Received: 14 September 2022 | Accepted: 5 April 2023

DOI: 10.1111/irel.12334

ORIGINAL ARTICLE

# Performance-related pay, mental and physiological health

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**Funding information**
Economic and Social Research Council, Grant/Award Number: ES/R01163X/1

**Abstract**

Much of the literature on performance-related pay (PRP) and poor health relies on self-reported data, and the relationship is difficult to examine due to confounding variables. We examine the relationship between PRP and three groups of health measures using data from the UKHLS: blood pressure, inflammation markers in blood, and self-reported health. Regressions correcting for self-selection bias and socio-demographic covariates find that PRP contracts are associated with poorer mental health, higher systolic blood pressure, and higher levels of fibrinogen. These findings suggest that firms that use PRP may need to implement policies to mitigate against PRP-related stress.

**JEL CLASSIFICATION**

J33, I0, I14

Basing employees' salaries on their performance (performance-related pay or PRP) has traditionally been perceived as a payment system with a range of positive outcomes. There is a well-established link between PRP and higher productivity through incentivization and self-sorting effects, and consequently higher earnings for the employee and higher productivity for employers. Traditionally then, it has been widely accepted that PRP is of benefit to all parties involved and leads to an alignment between the goals of the employers and employees. However, in his book *The Wealth of Nations*, Scottish economist Adam Smith made the following observation: "Workmen… when they are liberally paid by the piece, are very apt to overwork themselves and to ruin their health and constitution in a few years." (Smith 1937, p. 83). This early observation suggests that PRP may have unintended negative consequences on workers' health.

Despite this early observation, it is only in the past two decades that researchers have begun seriously investigating this claim empirically and subsequently finding a relationship between

PRP and various measures of poor health (Artz & Heywood 2015; Bender & Theodossiou 2014). These studies have to date, almost entirely relied on subjective evaluations or recollections of injuries, medical conditions or health. In contrast, there is little research on PRP and health using biomarkers as physiological indicators of health in large-scale survey data. Furthermore, there is a well-known sorting effect when workers select into PRP. It is possible then that the link between PRP and poor health is due to confounding variables and sorting, rather than PRP leading to worse health.

We address these limitations in the current study by using an individual level dataset that includes both labor market information as well as a nurse health assessment with objective measures of health. By including contextual variables that are related to PRP but not directly related to health as instruments, we are able to statistically correct for the self-selection bias found among PRP workers. In addition to this important statistical correction, the availability of a nurse assessment of health allows us to examine the relationship between PRP and health using more robust and objective measures of health than those found in the current literature.

## LITERATURE REVIEW

Although there are several studies that have found a link between PRP and health in survey data, a wide range of observed health outcomes are included in the literature such as injuries, insurance premiums, medication use, and self-reported health. Consequently, there is likely more than one causal mechanism through which PRP may impact on health and the literature can broadly be defined into three such pathways.

The first pathway is based on the association between PRP and injuries. It is possible that making earnings dependent on performance incentivizes individuals to increase their rate of output, thereby also encouraging risk-taking behaviors which in turn lead to higher rates of injuries and accidents at work. This is typically supported by industry-specific examples. For example, Freeman and Kleiner (2005) find that an American shoe-manufacturing company that switched from PRP to fixed salary contracts saw a decrease in workers' compensation insurance premiums, suggesting that accidents and injuries lessened after the switch. Comparisons between groups demonstrate similar results. For example, a study examining long-haul truckers (Monaco & Williams 2000) finds that accidents were more frequent among groups of truckers who are paid by percentage of revenue in comparison to those who are paid by the mile (18% vs. 13%) and in line with this, Saha et al. (2004) show that workers in fertilizer production who are paid by PRP are 1.7–4.3 times more likely to have accidents than their counterparts on time-based pay contracts over a 5-year period. Finally, beyond these industry-specific findings, several studies have used nationally representative survey data and find that there is a robust link between PRP and injuries/accidents across industries and occupations (Artz & Heywood 2015; Bender et al. 2012).

However, PRP is also associated with health outcomes not directly related to injuries. For example, Dahl and Pierce (2020) study Danish firms who switched from fixed to PRP contracts and discover a 4%–6% increase in the use of anti-depressants and anxiety medication by employees, indicating that mental health was poorer after the switch. Bender and Theodossiou (2014) find that PRP workers were more likely than others to report issues with cardiovascular health, stomach/digestive problems, and poorer emotional health. This may be due to a second pathway; the consequences of working more hours when employed in a PRP contract. Previous research in the UK has found that PRP workers are likely to work 1.5 hours more per week than those on fixed pay (Bender & Theodossiou 2014). Therefore, there may be a trade-off of earnings versus leisure time that could otherwise be spent on activities that promote physical and mental health. On the other hand, it may be that rather than causing a decrease in healthy activities, the additional hours worked may lead to an increase in behaviors detrimental to health as a coping mechanism. For example, Artz et al. (2021) find that workers paid via PRP are more likely to drink alcohol and use drugs than workers on a fixed salary, even after controlling for individual and firm fixed effects and endogeneity. Similar findings seem to be prevalent in Germany as well (Baktash et al. 2022).

Finally, a third pathway suggests that working in a PRP contract is inherently stressful, either because of working additional hours as suggested by Bender and Theodossiou (2014), or due to the financial uncertainty that is associated with a variable income stream and the pressure to keep productivity high. Although humans are generally good at adapting to brief episodes of stress, persistent and chronic stress increases allostatic load over time, that is, physiological "wear and tear" on the body (McEwen 1998). Increased allostatic load may eventually reduce the efficacy of the immune system, putting individuals at higher risk of experiencing health issues (Rohleder 2014). This third pathway is the focus of the current paper and is explored through analysis of large-scale survey data. Importantly though, none of these pathways are mutually exclusive, and it is possible that PRP employees are at higher risk of poor health through more than one pathway at the same time.

One of the limitations of examining PRP and health using survey data is the possibility of confounding variables causing both self-sorting into PRP and poorer health outcomes. Although not impossible, it is often difficult to statistically control for endogeneity. For example, it may be that workers who are attracted to variable pay have a higher risk-preference in comparison to their fixed salary counterparts (e.g., Bandiera et al. 2015; Cornelissen et al. 2011; Grund & Sliwka 2010). A high level of risk-preference then is likely to correlate with risk behavior which in turn is correlated with poorer mental (Cobb-Clark et al. 2022) and physical health (Anderson & Mellor 2008; Dohmen et al. 2011), leading workers with a high-risk preference to both be more likely to be found in PRP contracts as well as having poorer health. Alternatively, there may be a selection effect which is correlated with better health. For example, workers who sort into PRP are more likely to have higher cognitive ability (Curme & Stefanec 2007), a characteristic which to some extent is correlated with better health (Cutler & Lleras-Muney 2010). Then, employees who sort into PRP may be more likely to have better health than their fixed salary counterparts, potentially obscuring any health issues caused by working in PRP contracts.

Allan et al. (2021) recently address this issue in an incentivized experiment. By randomly allocating participants to either a PRP or a fixed payment condition they circumvent the issue of self-selection. The study finds that even a brief 10-min work task leads to higher levels of the stress-related hormone, cortisol, in saliva when participants were paid by performance rather than a fixed payment. For survey data then, where random assignment is very rare, it is important to correct for self-selection bias, regardless of whether it is improving or worsening health.

A second limitation of the existing literature is the lack of physiological measures of health. Although Allan et al. (2021) provide evidence for a causal link between PRP and increased levels of cortisol in a lab setting, the study has common experimental limitations such as a homogeneous sample and perhaps more importantly, only provides evidence for acute physiological stress. In contrast, studies using survey data are able to investigate PRP and health across a range of industries and occupations and with a representative sample of the workforce. Previous studies based on survey data examine a range of health outcomes, including workplace injuries (Artz & Heywood 2015; Bender et al. 2012), subjective overall health, and a range of conditions associated with stress including heart problems, stomach/digestive problems and anxiety/depression (Bender & Theodossiou 2014). However, to date research has not explored the relationship between PRP and well-known physiological markers of stress, which are arguably more robust than self-report measures and which can give some insight into more chronic effects of stress. The aim of the current study was to address this gap in the literature by examining the association between PRP and physiological health variables whilst correcting for self-selection bias.

## METHODOLOGY

The following basic equation for estimating health is similar to a health production function (Grossman 1972):

$$H_i = X_i\beta + \delta \mathrm{PRP}_i + \varepsilon_i, \quad (1)$$

where for person $i$, $H$ is a measure of health, $X$ is a set of socio-demographic and other characteristics that affect health though the parameters in $\beta$, PRP is a dummy variable capturing performance-related pay and $\varepsilon$ is an error term. The parameter, $\delta$, captures the relationship between PRP and health and given the literature and mechanisms explained above is expected to show that PRP leads to lower levels of health.

A key problem with estimating Equation (1) using survey data is that it is likely that those choosing a PRP contract are a self-selected group of workers and this selection process is not independent of health potentially biasing the estimate of $\delta$. For example, as discussed in the literature review PRP and health are both impacted by the risk tolerance of individuals—the less risk averse individuals are, the more likely they are to be in PRP jobs and to experience adverse health outcomes. Thus, Equation (1) needs to be modeled as an endogenous treatment in order to have more confidence that we are picking up causal influences of PRP on health and not just correlational associations. The endogenous treatment methodology involves two equations that are estimated simultaneously. The PRP choice equation is specified as follows:

$$\mathrm{PRP}_i = X_i\beta + Z_i\gamma + \mu_i. \quad (2)$$

A key element of this regression is the $Z$ matrix which are the instruments used to identify the model with their influence on the choice of a PRP contract given by $\gamma$. Although the model could be identified from the nonlinearity of the functional forms, here, we use two instruments used in the literature to help with identification. The first comes from a question asked of respondents about the size of the firm. Previous research by Conyon et al. (2001) and Heywood et al. (1997) suggests that there are fixed costs for setting up PRP systems, and that therefore, larger firms would be more likely to implement such systems. Consequently, our first instrument is a binary variable with two levels: a small firm size of 25 employees or less versus moderate-to-large firm size of more than 25 employees. The relatively low number of 25 employees was chosen as a substantial portion of survey respondents indicated that they did not know the exact number of employees but could confirm that it was above/below 25 employees. A second instrument comes from a widely used aggregation strategy (e.g., Artz & Heywood 2015; Baktash et al. 2022; Bilanakos et al. 2018; Cornelissen et al. 2011; Lee 2004; Woessmann & West 2006 and others). The share (%) of PRP workers is calculated for each three-digit occupation in Wave 2 of the UKHLS, omitting the observed individual when computing the share of PRP within the occupation for each respondent. Although the dataset has 81 three-digit occupations, we excluded occupations with less than 10 workers, leaving 74 occupations. This percentage will capture the propensity of different occupations to employ workers on PRP contracts, as performance may be easier to monitor in some occupations and in turn these occupations may have higher rates of PRP contracts (Bayo-Moriones et al. 2013).

Valid instruments need to be able to predict the selection variable without affecting the outcome variable (other than indirectly through the self-selection mechanism). For the reasons mentioned above, it is reasonable to assume that both of the instruments (firm size and percentage PRP within occupational group) are related to PRP, while there is no obvious reason for why they would be directly related to health in the current UK context. Although there is no way to formally test the validity of instruments, we can informally test the relationship between the instruments and the health outcomes by estimating only the health equation while also including PRP and both instruments as covariates. The absence of any significant relationships between either of the instruments and any of the health outcomes discussed in this paper after controlling for covariates (see Table 1) indicates that there is no direct statistical relationship between health and firm size or share of PRP within occupation. However, it is necessary to recognize that this is not a test of instrument validity, and it can be argued that if there is omitted variable bias in the treatment variable, this will be transferred to the instrument as well (Angrist & Pischke 2009). Instead, only reasoning can determine whether an instrument is valid or not while taking context and relevant covariates into account. For example, although firm size is likely to be related to health in countries where employees make use of workplace health insurance, it is less of an issue in the current dataset since health care is provided publicly in the UK. Also, by including two-digit occupation dummies as a covariate as has been done previously in the literature (Baktash et al. 2022), we are able to control for traits which predict both sorting into occupations as well as sorting into PRP.

With these two equations specified, maximum likelihood methods are used to estimate the two equations simultaneously for each health measure. Hausman overidentification tests comparing the model with one instrument versus both instruments consistently result in small test values ($\chi^2$ ranging from −0.76 to 1.20, *p*-values from 0.273). This indicates that, assuming that both instruments are valid, using two instruments is unlikely to be overfitting, and it is preferable to using a single instrument.

# DATA

There is a lack of survey data offering information about payment contracts, socio-demographic indicators as well as physical and mental health. One notable exception to this is the UK Household Longitudinal Survey (UKHLS, University of Essex, Institute for Social and Economic Research 2021), the replacement of the British Household Panel Survey. The UKHLS is a household panel study that started in 2009 and includes approximately 40,000 households across all countries in the UK. In contrast to its predecessor, the UKHLS does not only ask for self-reported evaluations of health, but also incorporates a Nurse Assessment module for a subset of the sample in the second and third wave of the UKHLS in 2010–2012 and 2011–2013, respectively (University of Essex, Institute for Social and Economic Research, National Centre for Social Research 2014), although the samples that took part in the health assessment do not overlap. In addition to these health data, it records broad information about PRP in every other wave of the study ("Does your pay include performance-related pay?"), meaning that the second wave of the UKHLS (from 2011 to 2012) includes both PRP and the nurse assessed health information about the sample. Consequently, the current paper focuses on Wave 2 of the UKHLS. Although the broad question about PRP does not differentiate between workers who are paid solely by piece rate or partial fixed salary (e.g., commission) or possibly even a bonus, this is likely to bias us towards finding a smaller effect rather than overestimating the true effect. The PRP question is only asked of workers who indicate that they are employees, and self-employed workers are therefore excluded from the analysis. Furthermore, although workers in Northern Ireland are included in the main UKHLS survey, the Nurse Assessment module is not offered to this group and so Northern Ireland residents are also excluded from the current analysis.[i] Finally, although the Nurse Assessment module offers a rare opportunity to explore the relationship between PRP and physiological measures of health, since the samples do not overlap it is unfortunately not possible to use panel data in the current paper.

In addition to the physiological measures from the Nurse Assessment module, the current study includes four measures of self-reported health derived from two scales. The first scale,

**TABLE 1** Instrument coefficients predicting health outcomes.

| | Self-reported GHQ-12 | Self-reported mental health | Self-reported physical health | Self-reported general health | Systolic blood pressure | Diastolic blood pressure | Blood pressure > 140/90 mmHg | (log of) C-reactive protein | Fibrinogen |
|---|---|---|---|---|---|---|---|---|---|
| % PRP across occupation | −0.27 | −0.73 | 1.94 | 0.21 | 1.37 | 0.09 | −0.16 | −0.11 | 0.01 |
| | (0.79) | (1.37) | (1.23) | (0.18) | (2.23) | (1.69) | (0.28) | (0.10) | (0.10) |
| Size of firm | −0.10 | −0.32 | 0.29 | 0.00 | −0.32 | −0.29 | 0.03 | 0.00 | −0.02 |
| | (0.14) | (0.24) | (0.21) | (0.03) | (0.39) | (0.29) | (0.05) | (0.02) | (0.02) |

*Note*: Standard errors in brackets. All regressions include PRP, age, age squared, occupation, BMI > 25, smoking, (log of) income, male, not married, highest education level, white ethnicity, country of residence, non-manual labor, and weekly work hours. Full results are available upon request from author.

None of the coefficients are significant at $p < 0.1$.

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

the GHQ-12, is commonly used when screening for mental health difficulties (Goldberg & Williams 1988). It consists of 12 items that are rated on a 4-point Likert scale from 0 to 3 (Better/More than usual, Same as usual, Less than usual, and Not at all) and then summed, resulting in a score from 0 to 36. The other three measures are derived from the SF-12 scale, which is commonly used as a health-related quality of life measure (Jenkinson & Layte 1997). The physical and mental health subscales of the SF-12 focus on the extent to which the respondent's physical/mental health impact on their everyday life (Ware Jr et al. 1996). Both scales use a mixture of binary or 5-point Likert ratings. The questions are prefaced with “During the past 4 weeks….” The physical scale consists of the following six items: (1) In general, would you say your health is Excellent-Poor, (2) Does your health now limit you in these activities, (a) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf, (b) Climbing several flights of stairs, (3) Have you had any of the following problems with your work or other regular daily activities as a result of your health, (a) Accomplished less than you would like, (b) Were limited in the kind of work or other activities, (4) How much did pain interfere with your normal work. The mental scale also consists of six items: (1) Have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems, (a) Accomplished less than you would like, (b) Didn't do work or other activities as carefully as possible, (2) Have you felt calm and peaceful, (3) Did you have a lot of energy, (4) Have you felt downhearted and blue, (5) How much of the time has your physical health or emotional problems interfered with your social activities. Both subscores are transformed into scores ranging 0–100 where higher values indicate better functioning. The UKHLS also provides the individual responses for the first item on the SF-12 scale, “In general, would you say your health is….” This item is rated on a 5-point Likert scale (Excellent, Very good, Good, Fair, and Poor) and is used here as a general measure of health. Both this single health item and the GHQ-12 were coded in the same direction as the physical/mental health subscores for consistency when reporting the self-reported health measures in the next section.

The Nurse Assessment module of the UKHLS provides a range of health measures beyond self-report. These include systolic and diastolic blood pressure, as well as c-reactive protein and fibrinogen markers as extracted from blood samples provided by the respondents. Self-reported stress is associated with increases in both systolic and diastolic blood pressure both in research examining brief episodes of stress in the lab (Hjortskov et al. 2004) as well as longitudinal survey data measuring chronic psychosocial stress (Steptoe et al. 2005). Furthermore, people with blood pressure above 140/90 mmHg are considered at risk for hypertension (National Institute for Health and Care Excellence 2019), suggesting that this is another important outcome to measure. Similarly, c-reactive protein is a marker of inflammation where levels >3 mg/L is considered a risk factor for cardiovascular disease (Pearson et al. 2003). It has been linked with lower socio-economic status (Owen et al. 2003) and a systematic review by Johnson et al. (2013) suggests that levels of c-reactive protein may mediate the relationship between chronic stress and health outcomes. The UKHLS reports that c-reactive protein levels in males and females from their Nurse Assessment sample are on average 2.3 and 3.1 mg/L, respectively, similar to the levels found in the Health Survey for England (HSE, University College London, Department for Epidemiology and Public Health 2015). Although there are no clinical cut-off points, fibrinogen is increased by acute mental stress (Ellins et al. 2017; Steptoe et al. 2003) and a link has also been found between increased fibrinogen levels and lower education levels and income (Panagiotakos et al. 2004), lower socio-economic status (Ramsay et al. 2015) and chronic stress (Siegrist et al. 1997). In the full UKHLS Nurse Assessment males and females have average fibrinogen levels of 2.7 and 2.8 g/L, respectively, levels which are again comparable to those reported in the HSE (2015).

There are discrepancies in the sample size for each health measure in the UKHLS. Not all survey respondents were invited to take part in the Nurse Assessment, and although the majority of Nurse Assessment participants were invited to provide blood samples, a subset of the blood is frozen for future research and thus there are no inflammation markers for these respondents. In the current study we have aimed to use the larger sample size where possible. In addition, for the blood marker sample, respondents with c-reactive protein levels greater than 10 mg/L are removed from analysis as recommended by UKHLS (Benzeval et al. 2014). A small number of respondents report earning less than £100 and one more than £27,000 per month. These are removed from the analysis. Thus, after these restrictions and removing those without valid data for the other variables, the sample sizes for the three regression analyses are 6100 (outcome: self-reported health), 5647 (blood pressure), and 4013 (inflammation markers).

In addition to the key health and PRP data, the UKHLS has a rich array of other variables that would serve as covariates. We have included socio-demographic information such as age, gender, ethnicity, country of residence, education, income, hours worked per week, and occupation. Furthermore, we have included other factors which may affect health such as ever smoked status, body mass index (BMI), and whether the job is manual or not. Finally, taking prescribed medication is included as a covariate as physiological health markers may be influenced by medication.

# RESULTS

## Descriptive statistics

The sociodemographic breakdown of the three samples can be seen in Table 2. Unsurprisingly, the proportion of non-PRP workers (82.92%) is higher than PRP workers (17.08%) in the largest sample and, importantly, the percentage remains comparable across all three samples. The samples also include a higher proportion of respondents who are white, living in England, female, have a higher education, and are employed in a non-manual occupation. Furthermore, respondents are more likely to have a BMI > 25, smoke or have smoked but not need medication for illnesses. The age of respondents at the time of the survey ranges from 16 to 65 years, and the average age is 42.28 years in the largest sample. Finally, the average monthly take-home income is £1689.97 across all workers, albeit a proportion of these are part-time workers. Visual inspection of the health outcome variables (Figure 1) finds a mostly normal distribution for all variables except c-reactive protein which has an expected positive skew, necessitating the transformation of this variable into logs. Simple comparisons of means show significant differences in self-reported general health, physical health, c-reactive protein and fibrinogen when comparing PRP and fixed pay contracts (see Table 3), all of which at a first glance suggest that PRP workers have better health. There are no significant differences in GHQ-12, self-reported mental health or either of the blood pressure measures although PRP respondents were slightly more likely to have blood pressure above the clinical cut-off values of 140/90 mmHg than non-PRP workers (17.21% vs. 14.23%).

There are several potential explanations for these results that run contrary to the hypothesis and previous findings that PRP is detrimental to health. The first is that the PRP sample contains participants with more of the characteristics that are strong predictors of better health outcomes, such as younger age (41.36 years for PRP workers vs. 42.53 years for non-PRP workers), higher monthly income (£2126.32 vs. £1601.17) and more likely to have studied in higher education (52.11% vs. 43.55%), consequently netting out much of the effect that working in PRP may have on health, suggesting the need to control for such factors in a regression framework. Secondly, as discussed in the previous section there is likely to be a self-selection bias. Individuals who are struggling with their health will be more likely to sort out of payment contracts which require a high rate of productivity, meaning that there is a limited time to "catch them" in PRP employment when measuring health. Alternatively, individuals with

**TABLE 2** Frequency of sociodemographic variables.

| | Self-report sample (*n* = 6100) | Blood pressure sample (*n* = 5647) | Inflammation marker sample (*n* = 4013) |
|---|---|---|---|
| Non-PRP | 5058 (82.92%) | 4717 (83.53%) | 3346 (83.38%) |
| PRP | 1042 (17.08%) | 930 (16.47%) | 667 (16.62%) |
| BMI > 25 | 4040 (66.23%) | 3718 (65.84%) | 2741 (68.30%) |
| BMI ≤ 25 | 2060 (33.77%) | 1929 (34.16%) | 1272 (31.70%) |
| Has never smoked | 2628 (43.08%) | 2592 (45.90%) | 1718 (42.81%) |
| Has ever smoked | 3472 (56.92%) | 3055 (54.10%) | 2295 (57.19%) |
| Female | 3444 (56.46%) | 3213 (56.90%) | 2226 (55.47%) |
| Male | 2656 (43.54%) | 2434 (43.10%) | 1787 (44.53%) |
| Married | 3473 (56.93%) | 3229 (57.18%) | 2347 (58.41%) |
| Not married | 2627 (43.07%) | 2418 (42.82%) | 1666 (41.52%) |
| Education—high | 2746 (45.02%) | 2576 (45.62%) | 1764 (43.96%) |
| Education—mid | 1320 (21.64%) | 1214 (21.50%) | 847 (21.11%) |
| Education—lower | 2034 (33.34%) | 1857 (32.88%) | 1402 (34.94%) |
| Non-White ethnicity | 313 (5.13%) | 370 (6.55%) | 213 (5.31%) |
| White ethnicity | 5787 (94.87%) | 5277 (93.45%) | 3800 (94.69%) |
| Resident in England | 5642 (92.49%) | 5226 (92.54%) | 3690 (91.95%) |
| Resident in Scotland | 305 (5.00%) | 286 (5.06%) | 218 (5.43%) |
| Resident in Wales | 153 (2.51%) | 135 (2.39%) | 105 (2.62%) |
| Manual work | 1365 (22.38%) | 1265 (22.40%) | 969 (24.15%) |
| Non-manual work | 4735 (77.62%) | 4382 (77.60%) | 3044 (75.85%) |
| Medication | 2365 (38.77%) | 2224 (39.38%) | 1553 (38.70%) |
| No medication | 3735 (61.23%) | 3423 (60.62%) | 2460 (61.30%) |
| Weekly work hours | 32.34 | 32.24 | 32.73 |
| Age (years) | 42.33 | 42.47 | 43.54 |
| Monthly income | £1690.88 | £1688.24 | £1699.37 |

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

good health may be willing to undertake more risk and uncertainty, or able to generate more income (Lazear 2000), so be more willing to opt for a PRP payment scheme. Consequently, to examine this further it is necessary to run an endogenous treatment regression that controls for covariates which may impact on health and corrects for self-selection bias to determine whether this positive association between PRP and health is robust to these issues.[ii]

## Regression results

Firstly, models that do not correct for self-selection were estimated in Stata. As the self-reported general health measure is an ordinal variable, it is estimated with an ordered probit regression. Similarly, the likelihood of having blood pressure above the clinical cut-off point is a binary variable, and consequently it was estimated with a probit regression. All the remaining equations are estimated with a linear regression model and although the GHQ-12 is scored using a Likert scale, the 0–36 scoring used here results in a normal distribution which is suitable for parametric testing (Banks et al. 1980). In addition to PRP,

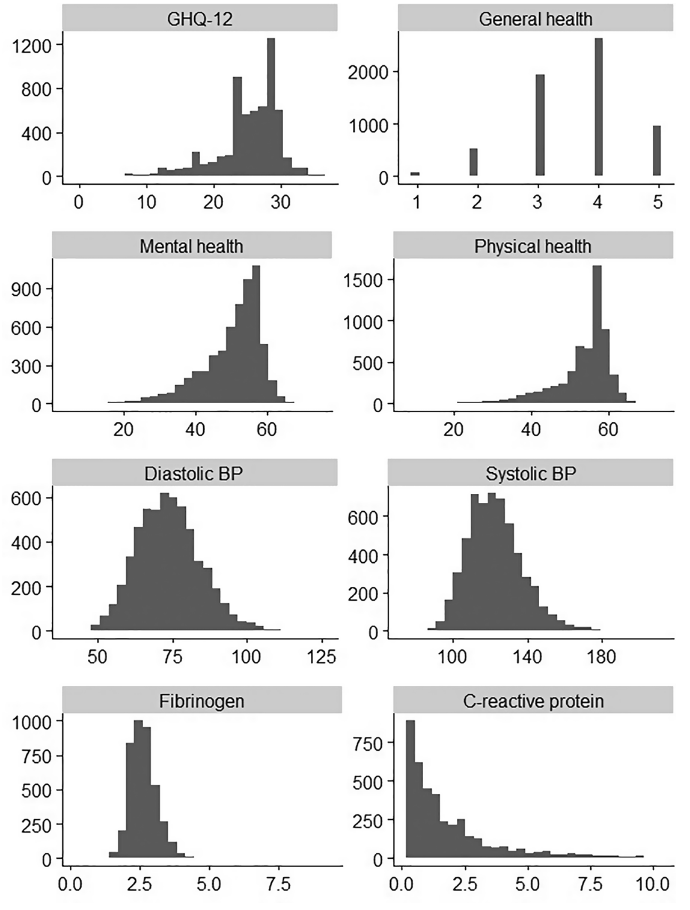


**FIGURE 1** Distributions of health outcomes.

the regression includes a number of sociodemographic variables such as: the log of monthly net income/1000, manual work, age, age squared, gender, education level, marital status, ethnicity, hours worked in a week, and country of residence in the UK as well as variables which are known to affect physiological markers and perceptions of health, including BMI, previous or current smoking and taking prescribed medication, are included in the model. The log of c-reactive protein was used to mitigate against the positive skew mentioned previously. As can be seen in column (1) in Tables 4, 5 and 6, PRP is not a significant predictor of any of the health outcomes after controlling for covariates. This suggests that if there is a detrimental effect of PRP on health, one possibility may be that it is masked by unobservable characteristics causing a positive selection on health, such as cognitive ability as mentioned in the literature review.[iii]

All models correcting for self-selection bias were estimated in Stata using the commands `etregress`, `eprobit`, and `eoprobit`. As previously discussed, an endogenous treatment model is estimated for each health outcome involving the simultaneous estimation of two equations—one predicting self-selection into PRP while the other is the specific health equation. The health equation includes the same list of variables estimated in the models that do not correct for health. The PRP selection equation includes all the variables from the health equation as well as the two instruments: firm size and percentage of PRP in an occupation. All regressions are estimated simultaneously using full maximum likelihood procedures.

**TABLE 3** Means and standard deviations for dependent variables.

| | Self-report sample ($n = 6100$) | | | | Blood pressure sample ($n = 5647$) | | | Inflammation marker sample ($n = 4013$) | |
|---|---|---|---|---|---|---|---|---|---|
| | **Self-reported GHQ-12** | **Self-reported general health** | **Self-reported physical health** | **Self-reported mental health** | **Systolic blood pressure** | **Diastolic blood pressure** | **Blood pressure >140/90 mmHg (%)** | **C-reactive protein** | **Fibrinogen** |
| Fixed pay | 25.16 (4.92) | 3.62 (0.89) | 52.97 (8.00) | 50.24 (8.54) | 122.68 (15.07) | 73.81 (10.73) | 14.56 | 0.92 (0.54) | 2.66 (0.52) |
| PRP | 25.44 (4.68) | 3.70 (0.86) | 54.05 (6.97) | 50.30 (8.52) | 123.24 (14.62) | 74.29 (10.94) | 15.38 | 0.86 (0.50) | 2.59 (0.47) |

*Note*: Standard deviations in parentheses. The GHQ-12 (0–36) and general health (1–5) scores have been reversed so that higher scores indicate better health, in line with the physical and the mental health subscores (0–100).

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

**TABLE 4** Marginal effects for each endogeneity treatment regression for self-reported health.

| | Self-reported GHQ-12 | | Self-reported general health | | Self-reported mental health | | Self-reported physical health | |
|---|---|---|---|---|---|---|---|---|
| | $n=6100$ | | $n=6100$ | | $n=6100$ | | $n=6100$ | |
| | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| Self-selection regression | | | | | | | | |
| Instrument—% PRP across occupation | | 0.39*** | | 0.55*** | | 0.40*** | | 0.55*** |
| | | (0.07) | | (0.07) | | (0.05) | | (0.07) |
| Instrument—firm size | | 0.03** | | 0.05*** | | 0.04*** | | 0.05*** |
| | | (0.01) | | (0.02) | | (0.01) | | (0.02) |
| Outcome regression | | | | | | | | |
| PRP | 0.06 | −7.15*** | −0.02 | −0.01 | −0.12 | −11.84*** | 0.25 | 2.69*** |
| | (0.17) | (0.25) | (0.04) | (0.07) | (0.30) | (0.53) | (0.27) | (0.76) |
| Age | −0.26 | −0.27*** | −0.01 | −0.003 | −0.36 | −0.37*** | −0.04 | −0.04 |
| | (0.04) | (0.06) | (0.01) | (0.002) | (0.06) | (0.12) | (0.06) | (0.07) |
| Age squared | 0.00 | 0.003*** | 0.00 | <0.001 | 0.00 | 0.004*** | 0.00 | −0.001 |
| | (0.00) | (0.001) | (0.00) | (<0.001) | (0.00) | (0.001) | (0.00) | (0.001) |
| BMI > 25 | −0.26 | −0.18 | −0.36 | −0.08*** | −0.47 | −0.34 | −1.65 | −1.68*** |
| | (0.14) | (0.25) | (0.03) | (0.01) | (0.24) | (0.38) | (0.21) | (0.24) |
| Smoker | −0.47 | −0.45*** | −0.21 | −0.05*** | −0.73 | −0.71*** | −0.71 | −0.72*** |
| | (0.13) | (0.12) | (0.03) | (0.01) | (0.22) | (0.16) | (0.20) | (0.25) |
| (log of) monthly income/1000 | 0.88 | 1.87*** | 0.38 | 0.08*** | 1.61 | 3.22*** | 2.30 | 1.96*** |
| | (0.25) | (0.22) | (0.06) | (0.03) | (0.44) | 0.23 | (0.39) | (0.34) |
| Male | 0.74 | 0.99*** | −0.06 | −0.01*** | 1.31 | 1.72*** | −0.09 | −0.18 |
| | (0.15) | (0.19) | (0.03) | (0.01) | (0.26) | (0.34) | (0.23) | (0.25) |
| Not married | −0.69 | −0.87*** | −0.14 | −0.03*** | 1.71 | −2.00*** | −0.30 | −0.24 |
| | (0.14) | (0.14) | (0.03) | (0.01) | (0.24) | (0.24) | (0.21) | (0.27) |

**TABLE 4** (Continued)

| | Self-reported GHQ-12 | | Self-reported general health | | Self-reported mental health | | Self-reported physical health | |
|---|---|---|---|---|---|---|---|---|
| | $n=6100$ | | $n=6100$ | | $n=6100$ | | $n=6100$ | |
| | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| Education—lower | 0.20 | 0.31** | −0.12 | −0.03*** | 0.23 | 0.41 | −0.71 | −0.75*** |
| | (0.17) | (0.15) | (0.04) | (0.01) | (0.30) | (0.30) | (0.27) | (0.27) |
| Education—mid | 0.17 | 0.38 | −0.10 | −0.02** | 0.40 | 0.75 | −0.58 | −0.65*** |
| | (0.18) | (0.21) | (0.04) | (0.01) | (0.31) | (0.40) | (0.27) | (0.21) |
| White ethnicity | 0.18 | −0.002 | 0.33 | 0.08*** | 1.60 | 1.30** | 2.21 | 2.27*** |
| | (0.28) | (0.26) | (0.06) | (0.01) | (0.49) | (0.65) | (0.44) | (0.48) |
| Resident in Scotland | 0.59 | 0.45 | 0.09 | 0.02 | 0.86 | 0.63 | 0.32 | 0.36 |
| | (0.28) | (0.27) | (0.06) | (0.02) | (0.49) | (0.40) | (0.44) | (0.39) |
| Resident in Wales | −0.26 | −0.23 | −0.07 | −0.02 | −0.55 | −0.49 | −1.27 | −1.29 |
| | (0.40) | (0.44) | (0.09) | (0.02) | (0.69) | (1.16) | (0.62) | (0.70) |
| Non-manual work | 0.41 | 0.63 | 0.00 | <0.001 | 0.40 | 0.75 | 0.32 | 0.25 |
| | (0.24) | (0.33) | (0.05) | (0.01) | (0.41) | (0.73) | (0.37) | (0.57) |
| Hours | 0.01 | 0.02*** | 0.00 | <0.001 | −0.01 | 0.02 | 0.00 | −0.01 |
| | (0.01) | (0.01) | (0.00) | (<0.001) | (0.01) | (0.01) | (0.01) | (0.01) |
| No medication | – | – | – | – | – | – | – | – |
| Constant | 29.60 | 30.14*** | – | – | 53.68 | 54.55*** | 55.42 | 55.23*** |
| | (1.14) | (1.27) | | | (1.98) | (2.94) | (1.77) | (1.78) |
| Means | | 25.21 | | 15.79% | | 50.25 | | 53.16 |

*Note*: Standard errors in brackets. Reference categories include BMI ≤ 25, non-smoker, female, married, high education, ethnicity other than White, resident in England, manual work and taking prescribed medications. All covariates from the health regression are also included in the self-selection regression in column (2). Occupation split into nine levels is included as a covariate but not reported here for the sake of brevity.

Constants are not provided for the ordered probit regression. Instead, model determines the following cut points: −3.38, −2.36, −1.22, and 0.07. The ordered probit predicts highest level of health (5). Means of the dependent variable are given in the bottom row except for self-reported general health which is the percentage in the highest category.

$^{**}p < 0.05$; $^{***}p < 0.01$.

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

**TABLE 5** Marginal effects for each endogeneity treatment regression for blood pressure.

| | **Systolic blood pressure** | | **Diastolic blood pressure** | | **Blood pressure > 140/90 mmHg** | |
|---|---|---|---|---|---|---|
| | ***n*** **= 5648** | | ***n*** **= 5648** | | ***n*** **= 5648** | |
| | **(1)** | **(2)** | **(1)** | **(2)** | **(1)** | **(2)** |
| Self-selection regression | | | | | | |
| Instrument—% PRP across occupation | | 0.45*** | | 0.60*** | | 0.59*** |
| | | (0.04) | | (0.05) | | (0.05) |
| Instrument—firm size | | 0.03** | | 0.05** | | 0.04*** |
| | | (0.01) | | (0.02) | | (0.02) |
| Outcome regression | | | | | | |
| PRP | 0.06 | 16.48*** | 0.02 | −0.19 | 0.04 | <0.001 |
| | (0.49) | (1.05) | (0.37) | (1.61) | (0.06) | (0.05) |
| Age | −0.29 | −0.28 | 0.82 | 0.82*** | 0.02 | 0.004 |
| | (0.11) | (0.15) | (0.08) | (0.07) | (0.01) | (0.003) |
| Age squared | 0.01 | 0.01*** | −0.01 | −0.01*** | 0.00 | <0.001 |
| | (0.00) | (0.002) | (0.00) | (0.001) | (0.00) | (<0.001) |
| BMI > 25 | 5.58 | 5.31*** | 5.16 | 5.17*** | 0.43 | 0.09*** |
| | (0.38) | (0.23) | (0.29) | (0.29) | (0.05) | (0.01) |
| Smoker | −0.09 | −0.29 | −0.03 | −0.03 | −0.01 | −0.001 |
| | (0.35) | (0.45) | (0.27) | (0.30) | (0.04) | (0.01) |
| (log of) monthly income/1000 | −3.02 | −5.28*** | 1.20 | −1.17 | −0.15 | −0.03 |
| | (0.71) | (0.74) | (0.54) | (1.12) | (0.09) | (0.03) |
| Male | 9.09 | 8.52*** | 2.07 | 2.08*** | 0.35 | 0.07*** |
| | (0.42) | (0.53) | (0.32) | (0.35) | (0.05) | (0.01) |
| Not married | 0.52 | 0.98*** | 0.48 | 0.48** | 0.05 | 0.01 |
| | (0.38) | (0.21) | (0.29) | (0.23) | (0.05) | (0.01) |
| Education—lower | 0.62 | 0.64 | −0.17 | −0.17 | 0.00 | <0.001 |
| | (0.48) | (0.62) | (0.36) | (0.47) | (0.06) | (0.01) |
| Education—mid | 0.67 | 0.37 | 0.31 | 0.32 | 0.00 | <0.001 |
| | (0.50) | (0.25) | (0.38) | (0.36) | (0.06) | (0.01) |
| White ethnicity | 1.35 | 1.72 | −0.33 | −0.33 | 0.00 | <0.001 |
| | (0.72) | (0.97) | (0.55) | (0.34) | (0.09) | (0.02) |
| Resident in Scotland | 0.95 | 1.11 | 1.17 | 1.16 | 0.06 | 0.01 |
| | (0.79) | (1.07) | (0.60) | (0.67) | (0.10) | (0.02) |
| Resident in Wales | −0.61 | −0.66 | −0.76 | −0.76 | −0.02 | −0.004 |
| | (1.14) | (0.77) | (0.87) | (0.82) | (0.14) | (0.01) |
| Non-manual work | −0.44 | −0.88 | 0.08 | −0.09 | 0.00 | −0.001 |
| | (0.66) | (1.28) | (0.50) | (0.69) | (0.08) | (0.03) |
| Hours | 0.11 | 0.08*** | 0.07 | 0.07*** | 0.01 | 0.002*** |
| | (0.02) | (0.02) | (0.01) | (0.01) | (0.00) | (<0.001) |

**TABLE 5** (Continued)

| | Systolic blood pressure | | Diastolic blood pressure | | Blood pressure > 140/90 mmHg | |
|---|---|---|---|---|---|---|
| | *n* = 5648 | | *n* = 5648 | | *n* = 5648 | |
| | (1) | (2) | (1) | (2) | (1) | (2) |
| No medication | −0.71 | −0.89 | −0.50 | −0.50** | −0.10 | −0.02** |
| | (0.37) | (0.52) | (0.28) | (0.22) | (0.05) | (0.01) |
| Constant | 96.23 | 95.36*** | 41.79 | 41.80*** | 3.47 | 3.46*** |
| | (3.21) | (4.43) | (2.44) | (1.92) | (0.44) | (0.45) |
| Means | | 122.78 | | 73.89 | | 14.70% |

*Note*: Standard errors in brackets. Reference categories include BMI ≤ 25, non-smoker, female, married, high education, ethnicity other than White, resident in England, manual work and taking prescribed medications. All covariates from the health regression are also included in the self-selection regression in column (2). Occupation split into nine levels is included as a covariate but not reported here for the sake of brevity.

**$p < 0.05$; ***$p < 0.01$.

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

As can be seen in column (2) in Tables 4 and 5, the self-selection regressions find that both instruments are statistically significant predictors of PRP at a 0.05 level or lower for each health outcome with the exception of the regressions estimated for c-reactive protein and fibrinogen, which are just above 0.05 (Table 6). In line with research by Conyon et al. (2001) and Heywood et al. (1997), firms with a smaller number of employees are statistically less likely to utilize PRP contracts with marginal effects ranging from 0.03 to 0.05. Unsurprisingly, and as demonstrated by Artz et al. (2021), we find that share of PRP workers per occupation category is also a statistically significant predictor of self-selection into PRP for all health outcome regressions (0.38–0.60).

Examining each of the health outcomes after correcting for self-selection bias in the bottom part of column (2) in Tables 4–6, we find that PRP contracts are associated with a range of indicators of poor health. In line with Dahl and Pierce (2020) who find that PRP workers are prescribed more antidepressants, PRP predicts poorer self-reported mental health as measured by the GHQ-12 (marginal effect: −7.15) and the mental health component of SF-12 (−11.84). PRP is also a significant predictor of higher systolic blood pressure (16.48) and higher likelihood of having clinically high blood pressure (<0.001) at a 5% and 10% level, respectively, but not higher diastolic blood pressure. Having high systolic blood pressure in conjunction with normal diastolic blood pressure is one of the most common forms of hypertension in both young adult and elderly males (Scott et al. 2021), albeit through different mechanisms. Regardless of the mechanism, it is associated with increased cardiovascular risk. Finally, PRP is also a significant predictor of higher levels of fibrinogen (0.57). Importantly, as mentioned in the introduction, both blood pressure and fibrinogen are associated with chronic stress (Siegrist et al. 1997), suggesting that PRP workers may be at higher risk of this than their non-PRP equivalents.

Somewhat surprisingly, PRP also predicts improved levels of self-reported physical health (2.69), even after controlling for covariates and endogenous treatment of PRP, although it must be noted that the physical health component of the SF-12 measures pain and activity limitation in daily life due to poor physical health rather than overall self-reported physical health. Our sample contains few respondents with severe mobility issues, and so it is not clear whether the PRP workers in our sample are less likely to struggle with physical health conditions or are just less limited by them. It is also important to note that severe health conditions arising after cumulative exposure to PRP are unlikely to be seen until a sufficient amount of time has

**TABLE 6** Marginal effects for each endogeneity treatment regression for inflammation markers.

| | (log of) C-reactive protein | | Fibrinogen | |
|---|---|---|---|---|
| | $n = 4013$ | | $n = 4013$ | |
| | (1) | (2) | (1) | (2) |
| Self-selection regression | | | | |
| Instrument—% PRP across occupation | | 0.54*** | | 0.38*** |
| | | (0.08) | | (0.10) |
| Instrument—firm size | | 0.04 | | 0.03 |
| | | (0.02) | | (0.02) |
| Outcome regression | | | | |
| PRP | −0.01 | −0.08 | −0.02 | 0.62*** |
| | (0.02) | (0.09) | (0.02) | (0.15) |
| Age | −0.01 | −0.005 | 0.01 | 0.01 |
| | (0.01) | (0.004) | (0.00) | (0.01) |
| Age squared | 0.00 | <0.001 | 0.00 | <0.001 |
| | (0.00) | (<0.001) | (0.00) | (<0.001) |
| BMI > 25 | 0.30 | 0.30*** | 0.20 | 0.20*** |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Smoker | 0.04 | 0.04 | 0.05 | 0.05*** |
| | (0.02) | (0.03) | (0.02) | (0.02) |
| (log of) monthly income/1000 | −0.09 | −0.08 | −0.07 | −0.16*** |
| | (0.03) | (0.05) | (0.03) | (0.04) |
| Male | −0.12 | −0.11*** | −0.16 | −0.18*** |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Not married | 0.02 | 0.02 | 0.02 | 0.03 |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| Education—lower | 0.05 | 0.05 | 0.07 | 0.05** |
| | (0.02) | (0.03) | (0.02) | (0.03) |
| Education—mid | 0.03 | 0.03 | 0.06 | 0.04 |
| | (0.02) | (0.03) | (0.02) | (0.03) |
| White ethnicity | −0.04 | −0.04 | −0.09 | −0.09*** |
| | (0.04) | (0.05) | (0.03) | (0.03) |
| Resident in Scotland | 0.00 | 0.004 | −0.06 | −0.06 |
| | (0.04) | (0.02) | (0.03) | (0.04) |
| Resident in Wales | −0.06 | −0.06 | −0.06 | −0.04 |
| | (0.05) | (0.04) | (0.05) | (0.03) |
| Non-manual work | −0.01 | −0.01 | 0.01 | −0.01 |
| | (0.03) | (0.01) | (0.03) | (0.01) |
| Hours | 0.00 | 0.003*** | 0.00 | 0.001 |
| | (0.00) | (0.001) | (0.00) | (0.001) |
| No medication | −0.09 | −0.09*** | −0.02 | −0.03 |
| | (0.02) | (0.02) | (0.02) | (0.02) |

**TABLE 6** (Continued)

| | **(log of) C-reactive protein** | | **Fibrinogen** | |
|---|---|---|---|---|
| | ***n*=4013** | | ***n*=4013** | |
| | **(1)** | **(2)** | **(1)** | **(2)** |
| Constant | 0.71 | 0.71*** | 2.16 | 2.14*** |
| | (0.16) | (0.11) | (0.15) | (0.10) |
| Means | | 0.91 | | 2.65 |

*Note*: Standard errors in brackets. Reference categories include BMI ≤ 25, non-smoker, female, married, high education, ethnicity other than White, resident in England, manual work and taking prescribed medications. All covariates from the health regression are also included in the self-selection regression in column (2). Occupation split into nine levels is included as a covariate but not reported here for the sake of brevity.

**$p < 0.05$; ***$p < 0.01$.

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

passed (Bender & Theodossiou 2014), which may not be captured in a cross-sectional analysis. Finally, PRP is not a statistically significant predictor of self-reported general health or (the log of) c-reactive protein.

## Group differences

Finally, it is possible that the relationship between PRP and health outcomes may differ depending on the subsample that is studied. In particular, we are interested in how the relationship differs when comparing males and females, who are known to have different physiological makeup (and in the results in Tables 4–6 are typically statistically significantly different across the two groups), as well as manual and non-manual workers where the nature of the work tasks differ substantially. Consequently, we estimate regressions for each of the health outcomes across these four subsamples whilst controlling for self-selection and the same covariates as in the full regression.

As can be seen in Table 7, there are some noticeable differences between males and females. Although both groups show a similar significant effect of PRP on poorer GHQ-12 scores (marginal effects: −6.96 and −7.11) and poorer mental health as measured by SF-12 (−11.78 and −11.12) as well as no effect of PRP on the self-reported general health item, PRP is only a significant predictor of better self-reported physical health among males (3.64). On the other hand, PRP is a significant predictor of higher systolic blood pressure among both males and females (14.98 and 16.87) but not a significant predictor of higher diastolic blood pressure or having blood pressure above the clinical cut-off points in either of the subsamples. Finally, when estimating biomarkers in blood we can see that PRP is a significant predictor of higher c-reactive protein (0.76) as well as higher levels of fibrinogen (0.70) among male workers. However, there is no significant effect of PRP on fibrinogen among female workers in this particular subsample. It is not clear why this is, although we can speculate that working in full or partial PRP-contracts may allow for more flexible working patterns which is particularly valued by female workers (Bender et al. 2005; Hill et al. 2008) and thereby may cancel out some of the negative consequences of PRP. Although number of hours worked controls for the possibility of PRP workers being more likely to work part-time, there is no information available from UKHLS about shift schedules or workplace flexibility which may explain some of the gender differences.

Unsurprisingly, there are also some differences when splitting the sample by manual and non-manual workers. For example, manual workers see a positive effect of PRP on GHQ-12

**TABLE 7** Marginal effects for PRP predicting health outcomes for each subsample regression from sample selection regressions.

| | Self-reported GHQ-12 | Self-reported general health | Self-reported mental health | Self-reported physical health | Systolic blood pressure | Diastolic blood pressure | Blood pressure >140/90 mmHg | (log of) C-reactive protein | Fibrinogen |
|---|---|---|---|---|---|---|---|---|---|
| Full sample | −7.15*** | −0.01 | −11.84*** | 2.69*** | 16.48*** | −0.19 | <0.001 | −0.08 | 0.62*** |
| | (0.25) | (0.07) | (0.53) | (0.76) | (1.05) | (1.61) | (0.05) | (0.09) | (0.15) |
| Male | −6.96*** (0.25) | −0.002 (0.02) | −11.78*** (0.65) | 3.64*** (0.48) | 14.98*** (1.41) | −1.37 (0.90) | 0.03 (0.07) | 0.76*** (0.05) | 0.70*** (0.15) |
| Female | −7.11*** (0.59) | −0.01 (0.05) | −11.12*** (1.05) | 1.29 (1.33) | 16.87*** (0.83) | 1.67 (2.56) | −0.03 (0.07) | −0.11 (0.06) | −0.13 (0.07) |
| Manual | 2.81*** (0.91) | −0.03 (0.04) | 4.28 (2.50) | 2.35** (0.98) | 19.49*** (0.83) | 10.07*** (3.26) | −0.04 (0.17) | −0.40 (0.24) | 0.69*** (0.06) |
| Non-manual | 0.17 (0.70) | <0.001 (0.03) | −0.96 (1.93) | 2.32** (0.87) | 15.78*** (0.94) | −0.46 (0.80) | 0.01 (0.06) | −0.17*** (0.03) | −0.11*** (0.04) |

*Note:* Standard errors in brackets. Regressions include all previously mentioned covariates but are omitted here for brevity. Full results are available upon request from author.

** $p < 0.05$; *** $p < 0.01$.

*Source*: UKHLS dataset (Wave 2, years 2010–2012).

scores (marginal effect: 2.81) indicating better mental health in PRP manual workers whereas there is no effect among non-manual workers and there is no effect of PRP on mental health as measured by SF-12 in either group. In line with the full sample regression, neither group finds a significant effect of PRP on self-reported general health and PRP predicts better physical health in both groups (2.35 and 2.32). In line with the full sample, we find a positive relationship between PRP and higher systolic blood pressure in both the manual (19.49) and non-manual sample (15.78) but no relationship between PRP risk of being above the clinical cut-off point in either subsample. Surprisingly, in the manual group PRP also predicts slightly higher diastolic blood pressure (10.07). On the other hand, PRP is a significant predictor of higher fibrinogen (0.69) but has no impact on c-reactive protein among manual workers, and is associated with both slightly lower c-reactive protein (−0.13) and fibrinogen (−0.17) among non-manual workers. We can conclude then that some of the differences seen in the full sample are driven by the stronger effects among males and occasionally non-manual workers, albeit the number of PRP workers in manual occupations is small ($n = 92$) and it is unclear how specific PRP structures differ between the two types of occupation. Results should therefore be interpreted with caution.

## CONCLUSION

The aim of the current study was to examine the relationship between PRP and poor health using biomarkers of stress and health in workforce survey data. Although there is a growing body of evidence investigating the relationship between PRP and health, our study is able to address two limitations of previous research. Firstly, by measuring blood pressure and inflammation markers in blood it is possible to circumvent some of the issues traditionally associated with self-reported health measures in the literature on PRP. Secondly, by correcting for self-selection bias the study controls for some of the endogeneity that is associated with workers both self-selecting into PRP as well as having poorer health.

The findings from the current study are largely in line with previous research that has found that PRP workers are more likely to have poor health. Like Dahl and Pierce (2020), we find evidence that PRP workers self-report poorer mental health and like Bender and Theodossiou (2014), who find that workers spending more time in PRP employment are more likely to suffer from cardiovascular health issues, this study shows higher levels of blood pressure among PRP workers. For the first time, this study is also able to show that PRP employees have higher levels of fibrinogen, particularly if they are also male, which in turn is associated with chronic levels of stress. Chronic stress in PRP employees could be due to the need to put in more effort at work (Bender & Theodossiou 2014), to work under time or performance target pressure, or due to the stress associated with a variable income stream. Regardless of the pathway, chronic stress may both exacerbate health issues directly and lead to unhealthy coping mechanisms such as alcohol and drug use (Artz et al. 2021). The use of biomarkers in the current study provides novel evidence for physiological wear and tear in PRP workers. Finally, a main finding is that these differences between non-PRP and PRP workers are only present after statistically correcting for self-selection bias, suggesting that endogeneity is a key issue when studying the effects of PRP on health. Looking at differences in the PRP-health relationship suggests that men may have the largest risk of poor health due to PRP.

Although the UKHLS dataset provided a unique opportunity to look at biomarkers of stress, the paper does have some common survey data limitations. For example, the strongest level of income uncertainty may be felt when all of your pay is PRP, such as piece rate jobs. As the UKHLS only ask about PRP in a broad sense, it is not possible to distinguish between participants whose pay is fully based on performance, and those who receive a combination of both PRP and a fixed salary. As different PRP structures may be more prevalent in certain occupations, this may explain some of the differences that we see between manual and non-manual workers. Future research should examine the interaction between manual labor and PRP structures. Another potential limitation is that there may be a compensation effect as firms utilizing PRP may have to compensate workers with higher earnings in exchange for risk, which in turn will correlate with health. Indeed, we find that PRP workers have higher earnings in general. However, if this is the case, it is likely to bias us towards no effect. The second wave of the UKHLS also does not ask about personality traits, risk aversion, or perceived ability, all of which may affect sorting into PRP and health outcomes. To some extent, this limitation may be mitigated by including smoking as a covariate in our model, which is often used a proxy for risk-taking, and by using the two-stage regression procedure. However, if a dataset including labor information, physiological data, and personality traits become available we believe that this would be a fruitful avenue for future research.

In summary, much of the previous literature has focused on the association between injuries or self-reported health and PRP. However, the current study finds evidence of a link between physiological markers of chronic stress and performance related pay once self-selection bias has been corrected for. These findings have implications for public health and employee relations given the established linkages between stress and health outcomes. While it may be that PRP is the optimal payment contract for a firm and there are compensating wage differentials which increase the preference for it, use of PRP in the labor market can still have widespread detrimental effects on the employed population, which in turn may affect the long-term productivity of the labor force. This may not only lead to costs associated with employee illness but may also endanger the employee relationship if firms do not prioritize employee wellbeing. Firms that use PRP may benefit from introducing non-pay policies that mitigate against the detrimental effects of chronic stress on the health of their workforce so they can avoid elevated rates of employee absences as well as stay consistent with potential employee wellbeing goals.

## ACKNOWLEDGMENTS

Funding from the ESRC is gratefully acknowledged (Grant ES/R01163X/1). We are grateful for access to the data from Understanding Society, an initiative funded by the Economic and Social Research Council and various Government Departments, with scientific leadership by the Institute for Social and Economic Research, University of Essex, and survey delivery by NatCen Social Research and Kantar Public. The research data are distributed by the UK Data Service. We would also like to extend our thanks to attendants at the CELMR workshop at University of Aberdeen.

## CONFLICT OF INTEREST STATEMENT

The authors report that there are no competing interests to declare.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available upon request from the UK Data Service in "Understanding Society: Waves 1-12, 2009-2021 and Harmonised BHPS: Waves 1-18, 1991-2009" at https://doi.org/10.5255/UKDA-SN-6614-18, study number 6614, as well as "Understanding Society: Waves 2-3 Nurse Health Assessment, 2010-2012" at https://doi.org/10.5255/UKDA-SN-7251-5, study number 7251.

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## ENDNOTES

[i] Furthermore, individuals were not invited if they were not residents in the UK, had completed the main survey by telephone or post, or in another language than English. Out of the eligible respondents, some were not contactable and a portion refused to take part in the nurse assessment, resulting in a final a response rate of 58.6%. However, the portion of PRP participants remains steady in both the main survey and the final subsample of the Nurse Assessment (16.45% vs. 17.08%).

[ii] We also calculated Oster bounds (Oster 2019) to examine the likelihood of there being a bias in regressions that do not control for self-selection. Each regression resulted in a delta substantially below 1 (with the sole exception of the binary blood pressure variable) suggesting that the regressions are typically significantly biased by unobservable measures.

[iii] To further explore the selection mechanisms additional regressions are estimated controlling for measures of numeracy (from wave 3) and self-reported risk (wave 1). Although numeracy and risk-preference are often direct predictors of health outcomes in these regressions, the inclusion of these covariates does not alter the relationship between PRP and health (with the exception of PRP predicting lower c-reactive protein in a regression controlling for self-selection and self-reported risk), regardless of whether self-selection was corrected for or not. The lack of influence on PRP and health suggests that these measures of risk and numeracy do not explain the selection effect, although it is important to note that the measures are not concurrent with wave 2 and consequently the sample size is lower. Full results are available upon request from the authors.

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**How to cite this article:** Andelic, Nicole, Julia Allan, Keith A. Bender, Daniel Powell and Ioannis Theodossiou. 2023. “Performance-related pay, mental and physiological health.” *Industrial Relations: A Journal of Economy and Society* 00(0): 1–23. https://doi.org/10.1111/irel.12334.