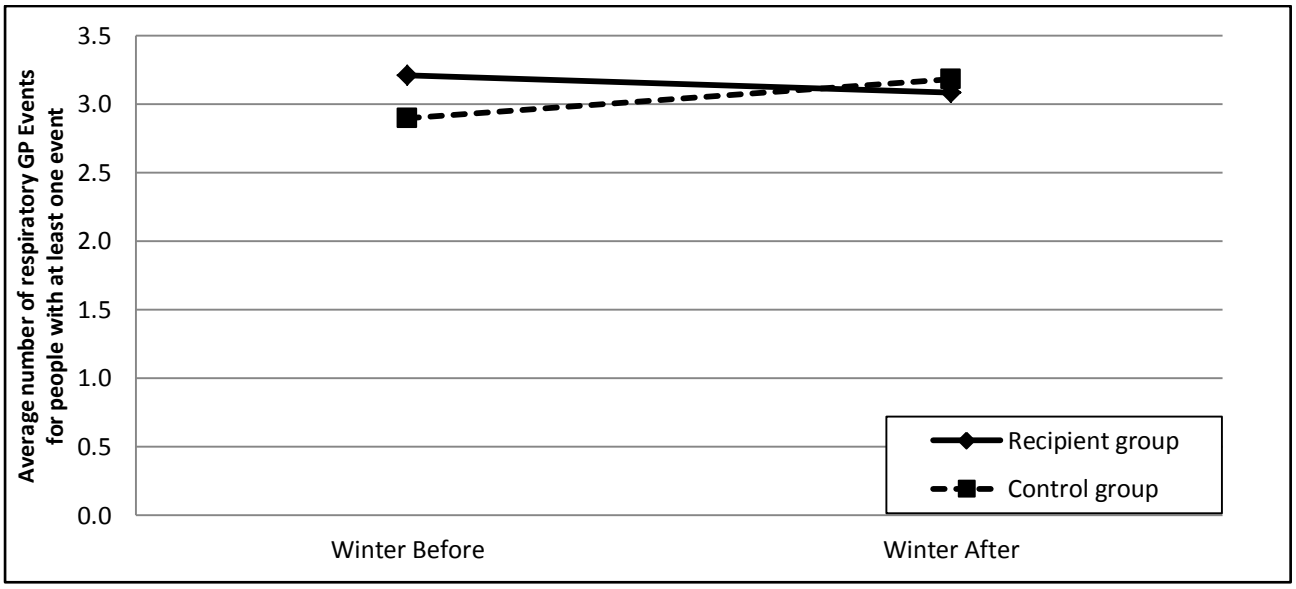
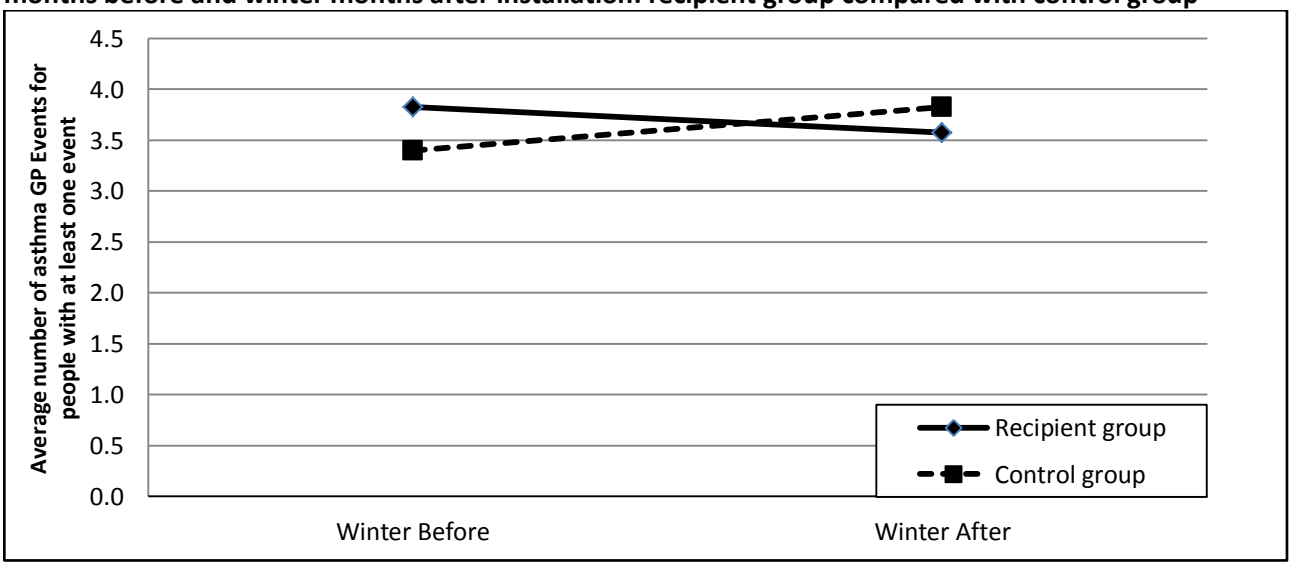


Chart 2 The average number of asthma GP Events per person for people with at least one event in the winter months before and winter months after installation: recipient group compared with control group



The impact on cardiovascular and respiratory health

38. The number of hospital admissions for both cardiovascular and respiratory conditions were compared for the winter before and the winter after the recipient households received a home energy efficiency measure. Emergency admissions for these conditions are relatively rare events and therefore only small numbers of events were available for analysis (see Tables 5 and 6). Due to small numbers the differences observed did not reach the level of statistical significance. These differences are nevertheless worthy of note but should be interpreted with caution.

Table 5 Emergency Hospital Admissions for Cardiovascular Conditions

Emergency Hospital Admissions	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	58	62	1.07	85	87	1.02
Winter After	64	69	1.08	102	108	1.06

** Number of people with at least one admission recorded*
*** The total number of admissions recorded*
‡ *Average number of admissions recorded per person*

Table 6 Emergency Hospital admissions for Respiratory Conditions

Emergency Hospital Admissions	Recipient group			Control group		
	People *	Events **	Average events per person ‡	People *	Events **	Average events per person ‡
Winter Before	101	116	1.15	123	140	1.14
Winter After	81	88	1.09	142	163	1.15

** Number of people with at least one admission recorded*
*** The total number of admissions recorded*
‡ Average number of admissions recorded

39. For Warm Homes Nest recipients, the data suggests a 'protective effect' on hospital admissions for cardiovascular conditions. An increase was found in the number of cardiovascular admissions of 11.3% the winter after measures were installed (see Chart 3, below). This compares with an increase of 24.1% in the control group for the same time period.
40. For Warm Homes Nest recipients the data suggests a positive impact on hospital admissions for respiratory conditions. A decrease was found in the number of emergency respiratory admissions of 24.1% the winter after measures were installed compared with the winter before. This compares with an increase of 16.4% in the control group for the same time period.
41. Further analysis of respiratory admissions showed that the difference was not due to the probability of having an emergency admission i.e. the number of people who had an admission in the first place; rather, the data suggests a difference, for those who **did** have events, in the number of events they had. For those who **did** have a respiratory admission, Warm Homes Nest recipients had a decrease in the average number of respiratory admissions of 5.5% the winter after measures were installed (see Chart 3, below). This compares with an increase of 0.9% in the control group for the same time period.
42. Due to small numbers, hospital admissions for cardiovascular and respiratory conditions did not warrant analysis by age group.
43. The number of emergency admissions for both respiratory and cardiovascular conditions was higher for the recipient group than the control group at baseline i.e. the winter before measures were installed. As noted above (see Paragraph 35), successful targeting of the Scheme towards households with poorer health may explain these differences. However, further analysis would be required to explore this issue further before this effect could be attributed to Warm Homes Nest.
44. These results suggest a positive impact of the Warm Homes Nest scheme on both the cardiovascular and respiratory health of recipients. As noted above, due to the small numbers these findings should be viewed with caution; however, further analysis is planned to extend the follow up time to compare admissions for two years before and after installation. This would not only yield greater numbers for analysis, potentially allowing us to examine whether the effects 'suggested' by the current analysis are statistically significant but would also allow any longer term effects of the Scheme on the health of recipients to be examined.

Chart 3 The number of Cardiovascular Hospital Admissions per 1,000 people in the winter months before and winter months after installation: recipient group compared with control group

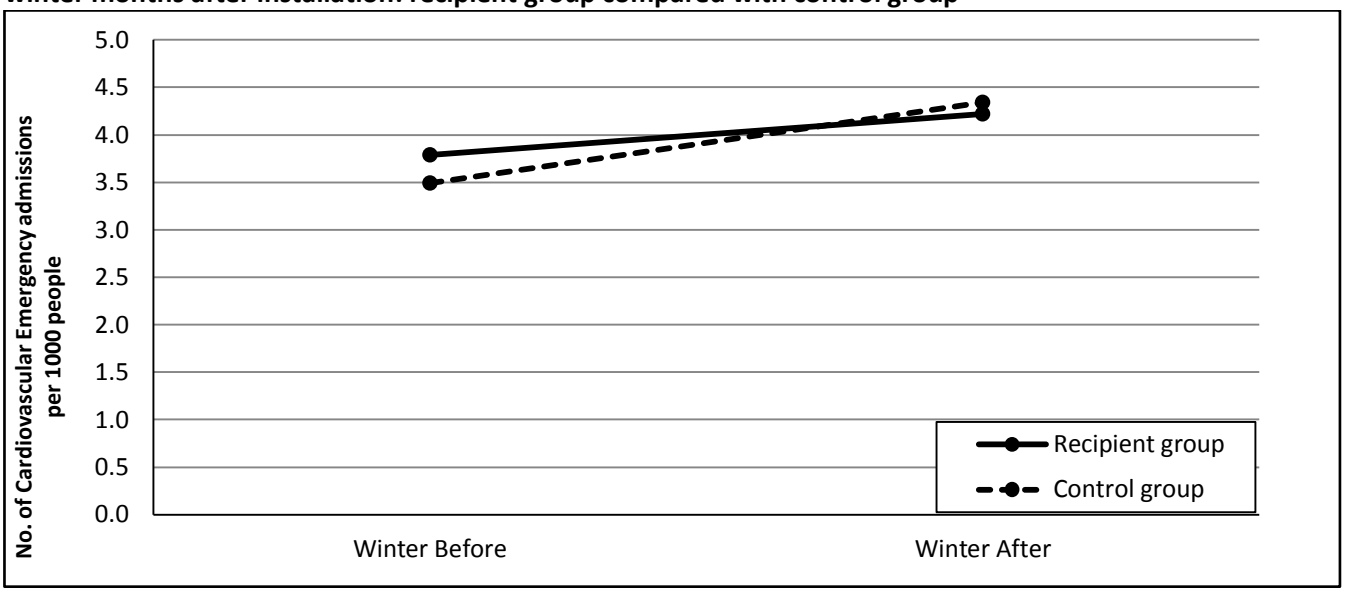
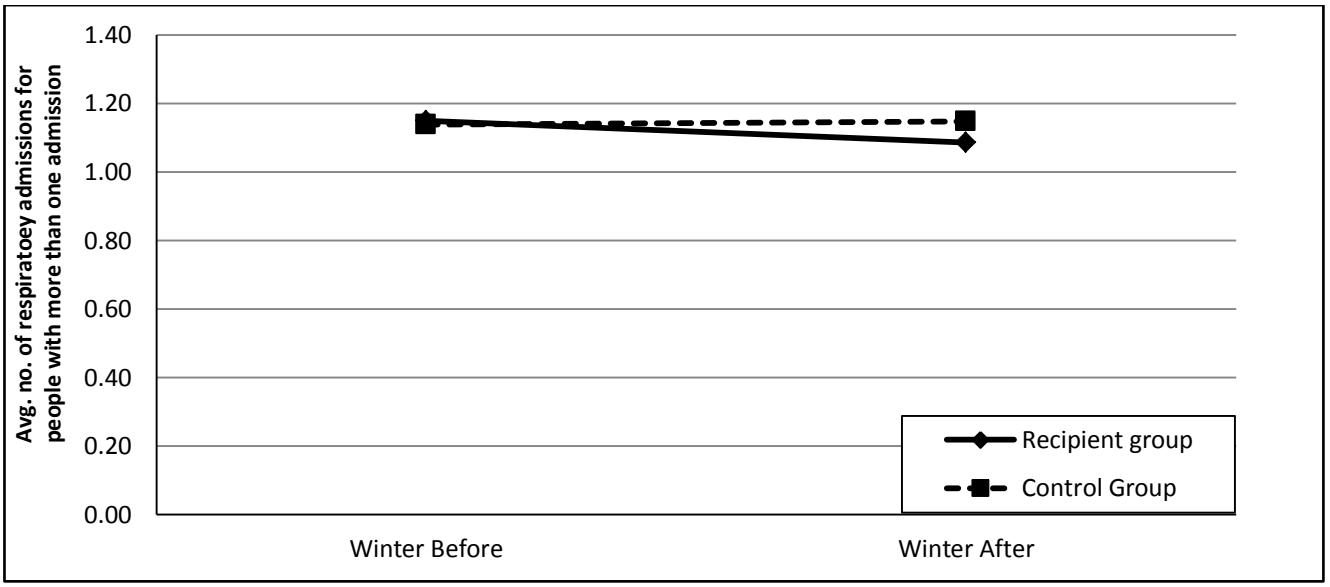


Chart 4 The average number of emergency respiratory hospital admissions in the winter months before and winter months after installation: recipient group compared with control group - people with one or more admissions



Next Steps

45. This bulletin presents findings from the first analysis of linked administrative data for the Warm Homes Nest scheme.

46. Future publications will:

- Include a peer review journal article documenting the methodology in full and discussing the findings further to follow in due course;
- Widen the follow up time to compare admissions for two years before and after installation;
- Report analysis relating to additional health conditions;
- Present a comparative analysis of the health impacts of the demand-led Warm Homes Nest and area-based Warm Homes Arbed schemes;
- Report analysis relating to the impact of the Warm Homes Nest scheme on educational attainment;
- As noted above, further analysis would be required to examine whether the differences in health events between the recipient and control groups observed at

baseline could be attributed to the successful targeting of Warm Homes Nest.

Key Quality Information

47. The data linking technique used resulted in 74% of the Nest Warm Homes data being linked to health data sets. Work is underway to improve the data linking rate by including anonymised address information. Based on the limited information available about recipients, there was no evidence of bias in terms of the characteristics of the individuals for whom record linkage was possible compared with those for whom record linkage failed i.e. no particular group is relatively less well-represented in the analysis presented in this report.
48. The data included a small number of households that contained unexpectedly large numbers of members, possibly indicating the inclusion of some multiple occupancy residences (e.g. converted houses or hostels) where it is probable that not all residents will have received the relevant measure. On the basis of advice from the ADRC-W statistician, households with more than 10 members were excluded from the analysis[16], but the data may therefore still include some multiple occupancy residences. A sensitivity analysis was completed of the overall pattern of GP Events, GP prescribing and Hospital Admissions which demonstrated that the overall pattern was unaffected when the cut-of point for household size was reduced from 10 to 5 members i.e. to a point where it is probable that all residents did receive the measure.
49. As part of the process of data linkage an indication is provided of the quality of each match. Each match is assessed to be a high, intermediate or low quality match. Low quality matches were excluded.
50. There is a limitation with regard to the analysis of health events over time using the SAIL Databank. This problem arises due to the slow reporting of address change by GP patients to their GP practice, including delays in registering with a new practice when people move house. If a person remained registered at a GP practice despite having moved either temporarily or permanently away, it is not possible to detect this in SAIL and people will be included in the analysis in error. The delayed GP registration issue tends to be particularly pronounced among mobile, young, healthy people (particularly men), who may not need to visit a doctor for long periods and who may migrate for education (e.g. students) or employment without registering with a new GP[17], this combined with low levels of migration over the entire study period in both groups, means this is likely to have had a relatively minimal impact on this analysis.
51. GP Event records are currently available for around 78% of the population of Wales on a practice by practice basis and are therefore not randomly or geographically evenly spread. Work by SAIL means that this figure is increasing all the time. There is no simple way in SAIL to distinguish between individuals who have no GP Events because they have not visited their GP and individuals who have no GP Events because their practice is not signed up to provide the data to SAIL. However, where individuals are missing from the 'winter before' they will also almost certainly be missing from the 'winter after', thus affecting both sides of the equation equally. The research methodology used for the analysis therefore minimises any potential for bias due to missing data.
52. At present the analysis does not account for the number of home energy efficiency improvement measures installed in the dwelling or the size of the improvement the measures are estimated to have made (i.e. estimated improvement in SAP score). However, since the selection of measures for installation was dependent not only on the necessity of the measure but its suitability to the dwelling (subject to the scheme maximum spending cap), examining variations in health outcomes by the number of measures or the estimated improvement in SAP score was not considered a fruitful approach.
53. The project was supported by Professor D Berridge, Chair in Applied Statistics at Swansea University, in the design and interpretation of the statistical analysis. Quality Assurance processes were applied to test the robustness of the research methodology and writing of analytical code. These processes involved presenting the methods to a group of peers including data analysts and researchers as well as checking by peers of the data coding.

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[7] A control group is a group of individuals who have not received an intervention who are similar enough to be compared with the group who have received the intervention. This is to determine whether it is the intervention that has caused any observed change.

[8] We used a stepped wedge with cohort crossover design to construct an intervention and control cohort for each year of the study period. We conducted difference in difference (DID) estimations between groups over time. Probabilities of a zero event were examined by investigating the interaction between group and period using binary logistic regression models. The difference in difference analysis for the non-zero means used truncated Poisson regression models. As noted above, a peer review journal article documenting the methodology in full and discussing the findings further will follow in due course.

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An ESRC Data Investment

Acknowledgements:

This publication is based on research supported jointly by the Economic and Social Research Council and the Welsh Government. The data sets used were accessed via the Administrative Data Research Centre Wales (ADRC-W), funded by the Economic and Social Research Council (ESRC Grant ES/L007/444/1). The Warm Homes Nest Scheme data was provided by the Nest Scheme Manager. This study makes use of anonymised data held in the Secure Anonymised Information Linkage (SAIL) system, which is part of the national e-health records research infrastructure for Wales. We would like to acknowledge all the data providers who make anonymised data available for research. The support of the Farr Institute CIPHER (MRC Grant MR/K006525/1) is also gratefully acknowledged.

Views expressed in this report are those of the researchers and not necessarily those of the Welsh Government or other organisations mentioned above.

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 Digital ISBN 978-1-4734-9410-7