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Is the effort-reward imbalance associated with hypertension among Brazilian civil servants? Results from the ELSA-Brasil study

O desequilíbrio esforço-recompensa está associado à hipertensão arterial entre servidores públicos brasileiros? Resultados do ELSA-Brasil

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Abstract

Objectives: to evaluate the association between job stress, according to the effort-reward imbalance (ERI) model, and hypertension (HTN), as well as to investigate the effect modifier role of overcommitment (OC) and sex. *Methods:* cross-sectional analysis of data from active workers who participated in the second data collection wave (2012-2014) of the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). Job stress was measured by the ERI scale – Brazilian version, comprising three dimensions: effort, reward, and OC. HTN was defined as systolic or diastolic blood pressure levels ≥ 140/90 mmHg or antihypertensive medication use. Associations were estimated by logistic regression, crude and adjusted for potential confounding factors. Multiplicative interactions were investigated. *Results:* a total of 9,465 civil servants participated in the study, 51.9% females. HTN prevalence was 34.9%. The adjusted model identified borderline associations between ERI (ratio > 1) and higher OC with higher odds of HTN (OR = 1.11, 95%CI = 1.00; 1.24; and OR = 1.13; 95%CI = 1.01; 1.26, respectively). Interaction analysis indicated no differences in associations according to sex and OC. *Conclusion:* results show that ERI and OC are associated with higher odds of HTN after adjustment. Sex and OC were not effect modifiers.

Keywords: *hypertension; working conditions; psychological stress; effort-reward imbalance; cross-sectional study; occupational health.*

Resumo

Objetivos*: analisar a associação entre o estresse no trabalho, segundo o modelo de desequilíbrio esforço-recompensa (DER), e a hipertensão arterial (HA), assim como investigar o papel modificador de efeito do excesso de comprometimento (EC) e do sexo.* Métodos*: análise seccional de dados de trabalhadores(as) ativos que participaram da segunda onda de coleta de dados (2012-2014) do Estudo Longitudinal de Saúde do Adulto (ELSA-Brasil). O estresse no trabalho foi mensurado pela versão brasileira da escala de DER, composta por três dimensões: esforço, recompensa e EC. A HA foi definida como níveis de pressão arterial sistólica/diastólica ≥ 140/90 mmHg ou uso de medicamento anti-hipertensivo. Empregou-se regressão logística, bruta e ajustada por potenciais fatores de confusão. As interações multiplicativas foram investigadas.* Resultados*: participaram 9.465 servidores, 51,9% do sexo feminino. A prevalência de HA foi de 34,9%. No modelo ajustado, associações limítrofes foram identificadas entre o DER (razão>1) e maior EC com maiores chances de HA (OR: 1,11; IC95%: 1,00; 1,24; e OR: 1,13; IC95%: 1,01; 1,26, respectivamente). A análise de interação indicou que sexo e EC não são modificadores de efeito.* Conclusão*: DER e EC associaram-se a maiores chances de HA, após ajuste. Sexo e EC não foram modificadores de efeito.*

Palavras-chave: *hipertensão; condições de trabalho; estresse psicológico; desequilíbrio esforço-recompensa; estudos transversais; saúde do trabalhador.*

Introduction

Hypertension (HTN) is a major cardiovascular risk factor, affecting almost a third of the world's population[1], with a greater impact on low- and middle-income countries compared to high-income nations[2]. Along with other cardiovascular diseases, it features among the main causes of death in Brazil[3], causing serious damage to public health, totaling about R$ 2 billion in expenses for the Unified Health System (SUS) including hospitalizations, outpatient procedures and medications in 2018[4]. HTN impacts quality of life and work, leading to limitations in carrying out daily activities due to worsening of the disease and target-organ damage[3,4].

Work-related stress, one of the factors presented as potentially damaging to occupational health, is associated with a higher risk of cardiovascular diseases and HTN[5]. Several studies[5-8] have investigated this topic, mainly in developed Western countries—in Europe and North America—where a greater body of scientific evidence allows job stress to be associated with health.

However, studies on the association between job stress and increased blood pressure present divergent results, often due to methodological differences such as study design and population, job stress and blood pressure measurement methods and instruments, confounding variables considered and effect modification by multiple factors (e.g., gender)[7,8]. Regarding this last aspect, research has shown more consistent associations between job stress and HTN among men when compared with women[7]. Exploring the effects differentiated by gender is justified because women generally have different occupational trajectories than men and add an overload of family responsibilities to work-related psychosocial factors[7].

Among the instruments widely used to assess job stress are the Demand-Control Model (DCM)[9] and the Effort-Reward Imbalance (ERI)[10], both of which have advantages and disadvantages in capturing this construct and in covering different aspects of the occupational environment and its impacts on health. Both instruments have versions duly validated for the Brazilian context[11-13]. The DCM[9] considers interactions between two occupational strain-promoting components: psychological demands and control, which can be enhanced by a perceived low social support. Its use has been questioned regarding its applicability in certain occupations (especially in service sectors). Devised in the late 1970s, in the context of industrial organizations, the model emphasizes work tasks characteristics disregarding the recent changes in the nature of work related to the global economy, which added factors such as job insecurity, rapid organizational changes and few prospects for promotion[12].

Developed more recently, the Effort-Reward Imbalance (ERI) model[10] assumes that the lack of reciprocity in work relations between efforts expended and rewards received—in relation to financial aspects, opportunities, professional stability, and recognition—can have serious consequences for health. Moreover, it considers a third intrinsic element: overcommitment (OC). Reflecting a pattern of exaggerated effort associated with a strong desire for recognition and esteem, OC has been considered an effect modifier of work-related stress and health outcomes[10,14,15].

In Brazil, few studies have analyzed the impact of job stress on health using the ERI[6,11,12] scale, and, to our knowledge, no research has used the model and investigated its association with HTN or blood pressure levels. The studies identified showed an association between job strain, assessed by the Demand-Control Model (DCM), and outcomes related to blood pressure levels, with some showing a positive association and others showing no association[13,16-18].

Given the intense transformation of the Brazilian labor market, characterized by precarious employment, with an increase in informality and job insecurity[19], it is important to investigate how job stress relates to HTN in the working population, especially when assessed by ERI, which reflects central aspects of the current labor market[15].

In this context, the limited number of publications on the subject in Brazil, the inconsistent results of international studies, the predominant use of the DCM, and the severity and magnitude of HTN in the adult population, reinforces the need for further research into the relation between the ERI model and HTN, as well as understanding the effect-modifying role of gender and OC at work. Understanding the occupational factors related to the occurrence of HTN among workers can support policies and strategies aimed at its prevention and control, since the workplace is a prime location for implementing preventive strategies.

Hence, this study analyzes the association between job stress, assessed by ERI, and HTN and investigates the effect modifier role of OC and gender.

Methods

Study design and population

This cross-sectional study used data from the Longitudinal Study of Adult Health (ELSA-Brasil), a multicenter cohort conducted in higher education and research institutions located in six Brazilian state capitals: Porto Alegre, São Paulo, Rio de Janeiro, Vitória, Belo Horizonte and Salvador. Its main objective is to investigate the development of chronic diseases over time, especially diabetes and cardiovascular diseases[20].

Baseline (wave 1) took place between 2008 and 2010, in which 15,105 volunteers took part: active and retired civil servants aged between 35 and 74 from the aforementioned state capitals. Exclusion criteria consisted of intention to quit, pregnant women (temporary exclusion), compromised cognitive and communication skills, and retirees living outside the metropolitan area of the research centers. Wave 2 took place between 2012 and 2014, with the participation of 14,014 volunteer civil servants.

Sample size was calculated considering the incidence of the two main outcomes of interest—type 2 diabetes and myocardial infarction—a significance level of 5%, a power of 80%, an exposure prevalence of 20% and a relative risk of 2.0. The sample was estimated at approximately 6,400 individuals. To perform gender-specific analyses and compensate for possible follow-up losses, the sample size was set at approximately 15,000 people. Further details are available in Aquino et al[20].

Exposure variable: job stress

Job stress was assessed using the Brazilian version[21] of Siegrist's instrument developed to evaluate the ERI model[14]. The questionnaire used contains 23 items divided into two extrinsic dimensions—effort (6 items) and reward (11 items)—and one intrinsic dimension—OC (6 items). Reward has three sub-dimensions, namely: esteem (5 items), promotion prospects and salary (4 items) and job security (2 items). Each item is scored on a scale from 1 to 4. However, the item "I have little job stability" was removed from the ELSA-Brasil questionnaire, given that the cohort is made up of civil servants whose employment relationship gives them high job stability[6]. The ERI model – Brazilian version showed satisfactory internal consistency (Cronbach's Alpha equal to 0.68 for effort and 0.78 for reward and OC)[21].

Total scores for each dimension were calculated by adding up the scores for each question, resulting in a range of 6-24 points for effort, 10-40 points for reward, and 6-24 points for OC; the higher the score, the higher the levels of effort, reward, and OC, respectively. ERI was calculated using the formula $e/(r*c)$, represented by the ratio between the sum of the effort scores (e) and the product of the sum of the reward scores (r) with a correction factor ($c = 0.6$), used to compensate for the difference between the number of items in each dimension[6,14].

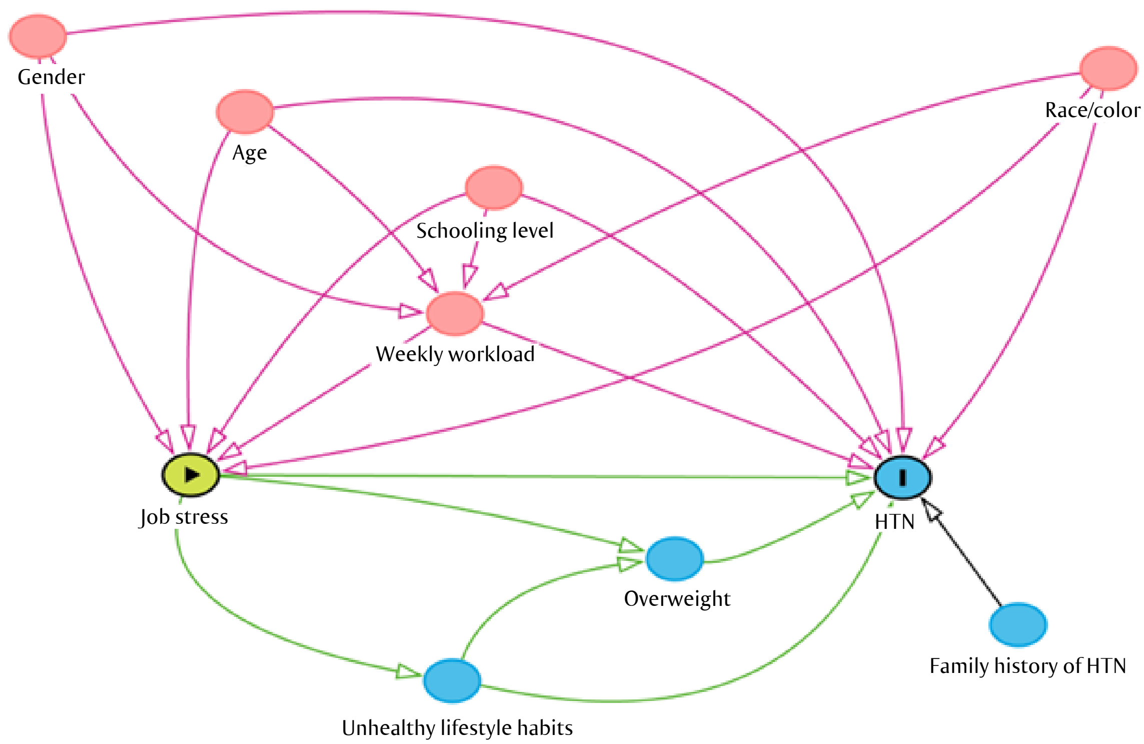
For this study, we compared different ways of operationalizing the exposure variable proposed in the literature[6,10,22,23]. In addition to the ratio analysis, each ERI dimension was analyzed separately (effort, reward and OC). The dimensions and ratio were categorized into quartiles and each quartile was compared with the first (reference category). Moreover, we compared the fourth quartile with the others (reference category), and the ratio categorized based on the cut-off point ≤ 1 and > 1.

Outcome variable: hypertension (HTN)

Blood pressure was measured at the research center, in the morning, in a quiet, air-conditioned environment (20°C to 24°C), after emptying the bladder and resting for at least 5 minutes, with the participant sitting with their feet flat on the floor and their arm resting at heart level. Three measurements were performed on the left arm, two minutes apart, using a validated oscillometer device (Omron HEM 705CPINT). The arm circumference determined the size of the cuff to be used. Blood pressure was defined as the mean between the last two measurements. Participants who had systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg or were taking antihypertensive medication were considered hypertensive[3].

Covariates

Age (continuous in complete years), race/skin color (black, mixed race/"pardo", white, Asian, and Indigenous), schooling level (up to complete primary education, complete secondary education and complete higher education) and weekly workload (up to 40 hours and more than 40 hours) were the covariates considered as potential confounders. These were selected by drafting a directed acyclic graph (DAG) using the DAGitty program (**Figure 1**). Unhealthy lifestyle habits (poor diet, physical inactivity, alcohol, and tobacco use) and overweight were not considered confounding factors, because they act as potential mediators of the relationship studied[7]. Likewise, family history of HTN was not included as a confounding factor in the analyses due to lack of evidence supporting an association with the exposure variable. The variables gender (male and female) and OC were evaluated as effect modifiers. Age was categorized (35-44, 45-54, 55-64, 65-74 years) to calculate the prevalence of HTN.



Legend: Symbols ▶ and ▮ denote the exposure and outcome variables, respectively. Pink circles represent the variables that simultaneously precede exposure and the outcome; the blue circles indicate the variables that precede only the outcome. Green lines represent the causal paths (mediators) and the pink lines indicate the paths that potentially bias the estimates of the association studied (confounders). HTN, hypertension.

Figure 1 Directed Acyclic Graph (DAG) of the association between job stress and hypertension

Statistical analysis

Descriptive analysis calculated the mean and standard deviation for the variable continuous age. Absolute and relative frequencies and Pearson's chi-squared test were calculated for the categorical variables.

Binary logistic regression analyzed the association between the ERI components (dimensions and ratio) and HTN. Crude models were estimated and adjusted for the confounding variables indicated by the DAG (age, gender, race/skin color, schooling level, and weekly workload), and the results were presented as *odds ratio* (OR), followed by their 95% confidence intervals (95%CI). The quality of the fit was assessed using the Hosmer and Lemeshow test, considering a significance level of 5%.

Finally, a multiplicative scale was used to explore OC and gender as possible effect modifiers of the association investigated by inserting an interaction term into the model. Non-significance of the interaction term indicates no effect modification.

Analyses were performed in the R software (version 4.0.5).

ELSA-Brasil was approved by the National Research Ethics Commission (Conep – No. 13065) and by the research ethics committees of each of the institutions involved. All participants signed an informed consent form in waves 1, 2, and 3 of the study.

Results

For this study, which consisted of a cross-sectional analysis of data from wave 2 of ELSA-Brasil, only active participants were considered (n = 10,034). We also excluded 569 participants with missing data in the study variables, resulting in a final sample of 9,465 civil servants.

The proportion of female participants was slightly higher (51.9%). Mean age of the study participants was approximately 52 years, with a standard deviation of 6.7 years. Whites accounted for 51% of the sample, followed by mixed race/"pardo" and black people, with 29.3% and 16.3% respectively. Around 59% had complete tertiary education and almost half (49%) reported working more than 40 hours a week (**Table 1**).

Overall prevalence of HTN was 34.9%, with higher proportions among males (39.6%), aged over 65 years (53.7%), black (47.9%), with complete primary education (49.9%) and workload up to 40 hours per week (38.5%). The 1st quartile of effort (37.6%), OC (37.1%), and ERI (38.5%) showed the highest prevalence of HTN (**Table 1**).

As for the effort and OC components, we found an inverse association for all quartiles in the crude model. After adjusting for age, gender, race/color, schooling level, and weekly workload, however, there was no statistically significant association. We observed a positive association in the crude model between reward and HTN only in the 3rd quartile (OR = 1.13; 95%CI = 1.01;1.27). However, this association was not maintained after adjustment (**Table 2**).

The higher the ERI, the lower the odds of HTN in the crude model for all the quartiles investigated (2nd quartile: OR = 0.82; 95%CI = 0.73; 0.92; 3rd quartile: OR = 0.81; 95%CI = 0.72; 0.91; and 4th quartile: OR = 0.80; 95%CI = 0.71; 0.90). However, this association was not maintained after adjustment (**Table 2**).

Table 3 shows the results of the regression analysis which compared the fourth quartile of the dimensions with the other quartiles combined (reference category) and the ERI as a cut-off point of 1. Being in the highest OC quartile was associated with greater odds of HTN in the adjusted model (OR = 1.13; 95%CI = 1.01; 1.26). We also observed a borderline positive statistical association between ERI > 1 and HTN, even after adjustment (OR = 1.11; 95%CI = 1.00; 1.24).

In the multiplicative interaction analysis, OC did not prove to be an effect modifier in the association between ERI, categorized using cut-off points ≤ 1 and > 1, and HTN (p-value for the interaction term = 0.85). We found the same result for the interaction between gender and ERI (p-value for the interaction term = 0.95). Similar results were obtained for the other ways of ERI categorization.

Table 1 Sample characteristics and prevalence of hypertension, ELSA-Brasil, 2012-2014

	Total	*Arterial hypertension*	*p-value*
	n (%)	*n (%)*	
Age (years)			
35-44	1,361 (14.4)	229 (16.8)	< 0.001
45-54	4,855 (51.3)	1,530 (31.5)	
55-64	2,914 (30.8)	1,362 (46.7)	
65-74	335 (3.5)	180 (53.7)	
Gender			
Male	4,553 (48.1)	1,801 (39.6)	< 0.001
Female	4,912 (51.9)	1,500 (30.5)	
Race/skin color			
Black	1,545 (16.3)	740 (47.9)	< 0.001
Mixed race/“Pardo”	2,775 (29.3)	1,019 (36.7)	
White	4,826 (51.0)	1,437 (29.8)	
Asian	223 (2.4)	72 (32.3)	
Indigenous	96 (1.0)	33 (34.4)	
Schooling level			
Complete primary education	811 (8.6)	405 (49.9)	< 0.001
Complete secondary education	3,111 (32.9)	1,252 (40.2)	
Complete tertiary education	5,543 (58.6)	1,644 (29.7)	
Weekly workload			
Up to 40 hours	4,828 (51.0)	1,860 (38.5)	< 0.001
More than 40 hours	4,637 (49.0)	1,441 (31.1)	
Effort			
1st quartile [6-12]	2,600 (27.5)	977 (37.6)	0.003
2nd quartile [12-15]	2,612 (27.6)	911 (34.9)	
3rd quartile [15-18]	2,397 (25.3)	810 (33.8)	
4th quartile [18-24]	1,856 (19.6)	603 (32.5)	
Reward			
1st quartile [10-29]	2,936 (31.0)	982 (33.4)	0.189
2nd quartile [29-32]	2,114 (22.3)	745 (35.2)	
3rd quartile [32-35]	2,206 (23.3)	801 (36.3)	
4th quartile [35-40]	2,209 (23.3)	773 (35.0)	
ERI			
1st quartile [0.25-0.62]	2,354 (24.9)	907 (38.5)	< 0.001
2nd quartile [0.62-0.79]	2,344 (24.8)	794 (33.9)	
3rd quartile [0.79-0.98]	2,433 (25.7)	821 (33.7)	
4th quartile [0.98-3.03]	2,334 (24.7)	779 (33.4)	
OC			
1st quartile [6-9]	2,694 (28.5)	999 (37.1)	0.041
2nd quartile [9-13]	2,696 (28.5)	918 (34.1)	
3rd quartile [13-16]	1,755 (18.5)	590 (33.6)	
4th quartile [16-24]	2,320 (24.5)	794 (34.2)	

ERI: Effort-Reward Imbalance, OC: Overcommitment.

Table 2 Odds ratio (OR) and 95% confidence interval (95%CI) of the association between effort-reward imbalance (in quartiles) and arterial hypertension, ELSA-Brasil, 2012-2014

	OR (95%CI)	
	Crude Model	*Adjusted model*[a]
Effort		
1st quartile [6-12]	1.00	1.00
2nd quartile [12-15]	**0.89 (0.79; 1.00)**	0.99 (0.88; 1.12)
3rd quartile [15-18]	**0.85 (0.75; 0.95)**	1.02 (0.91; 1.16)
4th quartile [18-24]	**0.80 (0.71; 0.91)**	1.02 (0.89; 1.17)
Reward		
1st quartile [10-29]		
2nd quartile [29-32]	1.08 (0.96; 1.22)	0.99 (0.88; 1.12)
3rd quartile [32-35]	**1.13 (1.01; 1.27)**	1.00 (0.88; 1.13)
4th quartile [35-40]	1.07 (0.95; 1.20)	0.92 (0.81; 1.04)
ERI		
1st quartile [0.25-0.62]	1.00	1.00
2nd quartile [0.62-0.79]	**0.82 (0.73; 0.92)**	0.92 (0.81; 1.05)
3rd quartile [0.79-0.98]	**0.81 (0.72; 0.91)**	0.99 (0.87; 1.12)
4th quartile [0.98-3.03]	**0.80 (0.71; 0.90)**	1.04 (0.91; 1.18)
OC		
1st quartile [6-9]	1.00	1.00
2nd quartile [9-13]	**0.88 (0.78; 0.98)**	0.96 (0.85; 1.08)
3rd quartile [13-16]	**0.86 (0.76; 0.97)**	0.97 (0.85; 1.11)
4th quartile [16-24]	**0.88 (0.79; 0.99)**	1.10 (0.97; 1.26)

ERI: Effort-Reward Imbalance, OC: Overcommitment.
95%CI: 95% Confidence Interval; OR: Odds Ratio.
[a] Adjusted for age, gender, race/color, schooling level and weekly workload.

Table 3 Odds ratio (OR) and 95% confidence interval (95%CI) of the association between effort-reward imbalance (dichotomized) and hypertension, ELSA-Brasil, 2012-2014

	OR (95%CI)	
	Crude Model	*Adjusted model*[a]
Effort		
Other [6-18]	1.00	1.00
4th quartile [18-24]	0.88 (0.79; 0.98)	1.01 (0.90; 1.14)
Reward		
Other [10-35]	1.00	1.00
4th quartile [35-40]	1.01 (0.91; 1.11)	0.92 (0.83; 1.02)
ERI		
Other [0.25-0.98]	1.00	1.00
4th quartile [0.98-3.03]	0.92 (0.83; 1.01)	1.07 (0.96; 1.19)
OC		
Other [6-16]	1.00	1.00
4th quartile [16-24]	0.96 (0.87; 1.06)	**1.13 (1.01; 1.26)**
ERI		
≤ 1	1.00	1.00
> 1	0.94 (0.85; 1.05)	**1.11 (1.00; 1.24)**

ERI: Effort-Reward Imbalance, OC: Overcommitment.
95%CI: 95% Confidence Interval; OR: Odds Ratio.
[a] Adjusted for age, gender, race/color, schooling level and weekly workload.

Discussion

Our results identified borderline associations between ERI (ratio > 1) and OC and higher odds of HTN after adjustment for potential confounders. Moreover, gender and OC were not effect modifiers of the association investigated.

Similarly, research conducted in different countries has found a positive association between ERI and HTN[5,7,24]. In a study with workers in China, Yong et al.[23] noted an association between ERI (ratio > 1) and a 203% increase (OR = 3.03; 95%CI = 1.66;5.52) in the odds of HTN. However, literature on the subject lacks consensus. Faruque et al.[25] found that ERI was associated with higher diastolic blood pressure, but not systolic blood pressure and HTN, among 63,800 Dutch workers. Conversely, a prospective cohort performed three ERI assessments over five years and observed that women who were exposed to ERI during follow-up showed an increase in systolic blood pressure but found no association with HTN incidence[26].

Research suggests that job stress contributes to an increase in blood pressure through neuroendocrine mechanisms, such as activation of the hypothalamic-pituitary-adrenocortical axis and the sympathetic nervous system, causing long-term structural vascular changes[27]. It can also act by indirect mechanisms, through exposure to unhealthy lifestyle habits such as alcohol overconsumption[28], poorer diet quality[29] and physical inactivity[30], as well as greater body adiposity[31].

Based on the different proposals found in the literature, we explored various ways of categorizing the ERI, such as distribution in terciles[11], binary—with values greater than one as the cut-off point[23]—or in quartiles[6]. A statistically significant association, albeit borderline, was observed only when considering the model's original cut-off point, which assumes a ratio greater than 1, and reflects an imbalance situation where there is greater effort and less reward, generating frustration and feelings of injustice[10]. Conversely, a study comparing different ways of operationalizing the ERI ratio in participants from the GAZEL cohort, made up of French electricity company workers, observed a significant association with self-reported health when exposure was categorized as ratio with cut-off point above one, quartiles, continuous ratio and log-transformed ratio[22]. This reinforces the need for further studies comparing the different ways of operationalizing the ERI variable in order to provide a broader understanding of its correlation with different outcomes, as in this study.

Our research also explored the independent associations between the ERI dimensions and HTN. We identified a positive association between OC and HTN, in line with the theoretical model proposed by Siegrist et al.[10,14], who considers that this intrinsic component, even without the presence of ERI, is related to a greater health risk, as it can result in exaggerated efforts and, consequently, disappointing rewards. In line with our findings and those of other authors[7,24,32], a meta-analysis including 22 studies, aiming to analyze the association between the ERI model and cardiovascular health indices, found a positive association between overcommitment and HTN[5].

As for effort and reward, our study found no association with HTN in the adjusted models, similarly to other studies that evaluated the independent effect of these two dimensions[33,34]. Studies have shown different associations for the different ERI dimensions in relation to health outcomes, depending on the use of independent dimensions or the ratio between the two dimensions. For example, high ERI (ratio between the two dimensions) and low reward had an effect on coronary artery disease, unlike effort, which had no significant result[35]. Similarly, other authors have shown that both ERI and low reward were associated with HTN, but not effort[36]. In turn, a study with administrative workers in Sri Lanka found that ERI and effort were positively associated with the odds of HTN, but no significant associations were observed for reward[24]. Thus, further studies are needed to elucidate the combined and individual effects of the ERI dimensions.

In this study, gender was not an effect modifier in the correlation between job stress, as measured by the ERI scale, and HTN despite evidence of this potential, as found in a systematic review of 74 studies, in which 12 used the ERI model[7]. In this study, which aimed to investigate the association between work-related psychosocial aspects and blood pressure/HTN, the authors found more consistent associations for men than for women[7]. However, a meta-analysis on the association between job strain and coronary artery disease, including individual data from 13 European cohorts and 197,473 workers, found similar effects between genders[37], similar to our findings.

This possible differential effect of job stress between genders has been attributed to various factors, reinforcing the need for analyses stratified by gender. Firstly, blood pressure increase in women occurs later than in men, meaning that associations are only observed at older ages[7]. Moreover, the lower impact of job stress on women may be due to complex exposure to other factors of particular importance such as family responsibilities, work-family conflict and multiple social roles[7,38]. Thus, future studies evaluating age differences among women in the association between job stress and HTN, as well as considering combined exposure to external stressors that can intensify the deleterious effects of occupational factors on health, are necessary to elucidate these aspects.

OC also did not prove to be an effect modifier of the relation between ERI in our study, contradicting the interaction hypothesis of the ERI model about this intrinsic component[14]. Few studies to date have explored this hypothesis of interaction in relation to blood pressure/HTN[7] and, as in this study, others found no significant effects[39]. However, a study with Chinese workers from different occupations that investigated the independent effects of ERI and OC, as well as their interaction, observed that the prevalence of HTN was significantly higher when high OC and high ERI were combined (synergism index = 5.85 and multiplicative interaction term < 0.001)[32].

Strengths of this study include the methodological rigor of data collection, the sample size, the interaction analysis with OC, which is still little explored, and it being the first nationwide investigation to evaluate the association between job stress and HTN using the ERI model. Using DAG also aided in selecting potential confounders of the relation studied, as it reduces bias in estimating effect measures.

Its limitations include the cross-sectional nature of the analysis, which does not allow us to ensure the temporality of the associations studied. Moreover, samples made up of volunteers run the risk of not representing the target population, making it difficult to estimate the direction of its effects. For this reason, ELSA-Brasil implemented some strategies at the time of recruitment to minimize this potential bias. Similar proportions of men and women were recruited, as well as predefined proportions of age groups and functional categories, a percentage of actively recruited participants was also included from lists of employees randomly ordered[20]. Use of casual blood pressure measurement may also represent a limitation, as it portrays the behavior of blood pressure levels at a single moment, resulting in possible inaccurate HTN classification[3]. Although we used only the multiplicative scale to assess the interaction between ERI, gender and OC in the association with HTN, it can also be evaluated on the additive scale[6]. Finally, using the ERI model may also have been a limitation as it does not measure psychological demands and includes few questions about social relations in the workplace. Its combined use with the demand-control model to evaluate different health outcomes related to job stress has been suggested[11,12,40].

Conclusion

Our findings showed that ERI resulting from high efforts, as opposed to unsatisfactory rewards, is associated with higher odds of HTN. Moreover, OC was associated with higher odds of this outcome. Gender and OC were not considered effect modifiers in the association between ERI and HTN. Using the ERI model proved relevant because it addresses current aspects of workplace stressor and how they interrelate and are associated with HTN.

Results point to the need for further studies to continue discussions on this topic, exploring different approaches that can complement the ERI model, as well as other potential effect modifiers of the association studied, such as age and family responsibilities. They also contribute to the development of public health policies and preventive interventions aimed at cardiovascular health.

References

1. NCD Risk Factor Collaboration. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021;398(10304):957-80.
2. Zhou B, Perel P, Mensah GA, Ezzati M. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. Nat Rev Cardiol. 2021;18(11):785-802.
3. Barroso WKS, Rodrigues CIS, Bortolotto LA, Mota-Gomes MA, Brandão AA, Feitosa ADM, et al. Diretrizes Brasileiras de Hipertensão Arterial – 2020. Arq Bras Cardiol. 2021;116(3):516-658.
4. Nilson EAF, Andrade RCS, Brito DA, Oliveira ML. Custos atribuíveis a obesidade, hipertensão e diabetes no Sistema Único de Saúde, Brasil, 2018. Rev Panam Salud Pública. 2020;44:e32.
5. Eddy P, Wertheim EH, Kingsley M, Wright BJ. Associations between the effort-reward imbalance model of workplace stress and indices of cardiovascular health: A systematic review and meta-analysis. Neurosci Biobehav Rev. 2017;83:252-66.

6. Araújo TM, Siegrist J, Moreno AB, Fonseca MJM, Barreto SM, Chor D, et al. Effort-Reward Imbalance, Over-Commitment and Depressive Episodes at Work: Evidence from the ELSA-Brasil Cohort Study. Int J Environ Res Public Health. 2019;16(17):3025.
7. Gilbert-Ouimet M, Trudel X, Brisson C, Milot A, Vézina M. Adverse effects of psychosocial work factors on blood pressure: systematic review of studies on demand-control-support and effort-reward imbalance models. Scand J Work Environ Health. 2014;40(2):109-32.
8. Juvanhol LL, Melo ECP, Chor D, Fonseca MJM, Rotenberg L, Bastos LS, et al. Association between demand-control model components and blood pressure in the ELSA-Brasil study: exploring heterogeneity using quantile regression analyses. Scand J Work Environ Health. 2018;44(6):601-12.
9. Karasek Jr RA. Job demands, job decision latitude, and mental strain: implications for job redesign. Adm Sci Q.1979;24(2):285-308.
10. Siegrist J. Adverse health effects of high-effort/low-reward conditions. J Occup Health Psychol. 1996;1(1):27-41.
11. Souza Santos R, Härter Griep R, Mendes da Fonseca MJ, Chor D, Santos IS, Melo ECP. Combined use of job stress models and the incidence of glycemic alterations (prediabetes and diabetes): results from ELSA-Brasil study. Int J Environ Res Public Health. 2020;17(5):1539.
12. Griep RH, Rotenberg L, Landsbergis P, Vasconcellos-Silva PR. Combined use of job stress models and self-rated health in nursing. Rev Saúde Pública 2011;45(1):145-52.
13. Alves MGM, Chor D, Faerstein E, Werneck GL, Lopes CS. Estresse no trabalho e hipertensão arterial em mulheres no Estudo Pró-Saúde: Estudo Pró-Saúde (Pro-Health Study). Rev Saúde Pública. 2009;43(5):893-6.
14. Siegrist J, Starke D, Chandola T, Godin I, Marmot M, Niedhammer I, et al. The Measurement of effort-reward imbalance at work: European comparisons. Soc Sci Med. 2004;58(8):1483-99.
15. Siegrist J. Psychosoziale arbeitsbelastungen und erkrankungsrisiken: wissenschaftliche evidenz und praktische konsequenzen [Psychosocial stress at work and disease risks: Scientific evidence and implications for practice]. Internist (Berl). 2021;62(9):893-8.
16. Juvanhol LL, Melo ECP, Carvalho MS, Chor D, Mill JG, Griep RH. Job strain and casual blood pressure distribution: looking beyond the adjusted mean and taking gender, age, and use of antihypertensives into account. results from ELSA-Brasil. Int J Environ Res Public Health. 2017;14(4):451.
17. Muniz DD, Siqueira KS, Cornell CT, Fernandes-Silva MM, Muniz PT, Silvestre OM. Ideal cardiovascular health and job strain: a cross-sectional study from the Amazon Basin. Arq Bras Cardiol. 2019;112(3):260-8.
18. Pimenta AM and Assunção AÁ. Estresse no trabalho e hipertensão arterial em profissionais de enfermagem da rede municipal de saúde de Belo Horizonte, Minas Gerais, Brasil. Rev Bras Saúde Ocup. 2016;41:e6.
19. Nascimento TCC, Araújo MRM. Levantamento sistemático dos estudos desenvolvidos sobre precarização do trabalho no Brasil. Barbarói. 2021;1(60):259-85.
20. Aquino EML, Barreto SM, Bensenor IM, Carvalho MS, Chor D, Duncan BB, et al. Brazilian Longitudinal Study of Adult Health (ELSA-Brasil): objectives and design. Am J Epidemiol. 2012;175(4):315-24.
21. Chor D, Werneck GL, Faerstein E, et al. The Brazilian Version of the Effort-Reward Imbalance Questionnaire to Assess Job Stress. Cad Saúde Pública. 2008;24:219–24.
22. Niedhammer I, Tek M-L, Starke D, Siegrist J. Effort-reward imbalance model and self-reported health: cross-sectional and prospective findings from the GAZEL cohort. Soc Sci Med. 2004;58(8):1531-41.
23. Yong X, Gao X, Zhang Z, Ge H, Sun X, Ma X, et al. Associations of occupational stress with job burn-out, depression and hypertension in coal miners of Xinjiang, China: a cross-sectional study. BMJ Open. 2020;10(7):e036087.
24. Gamage AU, Seneviratne RDA. Perceived Job Stress and Presence of Hypertension Among Administrative Officers in Sri Lanka. Asia Pac J Public Health. 2016;28(1 Suppl):41S-52S.
25. Faruque MO, Framke E, Sørensen JK, Madsen IEH, Rugulies R, Vonk JM, et al. Psychosocial work factors and blood pressure among 63 800 employees from The Netherlands in the Lifelines Cohort Study. J Epidemiol Community Health. 2022;76(1):60-6.
26. Trudel X, Brisson C, Milot A, Masse B, Vézina M. Adverse psychosocial work factors, blood pressure and hypertension incidence: repeated exposure in a 5-year prospective cohort study. J Epidemiol Community Health. 2016;70(4):402-8.
27. Byrne CJ, Khurana S, Kumar A, Tai TC. Inflammatory Signaling in Hypertension: Regulation of Adrenal Catecholamine Biosynthesis. Front Endocrinol. 2018;9:343.
28. Skogen JC, Thørrisen MM, Bonsaksen T, Vahtera J, Sivertsen B, Aas RW. Effort-reward imbalance is associated with alcohol-related problems. WIRUS-screening study. Front Psychol. 2019;10:2079.
29. Chen SW, Peasey A, Stefler D, Malyutina S, Pajak A, Kubinova R, et al. Effort-reward imbalance at work, over-commitment personality and diet quality in Central and Eastern European populations. Br J Nutr. 2016;115(7):1254-64.

30. Griep RH, Nobre AA, Alves MGM, Fonseca MJM, Cardoso LO, Giatti L, et al. Job strain and unhealthy lifestyle: results from the baseline cohort study, Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). BMC Public Health. 2015;15:309.
31. Fonseca MJM, Juvanhol LL, Rotenberg L, Nobre AA, Griep RH, Alves MGM, et al. Using gamma and quantile regressions to explore the association between job strain and adiposity in the ELSA-Brasil Study: does gender matter? Int J Environ Res Public Health. 2017;14(11):1404.
32. Xu W, Yu H, Hang J, Gao W, Zhao Y, Guo L. The interaction effect of effort-reward imbalance and overcommitment on hypertension among Chinese Workers: findings from SHISO study. Am J Ind Med. 2013;56(12):1433-41.
33. Maina G, Bovenzi M, Palmas A, Prodi A, Filon FL. Job strain, effort-reward imbalance and ambulatory blood pressure: results of a cross-sectional study in call handler operators. Int Arch Occup Environ Health. 2011;84(4):383-91.
34. Yu SF, Zhou WH, Jiang KY, Gu GZ, Wang S. Job stress, gene polymorphism of beta2-AR, and prevalence of hypertension. Biomed Environ Sci. 2008;21(3):239-46.
35. Aboa-Éboulé C, Brisson C, Maunsell E, Bourbonnais R, Vézina M, Milot A, et al. Effort-reward imbalance at work and recurrent coronary heart disease events: a 4-year prospective study of post-myocardial infarction patients. Psychosom Med. 2011;73(6):436-47.
36. Peter R, Alfredsson L, Hammar N, Siegrist J, Theorell T, Westerholm P. High effort, low reward, and cardiovascular risk factors in employed Swedish men and women: baseline results from the WOLF Study. J Epidemiol Community Health. 1998;52(9):540-7.
37. Kivimäki M, Nyberg ST, Batty GD, Fransson EI, Heikkilä K, Alfredsson L, et al. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. Lancet. 2012;380(9852):1491-7.
38. Griep RH, Silva-Costa A, Chor D, Cardoso LO, Toivanen S, Fonseca MJMD, et al. Gender, work-family conflict, and weight gain: four-year follow-up of the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). Cad Saude Publica. 2022;38(4):EN066321.
39. Gilbert-Ouimet M, Brisson C, Vézina M, Milot A, Blanchette C. Repeated exposure to effort-reward imbalance, increased blood pressure, and hypertension incidence among white-collar workers: effort-reward imbalance and blood pressure. J Psychosom Res. 2012;72(1):26-32.
40. Jachens L, Houdmont J. Effort-reward imbalance and job strain: a composite indicator approach. Int J Environ Res Public Health. 2019;16(21):4169

Authors’ contributions:

Fontes RO, Juvanhol LL and Nobre AA conceived the study, analyzed and interpreted the data and drafted the manuscript. Fonseca MJM, Gonçalves LG, and Griep RH designed the study, collected data and critically reviewed the article. Patrão, A.L. interpreted the data and critically reviewed the article. All authors have read and approved the published final version and assume full responsibility for the study and the published content.

Data availability declaration

The dataset supporting the results of this study is available upon request to the corresponding author.

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