



Factors associated with symptoms of poor mental health among women factory workers in China's supply chain

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Abstract

Objective Foreign direct investment (FDI) to China has motivated increased labor migration to export processing zones (EPZs). Work environments with high occupational stress, such as production line jobs typical in EPZs, have been associated with adverse mental health symptoms.

Methods A cross-sectional survey that examined occupational stress and symptoms of poor mental health was implemented among Chinese women factory workers in three electronic factories in the Tianjin Economic-Technological Development Area. Symptoms of mental health measured in the survey were hopelessness, depression, not feeling useful or needed, and trouble concentrating. Crude and adjusted prevalence odds ratios and their 95% confidence intervals were calculated with logistic regression.

Results Responses were collected from 696 women factory workers. Participants were aged 18–56 years (mean 28 ± 5.8), 66% of whom were married and 25% of whom were migrants. Nearly 50% of participants reported at least one symptom of poor mental health. After adjusting for covariates associated with each outcome in the bivariate analysis, high job strain was associated with hopelessness (OR 2.68, 95% CI 1.58, 4.56), not feeling useful (OR 2.05, 95% CI 1.22, 3.43), and feeling depressed (OR 1.78, 95% CI 1.16, 2.72).

Conclusion This study expands on the international body of research on the well-being of women working in the global supply chain and provides evidence on the associations between occupational stressors, migration, and social support on symptoms of poor mental health among women workers. Future research to better understand and improve psychological health and to prevent suicide among workers in China's factories is critical to improve the health of China's labor force.

Keywords Transients and migrants · Mental health · Occupational health · Women · China

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Introduction

Over the past 4 decades, China has experienced exponential economic growth (Garnaut et al. 2018). While this growth has provided improved economic gains for the country, the benefits for China's rural population are mixed (Garnaut et al. 2018). Foreign direct investment (FDI) to China has motivated increased rural-to-urban cyclic labor migration to export processing zones (EPZs) (Garnaut et al. 2018). Young rural migrant workers are considered a vulnerable group (Zhong et al. 2018; Li et al. 2020; Wang and Tang 2020), their healthcare needs are often underserved in their urban workplaces, and their rural communities are underequipped to address these needs, leaving women migrants with minimal recourse for healthcare access (Hou et al. 2015; Li 2017; Liu et al. 2020). This study, which was conducted in response to documented suicides in Foxconn factories in

China (Ngai and Chan 2012), remains relevant today (Che et al. 2020) and provides new insights into factors associated with symptoms of poor mental health among women working in factories in Tianjin China.

Many foreign electronic companies in China are located within EPZs and more than 10 million people are employed in the Chinese electronic industry, which accounts for 7.3% of the total Chinese labor supply (Han et al. 2008). Oftentimes, Chinese migrant workers in EPZs are employed in low-level positions in factories characterized by shift work, night work, and long hours of 9–15 h a day 6–7 days a week (Wang 2020; Leung 2021). More than half of Chinese migrant laborers are women and their occupational health has been historically neglected (Sun et al. 2012; Cirera and Lakshman 2017). While FDI has been found generally to improve health in low- and middle-income countries, there is a slight worsening of health when investment is in the secondary (i.e., manufacturing) sector (Burns et al. 2017). In a recent systematic review of the mental health of young workers, overtime, low autonomy, job insecurity, and low job control were factors associated with poor mental health (Law et al. 2020). Furthermore, concerns have arisen regarding the potential adverse mental health impacts of employment in EPZs. A Chinese study investigating 6711 employees of 13 enterprises found that front-line supply chain workers had the highest risk for depressive symptoms compared with other types of employees (Gu et al. 2015). Another study of migrants showed that 34% of rural-to-urban migrant workers in China exhibited common mental health problems (Zhong et al. 2018). Also, it has been reported that more than 75% of Chinese electronic employees had at least slight depressive symptoms, higher than observed in other occupational populations (Yang et al. 2018).

Due to global competition and rapid technological innovation (Kim et al. 2014), supply line workers face high job demands that may negatively affect their mental health (Zhang et al. 2017). The high burden of adverse mental health outcomes among factory workers may be due to their high workloads and the repetitive nature of their work (Zhang et al. 2017). Work environments with high occupational stress, such as in manufacturing jobs typical in EPZs, have been associated with adverse mental health outcomes including depression and anxiety (Wang et al. 2017; Zhang et al. 2017). Underlying this finding, a significant association between occupational stress, mental health, and poor quality of life has been documented (Laaksonen et al. 2006; Park et al. 2009; Mark and Smith 2012; Shanbhag and Joseph 2012; Zhu et al. 2012).

Migration itself has been shown to worsen mental health outcomes due to the disruption of social networks, social isolation, discrimination, and the stress of adapting to a new environment (Lin et al. 2011; Qiu et al. 2011; Mao and Zhao 2012; Huang et al. 2017). Additionally, women

workers are more likely to have mental health challenges, more frequently exposed to discrimination, and less likely to hold management positions compared with men (Bildt and Michélsen 2002; Mou et al. 2011; He and Wong 2013; Huang et al. 2017). However, there is a dearth of evidence in the public health literature assessing mental health outcomes, migrant status, and work characteristics among women workers in the global supply chain. This study examines factors associated with symptoms of poor mental health among women working in factories in Tianjin, China, and seeks to disentangle the independent roles of migration, working conditions, and social isolation as key risk factors for poor mental health.

Methods

A cross-sectional survey was conducted in three electronics factories in the Tianjin Economic Development Area, which employed predominantly women. Field work was completed in July and August, 2010 in collaboration with the Department of Occupational Health at the Tianjin Centers for Disease Control and Prevention. The study was approved by the University of Michigan Institutional Review Board and the Tianjin Centers for Disease Control and Prevention. The methods of this survey are described in more detail elsewhere (Sznajder et al. 2014). In brief, a total of 744 women workers were approached during work breaks. Women were included in the survey if they were working at the factory, could read and write in Chinese, and were not cognitively impaired. Workers who agreed provided written consent and completed a self-administered structured questionnaire.

The survey obtained information on demographic characteristics, job characteristics, and mental health symptoms. Demographic variables included age (continuous), level of education (more or less than high school), and income level (more or less than 2001 RMB). Women were asked “In the last 12 months, have you become pregnant” with the possible response options of yes and no. Migrant status was determined by asking if the respondent held a local resident card (yes or no). Social support was estimated as over ten friends compared with ten friends or less based on the question “How many friends do you have in Tianjin now” with possible responses as 0, 1–10, 11–20, and more than 20.

Participants were asked about the average number of hours worked each day in the last month and this variable was dichotomized at the mean of 10 h. Assessment of occupational stressors included measures of job type (laborer or office), overtime in the last year (yes or no), and night work in the last year (yes or no). Perceived job insecurity was measured with the question “Sometimes people permanently lose jobs they would like to keep. How likely is it that during the next couple of years you

will lose your present job with your employer?” and the responses were dichotomized as strongly agree and agree compared with strongly disagree and disagree. Job strain was assessed by a Chinese version of the Job Content Questionnaire (JCQ) (Karasek et al. 1998; Li et al. 2004). The composite score for the JCQ was computed according to Karasek’s job strain equation; high psychological demands low decision latitude. All questions on the JCQ had the response options of strongly disagree (1), disagree (2), agree (3), and strongly agree (4). The psychological demands’ variable (Cronbach’s Alpha = 0.45) was defined as the score on the following two questions “My job requires me to work very fast”, “My job requires me to work very hard” multiplied by three and added with the sum of the scores of the following questions, “I am not asked to do an excessive amount of work”, “I have enough time to get the job done”, and “I am free from conflicting demands that others make” subtracted by 15 and multiplied by two. Decision latitude was determined by the summation of decision authority and skill discretion. Decision authority (Cronbach’s Alpha = 0.41) was calculated as the sum of the following three questions “My job allows me to make a lot of decisions on my own”, “I have a lot of say about what happens on my job”, and the reverse coded variable: “On my job, I have very little freedom to decide how I do my work” multiplied by four. Skill discretion (Cronbach’s Alpha = 0.65) was calculated as the summation of the responses for the following questions, “My job requires that I learn new things”, “My job requires me to be creative”, “My job requires a high level of skill”, “I get to do a variety of different things on my job”, “I have an opportunity to develop my own special abilities,” and the reverse coded variable, “My job involves a lot of repetitive work”. Study participants who fell above the sample median on job demands and below the median on decision latitude were defined as having high job strain (Karasek et al. 1998). Missing items used to construct the composite job strain score were imputed by substituting the mean for each variable when only one or two questions had missing values for that participant. A composite job strain score was coded as missing when more than two items had missing values. The respondents’ view of their own health was examined by a self-reported rating of fair or poor compared to excellent, very good, or good. Four questions drawn from the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977) and the Zung Depression Scale (Zung 1986) were used to assess self-reported symptoms of poor mental health: “I feel hopeful about the future”; “I feel that I am useful and needed”; “I feel depressed”; and “I have trouble keeping my mind on what I am doing”. Potential responses, “strongly disagree, disagree, agree, and strongly agree”,

were dichotomized for analysis as agree and disagree, with the negative response coded as one.

Of the 744 participants, 24 women were missing information on age and 24 women who did not complete questions on mental health symptoms were excluded, leaving 696 women eligible for this analysis. The distribution for demographic, work, and adverse mental health responses were calculated. Bivariate and multivariable logistic regression models were built to examine associations between demographic and occupational characteristics and each mental health symptom. Crude and adjusted prevalence odds ratios and their 95% confidence intervals were calculated. Independent variables associated (p value < 0.05) with each outcome variable in the bivariate analysis were included in the multivariable logistic regression models. The significance level in the bivariate analysis was confirmed by a t test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables at a p value < 0.05. If the prevalence of the outcome was more than 10%, the corrected risk ratio was calculated using the calculator based on the article by Zhang et al. (ClinCalc.com; Zhang and Yu 1998). Analyses were conducted in SAS 9.4.

Results

The 696 participants were between 18 and 56 years of age (mean 28 ± 5.8), 25% were migrants, 67% had less than a high school education, 15% lived in a dormitory, 8% were pregnant, 72% had an income of less than 2001 yuan (~300USD in 2010), and 67% were laborers. Among the participants, 24% reported high job strain, 69% reported low job security, 40% reported working more than 10 h on average each day in the last month, 46% reported working at night, and 30% reported working overtime. About 36% of women in the study reported having more than ten friends. In regards to mental health symptoms, 17% reported being hopeful, 21% felt that they were not useful, 23% reported feeling depressed, and 28% reported trouble focusing. In fact, 50% of participants reported at least one symptom of poor mental health (Table 1).

In a bivariate analysis, migrants were more likely to be younger, never married, have lower education, live in a dormitory at work, earn less than 2001 RMB (about \$300 USD) per month, have fewer friends, and work as a factory laborer as compared with Tianjin residents. However, Tianjin residents were more likely to report their own health was fair or poor. Frequency of reporting each mental health symptom did not differ between migrants and residents, production or office workers, high or low income, nor whether or not the participants lived in a dormitory setting. Furthermore, there was no difference in the presence of job strain or job security between migrants and residents.

Table 1 Demographic, working conditions, social support, and mental health characteristics of the study population

Characteristics of the study population	Study population (n=696)
Demographic	
Never married	238 (34.4%)
Education high school or lower	464 (67.4%)
Lives in dormitory at work	107 (15.4%)
Income less than 2001 yuan	493 (72.1%)
Poor self-reported health	170 (24.9%)
Pregnant	56 (8.0%)
Working conditions	
Factory laborer	445 (67.1%)
Migrant	167 (24.8%)
High job strain	163 (23.6%)
Low job security	340 (69.4%)
Worked more than 10 h a day on average in the last month	278 (39.9%)
Working at night in the past year	307 (45.6%)
Worked overtime in the past year	201 (29.7%)
Social support	
Have less than 11 friends	244 (35.8%)
Mental health	
Feeling hopeless	114 (16.7%)
Not feeling useful	148 (21.4%)
Feeling depressed	158 (22.9%)
Trouble focusing	189 (27.5%)
At least one mental health symptom	351 (50.4%)

The frequencies of reporting feeling depressed, hopeless, not feeling useful, trouble focusing, and reporting at least one of these mental health symptoms as well as crude and adjusted associations with participant characteristics and working conditions are presented in Tables 2–6. Feeling depressed (Table 2) was associated with working at night, working overtime, having few friends, and poor self-reported health in the bivariate analysis. In the multiple regression model, high job strain (RR 1.11, 95% CI 1.03, 1.17), working overtime (RR 1.09, 95% CI 1.00, 1.16), and poor self-reported health (RR 1.14, 95% CI 1.07, 1.19) remained associated with reporting feeling depressed. For feeling hopeless (Table 3), high job strain, low job security, working more than 10 h a day on average, working at night, and reporting poor health were significantly associated in the bivariate models. In the multiple regression model, high job strain (RR 1.12, 95% CI 1.07, 1.15) and working at night (RR 1.0, 95% CI 1.01, 1.13) remained significantly associated with hopelessness. When examining not feeling useful (Table 4), older age, higher education, high job strain, low job security, working at night, having few friends, and poor self-reported health were associated with not feeling useful.

In the multiple regression model, high job strain (RR 1.12, 95% CI 1.04, 1.19), low job security (RR 1.16, 95% CI 1.08, 1.23), having few friends (RR 1.11, 95% CI 1.03, 1.18), and poor self-reported health (RR 1.12, 95% CI 1.05, 1.19) remained independently associated with not feeling useful. When examining factors associated with trouble focusing (Table 5), in the bivariate model, having few friends was the only significant association found (RR 1.09, 95% CI 1.01, 1.17). In the final bivariate analysis, the factors significantly associated with at least one symptom of poor mental health where high job strain, low job security, few friends, and poor self-reported health were associated in the bivariate analysis (Table 6). After adjustment, having few friends (RR 1.34, 95% CI 1.16, 1.51) and poor self-reported health remained independently associated (RR 1.27, 95% CI 1.06, 1.46) with having at least one mental health symptom.

Discussion

This study advances scientific understanding of the mental health of women working in factories in China. Half of the women working in factories in the Tianjin Economic Development Area population reported at least one mental health concern, including feeling depressed, feeling hopeless, not feeling useful, or trouble focusing. Adverse working conditions, including job strain, low job security, working at night, and working overtime, were independently associated with increased risk of self-reporting a mental health concern. Self-reporting of having few friendships was also associated with increased risk for reporting mental health symptoms. The findings in this study suggest that the work itself along with social support is associated with negative mental health symptoms.

Previous research has found that the job strain of front-line employees in the electronic manufacturing industry is significantly higher than the average level of all industries in China (Zhang et al. 2016) and research has highlighted that working conditions such as strenuous job demands and perceived job insecurity are associated with unhealthy mental states (Burgard et al. 2009; Meltzer et al. 2010; Kim and von Dem Knesebeck 2016; Cho et al. 2019) with conditions exacerbated within the electronic industry (Shigemi et al. 2000; Chen et al. 2011; Lee et al. 2015). In China, factory workers are vulnerable to symptoms of poor mental health and are often exposed to unfavorable psychosocial work environments, including perceived job insecurity, low levels of job control, and high levels of job demands (Sznajder et al. 2014; Ji et al. 2016; Huang et al. 2017). The COVID-19 pandemic has exacerbated these pre-existing negative working conditions and elevated the vulnerability of women working in the global supply chain through job loss, resulting in reduced income and increased food

Table 2 Crude and adjusted associations of demographic, working conditions, and social support with depression

	Feeling depressed (n = 158 22.9%)	Not feeling depressed (n = 531 77.1%)	OR (CI)	aOR (CI) ⁺	RR (CI) [^]
Age (mean, SD)	27.5 (±4.9)	28.1 (±6.0)	0.98 (0.95, 1.01)	–	–
Never married	59 (25.0%)	177 (75.0%)	1.19 (0.82, 1.72)	–	–
Education high school or lower	113 (24.6%)	347 (75.4%)	1.31 (0.89, 1.94)	–	–
Lives in dormitory at work	27 (25.9%)	77 (74.0%)	1.22 (0.75, 1.96)	–	–
Income less than 2001 yuan	116 (23.8%)	371 (76.2%)	1.17 (0.78, 1.76)	–	–
Pregnant	17 (10.8%)	39 (7.3%)	1.52 (0.84, 2.77)	–	–
Migrant	30 (18.1%)	136 (81.9%)	0.67 (0.43, 1.05)	–	–
Factory laborer	102 (23.1%)	339 (76.9%)	0.97 (0.66, 1.42)	–	–
High job strain	54 (33.8%)	106 (66.3%)	2.10 (1.42, 3.11)*	1.78 (1.16, 2.72)	1.11 (1.03, 1.17)
Low job security	99 (29.3%)	239 (70.7%)	1.51 (0.96, 2.39)	–	–
Working more than 10 h a day on average in the last month	70 (25.3%)	207 (74.7%)	1.25 (0.87, 1.78)	–	–
Working at night in the past year	81 (26.6%)	224 (73.4%)	1.49, 1.03, 2.14)*	1.13 (0.75, 1.71)	1.01 (0.93, 1.11)
Worked overtime in the past year	62 (31.2%)	137 (68.9%)	1.83 (1.26, 2.66)*	1.56 (1.01, 2.42)	1.09 (1.00, 1.16)
Less than 11 friends	60 (24.8%)	182 (75.2%)	1.17 (0.81, 1.69)	–	–
Poor self-reported health	57 (33.7%)	112 (66.3%)	2.18 (1.48, 3.21)*	2.12 (1.41, 3.17)	1.14 (1.07, 1.19)

*Significant *p* value < 0.05 calculated by a *t* test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables

⁺Variables significant at alpha < 0.05 in the bivariate analyses were included in the adjusted model

–Variable not included in the model

[^]Corrected risk ratio (Zhang and Yu 1998)

Table 3 Crude and adjusted associations of demographic, working conditions, and social support with hopelessness

	Feeling hopeless (n = 114 16.7%)	Feeling hopeful (n = 570 83.3%)	OR (CI)	aOR (CI) ⁺	RR (CI) [^]
Age (mean, SD)	27.5 (±4.9)	28.0 (±5.9)	0.99 (0.95, 1.02)	–	–
Never married	40 (16.9%)	196 (83.1%)	1.04 (0.68, 2.58)	–	–
Education high school or lower	84 (18.5%)	370 (81.5%)	1.51 (0.96, 2.39)	–	–
Lives in dormitory at work	17 (16.4%)	87 (83.7%)	0.97 (0.55, 1.71)	–	–
Income less than 2001 yuan	83 (17.2%)	401 (82.9%)	1.18 (0.74, 1.89)	–	–
Pregnant	7 (4.9%)	41 (7.2%)	0.75 (0.33, 1.69)	–	–
Migrant	25 (15.1%)	140 (84.9%)	0.88 (0.54, 1.43)	–	–
Factory laborer	73 (16.8%)	361 (83.2%)	0.95 (0.62, 1.47)	–	–
High job strain	50 (31.3%)	110 (68.8%)	3.22 (2.11, 4.93)*	2.68 (1.58, 4.56)	1.12 (1.07, 1.15)
Low job security	67 (20.1%)	267 (79.9%)	2.04 (1.14, 3.66)*	1.51 (0.81, 2.84)	1.06 (0.96, 1.12)
Working more than 10 h a day on average in the last month	58 (21.3%)	214 (78.7%)	1.72 (1.15, 2.58)*	1.25 (0.71, 2.19)	1.04 (0.94, 1.10)
Working at night in the past year	64 (21.1%)	239 (78.9%)	1.92 (1.26, 2.92)*	1.91 (1.09, 3.36)	1.09 (1.01, 1.13)
Worked overtime in the past year	37 (18.6%)	162 (81.4%)	1.19 (0.78, 1.85)	–	–
Less than 11 friends	43 (18.1%)	195 (81.9%)	1.20 (0.79, 1.83)	–	–
Poor self-reported health	42 (25.3%)	124 (74.7%)	2.14 (1.39, 3.29)*	1.69 (0.99, 2.89)	1.07 (0.99, 1.12)

*Significant *p* value < 0.05 calculated by a *t* test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables

⁺Variables significant at alpha < 0.05 in the bivariate analyses were included in the adjusted model

–Variable not included in the model

[^]Corrected risk ratio (Zhang and Yu 1998)

Table 4 Crude and adjusted associations of demographic, working conditions, and social support with not feeling useful

	Not feeling useful (<i>n</i> = 128 21.4%)	Feeling useful (<i>n</i> = 543 78.6%)	OR (CI)	aOR (CI) ⁺	RR (CI) [^]
Age (mean, SD)	27.1 (± 4.9)	28.2 (± 5.9)	0.96 (0.93, 0.99)*	0.99 (0.95, 1.04)	0.99 (0.99, 1.01)
Never married	57 (24.3%)	178 (75.7%)	1.27 (0.87, 1.85)	–	–
Education high school or lower	109 (23.7%)	351 (76.3%)	1.51 (1.00, 2.28)*	1.02 (0.58, 1.81)	1.00 (0.87, 1.11)
Lives in dormitory at work	26 (25.0%)	78 (75.0%)	1.27 (0.78, 2.07)	–	–
Income less than 2001 yuan	112 (22.9%)	377 (77.1%)	1.36 (0.89, 2.09)	–	–
Pregnant	12 (8.5%)	44 (7.7%)	1.00 (0.51, 1.95)	–	–
Migrant	37 (22.4%)	128 (77.6%)	1.01 (0.72, 1.68)	–	–
Factory laborer	104 (23.6%)	337 (76.4%)	1.51 (0.99, 2.29)	–	–
High job strain	58 (36.0%)	103 (63.9%)	2.75 (1.86, 4.08)*	2.05 (1.22, 3.43)	1.12 (1.04, 1.19)
Low job security	90 (26.6%)	248 (73.4%)	3.02 (1.70, 5.34)*	2.72 (1.43, 5.17)	1.16 (1.08, 1.23)
Working more than 10 h a day on average in the last month	68 (24.6%)	209 (75.5%)	1.36 (0.94, 1.96)	–	–
Working at night in the past year	78 (25.5%)	228 (74.5%)	1.63 (1.12, 2.37)*	1.42 (0.85, 2.36)	1.07 (0.96, 1.15)
Worked overtime in the past year	48 (24.1%)	151 (75.9%)	1.26 (0.85, 1.86)	–	–
Less than 11 friends	62 (25.6%)	180 (74.4%)	1.51 (1.03, 2.19)*	1.82 (1.13, 2.95)	1.11 (1.03, 1.18)
Poor self-reported health	56 (33.1%)	113 (66.9%)	2.40 (1.62, 3.57)*	2.04 (1.24, 3.37)	1.12 (1.05, 1.19)

*Significant *p* value < 0.05 calculated by a *t* test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables

⁺Variables significant at alpha < 0.05 in the bivariate analyses were included in the adjusted model

–Variable not included in the model

[^]Corrected risk ratio (Zhang and Yu 1998)

Table 5 Crude and adjusted associations of demographic, working conditions, and social support with trouble focusing

	Trouble focusing (<i>n</i> = 189 27.5%)	No trouble focusing (<i>n</i> = 498 72.5%)	OR (CI)	aOR (CI) ⁺	RR (CI) [^]
Age (mean, SD)	28.3 (± 5.8)	27.8 (± 5.7)	1.02 (0.99, 1.05)	–	–
Never married	66 (28.1%)	169 (71.9%)	1.05 (0.74, 1.49)	–	–
Education high school or lower	127 (27.8%)	330 (72.2%)	0.99 (0.69, 1.42)	–	–
Lives in dormitory at work	27 (25.7%)	78 (74.3%)	0.89 (0.56, 1.44)	–	–
Income less than 2001 yuan	132 (27.2%)	354 (72.8%)	0.89 (0.61, 1.28)	–	–
Pregnant	13 (6.9%)	41 (8.2%)	0.82 (0.43, 1.57)	–	–
Migrant	40 (24.4%)	124 (75.6%)	0.82 (0.55, 1.24)	–	–
Factory laborer	114 (25.9%)	326 (74.1%)	0.76 (0.53, 1.08)	–	–
High job strain	44 (26.9%)	119 (73.0%)	0.98 (0.66, 1.46)	–	–
Low job security	99 (29.6%)	236 (70.5%)	0.86 (0.56, 1.30)	–	–
Working more than 10 h a day on average in the last month	77 (27.8%)	200 (72.2%)	1.02 (0.73, 1.44)	–	–
Working at night in the past year	84 (27.6%)	220 (72.4%)	0.98 (0.69, 1.38)	–	–
Worked overtime in the past year	64 (31.8%)	137 (68.2%)	1.34 (0.93, 1.92)	–	–
Less than 11 friends	79 (32.6%)	163 (67.4%)	1.49 (1.05, 2.10)*	1.49 (1.05, 2.10)	1.09 (1.01, 1.17)
Poor self-reported health	51 (30.5%)	116 (66.5%)	1.19 (0.82, 1.76)	–	–

*Significant *p* value < 0.05 calculated by a *t* test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables

⁺Variables significant at alpha < 0.05 in the bivariate analyses were included in the adjusted model

–Variable not included in the model

[^]Corrected risk ratio (Zhang and Yu 1998)

Table 6 Crude and adjusted associations of demographic, working conditions, and social support with at least one mental health symptom

	At least one mental health symptom (<i>n</i> = 351 50.0%)	No mental health symptom (<i>n</i> = 345 50.0%)	OR (CI)	aOR (CI) ⁺	RR (CI) [^]
Age (mean, SD)	27.8 (±5.4)	28.1 (±6.2)	0.99 (0.97, 1.02)	–	–
Never married	127 (53.4)	111 (46.6%)	1.20 (0.88, 1.64)	–	–
Education high school or lower	242 (52.2%)	222 (47.8%)	1.19 (0.87, 1.64)	–	–
Lives in dormitory at work	52 (48.6%)	52 (51.4%)	0.92 (0.61, 1.39)	–	–
Income less than 2001 yuan	249 (50.5%)	244 (49.5%)	0.99 (0.71, 1.38)	–	–
Pregnant	32 (9.1%)	24 (6.9%)	1.34 (0.77, 2.33)	–	–
Migrant	77 (46.1%)	90 (53.9%)	0.83 (0.58, 1.17)	–	–
Factory laborer	223 (50.1%)	222 (49.9%)	0.93 (0.68, 1.29)	–	–
High job strain	102 (62.6%)	61 (37.4%)	1.93 (1.34, 2.76)*	1.57 (0.99, 2.49)	1.22 (0.99, 1.43)
Low job security	194 (57.1%)	146 (42.9%)	1.65 (1.12, 2.42)*	1.34 (0.88, 2.03)	1.15 (0.94, 1.34)
Working more than 10 h a day on average in the last month	150 (54.0%)	128 (46.0%)	1.27 (0.93, 1.72)	–	–
Working at night in the past year	165 (53.8%)	142 (46.2%)	1.29 (0.95, 1.75)	–	–
Worked overtime in the past year	114 (56.7%)	87 (43.3%)	1.42 (1.02, 1.98)*	1.31 (0.86, 2.00)	1.13 (0.93, 1.33)
Less than 11 friends	139 (56.9%)	105 (43.0%)	1.53 (1.12, 2.10)*	2.05 (1.37, 3.06)	1.34 (1.16, 1.51)
Poor self-reported health	107 (62.9%)	63 (37.1%)	1.99 (1.39, 2.85)*	1.72 (1.12, 2.68)	1.27 (1.06, 1.46)

*Significant *p* value < 0.05 calculated by a *t* test for continuous variables or a Mantel–Haenszel Chi-square for dichotomous variables

⁺Variables significant at alpha < 0.05 in the bivariate analyses were included in the adjusted model

–Variable not included in the model

[^]Corrected risk ratio (Zhang and Yu 1998)

insecurity, concerns related to the health of themselves and their families, high levels of anxiety, and increased gender-based violence (Shields and Guevara 2020).

Results from this study found that high job strain was associated with symptoms of poor mental health including not feeling useful, feeling hopeless, and feeling depressed; perceived job insecurity was associated with not feeling useful; working overtime was associated with depression; and night work was associated with feeling hopeless. These findings are supported by studies which have found that feeling useful is an important component of job satisfaction and can modify associations between job security and depression (Takaki et al. 2010; Kumari et al. 2014). Research has also shown that when people are under high stress and have high hope, they have a problem-focused coping style; whereas those with low hope have an emotion–expression coping style. It is possible that people who work in jobs characterized by high demands and low control have fewer opportunities to problem-solve, thereby reducing capacity for hope or positive mental well-being among those workers (Steffen and Smith 2013). Night work has been shown to be associated with poor mental health in some studies (Sancini et al. 2012; Angerer et al. 2017; Sato et al. 2020). It has been hypothesized that night work interrupts the circadian rhythm, thereby disturbing natural sleep cycles and causing fatigue which would lead to poorer mental health. Occupation type or job satisfaction may modify the association

between night work and poor mental health. A systematic review found that the association between poor mental health and night work was more often found in fields outside of healthcare (Angerer et al. 2017). Working overtime has been found in the previous research to be associated with depression (Kleppa et al. 2008; Virtanen et al. 2012). This association is thought to be related to the reduced opportunity for recovery time outside of work, reduced sleep, and increased negative coping behaviors (Bannai and Tamakoshi 2014; Tsuno et al. 2019). In addition to overtime, the working hours of participants in this study were long, averaging 10 h per day, which may have increased their risk for isolation and reduced their opportunities to release job stress.

Having low social support measured as ten friends or less was associated with not feeling useful and having trouble focusing. The electronic manufacturing production lines are highly repetitive and require strict discipline. This prohibits communication between workers, and can increase social isolation even during working hours and may reduce opportunities to form friendships. It is unclear why hope was not associated with social support, but it may be due to the fact that hope is future oriented (Barnett 2014; Ginevra et al. 2016). Furthermore, research has found that recovery experiences can mitigate the association between burnout and low life satisfaction (Song et al. 2021). Having more friends may allow for more recovery experiences to help protect workers from the negative effects of work stress on

mental health. Bromet et al. reported that high job demands combined with a lack of social support at work increase the risk for depression and anxiety (Bromet et al. 1988). Moreover, workers often experience social isolation due to conflicting demands between family and work (Zhang et al. 2017). These demands have likely exacerbated and social connections lessened during the COVID-19 pandemic (Srivastava et al. 2021; Tang and Li 2021). Migrants who are in a new location with low support from close relatives and friends may have more difficulty coping with stress (Li and Rose 2017). However, this study did not find an independent association between migrant status and any of our measured mental health concerns, which suggests that migration is not as critical a factor as poor working conditions and social support.

Finally, poor self-reported health was associated with not feeling useful, depression, and having at least one mental health concern. This finding could be due to participant's having an overall negative view of their health, but also could be associated with poor participant mental and/or physical health. If participants report poor overall perception of their own health, they may be less likely to be motivated to receive support to improve their mental health. This finding could support overall employee wellness programs within factories.

Hopelessness, feeling not needed or useful, and depression have all been correlated with suicide (Beck et al. 2006; Zhang and Li 2013; Whitlock et al. 2014; Xu et al. 2015; Alessi et al. 2019). Research has shown feeling needed or useful is associated with reduced suicide and improved healing following a suicide attempt (Sun and Long 2013). Suicide is a major concern among factory workers in global supply chains which have been attributed to pressure to meet quotas and work long hours, as well as low social support (Li et al. 2010; Ngai and Chan 2012; Lin et al. 2016). The findings from this study support research linking occupational strain and poor mental health. Furthermore, these findings can be interpreted within the scope of the literature on burnout. Studies have found that high job strain as measured by the JCQ is associated with burnout. Burnout has been found to be a key factor in poor mental well-being and suicide risk (Pompili et al. 2010; Xie et al. 2011; Wang et al. 2014; Koutsimani et al. 2019). Although the Chinese government has recently acknowledged that the deleterious '996' work schedule (the expectation that employees work 12 h days, 6 days a week usually justified as a way to maintain the competitiveness of the company) is illegal after recent work-related deaths, it is unclear whether this will result in reduced working hours or overtime compensation for factory workers (Huang 2021).

While this study has several strengths including a large sample size, diversity in jobs, and migrant status, as well as the inclusion of women from three factories, it also has a

number of limitations. Since all data were self-report, it is possible that there was underreporting of negative mental health symptoms. "Cultural stoicism" in Chinese adults may result in lower responses for our mental health questions in the survey (Liao et al. 2012). Therefore, the prevalence of mental health concerns may be underrepresented in this study and our associations may be biased toward the null. Additionally, mental health may be somaticized and our respondents may not identify with the response variables listed in the survey, but complain only of physical symptoms (i.e., pain) (Lord et al. 2013). This limitation, again, could bias our results toward the null. Furthermore, due to the cross-sectional nature of this research, temporality, and therefore, causality cannot be determined. It is just as possible that migrants without mental health concerns are more likely to make friends, for example, than it is for migrants with friends to have fewer mental health concerns. Additionally, as the study population was recruited from three electronics factories in Tianjin, China, these findings may not be generalizable outside that setting. However, this study further contributes to the larger supply chain literature by providing insights from Northeast China, a historically productive region that has experienced high cyclic migration. Furthermore, important covariates were not included in our data collection instrument and are therefore missing from the analysis. Variables such as social or familial responsibilities, parity, and menopausal status could confound the results and should be included in future studies on this research question. Finally, migrants included in our study may have been healthier than the general migrant population as migrants who experience severe mental health concerns may choose to return home; therefore, selection bias in the form of the healthy migrant effect could have been present in this study. Therefore, further underestimating the prevalence of poor mental health that may have occurred in previous migration cycles and who had dropped out of the migrant labor force before data were collected for this study. Thus, the more adaptive women who had developed positive coping mechanisms and wider sources of social support are more likely to be included in this cross-sectional study.

Mental health in China contributes to large health expenditures. It has been estimated that mental disorders in China's overall population accounted for 15% of the overall health expenditure for the country (Xu et al. 2016). Mental health was also an important concern of workers in our study with nearly half the workers showing one symptom of poor mental health. Due to cultural stoicism or somatic presentation of mental health symptoms, Chinese workers may not be likely to seek help if they struggle with poor mental well-being. A late diagnosis of depression or anxiety may cause more serious mental problems. These factors, coupled with the dearth of mental health resources for rural migrants in their home communities, and restricted access

to health facilities in urban China, place migrant women workers in an untenable bind. Therefore, health programs that include Chinese cultural values such as collectivism and social identification, as well as programs that encourage and support strong social and professional networks at the factory level would likely improve the mental health of factory workers in China. This research is of critical importance as it has illustrated a high degree of mental health concerns among factory workers, illustrating the vulnerability of this population in China. The findings from this study also inform the current research across the globe as the international economy is deeply dependent on the labor of the most vulnerable and the need for improved working conditions has been even more apparent during the COVID-19 pandemic (Brown 2021; HRB and Chowdhury Center for Bangladesh studies at UC Berkeley 2021). These findings are also applicable to China's growing footprint in the global supply chain not only as a source of manufacturing in China, but also as factory owners throughout the world, thereby potentially exporting the culture of overworked factory workers globally (Sun 2017; Brautigam et al. 2018). Greater attention to understanding the inequities and the link between working conditions and health outcomes will allow international actors and inter-governmental agencies to develop guidelines, practices, and indices to better ameliorate global inequities and structural inequalities of global supply chain dynamics. More research on the mental health of factory workers in China and across the globe is important to improving population health.

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Data availability Data and material will be provided upon reasonable request.

Code availability Code will be made available upon reasonable request.

Declarations

Conflict of interest The authors declare they do not have any conflicts of interest.

Ethical approval Ethics approval was provided by the University of Michigan and the Tianjin Centers for Disease Control and Prevention.

Consent to participate All participants provided consent to participate in this study.

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