Manufacturing plant social characteristics and incident hypertension, diabetes and ischemic heart disease

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background

Characteristics of the workplace environment have long been associated with increased hypertension and cardiovascular disease. In particular, there is a large descriptive literature of the effects of psychosocial characteristics that are intended to measure work context, rather than individual perceptions or individual psychological characteristics (1-3).

However, this work suffers from three major limitations that prevent it from contributing to prevention and informing workplace changes and interventions. First, virtually all of these studies use individual level reports of the environment as the exposure of interest. This is problematic because this may be confounded by individual level psychological characteristics that are not easy to control for in multivariate regression analysis. A second major limitation of prior studies is that most are cross-sectional in nature or examine prevalence of hypertension or cardiovascular disease, thus the temporal ordering of cardiovascular disease and work environment is unclear. Individuals with greater levels of disease may sort themselves into certain types of environments. Finally, prior studies have not controlled for factors that may influence the characteristics of the composition of particular workplaces. For example, health has been shown to vary dramatically by US county, and the correlation between workplace characteristics and health may actually reflect the correlation between workplace characteristics and the county they are located in.

The current study addresses all three of these limitations by examining incident hypertension, diabetes and ischemic heart disease while controlling for individual demographic characteristics and state of birth, along with current county characteristics. In addition, rather than using individual self-report of the work environment, we construct an environmental variable of aggregate rating of plant characteristics, based on the average survey response from each plant, thereby dramatically limiting the particular type of confounding that could occur due to individual characteristics that would jointly predict survey response to work environment questions and incident health outcomes.

methods

The study population is an occupational cohort obtained from 47 United States manufacturing plants with a total analytic size of 10,545. Key predictor variables were based on an anonymous 30 question yearly survey to workers about workplace environment, where four factors were

obtained from a principal components analysis: *Job Satisfaction* (factor 1), *Feelings toward Management* (factor 2), *Workplace Involvement* (factor 3) and *Work Stress* (factor 4). Individual level responses are aggregated to the plant (n=47) level, thus the exposure is an ecological variable. We examine these 4 predictors in separate models, as baseline predictors of disease incidence: *incident hypertension, incident ischemic heart disease,* and *incident diabetes* as defined by medical claims data. The definition we use is 2 years of being disease free since hire and 2 diagnoses of the outcome. We consider *individual* confounding characteristics composing plants that may impact exposure and outcome: gender, wages, race, grade and employment type. We also consider 68 candidate *county level* confounding factors, and evaluate a set for model inclusion using the random forest machine learning algorithm (4). While *a priori* theory is best to evaluate potential confounding variables, there is no strong theory to evaluate which of 68 potential county characteristics are most relevant for the exposures and outcomes examined.

Results

As an example of the variability by plant, we show here a series of residual plots of variability in the relationship between level of hypertension by plant, with substantial variation shown in the Model 1 plot which includes only a random effect term in the model for plant. While inclusion of demographic characteristics (Model 2) reduce the heterogeneity substantially, a high degree of plant level variability remains. Only the inclusion of demographic, plant level and county level characteristics results in almost complete accounting for variability in hypertension (Model 7), with state of birth characteristics (Model 8) contributing little additional explanatory power.

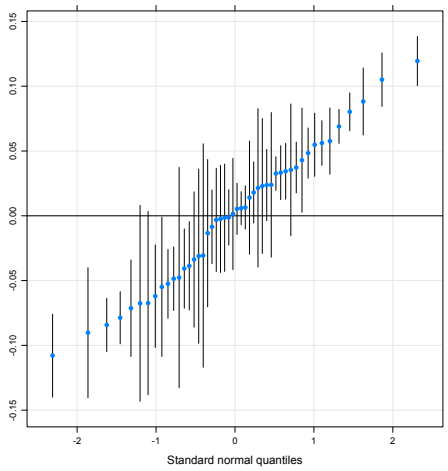
We will show that in basic models examining the effects of workplace social characteristics we find significant associations between baseline aggregate measures of workplace involvement with incident hypertension. Results of Random Forest analysis will be presented to show the selection of 10 potential county characteristics associated with exposure and outcome. Many of these factors were related to government social expenditures and socioeconomic attributes of the county population – and were different from those selected from a theory based model. After we control for these factors in regression models, we find workplace social characteristics and change in those characteristics remain generally associated with incident hypertension.

Conclusions

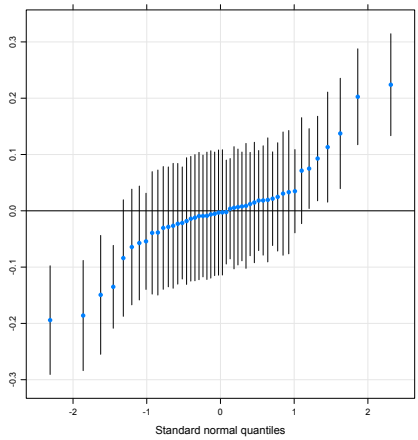
Our first conclusion is that studies of exposures with large amounts of county variation should take into account possible front-end selection bias by population characteristics at the county level in order to avoid biased inference. Secondly, our results point to the importance of county social expenditures and socioeconomic characteristics for predicting incident hypertension

Figure. Distribution of Random effect for models 1-8 – for hypertension

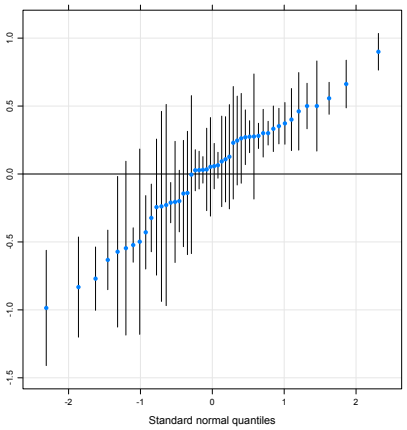
Model 1 – No fixed effect terms



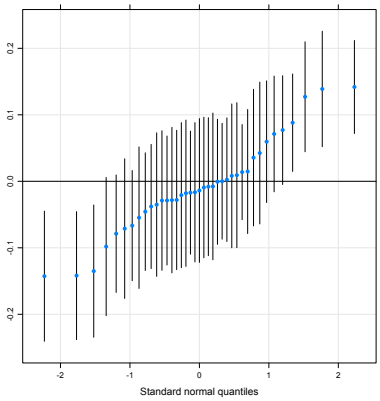
Model 2 – demographic fixed



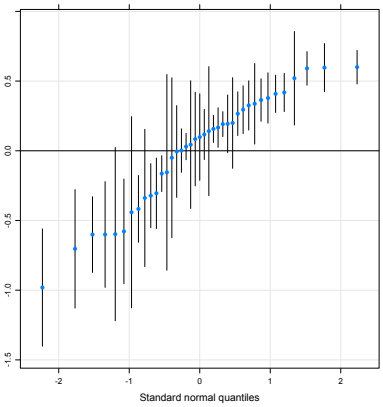
Model 3 – plant characteristics fixed



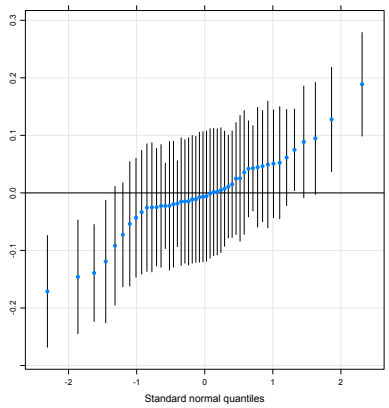
Model 4 – county characteristics fixed



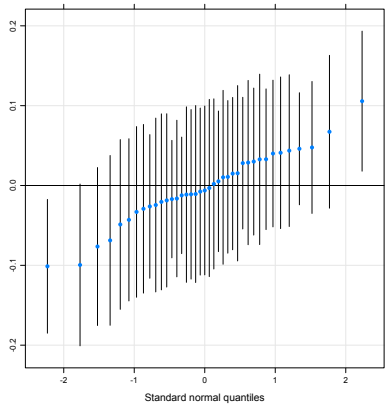
Model 5 – state of birth characteristics fixed



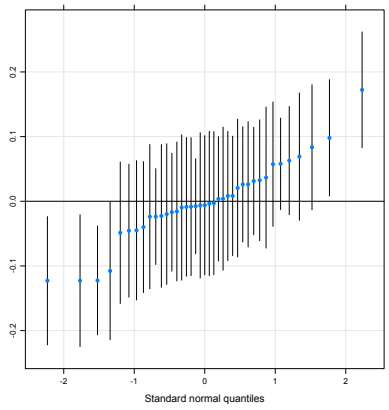
Model 6 - demographic + plant fixed



Model 7 – demographic + plant + county fixed



Model 8 – demographic + plant + county + state of birth characteristics fixed



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