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Research paper

Occupational factors associated with major depressive disorder: A Brazilian population-based study

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ABSTRACT

Background: There have been very few studies exploring the occupational risk factors for major depressive disorder (MDD) in the working populations in Latin America. The aim of this study was to explore the associations between a large set of occupational factors and MDD in the Brazilian working population.

Methods: The study was based on the cross-sectional data from the Brazilian National Health Survey, 2013. 60,202 people were interviewed (response rate: 91.9%). Among them, 36,442 were working, 19,450 men and 16,992 women. MDD was measured using the diagnostic algorithm (DSM-IV criteria) of the PHQ-9. Occupational factors included job characteristics, working time factors, psychosocial work stressors and physico-chemical exposures. Logistic regression models were performed and adjusted for sociodemographic factors. All analyses were conducted using weighted and stratified data by gender.

Results: The following occupational factors were associated with a higher risk of MDD: working part time (≤20 h a week) and stress at work for both genders, workplace violence, intense physical activity, exposure to noise and chemicals among women, and prolonged exposure to sun among men. Associations of stress and violence at work with MDD were particularly strong.

Limitations: Cross-sectional study design, healthy worker effect and reporting bias may have impacted the results.

Conclusions: This study, one of the first studies among the Brazilian working population, showed that psychosocial work stressors were the strongest risk factors for MDD. Physico-chemical exposures deserve more attention in association with MDD. Prevention policies oriented toward the work environment may help to prevent depression at the workplace.

1. Introduction

Major depressive disorder (MDD) is one of the most common mental disorders, one of the leading causes of disability and identified as a crucial public health issue because of its high social and economic costs (Greenberg et al., 2015; Kleine-Budde et al., 2013; Stewart et al., 2003). MDD also has serious consequences at the workplace through absenteeism, presenteeism, turn-over and reduced performance and productivity (Wang et al., 2006; Stewart et al., 2003). The identification of risk factors, including occupational risk factors, for MDD is thus important to better understand the disease and implement prevention policies.

Work factors, mainly psychosocial work factors, have been found to play a major role in depressive symptoms or disorders as underlined within the last decade by several reviews (Madsen et al., 2017; Rugulies et al., 2017; Verkuil et al., 2015; Theorell et al., 2015; Siegrist, 2008; Bonde, 2008; Netterstrom et al., 2008; Stansfeld and Candy, 2006).

Meta-analyses have summarized the literature on the associations between psychosocial work stressors and depression or depressive symptoms, and have highlighted the role of Karasek's stressors (Karasek et al., 1998), i.e. low decision latitude, high psychological demands, low social support, and job strain (combination of high psychological demands and low decision latitude) (Madsen et al., 2017; Theorell et al., 2015; Stansfeld and Candy, 2006), job insecurity

Abbreviations: IBGE, Brazilian Institute of Geography and Statistics; SIPD, Integrated Household Survey System; PNS, Pesquisa Nacional de Saúde - Brazilian National Health Survey; MoH, Ministry of Health; CONEP, National Commission of Ethics in Research

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(Stansfeld and Candy, 2006), effort-reward imbalance (Rugulies et al., 2017; Siegrist, 2008; Stansfeld and Candy, 2006), and workplace violence or bullying (Theorell et al., 2015; Verkuil et al., 2015). However, as reported by other authors (Bonde, 2008; Netterstrom et al., 2008), most studies did not use diagnostic instruments to measure MDD but used symptom scales for the measurement of depressive symptoms and there is a need for more studies using diagnostic criteria. Furthermore, the literature has mainly focused on psychosocial work stressors, and other occupational exposures have been neglected and there is also a need for more studies on the associations between physical and chemical exposures at work and depression (Theorell et al., 2015).

In addition, most of the studies exploring the association of occupational factors with depression were performed in Europe, North America, Australia, Japan, etc. i.e. in the more economically developed countries (MEDCs), and the studies are missing for the rest of the world, in the less economically developed countries (LEDCs) or in emerging countries, including Latin America. Thus, it may be difficult to say whether the results obtained for the MEDCs can be valid for the LEDCs. There are indeed strong differences in the working populations between LEDCs and MEDCs, for example regarding economic activities, informal work, etc. There are also large differences in occupational health prevention policies between LEDCs and MEDCs (Dias et al., 2011). However, very little is known about the prevalence of exposure to occupational factors in LEDCs and even less about the associations with MDD. Consequently, our study provides information about the prevalence of various occupational exposures in Brazil, but also and above all, information about the associations between these occupational factors and MDD, something that has not been published before.

Our study has thus the objective to fill the gap in providing information on the associations between a large set of occupational factors and MDD measured using diagnostic criteria in Brazil, one of the largest countries in Latin America.

2. Methods

2.1. Study population

A cross-sectional study was carried out using the data from the Brazilian National Health Survey (Pesquisa Nacional de Saúde - PNS, 2013) set up by the Brazilian Institute of Geography and Statistics (IBGE) in partnership with the Ministry of Health (MoH). The PNS was approved by the National Commission of Ethics in Research (CONEP) in June 2013 (no. 328.159). All people who were included in the final sample agreed to participate in the study and signed the informed consent form.

The PNS survey is a national household survey. The target population of the PNS survey was made up of adult residents aged 18 years and over residing in private households throughout the country. The PNS sample is a subsample of the Master Sample of the Integrated Household Survey System (SIPD, IBGE), which is a group of units of areas selected for use by various studies (including PNS), these units being considered as primary sampling units (PSUs). The sample design of the PNS survey was a three-stage cluster sampling with 1) PSU selection by simple random sampling, 2) selection of permanent private households within each PSU selected by simple random sampling and 3) selection of a resident aged 18 or older within each household by simple random sampling. More information can be found elsewhere (Brazilian Institute of Geography and Statistics, 2014; Souza-Júnior et al., 2015).

The survey was divided into three parts. The first part consisted of two questionnaires about the characteristics of the household. The second part (household interview) was composed of 9 questionnaires, answered by the household representative who provided information about all the residents of the household. The third part (individual interview) was composed of 9 additional questionnaires, answered only by the resident selected within the household (Brazilian Institute of Geography and Statistics, 2014; Souza-Júnior et al., 2015).

The fieldwork was carried out from August 2013 to February 2014 with the help of personal digital assistance (PDA). The data collection was performed by trained interviewers, with the support of supervisors and coordinators. Training and didactic materials were developed in partnership with the MoH (Brazilian Institute of Geography and Statistics, 2014).

At the end of the fieldwork, 6,069 PSUs were selected, 81,167 households were visited, of which 69,994 were occupied, and 64,348 household interviews and 60,202 individual interviews with the resident selected in the household were performed, with a response rate of 91.9% (Brazilian Institute of Geography and Statistics, 2014).

Among the 60,202 people who were interviewed, 34,776 subjects worked during the reference week of the interview, making the sample of the workers included in the study (19,450 men and 16,992 women).

2.2. Major depressive disorder (MDD)

MDD was evaluated using a diagnostic instrument which was the PHQ-9. PHQ-9 is composed of nine items assessing signs and symptoms of depression within the last two weeks and provides a sum score between 0–27 points. PHQ-9 is recognized and validated as a diagnostic tool based on the criteria of the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) (Kroenke et al., 2001). MDD was measured using the PHQ-9 diagnostic algorithm. MDD cases are defined by people who endorsed ≥ 5 of the 9 symptoms as present "more than half the days" (the 9th item counts if endorsed "several days") and one of the first two symptoms (depressed mood or loss of interest) is endorsed (Kroenke et al., 2001).

2.3. Occupational factors

The occupational factors were studied using 15 items selected from the literature and divided into four groups: 1- *Main job characteristics*: work status (domestic worker, public or private employee, self-employed); occupation (coded according to the International Standard Classification of Occupations (ISCO)); economic activities (coded according to the International Standard Industrial Classification of all economic activities (ISIC)); and multiple job-holder. 2- *Working time factors*: night work with and without shift work (2 items providing 3 response categories: no exposure to night work, night work without shift work, and night work with shift work) and working hours (measured on a continuous basis and categorized using statutory working hours a week in the country). 3- *Psychosocial work stressors*: workplace violence (2 items related to location and perpetrator of work-related violence committed by known and unknown people at the workplace) and exposure to stress at work (1 item related to activities that lead to nervousness). 4- *Physical and chemical work exposures:* exposure to intense physical activity, chemical substances, radioactive materials, urban waste, biological materials, marble dust and noise, and long exposure to sun.

2.4. Covariates

The adjustment variables were divided into 4 groups: **1. socio-demographic factors:** age (in 10-year age groups, i.e. <30, 30–39, 40–49, 50 or more), ethnicity (white versus non-white), marital status (alone versus not alone), participation in associative activities (participation in cultural, political, sport associations, etc.), voluntary work and religious services. The three social factors were based on one item each and composed of six response categories (never, once a year, sometimes a year, 2 to 3 times a month, once a week, more than once a week) and were dichotomized at the median of the total sample. The inclusion of the social factors as covariates had the objective of providing proxies for social support and network, as these variables may play a role in mental health. **2. Health behaviours:** practice of physical

activity (binary item about exercise within the last three months); smoking (item about the current smoking status); and binge drinking within the last 30 days with different thresholds for men (5 or more doses on a single occasion) and women (4 or more doses on a single occasion). **3. Chronic diseases:** the variable was based on the presence of chronic diseases relying on a medical diagnosis: hypertension, diabetes, heart disease, bronchitis, arthritis and/or rheumatism, chronic obstructive pulmonary disease, column problems or renal insufficiency. The variable was categorized according to the number of diseases: 0, 1, 2, 3 or more. **4. Work accident** within the last 12 months.

2.5. Statistical analysis

All analyzes were performed using weighted data that took the sampling characteristics, non-response and calibration into account. The study sample was described for all variables for men and women. Differences in the distribution of the variables between genders were performed using the Rao–Scott Chi-square test.

Associations between occupational factors and MDD were explored using weighted logistic regression models. Several models were performed: unadjusted bivariate and multivariate models (model 1 including all occupational factors simultaneously), and multivariate models adjusted for sociodemographic factors (model 2 including all occupational factors simultaneously as well as sociodemographic factors).

Interaction tests were performed to examine the differences between genders in the associations between occupational factors and MDD. Gender-interaction terms were included one by one in model 2 using the total sample of men and women.

Three sensitivity analyses were performed, including adjustment for the following covariates: health behaviours, work accident and chronic diseases.

Three model fit tests were performed: the likelihood ratio test, the efficient score test, and the Wald test for testing the significance of the explanatory variables. All three tests were significant for both model 1 and 2 among men and women ($p < 0.0001$).

All statistical analyses were stratified by gender and carried out using SAS 9.4 software (SAS Institute Inc. Cary, NC).

3. Results

In our total study sample, the weighted prevalence of MDD was found to 2.82% (95% CI: 2.55–3.19). The difference between genders was significant; the prevalence was higher among women (4.43% (95% CI: 4.00–4.94)) than among men (1.62% (95% CI: 1.32–2.00)). Differences in the prevalence of occupational factors were observed between genders (Table 1). Men were more likely to be manual workers, to work in the agriculture, manufacturing and construction sectors and as private sector employees or self-employed workers, and were more likely to be exposed to long working hours (≥ 45 h/week), night and shift work, intense physical activity, chemical substances, noise, sun, and marble dust. Women were more likely to be clerks/service workers and to work in the service sector and as public sector employees or domestic workers and to be exposed to part time work, biological agents and urban waste. There was no difference between genders for psychosocial work factors (stress and violence at work). Differences between genders were also observed for covariates, men were more likely to be non-white, to have binge drinking and physical activity, to smoke and to have a work accident. Women were more likely to live alone, to attend religious services and have chronic diseases.

Table 2 shows the results of the bivariate analyses for the associations of occupational factors and covariates with MDD. The following occupational factors were found to be associated with a higher risk of MDD for both genders: self-employed workers, part time work, workplace violence, stress at work, intense physical activity, and prolonged

Table 1
Description of the study population according to occupational factors, covariates and major depression in 2013, PNS, Brazil.

	Women (N = 16,992)			Men (N = 19,450)			
	n	%	%w	n	%	%w	p-value
Job characteristics							
Work status							0.0000
Private employee	6577	38.71	42.22	9690	49.82	54.52	
Public employee	3369	19.83	18.13	2472	12.71	10.72	
Domestic worker	2498	14.70	13.94	286	1.47	0.92	
Self-employed	4548	26.76	25.71	7002	36.00	33.84	
Economic activity							0.0000
Agriculture	985	5.80	5.80	3241	16.66	14.70	
Manufacturing	1560	9.18	10.50	2535	13.03	15.90	
Construction	139	0.82	0.70	2838	14.59	14.60	
Services	14,308	84.20	83.00	10,836	55.72	54.80	
Occupation							0.0000
Managers/ professionals	3106	18.28	18.89	2544	13.08	13.00	
Technicians/ associate professionals	1365	8.03	8.02	1713	8.81	9.20	
Clerks/service workers	6310	37.14	37.65	4085	21.00	20.50	
Manual workers	6211	36.55	35.44	11,108	57.11	57.30	
Multiple job-holder	798	4.70	4.30	868	4.46	4.30	0.9911
Working time factors							
Working hours a week							0.0000
≤20	3076	18.10	17.59	1467	7.54	6.85	
21–44	10,701	62.98	62.62	11,837	60.86	60.04	
≥45	3215	18.92	19.79	6146	31.60	33.11	
Night/shift work							0.0000
No	15,078	88.73	88.78	15,945	81.98	82.34	
Night work	1704	10.03	10.15	3020	15.53	15.49	
Night work and shift work	210	1.24	1.07	485	2.49	2.17	
Psychosocial work stressors							
Stress at work	5556	32.70	34.30	6748	34.70	36.40	0.1200
Workplace violence	221	1.30	1.44	250	1.29	1.14	0.1663
Physico-chemical exposures							
Intense physical activity at work	3029	17.83	17.30	6231	32.04	33.62	0.0000
Chemical substances	2579	15.18	15.46	3734	19.20	20.31	0.0000
Noise	3791	22.31	23.01	7329	37.68	39.87	0.0000
Exposure to sun	2110	12.42	11.47	8378	43.07	41.25	0.0000
Radioactive materials	276	1.62	1.48	345	1.77	1.63	0.5032
Urban waste	1707	10.05	9.00	1251	6.43	6.20	0.0000
Biological materials	1134	6.67	7.08	658	3.38	3.12	0.0000
Marble dust	521	3.07	2.96	2459	12.64	13.79	0.0000
Sociodemographic factors							
Age							0.0000
<30 years	4183	24.62	27.25	4857	24.97	28.65	
30–39 years	5328	31.36	28.40	5473	28.15	26.44	
40–49 years	4036	23.75	23.60	4453	22.89	20.55	
≥50 years	3445	20.27	20.75	4667	23.99	24.36	
Ethnicity							0.0244
White	7065	41.58	49.45	7679	39.48	47.40	
No-white	9927	58.42	50.55	11,771	60.52	52.60	
Marital status							0.0000
Live in a couple	6205	36.52	41.80	8304	42.69	46.80	
Live alone	10,787	63.48	58.20	11,146	57.31	53.20	
Associative activities							0.1021
Up to once a year	3420	20.13	19.10	4233	21.76	20.25	
Never	13,572	79.87	80.90	15,217	78.24	79.75	
Religious services							0.0000
Sometimes/ month	9406	55.36	55.41	7559	38.86	39.85	

(*continued on next page*)

Table 1 (*continued*)

	Women (N = 16,992)			Men (N = 19,450)			
	n	%	%w	n	%	%w	*p*-value
Sometimes/year	7586	44.64	44.59	11,891	61.14	60.15	
Voluntary work							0.1097
Up to once a year	2352	13.84	14.87	2549	13.11	13.84	
Never	14,640	86.16	85.13	16,901	86.89	86.16	
Health-related variables							
Binge drinking	1619	9.53	8.90	4810	24.73	24.10	0.0000
Smoking							0.0000
No	12,957	76.25	76.40	12,121	62.32	63.00	
Yes	1873	11.03	10.73	3755	19.31	18.60	
Ex-smoker	2162	12.72	12.87	3574	18.37	18.40	
No physical activity	12,061	70.98	69.17	12,030	61.85	61.45	0.0000
Chronic diseases							0.0000
0	10,694	62.94	60.45	13,444	69.12	68.30	
1	4252	25.02	26.28	4448	22.87	23.00	
2	1428	8.40	9.17	1212	6.23	6.90	
3 or more	618	3.64	4.10	346	1.78	1.80	
Work accident	348	2.05	2.44	717	3.69	3.71	0.0003
Major depression (MDD)	846	5.00	4.43	312	1.60	1.62	0.0000

%: raw frequency.
%w: weighted frequency.
p-value: Rao–Scott $\chi 2$ test p-value for the comparison between genders.

exposure to the sun. Among women, an increased risk of MDD was observed for domestic workers, manual workers, and for the exposure to night work with shift work, chemical substances, noise, urban waste and marble dust. Among the sociodemographic covariates, older age was associated with MDD. Among the health related variables, smoking and no physical activity were associated with MDD among men and women, while binge drinking was found to be a significant risk factor among women only. The presence of chronic diseases increased the risk of MDD for both genders, while work accident was associated with MDD among women only.

Table 3 presents the results of multivariate analyses for the associations of occupational factors with MDD among women. The following occupational factors were found to be associated with a higher risk of MDD: working as self-employed workers, working part time ($\leq$ 20 hours a week), stress at work, workplace violence, intense physical activity, exposure to noise and chemicals substances. The results were similar before and after adjustment for sociodemographic factors. Adjustment for health-related variables in sensitivity analyses did not modify the results substantially. However, two factors became non-significant: part time work ($\leq$ 20 hours a week) and exposure to chemical substances.

Table 4 presents the results of the multivariate analyses for the associations of occupational factors with MDD among men. The following occupational factors were found to be associated with a higher risk of MDD: working 20 h/week or less, stress at work and exposure to sun. Working as a domestic worker (compared to private employee) and exposure to the marble dust were associated with a lower risk of MDD. The associations were similar before and after adjustment for sociodemographic factors. Adjustment for health-related variables in sensibility analyses did not change the results.

The study of interaction tests showed that the associations of work status, working hours, chemical substances, noise and marble dust with MDD were different between genders. The association between work status and MDD differed between men and women (interaction term significant at $p < 0.001$). The association between working 20 hours a week or less and MDD was stronger for men than for women (interaction term significant at $p < 0.05$). The associations of chemical substances and noise with MDD were found to be significant among women only (the two interaction terms were significant at $p < 0.05$). The significant protective effect of marble dust on MDD was observed for men only (interaction term significant at $p < 0.001$).

4. Discussion

4.1. Main results

The MDD prevalence was higher among women than among men and differences between genders were found for most occupational factors. There was however no difference between genders for psychosocial work factors (stress and violence at work). Two risk factors for MDD were found for both genders: part time work ($\leq$ 20 h/week) and exposure to stress at work. Furthermore, the magnitude of the association of part time work with MDD was stronger among men than among women. Gender-specific risk factors were, among women, working as self-employed workers, exposure to workplace violence, intense physical activity, noise and chemicals substances and among men, long exposure to sun. However, gender-interaction terms were not found to be significant for workplace violence, physical activity, and exposure to sun.

4.2. Comparison with the literature

This study provided the first estimates for the prevalence of MDD in the Brazilian working population. In 2013, the overall prevalence of MDD was found to be 2.82%; 4.43% among women and 1.62% among men. In Brazil, studies exploring major depression through diagnostic instrument in the working population are rare and comparison may be difficult. A study among primary health care workers in the city of Sao Paulo, Brazil (da Silva et al., 2015) found a prevalence of 16% of MDD using PHQ-9, but it may be difficult to compare a specific occupational group such as primary health care workers in the city of Sao Paulo, Brazil to the whole national Brazilian working population which was studied in our study. The prevalence of MDD and the difference in this prevalence between genders (women had a higher prevalence than men) found in our Brazilian study are consistent with other studies exploring the prevalence of MDD through a diagnostic instrument in working populations (Murcia et al., 2013; Stansfeld et al., 2012; Blackmore et al., 2007).

In our study, men were more likely to work in the agriculture, manufacturing and construction, as manual workers and to be exposed to long working hours, night/shift work, and physical and chemical factors, while women were more likely to work in the services, as clerks/service workers, to have part time work, and to be exposed to biological factors. These gender differences were consistent with the results provided by previous studies in other countries such as France (Niedhammer et al., 2015, 2008). We found that self-employed workers were at higher risk of MDD among both men and women. To our knowledge, this result was not reported in the literature before. There may be differences in working conditions between self-employed workers and employees. A literature review showed that self-employed workers were more likely to be exposed to long working hours and low social support (because of social isolation) than employees (Expertise collective Inserm, 2011). As this last factor may be a risk factor of depression and was not available in our study, it might contribute to explain the result observed for self-employed workers in the present study.

We found that the associations of stress at work and workplace violence with MDD were very strong in our study. Work stress was measured using one single item related to stressful work activities. Our results may be thus compared to studies exploring other measures of job stress such as job strain (Karasek et al., 1998). A number of reviews and meta-analyses have summarized the studies exploring the associations between job strain and depression or depressive symptoms (Bonde, 2008; Madsen et al., 2017; Netterstrom et al., 2008; Stansfeld, 2006; Theorell et al., 2015b). Nevertheless, only a small part of these studies used a diagnostic instrument to measure major depression. A recent

Table 2
Binary associations between occupational factors and covariates and major depression stratified by gender, 2013, PNS, Brazil.

	Women				Men			
	OR	95%CI		*p*-value	OR	95%CI		*p*-value
Job characteristics								
Work status (ref: private employee)				0.000				<0.0001
Public employee	0.733	0.514	1.044	0.085	1.516	0.757	3.038	0.241
Domestic worker	**1.521**	**1.067**	**2.167**	0.020	**0.021**	**0.005**	**0.091**	<0.0001
Self-employed	**1.529**	**1.167**	**2.003**	0.002	**1.840**	**1.179**	**2.873**	0.007
Economic activity (ref: manufacturing)				0.448				0.521
Agriculture	1.002	0.601	1.671	0.994	1.597	0.732	3.481	0.239
Construction	1.106	0.368	3.325	0.858	1.335	0.656	2.716	0.426
Services	0.806	0.581	1.117	0.195	1.601	0.828	3.093	0.162
Occupation (ref: managers/professionals)				0.000				0.737
Technicians/associate professionals	0.908	0.497	1.658	0.754	0.608	0.241	1.532	0.291
Clerks/service workers	1.332	0.922	1.926	0.127	0.822	0.381	1.773	0.617
Manual workers	**1.858**	**1.305**	**2.646**	0.001	0.865	0.426	1.755	0.688
Multiple job-holder	1.153	0.659	2.018	0.617	0.772	0.372	1.604	0.488
Working time factors								
Working hours a week (ref: 21–44)				0.027				0.002
≤20	**1.497**	**1.112**	**2.017**	0.008	**3.326**	**1.631**	**6.782**	0.001
≥45	1.049	0.770	1.428	0.763	1.494	0.962	2.320	0.074
Night/shift work (ref: no)				0.051				0.480
Night work	1.041	0.743	1.458	0.816	1.356	0.808	2.275	0.249
Night work and shift work	**2.825**	**1.226**	**6.508**	0.015	1.235	0.580	2.631	0.584
Psychosocial work stressors								
Stress at work	**2.642**	**2.096**	**3.330**	<0.0001	**2.953**	**1.928**	**4.522**	<0.0001
Workplace violence	**3.142**	**1.579**	**6.255**	0.001	**4.908**	**1.506**	**15.992**	0.008
Physico-chemical exposures								
Intense physical activity at work	**2.431**	**1.862**	**3.175**	<0.0001	**1.634**	**1.067**	**2.500**	0.024
Chemical substances	**2.269**	**1.695**	**3.036**	<0.0001	1.109	0.714	1.722	0.645
Noise	**1.878**	**1.461**	**2.414**	<0.0001	1.297	0.855	1.966	0.221
Exposure to sun	**1.920**	**1.426**	**2.585**	<0.0001	**1.876**	**1.226**	**2.872**	0.004
Radioactive materials	1.088	0.448	2.643	0.852	1.126	0.335	3.784	0.848
Urban waste	**2.144**	**1.584**	**2.904**	<0.0001	1.859	0.954	3.621	0.068
Biological materials	1.395	0.900	2.160	0.137	1.369	0.426	4.399	0.598
Marble dust	**2.641**	**1.563**	**4.462**	0.000	0.762	0.493	1.178	0.221
Sociodemographic factors								
Age (ref: <30)				0.146				<0.0001
30–39	1.317	0.970	1.788	0.078	1.346	0.780	2.323	0.286
40–49	**1.471**	**1.027**	**2.109**	0.035	1.181	0.666	2.094	0.568
≥50	1.142	0.794	1.641	0.474	**3.339**	**1.877**	**5.942**	<0.0001
Ethnicity (ref: no-white)	1.059	0.839	1.337	0.630	1.283	0.834	1.975	0.257
Marital status (ref: live in a couple)	1.003	0.783	1.286	0.979	0.840	0.556	1.271	0.410
Associative activities (ref: up to once a year)	0.950	0.709	1.273	0.732	1.125	0.683	1.853	0.643
Religious services (ref: sometimes/month)	0.898	0.710	1.138	0.374	0.716	0.470	1.089	0.118
Voluntary work (ref: up to once a year)	0.938	0.673	1.308	0.707	1.101	0.623	1.945	0.740
Health-related variables								
Binge drinking	**1.492**	**1.062**	**2.096**	0.021	1.282	0.831	1.978	0.260
Smoking (ref: no)				<0.0001				0.008
Ex-smoker	**1.883**	**1.388**	**2.555**	<0.0001	1.656	0.999	2.747	0.051
Yes	**2.029**	**1.453**	**2.833**	<0.0001	**2.185**	**1.314**	**3.635**	0.003
No physical activity	**1.468**	**1.141**	**1.888**	0.003	**3.075**	**2.024**	**4.672**	<0.0001
Chronic diseases (ref: 0)				<0.0001				<0.0001
1	**1.969**	**1.504**	**2.578**	<0.0001	**2.341**	**1.472**	**3.724**	0.000
2	**2.572**	**1.837**	**3.602**	<0.0001	**5.931**	**3.161**	**11.129**	<0.0001
3 or more	**8.677**	**5.719**	**13.164**	<0.0001	**15.468**	**7.172**	**33.356**	<0.0001
Work accident	**2.232**	**1.388**	**3.588**	0.001	1.932	0.767	4.868	0.163

Results from weighted logistic regression analysis

systematic review and meta-analysis (Madsen et al., 2017) including prospective studies using diagnostic instrument reported that job strain was a risk factor for clinical depression in both published (RR = 1.77; 95% CI: 1.47–2.13) and unpublished studies (RR = 1.27; 95% CI: 1.04–1.55). Our results are in line with the findings of this review and meta-analysis.

Workplace violence was a significant risk factor for MDD among women and was borderline significant among men ($p = 0.08$) in our study, and the strength of the association was as strong as the association of work stress. A systematic review and meta-analysis (Verkuil et al., 2015) was published on the association between workplace bullying and mental health outcomes including depression. Correlation coefficients were found to be significant between workplace bullying and depression among both cross-sectional studies ($r = 0.29$ 95% CI: 0.23–0.34) and prospective studies ($r = 0.36$ 95% CI: 0.17–0.56). Nevertheless, the studies based on diagnostic instruments were very rare. A study (Rugulies et al., 2012) showed that workplace bullying increased the risk of major depressive episode (using MDI-10 algorithm in accordance with the criteria of DSM-IV) among female eldercare workers. Another study (Gullander et al., 2014) reported significant odds ratio for newly onset depression (using MDI-10 and SCAN interview with Diagnostic Criteria for Research (ICD-10-DCR)) among participants reporting bullying occasionally and among those frequently bullied in two cohort mainly composed of women employed in the public sector. However, in another study (Hogh et al., 2016), various measures of bullying did not predict depression (using the same two measures as aforementioned by Gullander et al. (2014).

If we consider the studies performed in Latin America, the literature

Table 3
Associations between occupational factors and major depression adjusted for covariates in women, 2013, PNS, Brazil.

Women	Model 1 (N = 16,992)				Model 2 (N = 16,992)			
	OR	95%CI		p-value	OR	95%CI		p-value
Job characteristics								
Work status (ref: private employee)				<0.0001				<0.0001
Public employee	0.695	0.472	1.024	0.066	0.672	0.449	1.007	0.054
Domestic worker	1.488	0.994	2.226	0.053	1.462	0.982	2.175	0.061
Self-employed	**1.797**	**1.310**	**2.465**	0.000	**1.765**	**1.273**	**2.448**	0.001
Economic activity (ref: manufacturing)				0.627				0.647
Agriculture	0.688	0.374	1.266	0.229	0.701	0.378	1.300	0.260
Construction	1.145	0.366	3.578	0.816	1.200	0.386	3.726	0.753
Services	0.879	0.595	1.296	0.514	0.883	0.596	1.309	0.537
Occupation (ref: managers/professionals)				0.197				0.175
Technicians/associate professionals	0.853	0.462	1.576	0.612	0.859	0.468	1.577	0.624
Clerks/service workers	1.318	0.907	1.915	0.147	1.365	0.933	1.996	0.109
Manual workers	1.440	0.954	2.175	0.083	1.466	0.958	2.243	0.078
Multiple job-holder	0.996	0.587	1.690	0.989	0.990	0.585	1.676	0.970
Working time factors								
Working hours (ref: 21–44)				0.013				0.009
≤20	**1.421**	**1.045**	**1.934**	0.025	**1.444**	**1.060**	**1.967**	0.020
≥45	0.807	0.586	1.112	0.191	0.797	0.578	1.097	0.164
Night/shift work (ref: no)				0.128				0.137
Night work	0.934	0.652	1.338	0.708	0.937	0.655	1.341	0.723
Night work and shift work	2.464	0.955	6.357	0.062	2.456	0.944	6.392	0.066
Psychosocial work stressors								
Stress at work	**2.734**	**2.084**	**3.587**	<0.0001	**2.736**	**2.083**	**3.593**	<0.0001
Workplace violence	**2.591**	**1.325**	**5.065**	0.005	**2.625**	**1.350**	**5.108**	0.005
Physico-chemical exposures								
Intense physical activity at work	**1.671**	**1.246**	**2.241**	0.001	**1.657**	**1.235**	**2.223**	0.001
Chemical substances	**1.512**	**1.106**	**2.067**	0.010	**1.491**	**1.092**	**2.035**	0.012
Noise	**1.354**	**1.010**	**1.814**	0.043	**1.367**	**1.021**	**1.831**	0.036
Exposure to sun	1.413	0.975	2.048	0.068	1.412	0.978	2.040	0.066
Radioactive materials	0.604	0.246	1.484	0.271	0.626	0.254	1.542	0.308
Urban waste	1.247	0.861	1.805	0.243	1.249	0.860	1.815	0.243
Biological materials	1.285	0.770	2.145	0.337	1.279	0.762	2.145	0.351
Marble dust	1.469	0.826	2.614	0.191	1.467	0.821	2.621	0.195

Results from weighted logistic regression analysis
Model 1: all occupational factors simultaneously
Model 2: model 1 + sociodemographic factors

is sparse. For example, in a study among primary health care workers of the city of Sao Paulo, Brazil (da Silva et al., 2015), various measures of workplace violence were found to be associated with depressive symptoms and probable major depression.

In our study, no association was found between long working hours and MDD. A recent systematic review and meta-analysis (Watanabe et al., 2016) pointed out that the association between long working hours and depressive disorders clinically diagnosed or assessed by a structured interview was small and non-significant. A previous review (Bannai and Tamakoshi, 2014) suggested that working long hours was associated with depressive state (disorders or symptoms). As these two reviews were based on a small number of studies, it may be difficult to draw conclusions. Limitations, mentioned in the review by Watanabe et al. (2016), may impact the results and include the healthy worker effect, which may explain at least in part our results. In other words, healthy workers may be able and continue to work long hours and sick workers are more likely to work part time.

Night work (with and without shift work) was not associated with MDD in our fully-adjusted models, but a significant bivariate association was found among women. A review and meta-analysis (Lee et al., 2017) showed that night or shift work was associated with depressive disorders or symptoms.

A systematic review and meta-analysis (Theorell et al., 2015) on the associations between all types of occupational exposures and depressive symptoms underlined the lack of studies exploring physical and chemical exposures on this topic. Our study is thus an attempt to fill this gap. In our study, several occupational exposures such as exposure to noise, chemical substances and intense physical activities were associated with MDD among women, while prolonged exposure to sun was a significant risk factor among men. The literature is still scarce on the associations between chemical and physical exposures and MDD, especially when considering studies using diagnostic instrument. We thus enlarged our comparison to studies using depressive symptom scales as well. In a Korean survey using a sample from the general working population (Yoon et al., 2014), occupational noise was associated with depressive symptoms in both men and women. However, the literature is very seldom on the association between occupational noise and mental health, although the exposure to noise may be more severe at the workplace than in the general environment. The association between environmental noise and mental health was discussed in some rare reviews (Makopa Kenda et al., 2014), whose findings remained inconclusive. Occupational exposure to chemicals is a crucial public health issue, but the studies addressing the effects on mental disorders, and especially depression, are still rare. A literature review (Freire and Koifman, 2013) suggested that exposure to pesticides may be associated with depression but scientific evidence remained limited and inconclusive. A study (Gaum et al., 2014) reported an association between occupational exposure to polychlorinated biphenyls and depressive syndrome. We did not find any study exploring the association of prolonged exposure to sun or intense physical activity with depression. In our study, the association between exposure to marble dust and MDD was protective, which may be related to a healthy worker effect. Indeed, the exposure to marble dust may be a marker of very difficult working conditions in the marble industry, and only very healthy workers may be able to work and continue to work in this sector. Significant associations between exposure to silica and asbestos and depressive symptoms were found in a Chinese cohort of factory workers (Lin et al., 2014).

Table 4
Associations between occupational factors and major depression adjusted for covariates in men, 2013, PNS, Brazil.

Men	Model 1 (N = 19,450)				Model 2 (N = 19,450)			
	OR	95%CI		p-value	OR	95%CI		p-value
Job characteristics								
Work status (ref: private employee)				<0.0001				<0.0001
Public employee	1.233	0.581	2.613	0.585	1.205	0.572	2.539	0.624
Domestic worker	**0.017**	**0.003**	**0.087**	<0.0001	**0.013**	**0.002**	**0.069**	<0.0001
Self-employed	**1.660**	**1.027**	**2.684**	0.039	1.353	0.823	2.224	0.233
Economic activity (ref: manufacturing)				0.864				0.837
Agriculture	0.944	0.353	2.526	0.909	0.953	0.369	2.459	0.921
Construction	0.965	0.432	2.155	0.931	0.960	0.443	2.076	0.917
Services	1.185	0.569	2.466	0.650	1.049	0.407	2.708	0.621
Occupation (ref: managers/professionals)				0.830				0.766
Technicians/associate professionals	0.659	0.261	1.666	0.378	0.650	0.258	1.640	0.362
Clerks/service workers	0.850	0.379	1.902	0.692	0.774	0.344	1.743	0.536
Manual workers	0.773	0.379	1.576	0.478	0.713	0.361	1.410	0.331
Multiple job-holder	0.578	0.268	1.249	0.163	0.669	0.312	1.434	0.301
Working time factors								
Working hours (ref: 21–44)				0.013				0.009
≤20	**3.522**	**1.695**	**7.318**	0.001	**3.291**	**1.650**	**6.562**	0.001
≥45	1.243	0.792	1.952	0.345	1.276	0.810	2.012	0.293
Night/shift work				0.625				0.562
Night work	1.275	0.715	2.274	0.411	1.352	0.753	2.429	0.312
Night work and shift work	0.828	0.339	2.022	0.679	0.894	0.374	2.136	0.801
Psychosocial work stressors								
Stress at work	**3.199**	**2.073**	**4.936**	<0.0001	**3.357**	**2.189**	**5.148**	<0.0001
Workplace violence	3.071	0.805	11.718	0.101	3.299	0.864	12.594	0.081
Physico-chemical exposures								
Intense physical activity at work	1.637	0.974	2.753	0.063	1.640	0.982	2.738	0.059
Chemical substances	0.953	0.582	1.560	0.848	0.998	0.616	1.619	0.995
Noise	0.945	0.618	1.445	0.794	0.990	0.647	1.514	0.962
Exposure to sun	**1.723**	**1.080**	**2.750**	0.022	**1.654**	**1.062**	**2.578**	0.026
Radioactive materials	0.960	0.248	3.713	0.953	0.998	0.251	3.967	0.998
Urban waste	1.599	0.768	3.330	0.210	1.634	0.810	3.296	0.170
Biological materials	1.082	0.286	4.087	0.907	1.080	0.281	4.153	0.910
Marble dust	**0.581**	**0.354**	**0.954**	0.032	**0.592**	**0.368**	**0.953**	0.031

Results from weighted logistic regression analysis
Model 1: all occupational factors simultaneously
Model 2: model 1 + sociodemographic factors

4.3. Strengths and limitations

The strengths of the study deserve to be underlined. The study was based on a large sample size, and the sample was representative of the Brazilian working population, allowing us to provide the first results on the associations between occupational exposures and major depression in Brazil. The response rate to the survey was very satisfactory (92%) and as weights were used, the results can be extrapolated to the whole Brazilian working population. Furthermore, all the analyses were performed for men and women separately, which is a requirement in occupational epidemiology (Niedhammer et al., 2000). Indeed, strong differences were observed between genders for the prevalence of MDD, occupational factors and covariates, and differences were also found in the associations between occupational factors and MDD between genders, confirming the interest to perform gender-stratified analyses. The study covered a large number of occupational exposures, and especially physico-chemical exposures that are understudied in the topic of major depression. The study was also able to provide the relative importance of the occupational factors in multivariate models and the results suggested that psychosocial work factors may play a stronger role in major depression than the other occupational exposures. Indeed, the associations were highly significant ($p < 0.01$) for psychosocial work factors, confirming previous results, and the significance of the associations was lower for physico-chemical exposures ($p < 0.05$ in general) and these last associations need to be confirmed by other studies. The outcome (MDD) was measured through a validated diagnostic instrument based on the DSM-IV criteria. Additional analyses were performed using the sum score of the PHQ-9 and found similar results. Our analyses were adjusted for a number of well-known risk factors of depression and different sensibility analyses were also performed that confirmed our results. This set of strengths made possible an unprecedented picture about major depression in Brazilian workers.

However, several limitations should be mentioned. A limitation is related to the study design, and as the study has a cross-sectional design, the conclusions about statistical associations may not be causal and reverse causation cannot be ruled out. A healthy worker effect may be possible and lead to underestimate the associations observed and can explain some rare protective associations found in our study. Most of the occupational exposures were assessed using a very low number of items and without validated scales or instruments, leading to imprecision in the assessment of exposures. Some important occupational factors may be missing such as for example social support at work or job insecurity (Stansfeld and Candy, 2006). Furthermore, as both exposures and outcome were based on self-reports, there may be a reporting bias, that may lead to inflated associations because of common method variance. Some covariates may have been missing as they were unavailable in the study such as life events. Finally, the lack of information about informal work may be a limitation of our study. In Brazil, informal workers represent a high part of the working population, are more likely to be low-skilled and low-paid workers and are more likely to be exposed to poor working conditions. They have no access to legal occupational and social security benefits and legal labor rights. Furthermore, the most unacceptable work situations, such as slavery and child/adolescent labor, still persist in Brazil (Dias et al., 2011).

5. Conclusions

Our study showed that the prevalence of MDD among Brazilian

workers was similar to the prevalence of major depression found in other working populations at international level and that psychosocial work factors played a major role in the association with MDD. Our study also suggested that physico-chemical exposures may be associated with major depression, especially noise, chemicals substances and intense physical activity as well as prolonged exposure to sun, these associations being different for men and women. The results regarding physico-chemical exposures deserve to be confirmed by other studies, and this study underlined the need for more research on this topic. Interventions and prevention policies aiming at preventing all types of occupational exposures can contribute to improve mental health at work.

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Author Contributions

NSX Oenning, BNG Goulart, PK Zielgelmann and I Niedhammer conceived and designed the study; NSX Oenning and I Niedhammer performed the study, data analysis and interpretation of the results and wrote the paper.

Conflict of Interest

None.

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