The effect of the Winter Fuel Payment on household temperature and health: a regression discontinuity design study

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Scientific summary

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Background

The Winter Fuel Payment (WFP) is an unconditional cash transfer that was introduced in 1997 to help older people meet the costs of heating during the colder winter months. Although the payment can be spent on any goods and services, labelling the cash transfer as payment for 'winter fuel' attempts to 'nudge' recipients towards increasing domestic heating, thereby combating fuel poverty, raising indoor temperatures and reducing morbidity and excess winter deaths. Previously, it has been shown that almost half (47%) of the WFP is actually spent on fuel (Beatty TK, Blow L, Crossley TF, O' Dea C. Cash by any other name? Evidence on labeling from the UK Winter Fuel Payment. *J Public Econ* 2014;**118**:86–96.). However, it remains unknown whether or not this increase in household energy expenditure has resulted in higher indoor temperatures and, most importantly, health benefits. As the total expenditure on the WFP has been estimated to range between £2B and £3B per year, studying the effectiveness of this programme seems crucial.

Objectives

In this study, we first test the association between indoor temperature and health. We then test whether or not the WFP protects older people from low indoor temperatures and the associated adverse health effects. To do this, we draw on high-quality micro data from the English Longitudinal Study on Ageing (ELSA) (Steptoe A, Breeze E, Banks J, Nazroo J. Cohort profile: the English longitudinal study of ageing. *Int J Epidemiol* 2013;**42**:1640–8).

Specifically, the current study asks four questions:

1. What health measures are most likely to respond to changes in ambient indoor temperature [specifically examining blood pressure, C-reactive protein (CRP) and fibrinogen levels, forced expiratory volume, reports of chest infection, and mental and physical health ratings]?
2. Does the WFP increase the household temperature in households eligible for the transfer?
3. Does the WFP improve recipient households' health outcomes, and, if so, what is the magnitude of these effects?
4. Do the household temperature and health benefits of the WFP differ based on the social position of household members (e.g. income, social class), and is there evidence that the WFP produces beneficial effects for those at risk of fuel poverty?

Methods

Participants

We draw data from the first six waves of the ELSA, covering the period 2002–12. The ELSA is a multidisciplinary and longitudinal study that collects detailed information on the health, well-being and socioeconomic status of individuals aged $\geq$ 50 years and living in England using a computer-assisted personal interview. A nurse visit is carried out every other wave (starting in wave 2) to collect biomarkers and additional measures of physical functioning. Analyses that examined the association between household temperature and health had a maximum sample of 11,751 adults aged 50–90 years. The regression discontinuity (RD) analyses draw on a maximum of 7032 observations.

Outcome measurement

Ambient indoor air temperature in the participant's household was measured as part of the ELSA nurse assessment in waves 2, 4 and 6 of the study. Temperature was assessed using a digital thermometer placed on a surface where the measurement probe was positioned so that it did not come in contact with any object (e.g. not hanging over the edge of a table). After 5 minutes, the study nurse recorded the ambient temperature correct to one decimal place. A set of health measures and a blood sample were taken from consenting participants during each of the nurse assessments. Following an extensive literature review of relevant participant-reported health indicators and objectively recorded biomarkers likely to be affected by indoor temperature, we selected a series of key measures. CRP and fibrinogen were used to assess inflammation, systolic blood pressure provided an index of cardiovascular functioning and respiratory functioning was assessed using a measure of forced expiratory volume. In addition, participants reported if they had recently experienced a chest infection and also rated their general health and the presence of depressive symptoms in the past week.

Indoor temperature and health

First, to estimate the link between ambient indoor temperature and the health outcome measures, we examine three waves of the ELSA spanning an 8-year period from 2004/5 to 2012/13. The longitudinal nature of the study allows both random- and fixed-effects models to be tested. Fixed-effects models examine within-person variation and, in this way, adjust for non-observed time-invariant confounders (e.g. social background, genetic factors), thereby providing more reliable estimates of the naturalistic relationship between temperature and health in the general population.

Main study design

To ascertain whether or not WFP eligibility (vs. ineligibility) is associated with differences in a series of relevant, objectively recorded and self-reported outcome measures, we conducted a series of RD design analyses. The RD analyses exploit the sharp eligibility criteria for the WFP, allowing the potential impact of the WFP to be estimated using non-experimental observational data. To be eligible for the WFP, the oldest member of the household needs to be aged > 60 years in the qualifying week of a given year. Our research design treats the WFP as a natural experiment and employs a regression discontinuity design (RDD) to estimate the potential causal effect of WFP on household temperature and health outcomes. We take advantage of rich information on health, demographic and socioeconomic characteristics (ELSA) and the unique eligibility of the WFP, which depends on the date of birth of the oldest member of the household. The randomisation around the date of birth of recipients and non-recipients allows for identification of causal effects by comparing households who are immediately below and above the eligibility age.

Intervention

The WFP is given annually to households that include a member aged > 60 years in the qualifying week as a lump sum payment (e.g. newly eligible households received £200 in 2016/17), typically in November or December. The goal of the payment is to increase energy expenditure, thus raising household temperature during cold weather and enhancing the health and well-being of older adults.

Statistical analyses

To estimate the potential causal effect of the WFP on household temperature and health outcomes, we treat the WFP as a natural experiment and employ a RDD. To be eligible for the WFP, the oldest member of the household needs to be aged > 60 years in the qualifying week of a given year. The assignment to the treatment is therefore determined exogenously by the age of the oldest member of the household in the arbitrary qualifying week, which is an observable variable. This randomisation around the date of birth of recipients and non-recipients allows for identification of causal effects by comparing households with a member immediately below and above the eligibility age.

We estimate a two-stage model in which the first stage predicts the effect of WFP on indoor temperature and the second stage models the effect of indoor temperature on health outcomes.

Results

Results from both random-effects multilevel regression models showed that low levels of indoor temperature were associated with raised systolic [increase in blood pressure (mmHg) per reduction in temperature by 1 °C: $\beta = 0.46$, standards error (SE) = 0.05; $p < 0.001$] and diastolic blood pressure levels ($\beta = 0.25$, SE = 0.03; $p < 0.001$) and raised fibrinogen ($\beta = 0.01$, SE = 0.002; $p < 0.001$) and CRP levels ($\beta = 0.008$, SE = 0.003; $p < 0.05$). These associations were robust to adjustment for a broad range of relevant confounders including demographic factors, socioeconomic background, the presence of health conditions, body mass index, and month of year and region. The linkages were also replicated in fixed-effects panel models. We also integrated weather station data specific to participant assessment times and areas of residence and showed that these associations were unaffected by adjustment for outdoor temperature levels. These analyses strengthened our rationale for examining blood pressure and inflammation as indicators that respond to changes in household temperature and may be affected by the WFP. In particular, systolic blood pressure showed substantial changes in response to differences in household temperature: those living in homes with temperature levels below 17 °C were found to have systolic blood pressure levels over four points higher ($\beta = 4.56$, SE = 0.55; $p < 0.001$) than those living in household temperatures of $\geq$ 23 °C.

The study found little evidence that the WFP alters indoor temperature, a finding that was consistent across RD model specifications. Similarly, although eligibility for the WFP was associated with some health outcomes, under certain model specifications we found little consistent evidence that the payment may have a beneficial impact on objectively recorded health markers or self-reported health outcomes. However, given the number of observations available in the current analyses, further research is required to precisely ascertain the magnitude of the relationship between receipt of the WFP and home temperature and the health of household members.

Discussion

This study capitalised on the sharp assignment rules regarding WFP eligibility to estimate the potential effect of the WFP on household temperature and health in a national sample of English adults. We showed that lower indoor temperatures are generally related to health problems as indexed by high blood pressure and inflammation levels. However, the RD design employed did not identify consistent evidence linking the WFP to warmer homes or specific health and well-being benefits. The study results suggest that the potential temperature and health benefits of the WFP are unlikely to be large at the aggregate population level. However, we cannot rule out the possibility that the WFP may have important implications for population health for certain individuals under certain circumstances. In support of this contention, our supplemental analyses examining mortality at the local authority level identified initial evidence to suggest that the WFP could attenuate the impact of particularly cold conditions (e.g. temperatures of $\leq$ 2 °C) on mortality.

Future work

Studies incorporating high-frequency measurement of indoor temperature in multiple rooms over prolonged periods would aid in reducing measurement error in the assessment of home temperature and in precisely identifying the effect of the WFP. Further research utilising larger samples of participants close to the WFP eligibility cut-off point is also needed to identify whether or not the WFP is linked to robust home temperature and health benefits not observed in the current study.

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