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Original article

Associations between Poorer Mental Health with Work-Related Effort, Reward, and Overcommitment among a Sample of Formal US Solid Waste Workers during the COVID-19 Pandemic

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ABSTRACT

Background: Effort–reward imbalance (ERI) and overcommitment at work have been associated poorer mental health. However, nonlinear and nonadditive effects have not been investigated previously.
Methods: The association between effort, reward, and overcommitment with odds of poorer mental health was examined among a sample of 68 formal United States waste workers (87% male). Traditional, logistic regression and Bayesian Kernel machine regression (BKMR) modeling was conducted. Models controlled for age, education level, race, gender, union status, and physical health status.
Results: The traditional, logistic regression found only overcommitment was significantly associated with poorer mental health (IQR increase: OR = 6.7; 95% CI: 1.7 to 25.5) when controlling for effort and reward (or ERI alone). Results from the BKMR showed that a simultaneous IQR increase in higher effort, lower reward, and higher overcommitment was associated with 6.6 (95% CI: 1.7 to 33.4) times significantly higher odds of poorer mental health. An IQR increase in overcommitment was associated with 5.6 (95% CI: 1.6 to 24.9) times significantly higher odds of poorer mental health when controlling for effort and reward. Higher effort and lower reward at work may not always be associated with poorer mental health but rather they may have an inverse, U-shaped relationship with mental health. No interaction between effort, reward, or overcommitment was observed.
Conclusion: When taking into the consideration the relationship between effort, reward, and overcommitment, overcommitment may be most indicative of poorer mental health. Organizations should assess their workers' perceptions of overcommitment to target potential areas of improvement to enhance mental health outcomes.

1. Introduction

Workplace psychosocial exposures are social determinants of health that may impact workers' psychological response to their work/workplace conditions, and their effects are wide in scope [1]. Of particular interest in epidemiological studies has been job stress, which may be evaluated using the effort–reward imbalance (ERI) model, a model of social reciprocity [2]. This model postulates that a lack of reciprocity in situations where high effort is expended by workers but the reward received is low may lead to job strain [2]. Effort encapsulates aspects such as workload and demands, while reward encapsulates aspects of money, esteem, and career growth opportunities [2]. An imbalance of these two psychosocial exposures has been consistently associated with higher job stress [3].

Beyond job stress, ERI has been associated with worse mental health. This association has been demonstrated in a wide range of occupations, including academics [4], teachers [5], correctional officers [6], and nurses [7] but has not been examined among formal United States (US) solid waste workers. Our team has previously shown that these workers suffer from ERI and high work-related overcommitment [8]. Overcommitment has been hypothesized to modify the relationship between ERI and job strain as overcommitted workers, "…suffer from inappropriate perceptions of demands and of their own coping resources more

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often than their less involved colleagues, because perceptual distortion prevents them from accurately assessing cost-gain relations" [9]. This hypothesis can be applied to the context of mental health. Higher effort at work may worsen mental health, while work-related rewards may help workers cope with the negative effects on their mental health. Overcommitment may modify this relationship as it can distort workers' perception of the cost–gain relationship between effort/reward and their mental health [4,9]. As such, we investigated four main hypotheses among this worker population.

(1) Higher effort and lower reward will be associated with poorer mental health.
(2) Effort and reward will have an interactive effect on mental health.
(3) Higher overcommitment increases the odds of poorer mental health (i.e., an additive effect of overcommitment).
(4) ERI in combination with overcommitment pose the greatest risk to mental health.

Research examining adverse health-related effects of ERI has typically focused on examining the additive effects of effort, reward, and overcommitment. While some research has examined potential interactions among these psychosocial exposures [4], these studies still assumed a linear relationship with job strain exists. Realistically, as workers likely feel the effects of effort, reward, and overcommitment simultaneously, their relationships with job strain may be complex, nonlinear, and nonadditive in nature. Traditional, linear or generalized linear (e.g., logistic) regression modeling is limited in this regard and may mask the true relationship of the psychosocial exposures on mental health. A modeling approach known as Bayesian Kernel machine regression (BKMR) has been proposed to capture complex, nonlinear, and nonadditive (interactive) relationships [10]. BKMR modeling further allows for examination of the overall effect of the exposures together, the individual relationships of each exposure, and the relative importance of each individual exposure [10].

Traditionally, BKMR modeling has been utilized in environmental and occupational epidemiology studies to disentangle the complex effects of a group of related exposures (e.g., PFAS, phthalates, air pollution, noise exposure) on health outcomes [11–14]. This study extends the application of BKMR modeling beyond chemical and physical exposures to psychosocial exposures among a sample of formal, US solid waste workers to test our five hypotheses. To our knowledge, this is the first study to examine a mixture of psychosocial exposures using BKMR modeling, which for comparison purposes we complemented with traditional generalized linear modeling.

2. Methods

2.1. Participants

Participant information from this cross-sectional study is provided in detail elsewhere [8]. Briefly, 68 adult waste workers (87% male) were recruited from three solid waste sites in southeast Michigan, USA in Fall 2021 during the COVID-19 pandemic through convenience and referral sampling. Participants came from an industrial waste site (75%), a county recycling site (12%), and a small, local business (13%). No statistically significant differences were observed for effort, reward, and overcommitment by the three job sites [8]. Each participant was administered a 74-item survey at the beginning or end of their work shift. The survey contained questions on demographics, perceived biohazard exposure and preparedness, ERI, and health and safety climate. ERI is the focus of this manuscript.

2.2. Measures

Demographic and background information (age, gender, race, education level, and union status) was obtained from the survey. Mental and physical health were each individually assessed from two questions asking, "How would you rate your overall [mental/physical] health?" on a 4-point scale of "poor," "fair," "good," "and "excellent." The main outcome of this study was defined as "poorer mental health," that is, a dichotomous outcome of whether a participant selected either "poor" or "fair." Poorer physical health was also dichotomized in the same fashion.

Effort, reward, and overcommitment were measured from the validated, short ERI questionnaire [15]. All items were asked on a 4-point scale of "strongly disagree" (assigned a value of 1) to "strongly agree" (value of 4). Effort was measured from three items such as whether workers felt constant time pressure due to heavy workload, had many interruptions/disturbances while performing their job, and if their job had become more demanding over the past few years. The sum of the effort scores for each participant was calculated, with higher scores indicating higher effort (score range 3–12).

Reward was measured from seven items. Four items were positively phrased, for example, "Considering all my effort and achievements, my salary/income is adequate." Three items were negatively phrased, for example, "My job security is poor." Negatively phrased items were reverse-coded, and the sum of reward scores was calculated, with higher scores indicating higher rewards (score range 7–28).

Lastly, overcommitment was measured from six items. Five items were negatively phrased, for example, "People close to me say I sacrifice too much for my job," while one item was positively phrased ("When I get home, I can easily relax and 'switch off' work"). The positively phrased item was reverse-coded, and the sum of overcommitment (OC) scores was calculated, with higher scores indicate higher overcommitment (score range 6–24). All scales indicated good internal consistency [8].

2.3. Analysis

All data cleaning and statistical analyses were conducted in RStudio using R v3.6.3 (Boston, MA, USA). ERI for each participant was assessed using the following, $ERI = E/(R^*c)$, where E = effort score, R = reward score, and c = 5/11 as a correction factor for the unequal number of items between the effort and reward scales [15]. An ERI >1 signifies an imbalance in effort–reward, where a worker exerts more effort for each reward they receive.

Descriptive statistics of effort, reward, ERI, and overcommitment were calculated for different participant characteristics. Hypothesis testing via survey t-test for dichotomous groups and Wald F-test for categorical groups was done to examine differences in effort, reward, ERI, and overcommitment by participant characteristics. A two-sided p-value <0.05 was considered statistically significant.

To assess the relationship between effort, reward, overcommitment, and poorer mental health, two types of modeling were performed: (1) traditional logistic regression and (2) BKMR probit modeling. All models were controlled for six confounders: age, gender, race, educational level, union status, and physical health status. Odds ratios (OR) and 95% confidence intervals (CIs; credible intervals for Bayesian regression) were estimated. The traditional logistic regression began with univariate

Table 1
Average (SD) of effort, reward, effort–reward imbalance (ERI), and overcommitment (OC) scores by participant characteristics

Characteristic	N (%)	Effort	Reward	ERI	OC
Overall	64 (100%)	7.9 (2.4)	19.6 (3.8)	0.93 (0.39)	14.0 (3.9)
Poorer mental health					
No	38 (59%)	7.2 (2.5)	20.5 (3.8)	0.82 (0.38)	12.3 (3.3)
Yes	26 (41%)	8.8 (2.0)†	18.3 (3.4)*	1.10 (0.35)†	16.5 (3.2)‡
Age					
18–34 years	25 (39%)	7.8 (2.5)	19.2 (3.3)	0.92 (0.36)	13.9 (4.0)
35–54 years	25 (39%)	7.9 (2.6)	20.2 (4.2)	0.92 (0.41)	13.8 (4.3)
55+ years	14 (22%)	7.9 (2.1)	19.3 (4.0)	0.97 (0.43)	14.4 (3.0)
Gender					
Male	55 (86%)	7.9 (2.5)	19.5 (3.8)	0.95 (0.40)	14.0 (4.1)
Female or other	9 (14%)	7.4 (2.2)	20.0 (4.0)	0.85 (0.33)	14.1 (2.3)
Race					
White	49 (77%)	8 (2.3)	19.7 (3.9)	0.96 (0.40)	14.0 (3.6)
Nonwhite	15 (23%)	7.4 (2.8)	19.4 (3.4)	0.86 (0.35)	13.9 (4.8)
Education level					
Some college or lower	38 (59%)	7.8 (2.5)	20.1 (3.8)	0.91 (0.41)	14.2 (4.4)
Associates degree or higher	26 (41%)	7.9 (2.4)	18.9 (3.7)	0.97 (0.36)	13.6 (3.0)
In a union					
No	54 (84%)	7.6 (2.5)	20.0 (3.7)	0.88 (0.35)	13.8 (3.8)
Yes	10 (16%)	9.2 (1.8)*	17.7 (4.0)	1.22 (0.47)*	15.1 (4.1)
Poor physical health					
No	37 (58%)	7.7 (2.6)	20.7 (3.4)	0.85 (0.32)	13.0 (4.3)
Yes	27 (42%)	8.0 (2.2)	18.1 (3.8)†	1.05 (0.45)	15.4 (3.0)†

* $p < 0.05$
† $p < 0.01$
‡ $p < 0.001$.

examination of the single effects of effort, reward, ERI, and overcommitment on the odds of poorer mental health after adjusting for the confounders. For this model and all other models run, reward was reverse-coded such that higher scores indicated less rewards rather than higher rewards, since higher values of the effort, ERI, and overcommitment variables were expected to be positively associated with higher odds of poorer mental health. Since we hypothesized that higher rewards would be negatively associated with higher odds of poorer mental health, we needed to reverse code the reward scores in order to effectively compare the strength of effect estimate of reward with the other factors. Next, the additive effects of effort, reward, and overcommitment together, as well as ERI and overcommitment together were assessed in two separate, fully adjusted models. Lastly, joint effects of effort, reward, and overcommitment on the odds of poorer mental health were examined in fully adjusted models to examine potential interactions between the factors. Combined categorical variables classified as no ERI (≤ 1) and low overcommitment (≤ 15), ERI (>1) and low overcommitment, no ERI and high overcommitment (>15), and ERI and high overcommitment were used. Departures from multiplicative joint effects were computed.

We extended the concept of BKMR modeling, previously used to assess exposures to groups of chemicals/physical hazards [11–14,16], to investigate how a "mixture" of factors (effort, reward, and overcommitment) is related to poorer mental health, denoted as $h(\cdot)$, while adjusting for confounders. We also investigated any potential nonlinear, interactive effects these factors have on mental health. Specifically, we modeled using probit regression, where Y_i is poorer mental health; $h(\cdot)$ is the set of nonlinear, interactive factors of effort, reward, and overcommitment; and x_i represents the set of six confounders. The model was run with 20,000 iterations using the default "slab-and-spike" priors.

$$Y_i = h(Effort_i, Reward_i, Overcommitment_i) + \beta x_i + \varepsilon_i$$

Several metrics and visualizations were extracted from the BKMR model. First, we examined the overall effect of increasing effort, decreasing reward, and increasing overcommitment on the odds of poorer mental health, when all three factors were set at their 25th to 75th percentiles simultaneously, and the confounders were set at their median. Next, the posterior inclusion probability of each factor (PIP, a metric of the importance of a variable to the outcome), as well as univariate psychosocial exposure–response relationships were constructed to examine which of effort, reward, or overcommitment drive the effect on poorer mental health. This also allowed us to examine any potential nonlinear relationships with this outcome. Lastly, the significance of potential interactive effects between any of the three factors was assessed. The bivariate psychosocial–response relationship between effort and reward was constructed in particular to examine whether effort and reward had an interactive effect on mental health.

3. Results

Of the 64 participants who completed the E, R, and OC items, 26 (41%) participants reported poorer mental health (Table 1). Typical effort averaged 7.9 (SD = 2.4; IQR = 6 to 9) with typical reward 19.6 (3.8; 17 to 21.25). The average ERI was 0.93 (0.39; 0.63 to 1.16). Average overcommitment was 14.0 (3.9; 12 to 16). Compared with participants with good or excellent mental health, those with poorer mental health reported significantly higher effort, ERI, overcommitment, and significantly lower reward.

Table 2 presents the odds of poorer mental health in association with the single effects of higher effort, lower reward, ERI, and overcommitment, as well as their collective additive effects, controlling for confounders of mental health. An IQR increase in effort was significantly associated with 3.3 (95% CI: 1.3 to 7.9) times higher odds of poorer mental health; while reward was not a significant factor of mental health, lower rewards were associated with poorer mental health. An IQR increase in ERI, however, was associated with 3.5 (95% CI: 1.3 to 9.5) times significantly higher odds of poorer mental health. The largest effect was observed from an IQR increase in overcommitment (OR = 6.1; 95% CI: 2.1 to 17.7). When simultaneously controlling for effort and reward (or ERI alone) with overcommitment, only overcommitment was significantly associated with poorer mental health (IQR increase: OR = 6.7; 95% CI: 1.7 to 25.5).

Table 2
Odds ratios (95% CI) of poorer mental health by effort, reward, effort–reward imbalance (ERI) and overcommitment scores

Variable	Single effect			Additive effect		
	One-unit increase	IQR increase	Dichotomous	One-unit increase	IQR increase	Dichotomous
Effort	1.5 (1.1, 2.0)	3.3 (1.3, 7.9)	2.5 (0.7, 8.7)	0.9 (0.6, 1.4)	0.8 (0.2, 2.8)	1.1 (0.3, 5.0)
Reward*	1.2 (1.0, 1.4)	2.0 (0.9, 4.5)	4.6 (1.0, 21.4)	1.1 (0.9, 1.3)	1.3 (0.5, 3.2)	4.4 (0.8, 23.7)
ERI (per 0.1 unit)†	1.3 (1.0, 1.5)	3.5 (1.3, 9.5)	11.8 (2.5, 55.1)	1.0 (0.8, 1.3)	1.0 (0.3, 3.4)	1.2 (1.0, 1.4)
Overcommitment	1.6 (1.2, 2.0)	6.1 (2.1, 17.7)	11.4 (2.4, 53.9)	1.6 (1.2, 2.4)	6.7 (1.7, 25.5)	10.4 (2, 55.1)

All models adjusted for age, education level, race, gender, union status, and physical health status.
* Reward was reverse-coded such that higher scores reflect lower rewards.
† The additive ERI effect estimates are adjusted with overcommitment only, and do not include effort or reward.

Table 3
Odds ratios (95% CI) of poorer mental health by joint effect between effort–reward imbalance (ERI) and overcommitment

	ERI ≤ 1	ERI >1	ERI within strata of overcommitment
Low overcommitment (≤ 15)	Reference	4.9 (0.5, 45.4)	4.9 (0.5, 45.4)
High overcommitment (>15)	9.0 (0.7, 119)	41.4 (4.1, 420)	4.6 (0.3, 84.1)

Measure of effect modification on multiplicative scale: odds ratio of interaction term (95% CI) = 0.9 (0, 31.7).
Model adjusted for age, education level, race, gender, union status, and physical health status.

Table 3 presents the estimated joint effects of ERI and overcommitment on the odds of poorer mental health. Participants with an ERI >1 and high levels of overcommitment (>15) had 41.4 (95% CI: 4.1 to 420) times significantly higher odds of poorer mental health. Although not significant, the additive effect of high overcommitment only (OR = 9.0; 95% CI: 0.7 to 119) was substantially higher than the effect of ERI only (OR = 4.9; 95% CI: 0.5 to 45.4). Estimates did not indicate any multiplicative interactive effects (OR of interaction term = 0.9; 95% CI: 0 to 31.7).

Nonlinear, interactive effects between effort, reward, and overcommitment on poor/fair mental health were examined. A simultaneous increase in higher effort, lower reward, and higher overcommitment at work, from the 25th to 75th percentile, was associated with an increase in the odds of poor/fair mental health, compared to when all psychosocial exposures were set at their median values (Fig. 1a). This indicates that higher effort, lower reward, and higher overcommitment have a positive joint effect on poorer mental health. Overall, an IQR simultaneous increase in higher effort, lower reward, and higher overcommitment was associated with 6.6 (95% CI: 1.7 to 33.4) times significantly higher odds of poorer mental health.

To evaluate which of the psychosocial exposures dominated the overall joint effect, PIPs of effort, reward, and overcommitment were calculated. Overcommitment was the most important factor (PIP = 1.0) of poorer mental health, with effort (PIP = 0.51) more important than reward (PIP = 0.21). The importance of each factor on poorer mental health was further evaluated by estimating the odds ratio from an IQR increase of a single factor, leaving the other factors fixed at their median. Fig. 1b displays the univariate psychosocial exposure–response relationship of each factor. Specifically, an IQR increase in overcommitment was associated with 5.6 (95% CI: 1.6 to 24.9) times significantly higher odds of poorer mental health, with effort and reward set at their median. Furthermore, the relationship between overcommitment and odds of poorer mental health appears exponential; that is, increasing overcommitment among workers who already have high levels of overcommitment more substantially worsens mental health than increasing overcommitment among workers with low levels. Neither effort nor reward was significantly associated with poorer mental health. However, while more rewards were generally associated with a decrease in the odds of poorer mental health, effort had a parabolic relationship with mental health. Low effort (score <7) was associated with increasing odds of poorer mental health, while higher effort (>7) decreased the odds of poorer mental health (Fig. 1b). Potential interactions between effort, reward, and overcommitment are displayed in Supplemental Figures A1 and A2; no interactive effects were observed.

Regardless, the bivariate psychosocial exposure–response relationship of effort at the 20th, 50th, and 80th quantiles of reward, setting, and overcommitment at its median was observed to examine a potential interaction between effort and reward (Fig. 2). The slopes of effort were similar at different levels of reward, suggesting no statistically significant interaction. It is important to highlight that the relationship between effort and odds of poorer mental health was parabolic regardless of the level of rewards. This is particularly critical as even when the ERI was present (ERI >1), the odds of poorer mental health continued to decrease.

4. Discussion

This study indicates that psychosocial exposures are risk factors of mental health among a sample of formal, manual labor, US solid waste workers. Higher effort and lower reward at work may not always be associated with poorer mental health, but rather they may have an inverse, U-shaped relationship with mental health, contrary to Hypothesis 1. The joint effect of effort and reward on

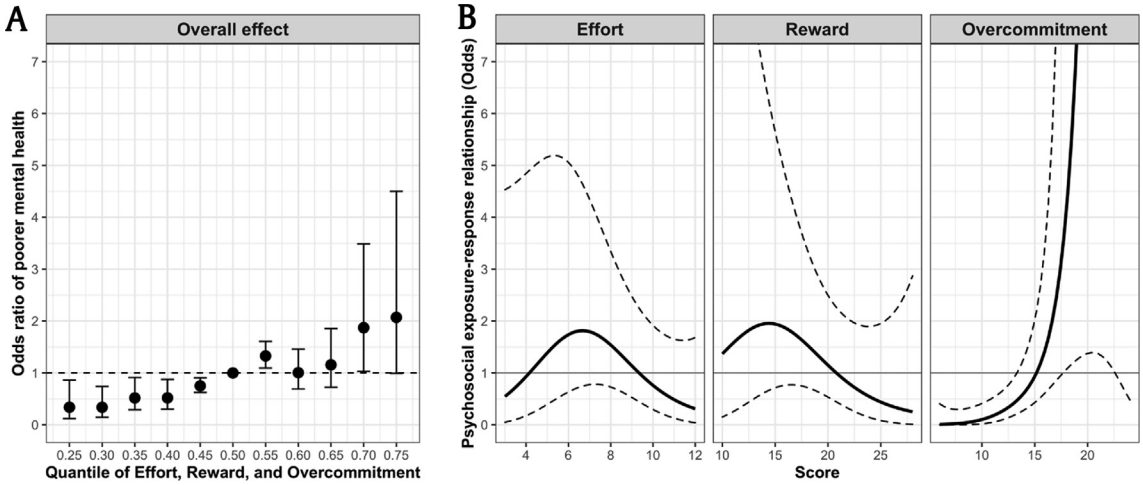

Fig. 1. (A) Overall odds of higher effort, lower reward, and higher overcommitment (95% CI) associated with poorer mental health. Effect reflects as the ratio in odds when the three factors are fixed at a specific quantile (ranging from 0.25 to 0.75), as compared to when the factors are fixed at their median value. The dashed line represents the null effect. (B) Univariate psychosocial exposure-response relationship with 95% credible intervals (top and bottom dashed lines) for each psychosocial exposure (effort, reward, and overcommitment). The Bayesian Kernel machine regression (BKMR) was adjusted for age, education level, race, gender, union status, and physical health status; all plots have the confounders set at the median. The solid gray line represents the null effect.

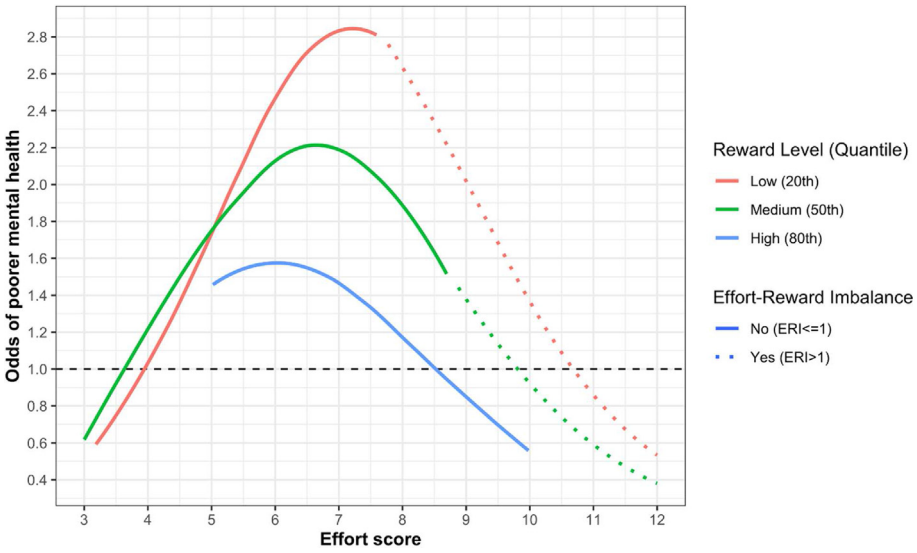

Fig. 2. Bivariate psychosocial exposure–response relationship of effort when reward was fixed at 20th (red line), 50th (green line), and 80th (blue line) percentile respectively, and all other confounders are set at the median. Solid line represents no effort-reward imbalance (ERI $\leq$ 1); dotted line represents effort–reward imbalance (ERI>1). The black, dashed line represents the null effect.

mental health did not indicate any interaction between the two psychosocial exposures, also contrary to Hypothesis 2. Importantly, overcommitment had not only the strongest association with poorer mental health, but an exponential one, providing evidence for Hypothesis 3. Overcommitment may therefore have the greatest overall effect on mental health and may be more predictive of poorer mental health than effort and reward. No interaction was observed between overcommitment, effort, and reward, but effort and reward in combination with overcommitment may pose the greatest risk to worker mental health, providing evidence for Hypothesis 4. Overall, the results suggest that among this occupational group, effort, reward, and overcommitment have additive, albeit nonlinear, effects on mental health.

Evidence supporting a nonlinear relationship between effort and mental health is limited and inconsistent. Studies examining this relationship have typically used linear statistical methodologies among non-blue-collar workers, or have not explored effort and reward individually, but only the imbalance between the two [6,7,17–22]. Regardless, comparisons can still be made. A 2006 study of primarily manual labor workers found that effort had a nonsignificant, near-null association with depressive symptoms or psychiatric disorders among men [22], similar to a 2014 analysis of medically certified sickness absence for mental health problems of nonmanual labor workers [17] and to our own logistic regression findings (Table 2). As our BKMR modeling suggests, this may be due a nonlinear relationship between effort and mental health. Conversely, a 2018 study of students at German universities found a positive, linear psychosocial exposure–response relationship between effort and depression and anxiety [20], as did an analysis of UK academics [4].

We have two primary hypotheses related to the inverse, U-shaped relationship we observed. First, workers such as solid waste workers perform repetitive, manual labor; some effort regardless of whether rewards are reciprocated may be perceived as dangerous and increase anxiety at work, while high effort may be indicative of more highly skilled and capable workers who, through muscle memory, practice, and experience, no longer perceive the manual labor as dangerous. Second, this study was conducted during the COVID-19 pandemic, which coincided with poorer mental health [23]. High effort, regardless of any reciprocated rewards of money or esteem, may have been sufficiently rewarding for these essential, solid waste workers, as demonstrated in Fig. 2.

The relationship of these psychosocial exposures with mental health was dominated by overcommitment. This finding was supported by the additive effects (Table 2), the joint effect of ERI and overcommitment (Table 3), and the BKMR analysis. A similar effect has been observed inconsistently in other studies [4,22]. Regardless, in the context of essential manual labor workers during the COVID-19 pandemic, the exponential relationship with poorer mental health may be due to substantially increased workloads and greater psychological distress as a result of the COVID-19 pandemic [24–26]. Anecdotally, the owners of the small, local waste business described how increased trash generation at home and the increased use of personal protective equipment by the general populous during COVID-19 had increased work hours, workdays, and the workload of the workers. A 2021 study of essential, Chinese frontline workers also highlighted the detrimental effect that substantial overcommitment resulting from the pandemic had on mental health [27].

4.1. Workplace implications

The context of the pandemic may help explain why overcommitment had such a dominant effect on mental health among this sample of “pandemic-proof” workers. Studies on workplace interventions targeting overcommitment using the ERI model are rare although a stress management intervention based on the ERI model observed improvements in depression, anxiety, and ERI among middle management workers [28]. Another intervention targeting ERI, among other psychosocial factors, found mental health indicators improved among healthcare professionals [29]. Interventions specifically targeting workplace overcommitment may have the greatest health impact among this worker population.

4.2. Limitations and strengths

This study had a few limitations. First, it was cross-sectional; causation cannot be inferred. Second, we did not utilize a validated questionnaire to measure mental health, such as the Short

General Health Questionnaire (GHQ-12). Asking a single, direct question about mental health may also lead to some workers under- or overrate the severity of their mental health. However, some studies have determined that a single-item measure of health status is acceptable [30–32]. Third, the sample size was relatively small, resulting in relatively low confidence of estimation of uncertainty in our models. The small sample size was a result of a few difficulties in recruitment. The study was conducted during the height of the COVID-19 pandemic, where workload was heightened at the sites, making sites less keen to participate. Nearly forty waste sites were contacted, yet only three chose to participate. Among the sites that did participate, the pandemic made some workers reluctant to participate due to the collection of saliva samples (not the focus of this paper). Fourth, the study consisted of only solid waste workers, limiting the generalizability of these findings to other waste sectors, such as medical waste.

However, these limitations are balanced by important strengths. First, this is the first study, to our knowledge, that has examined whether a complex, nonlinear, and nonadditive relationship between effort, reward, and overcommitment exists with an adverse health outcome (i.e., mental health) using BKMR. Second, traditional logistic regression was also utilized to compare the results of BKMR and to generalize our findings to other studies which have used traditional analyses. Our findings warrant future examination of complex relationships between these psychosocial exposures and other adverse health outcomes linked to ERI and overcommitment (e.g., coronary heart disease) to examine whether non-linear relationships exist elsewhere. Further, statistical methods that can handle complex, nonlinear relationships need to be incorporated in future studies examining ERI and mental health in other occupational groups.

5. Conclusion

Among a sample of formal, manual labor, US solid waste workers, while ERI may not result in poor mental health outcomes, when taking into the consideration the relationship between effort, reward, and overcommitment, overcommitment may be most indicative of poorer mental health. Organizations should assess their waste workers' perceptions of overcommitment to target potential areas of improvement to enhance mental health outcomes.

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Institutional review board statement

The study was approved by the Institutional Review Board of the University of Michigan (Protocol ID HUM00202683) on 26 August 2021.

Conflict of interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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