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Work and non-work stressors, psychological distress and obesity: evidence from a 14-year study on Canadian workers

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ABSTRACT

Objective: This study aimed to evaluate the contribution of work, non-work and individual factors to obesity with regard to gender-related differences, and to clarify the mediating role that psychological distress plays in these dynamics in Canada from 1994 to 2008 using the Canadian National Population Health Survey (NPHS).

Design: Longitudinal.

Settings: The NPHS is a randomised longitudinal cohort study with biennial interviews of the Canadian adult population from 18 to 64.

Participants: 5925 non-obese workers in cycle 1 (49% were women).

Measurements: Obesity was measured using the body mass index (BMI), with a threshold of BMI >30 kg/m^2. BMI was corrected in accordance with the recommendations of Connor Gorber *et al* to adjust for gender bias in responses.

Results: Of the work characteristics evaluated, only decision authority was associated with obesity for women but not for men. Living as a couple, child-related strains, psychotropic drug use, hypertension, being physically inactive and low psychological distress were obesity risk factors but were not moderated by gender. Overall, psychological distress did not mediate the associations that work factors have on obesity.

Conclusions: Our study suggests that men and women differ little in the extent to which work, non-work and individual factors predict obesity. However, for women, the level of decision authority is associated with a lower obesity risk. In addition, psychological distress did not mediate the contribution of work factors and actually seems, contrary to expectations, to decrease the obesity risk when work, non-work and individual factors are taken into account.

Strengths and limitations of this study

- This 14-year study is representative of the Canadian workforce aged from 18 to 64 years.
- Our study is using repeated measures multilevel logistical regression models that were gender stratified.
- The body mass index measure we used is derived from self-reported data, although it has been corrected to minimise gender response bias.
- We did not control for high levels of exposure to physical and chemical risks.
- The measure we used for physical activity was based solely on the duration that respondents assigned to it for the 3 months preceding the survey.

INTRODUCTION

Obesity develops primarily from imbalance between excessive consumption of high-calorie foods and declines in physical activity. Genetic factors do not appear to play a prominent role, as genetic predispositions may be countered by a health-conscious lifestyle.[1] The study of social determinants of obesity is a promising avenue, because longitudinal studies tend to support the existence of causal relationships between living environments (eg, both work and non-work such as family, networks, community), obesity and mental health problems.[2 3] However, little is known about the concomitant associations of work and non-work risk factors on obesity and mental health problems among workers.

This article aims to rectify this by analysing representative longitudinal data for the Canadian workforce population over a 14-year period.

Workplace factors and obesity

Workplace factors that contributed directly to obesity are limited in number,[4 5] and most longitudinal studies focus on weight change than on body mass index (BMI).[6] Overall, only long working hours showed a consistent contribution to higher risks of obesity over time.[7] However, several longitudinal studies have tested the demand–control (DC) model,[8] the demand–control–support (DCS) model[9] and

the effort–reward–imbalance (ERI) model.[10] Under the DC model, workplace demands were associated with weight gains or increases in BMI levels[11 12] in women and men.[11] High physical demand levels were positively associated with the highest BMI levels among men[13] and greater weight gains among women.[14] Psychological demands were positively associated with weight gains among female nurses over a 6-year period,[15] and presented a U-shaped pattern in a male cohort study.[16]

Low workplace control (a combination of decision authority and skill utilisation) was positively associated with obesity[17 18] and weight gains in men[11] and women[15] who were already overweight. In recent studies that did not use gender-based models, low workplace control was not significant.[12 19] As for social support in the workplace, only one study found low levels of support among men to be associated with increases in BMI and abdominal obesity over time.[20]

Job strain (low control, high psychological demands) was found to be positively associated with increases in BMI among middle-aged (40–59 years) women across a 5-year period,[21] while only men with high BMI (>27 kg/m^2) gained additional weight as a result of job strain, whereas men with lower BMI experienced weight loss.[11] A meta-analysis of 13 European cohort studies revealed that job strain led just as often to weight loss among underweight employees as to weight gain among obese employees.[12] Isostrain (low control and low social support at work, high psychological demands) yielded similar results: men with more isostrain episodes were at greater risk for becoming obese,[20] while it was not significant in women.

Studies of the role of the ERI model in obesity risk yielded mixed results. Although one study showed that imbalance between effort and reward was positively associated with increases in BMI over a 10-year period,[18] another, based on a small sample (N=72) and conducted over a 2-year period, showed that ERI was a poor BMI predictor.[17] Similarly, job insecurity has not only been associated with weight increases in men who were already obese, but also with weight losses among low-BMI workers.[16]

Regarding work contract, overtime was positively associated with weight increases of more than 15 kg over a 10-year period,[22] as was overtime exceeding 6 h/week among men.[14] Nevertheless, reducing overtime hours also seemed to give rise to substantial weight gain among men.[14] Night work, moreover, was associated with significant weight gains among women.[23] Weekend and fixed work schedules also seemed to favour BMI increases.[24]

Non-work factors and worker obesity

Few occupational studies have examined the role of non-work factors in relation to obesity. As far as the family is concerned, marital status leads to mixed results. Being single is not associated with the risk of being obese either among men or women,[25] but rather with a decline in BMI over time,[24] whereas living as a couple may[21] or may not[16] explain changes in BMI. Given that family and couple-related strains do not seem to be directly associated with weight change over time among either men or women,[19] work–family conflicts are thought to explain weight gain among women.[22] As for the social network, men are at lower risk for obesity when time spent with friends is irregular, whereas among women low satisfaction with social networks is associated with an increase in obesity risk.[25] However, stress among friends is not associated with weight change among either men or women.[19]

Overall, very few studies have tested work and non-work factors at the same time,[26] which would have made it possible to state with more assurance which work factors matter above and beyond the relative contribution of non-work factors to obesity.

Individual factors and worker obesity

Two longitudinal studies that tested gender differences have found female to be associated with a rise in BMI over time.[13 24] Still, these two studies suffered from major limitations: in one sample, women constituted only a small percentage (14%),[24] and in the other sample manual occupations and low educational levels were overrepresented (73.5% and 86.5%, respectively).[13] Age is another factor that leads to ambiguous results: some studies have shown a positive relationship between age and BMI;[13] others have reported opposite results.[16 24] Results on educational level were also mixed. Low educational levels have been positively associated with high BMI values for both genders;[21 27] age, however, moderates the relationship.[27] In another study, low educational levels were found to interact with female gender.[13]

As for lifestyle factors, results for high or at-risk alcohol consumption diverged. A combined-gender study found consumption to be not statistically associated with increases in BMI.[24] Another found it to be positively associated with obesity in men but not statistically significant for women.[20] Cigarette smoking was also tested and it was either positively associated with increased BMI[24] or not statistically significant.[13 28] As for physical activities, one study reported a positive association with obesity in women and men;[20] a second study showed that regular physical activity was associated with lower BMI;[21] and a third found no association between physical activity and changes in BMI.[13]

To the best of our knowledge, no longitudinal study of obesity in workers has yet tested individual factors such as personality traits or stressful childhood events. Yet since these factors have already been the subject of obesity studies in the general population, it is relevant to include them in our model.[29 30] The same is true for chronic diseases such as hypertension and diabetes, which have already been incorporated into studies of work stress and cardiovascular disease in workers.[31]

Towards a comprehensive social aetiology model of worker obesity

The profile of worker obesity, as it relates to the psychosocial risks of living environments and to individual

characteristics, is complex. Taking gender into account seems paramount for describing the contribution of work, non-work and individual factors as a whole, but a critical question remains to be dealt with: What specific role does mental health play in the association between obesity and work-related, non-work-related and individual-related risk factors? Mental health actually seems to be proving an important determinant of obesity, given that a cohort study has shown that generalised anxiety predicts weight gain in men.[19] The Whitehall II study has shown a positive association between mental health problems and the development of obesity over time.[32] We found only one longitudinal study, performed on a small sample of male workers, that showed a causal relationship between weight gain and the development of mental health problems (ie, anxiety, depression) across time.[33] Thus, there are increasing evidences that mental health problems could predict obesity and that obesity could also predict mental health problems.

Knowledge gained so far suggests that psychosocial risks arising in work and non-work living environments contribute to the development of mental health problems.[26 34] Moreover, to the best of our knowledge, no study has attempted to validate the mediating role that mental health problems play in the association between work and non-work psychosocial risks and obesity. Clarifying the specific nature of co-occurrences between mental health and obesity, as well as specifying their shared determinants, would seem to be a pivotal factor for further enhancing our understanding.

Relying on a validated multilevel theoretical model of workplace mental health determinants,[34 35] our study is built around a dynamic analysis of worker health that considers living environment diversity (eg, workplace, family, social networks) and individual characteristics (eg, demography, health status, personality traits, lifestyle, stressful childhood events). Its objective is dual: to investigate the role of determinants related to the work and non-work spheres in predicting obesity (ie, its incidence), paying special attention to gender-based differences among Canadian workers; and to clarify the mediating role that mental health plays in those dynamics.

MATERIALS AND METHODS

Data

Longitudinal data came from the National Population Health Survey (NPHS) of Statistics Canada covering the period between 1994–1995 and 2008–2009. Every 2 years (cycles 1–8), the survey gathered data on a representative sample from the Canadian population that included 17 276 individuals (response rate 70.7–92.8%). In this study, a cohort of workers was selected using two criteria: (1) respondents had to have held a job during the preceding 12 months (N=8098), and (2) they were not obese in 1994–1995 (cycle 1; N=6215). After adjusting for missing values, the sample included 5925 individuals, of whom 2901 were women and 3024 were men. The sample yielded 28 848 BMI observations for the period from 1994 to 2008.

Measures

Obesity

Obesity was measured using the BMI, with a threshold of BMI >30 kg/m^2. BMI was corrected in accordance with the recommendations of Connor Gorber *et al*[36] to adjust for gender bias in responses. The correction applied for men was BMI (measured)=−1.08+1.08 ×(BMI self-reported) and for women BMI (measured)= −0.12+1.05×(BMI self-reported).

Mental health

Psychological distress was measured using Kessler's K6 questionnaire[37] based on the Composite International Diagnostic Interview (6 items).[38] Respondents were asked to use a five-point Likert-type scale (from 'none of the time' to 'all of the time') to indicate the frequency of the following symptoms during the preceding month: so sad that nothing could cheer you up; nervous; restless or fidgety; hopeless; everything was an effort; worthless. Recent research in social epidemiology has argued for the relevance of considering prepathological mental health states such as psychological distress as a continuum rather than a binary outcome, an operationalisation most often associated with caseness on specific psychopathological disorders.[39 40] Psychological distress was thus treated as a range from 0 to 24 (Cronbach's α=0.77).

Workplace

Work factors were measured using questions adapted from the Job Content Questionnaire (JCQ),[41] including skill utilisation (3 items), decision authority (2 items), psychological demands (2 items), physical demands (1 item), social support in the workplace (3 items) and job insecurity (1 item). Measurements of work factors also included the total number of hours worked in the primary job and in other jobs per week, as well as irregular work schedules (0=regular schedule, 1=irregular schedule). Skill utilisation, decision authority, psychological and physical demands, social support, job insecurity and working hours per week were used as continuous variables in analyses.

Family and social network

Non-work factors encompassed family and network-related measures. Family variables included marital status (1=living as couple and 0=other), household income classed according to five levels of income sufficiency, parental status according to the presence or absence of children under age 12 (1=present, 0=absent), couple-related strains (3 items) and child-related strains (2 items).[42] Social support outside the workplace was measured using a four-item social support scale, which was then dichotomised (0=low, 1=high).

Individual characteristics

Individual characteristics were measured by age (in years, as reported for cycle 1); gender (0=men, 1=women); educational level (14 levels, highest level attained); locus of control (7 items);[43] stressful childhood events (7 items);[42] high-risk alcohol consumption, in line with Canadian gender-based standards for low-risk consumption, derived from the quantity and typical frequency of alcohol consumption; tobacco use (number of cigarettes smoked per day); physical activity (number of sessions ≥15 min during the preceding 3 months); hypertension (diagnosis in the preceding 12 months); diabetes (diagnosis in the preceding 12 months); and use of psychotropic drugs in the preceding 2 days and in the preceding month. All these variables have been associated with obesity and mental health in the past.

Analysis

The data are structured hierarchically such that measures taken over time (level 1) are nested within individuals (level 2). Repeated-measures multilevel logistical regression models were estimated using MLwiN V.2.27. The analyses were weighted at the individual level taking into account selection probability, non-response rates for each cycle, distribution by gender, age and province of residence as given in the 1996 Canadian population census. To take care of the design effects in the NPHS, SEs were inflated by the square root of the design effects (1.64) at cycle 1.[44 45] All models were run separately for men and for women. Parameters were estimated by the first-order marginal quasi-likelihood method. Models were estimated hierarchically by introducing independent variables using Baron and Kenny's method in order to evaluate any mediating effect for psychological distress.[46] Analyses are first carried out on both genders combined, then by gender to examine gender differences in both direction and magnitude of associations.[47]

RESULTS

Table 1 presents the sample descriptive statistics at cycle 1.

According to figure 1, obesity among men cumulated from 5.6% in 1996 (cycle 2) to 14.9% in 2008 (cycle 8), and among women from 4% in 1996 to 11.1% in 2008.

Table 2 presents the correlation matrix between the study's variables. Of note, all work variables are significantly correlated with psychological distress, which is an indication that psychological distress could therefore

Table 1 Descriptive statistics, National Population Health Survey (cycle 1)

	Men		Women	
	Mean, %	SD	Mean, %	SD
Psychological distress	2.93	2.87	3.52	3.23
Work				
Skill utilisation	7.27	2.37	6.84	2.39
Decision authority	5.63	1.85	5.13	1.95
Psychological demands	4.57	1.83	4.74	1.82
Physical demands	2.21	1.35	1.93	1.29
Social support at work	8.02	2.06	7.94	2.14
Job insecurity	1.32	1.13	1.43	1.17
Work schedule (irregular)	24.10		22.00	
Working hours (total)	47.32	22.47	36.92	17.78
Non-work				
Marital status (couple)	66.10		63.40	
Family income	3.76	0.96	3.72	0.98
Child at home	33.90		36.50	
Couple-related strains	0.17	0.51	0.23	0.63
Child-related strains	0.26	0.55	0.32	0.61
Social support outside work (high)	82.70		88.70	
Individual				
Gender (women)	0		100	
Age (in years)	37.3	12.23	36.74	11.84
Level of education	6.94	3.12	7.13	2.97
Locus of control	20.48	3.97	19.99	4.13
Stressful childhood events	0.76	1.07	1.00	1.24
High-risk alcohol consumption	9.40		5.40	
Cigarettes	5.42	10.07	4.13	8.11
Physical activity	20.66	21.64	20.14	21.11
Hypertension (diagnoses)	4.10		3.50	
Diabetes (diagnoses)	1.70		0.60	
Psychotropic drug use	2.50		6.50	

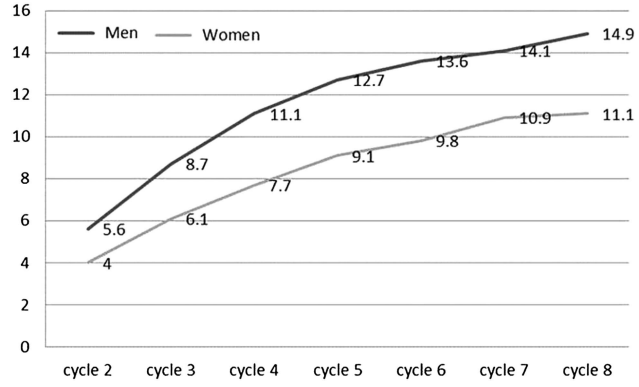

Figure 1 Percentage of body mass index >30 kg/m^2 over time (National Population Health Survey 1996–2008).

mediate the associations between work factors and obesity.

Men and women considered jointly

Table 3 presents the multilevel regression results on the pooled men–women sample. Model 1 shows that work factors have no association, although living as a couple is the only non-work factor associated with an increased obesity risk. In terms of individual characteristics, gender (women) and physical activity are significantly associated with a reduced obesity risk over time, while hypertension is associated with an increased obesity risk. In model 2, psychological distress is not significantly associated with obesity, after adjustment for individual characteristics. Psychological distress is also not associated with obesity when only adjusted for gender and age (OR=1.01 95% CI 0.99 to 1.04, results not shown). Under model 3, psychological distress is associated with a decreased obesity risk. As for non-work factors, living as a couple is still significant, and child-related strains emerge as an additional risk factor for obesity. Individual characteristics in the preceding models retain their effects in the full model. To these is added psychotropic drug use, which now also becomes a risk factor for obesity risk.

Men

According to model 1 in table 4, work is unrelated to the risk of being obese, whereas living as a couple is the only non-work factor associated with an increased obesity risk. With regard to individual characteristics, hypertension is associated with an increased risk of being obese, while physical activity is associated with a decrease in such risk. Model 2 evaluates the link that psychological distress has on obesity after adjusting for individual characteristics. It turns out that psychological distress is not statistically significant, while associations with individual characteristics maintained their significance. Under model 3, psychological distress is still not significant and does not modify the associations with work factors. Living as a couple is still significant, while child-related strains become significant and are associated with an increased obesity risk. The individual characteristics in the preceding models remain significant in the full model.

Women

Model 1 of table 5 shows that, in terms of work factors, only decision authority is associated with a decreased obesity risk, and non-work factors seemed not to affect obesity risk. Having hypertension almost doubles the chances of being obese, and physical activity is associated with a decreased obesity risk. Model 2 shows that psychological distress is not statistically significant, with the same individual characteristics significant in model 1, but locus of control also now shows a statistically significant association. Under model 3, psychological distress is still not significant. Decision authority remains significant in the full model. Again, none of the non-work factors is significant. Locus of control is no longer significant, although physical activity and high blood pressure still maintained their associations with obesity.

Overall, as for men and women differences, we conducted an analysis of all the work, non-work and individual-related risk factors in order to detect any interaction effects for gender using the Altman and Bland[47] method. That analysis indicated that only decision authority has a significant differential effect between men and women (Z=2.45, p<0.01).

DISCUSSION

The objective of this study was to evaluate the contribution of work, non-work and individual factors to obesity with regard to gender-related differences, and to clarify the mediating role that psychological distress plays in these dynamics over a 14-year period. The results of this study add to research on worker obesity, particularly studies that have drawn on broad cohorts, like the Whitehall Study.[32] First, we have evaluated the relative contribution of the living environments associated with work and non-work (ie, family, social networks), thus acknowledging criticisms that emerged from a systematic review on workers' health.[26] Second, we have evaluated how psychological distress and obesity were associated when they co-occurred at various points in time by testing for evidence that psychological distress mediated obesity. Finally, we have systematically investigated whether and how obesity dynamics explained differences between men and women in our cohort of workers.

As work is concerned, we found a little contribution of work factors measured in this study on obesity risk when non-work and individual factors are accounted for. Overall, only decision authority was related to obesity and the relationship holds only in women. Higher levels of decision authority were associated with a decreased obesity risk among women. These results differ from those found in the literature, where low decision authority was not statistically significant for obesity in women.[19] This result helps to go into greater detail than studies

Table 2 Sample correlation matrix (National Population Health Survey 1994–2010, N=5925)

	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Obesity																										
2. Psychological distress	−03																									
3. Skill utilisation	01	−05																								
4. Decision authority	01	−11	29																							
5. Psychological demands	05	11	17	−04																						
6. Physical demands	−02	05	−21	−07	02																					
7. Social support at work	−03	−15	07	16	−20	−03																				
8. Job insecurity	−02	14	−10	−22	04	−01	−16																			
9. Working hours (total)	04	00	10	10	14	08	−01	−02																		
10. Work schedule	00	03	−06	−05	−01	12	−03	05	01																	
11. Marital status	05	−13	09	11	11	−03	01	−05	00	−06																
12. Family income	08	−11	26	13	09	−22	01	−13	05	−05	22															
13. Child at home	00	−02	05	01	07	02	00	−01	01	−02	28	−10														
14. Couple-related strains	01	15	−02	−04	03	04	−08	05	−00	00	19	−01	08													
15. Child-related strains	05	10	−02	−01	05	05	−05	03	−01	01	10	−01	03	18												
16. Social support outside	01	−17	06	05	00	−05	09	−06	−02	00	08	10	02	−12	−06											
17. Gender (women)	−08	10	−10	−14	05	−10	−01	04	−28	−05	−07	−06	−01	06	02	07										
18. Age (in years)	06	−14	07	13	−08	−11	03	−05	−09	−06	28	20	−25	06	20	−05	−03									
19. Level of education	−01	−33	35	13	12	−27	02	−02	01	−03	01	25	05	−04	−08	08	05	−01								
20. Locus of control	00	−31	16	25	−03	−09	22	−20	05	−01	05	04	04	−18	−16	15	−04	−05	15							
21. Childhood events	02	16	−03	−06	09	07	−11	−11	02	03	−06	−07	02	08	10	−03	11	−08	−05	−09						
22. Alcohol	03	04	03	04	01	01	−03	−00	04	−02	−03	05	−04	01	01	−01	−07	−03	−02	02	04					
23. Cigarettes	−01	08	−09	−02	01	13	−06	04	08	03	−07	−13	−02	03	09	−06	−06	−03	−20	−04	14	15				
24. Physical activity	−02	−04	04	01	01	−01	02	−05	−04	02	−04	10	−04	−04	−02	07	01	−02	06	08	01	01	−11			
25. Hypertension	08	02	−03	02	−02	−02	−01	−00	−04	−00	02	03	−09	02	07	−02	−01	25	−04	−07	−00	−00	−01	−01		
26. Diabetes (diagnoses)	02	−00	−03	00	−03	−01	00	−01	01	02	00	−01	−03	00	03	−01	−03	08	−03	−01	−01	−01	−02	00	11	
27. Psychotropic drug	04	20	01	−04	04	−02	−04	02	−06	01	−02	02	−05	05	07	−03	10	09	01	−11	10	01	02	−00	08	01

*Decimals omitted. All correlations p<0.01.

Table 3 Results of multilevel regression models of obesity (National Population Health Survey 1994–2010, N=5925)

	Model 1		Model 2		Model 3	
Psychological distress			0.98	0.95–1.00	0.97*	0.95–1.00
Work						
Skill utilisation	1.00	0.97–1.04			1.00	0.96–1.04
Decision authority	0.99	0.95–1.03			0.99	0.95–1.03
Psychological demands	1.03	0.99–1.08			1.04	0.99–1.08
Physical demands	0.98	0.92–1.04			0.98	0.92–1.05
Social support at work	0.98	0.94–1.02			0.98	0.94–1.01
Job insecurity	0.95	0.89–1.02			0.95	0.89–1.02
Work schedule (irregular)	1.02	0.86–1.20			1.02	0.86–1.21
Working hours (total)	1.00	0.99–1.00			1.00	0.99–1.00
Non-work						
Marital status (couple)	1.30**	1.07–1.58			1.29**	1.06–1.57
Family income	1.00	0.90–1.10			1.00	0.90–1.10
Child at home	1.01	0.85–1.20			1.01	0.85–1.20
Couple-related strains	1.01	0.90–1.13			1.02	0.91–1.14
Child-related strains	1.12	1.00–1.25			1.13*	1.01–1.26
Social support outside work (high)	1.10	0.85–1.43			1.13	0.87–1.47
Individual						
Gender (women)	0.60**	0.47–0.75	0.58**	0.46–0.72	0.60**	0.48–0.76
Age	1.00	0.99–1.01	1.00	0.99–1.01	1.00	0.99–1.02
Level of education	0.99	0.95–1.03	0.99	0.96–1.03	0.99	0.95–1.03
Locus of control	1.00	0.98–1.01	1.00	0.99–1.02	1.00	0.98–1.02
Stressful childhood events	1.08	0.99–1.18	1.10*	1.00–1.20	1.09	0.99–1.19
Hazardous alcohol consumption	1.13	0.86–1.49	1.15	0.86–1.54	1.14	0.87–1.51
Cigarettes	0.99	0.98–1.01	0.99	0.98–1.01	0.99	0.98–1.01
Physical activity	0.99**	0.99–1.00	0.99**	0.99–1.00	0.99**	0.99–1.00
Hypertension	1.56**	1.17–2.07	1.54**	1.16–2.04	1.56**	1.17–2.07
Diabetes	0.82	0.47–1.41	0.83	0.48–1.45	0.83	0.48–1.44
Psychotropic drug use	1.19	0.97–1.46	1.22	1.00–1.51	1.24*	1.01–1.52
Time						
Cycle 3	4.48**	3.60–5.57	4.42**	3.57–5.47	4.44**	3.57–5.52
Cycle 4	6.08**	4.76–7.77	5.93**	4.68–7.51	5.98**	4.68–7.65
Cycle 5	7.28**	5.59–9.49	7.22**	5.63–9.26	7.19**	5.52–9.37
Cycle 6	8.48**	6.42–11.19	8.50**	6.55–11.04	8.42**	6.38–11.11
Cycle 7	9.78**	7.25–13.20	9.83**	7.42–13.03	9.71**	7.18–13.13
Cycle 8	11.60**	8.49–15.84	11.78**	8.78–15.82	11.59**	8.47–15.86
Random part						
σ^2 Individuals	3.86**	3.14–4.59	3.88**	3.12–4.64	3.85**	3.13–4.57
Goodness-of-fit						
χ^2(df)	944.86 (31)		832.39 (18)		968.09 (32)	

*p<0.05, **p<0.01.

using models that were not gender stratified[13] or that relied entirely on male study populations.[33] This result may be interpreted in the light of improved access to skilled jobs for women in recent decades.[48] Such jobs typically carry heavier responsibilities (eg, in the quality and quantity of workload).[9] In England, the trend towards greater obesity between 1997 and 2008 that characterised the professional classes indicated that women holding professional, technical and managerial jobs had the lowest obesity prevalence.[49] This may be a sign that decision authority makes women more active in their job, requiring them to stay in good shape to cope with challenges from the workplace. Another possible explanation is that high decision authority indicates a higher socioeconomic position,[3 50] and socioeconomic position has been inversely related to obesity.[28 51]

Regarding non-work factors, we found that living in couple and child-related strains are associated with an increased obesity risk, and these relationships are not moderated by gender. As for living in couple, the results are unsupportive of previous studies that do not integrate work and individual factors jointly,[16 25] but give support to a study carried out in the Swedish population.[21] Overall, this is not consistent with marital status acting as a protective factor for men's health (though not for women) and extends male longevity.[52] Why living in couple is a risk factor for obesity remains a matter of debate. As for child-related strains, this interesting result had not been investigated by previous research. This also holds true since child-related strains expressed by parents are most often studied in relation to paediatric obesity rather than their own.[53] In one

Table 4 Results of multilevel regression models of obesity (men; National Population Health Survey 1994–2010, N=3024)

	Model 1		Model 2		Model 3	
Psychological distress			0.97	0.93–1.01	0.96	0.93–1.00
Work						
Skill utilisation	1.01	0.96–1.06			1.01	0.96–1.06
Decision authority	1.03	0.97–1.09			1.03	0.97–1.10
Psychological demands	1.03	0.97–1.09			1.03	0.97–1.09
Physical demands	0.95	0.88–1.03			0.95	0.88–1.03
Social support at work	0.98	0.93–1.03			0.98	0.93–1.03
Job insecurity	0.93	0.85–1.02			0.93	0.85–1.02
Work schedule (irregular)	1.04	0.84–1.29			1.04	0.85–1.29
Working hours (total)	1.00	1.00–1.01			1.00	0.99–1.01
Non-work						
Marital status (couple)	1.43**	1.10–1.86			1.42**	1.09–1.84
Family income	1.03	0.89–1.18			1.03	0.89–1.18
Child at home	1.00	0.80–1.26			1.00	0.80–1.25
Couple-related strains	0.91	0.78–1.05			0.92	0.79–1.07
Child-related strains	1.17	1.00–1.37			1.18*	1.01–1.38
Social support outside work (high)	0.94	0.66–1.34			0.92	0.65–1.31
Individual						
Age	0.99	0.98–1.00	0.99	0.98–1.01	0.99	0.97–1.00
Level of education	0.96	0.91–1.01	0.97	0.93–1.02	0.96	0.91–1.01
Locus of control	1.01	0.98–1.03	1.01	0.98–1.03	1.00	0.98–1.03
Stressful childhood events	1.07	0.93–1.23	1.08	0.95–1.24	1.08	0.94–1.23
Hazardous alcohol consumption	1.34	0.98–1.85	1.37	0.97–1.95	1.36	0.99–1.87
Cigarettes	0.99	0.83–1.18	0.99	0.97–1.01	0.99	0.97–1.01
Physical activity	0.99**	0.99–0.998	0.99**	0.99–0.998	0.99**	0.99–1.00
Hypertension	1.47*	1.03–2.09	1.44*	1.02–2.03	1.48*	1.04–2.10
Diabetes	0.80	0.44–1.45	0.83	0.45–1.55	0.82	0.45–1.51
Psychotropic drug use	1.10	0.81–1.48	1.12	0.83–1.53	1.15	0.85–1.57
Time						
Cycle 3	4.81**	3.62–6.40	4.73**	3.58–6.24	4.77**	3.59–6.35
Cycle 4	6.51**	4.67–9.07	6.47**	4.70–8.89	6.39**	4.57–8.94
Cycle 5	7.50**	5.25–10.70	7.70**	5.56–10.68	7.41**	5.18–10.61
Cycle 6	8.57**	5.92–12.41	8.88**	6.30–12.50	8.49**	5.86–12.30
Cycle 7	9.30**	6.21–13.92	9.59**	6.60–13.94	9.21**	6.12–13.87
Cycle 8	11.36**	7.50–17.21	11.80**	8.02–17.38	11.33**	7.46–17.23
Random part						
σ^2 Individuals	2.58**	2.16–3.01	3.20**	2.43–3.97	3.21**	2.47–3.95
Goodness-of-fit						
χ^2(df)	591.18 (30)		488.23 (17)		520.21 (31)	

*p<0.05, **p<0.01.

study exploring the role of parenting stress on obesity in parents as well as children enrolled in a paediatric weight management programme, Guilfoyle *et al*[54] noted that 18% of parents reported clinically elevated levels of parenting stress, among which 66% were obese or morbidly obese. Having to take care of an obese child with special health needs might be a demanding task at hand (eg, emotional support of the child, monitor child adherence to health intervention), competing with resources (eg, time, knowledge, motivation, spousal support) parents must deploy to adopt and maintain healthier lifestyles for themselves. Given that our indicator of child-related strains expressed general (ie, presence of an unhappy child, serious concerns about the child) rather than specific strains (eg, presence of an obese child with special health needs), additional quantitative and qualitative insights are thus required to characterise how child-related strains associate with obesity among working parents. Nevertheless, this result gives further credence to mounting evidence emphasising the pivotal role of the quality of the family environment as a strong determinant not only for paediatric but also for adult obesity.[55] As a rule, studies show that becoming a parent causes BMI to rise as new parents develop lifestyles that are more sedentary and involve less exercise.[56] In addition, when we controlled for psychological distress, the child-related strains associate with increasing risks of becoming obese. As far as we know, our study is the first to bring the relationship between child-related strains and obesity to light among workers.

As for individual characteristics, first, the obesity risk over time is higher for men than women, which is not supportive of research that has reported increasing risks of obesity in women[13 24] but has failed to consider

Table 5 Results of multilevel regression models of obesity (women; National Population Health Survey 1994–2010, N=2901)

	Model 1		Model 2		Model 3	
Psychological distress			0.98	0.95–1.01	0.97	0.94–1.01
Work						
Skill utilisation	0.97	0.93–1.02			0.97	0.93–1.02
Decision authority	0.93*	0.88–0.99			0.93*	0.88–0.99
Psychological demands	1.04	0.98–1.11			1.05	0.98–1.11
Physical demands	1.00	0.91–1.10			1.00	0.90–1.10
Social support at work	0.98	0.93–1.03			0.98	0.93–1.03
Job insecurity	0.98	0.88–1.10			0.98	0.88–1.09
Work schedule (irregular)	0.94	0.72–1.23			0.94	0.72–1.24
Working hours (total)	1.00	0.99–1.01			1.00	0.99–1.01
Non-work						
Marital status (couple)	1.18	0.88–1.60			1.17	0.87–1.59
Family income	0.97	0.84–1.11			0.97	0.84–1.11
Child at home	1.02	0.79–1.32			1.02	0.79–1.31
Couple-related strains	1.11	0.95–1.30			1.12	0.95–1.32
Child-related strains	1.04	0.89–1.21			1.04	0.89–1.21
Social support outside work (high)	0.84	0.57–1.22			0.81	0.55–1.20
Individual						
Age	1.01	0.99–1.03	1.01	0.99–1.02	1.01	0.99–1.02
Level of education	1.04	0.98–1.11	1.03	0.97–1.10	1.05	0.99–1.11
Locus of control	0.99	0.97–1.02	0.97*	0.95–0.99	0.99	0.96–1.01
Stressful childhood events	1.09	0.96–1.23	0.90	0.80–1.02	1.10	0.97–1.24
Hazardous alcohol consumption	0.67	0.44–1.02	0.67	0.44–1.03	0.67	0.43–1.02
Cigarettes	0.99	0.97–1.02	0.99	0.97–1.02	0.99	0.97–1.02
Physical activities	0.99**	0.99–1.00	0.99**	0.99–1.00	0.99**	0.99–1.00
Hypertension	1.81*	1.09–3.01	1.78*	1.08–2.93	1.81*	1.09–3.01
Diabetes	0.81	0.21–3.09	0.86	0.24–3.16	0.81	0.21–3.12
Psychotropic drug use	1.21	0.91–1.60	1.27	0.95–1.70	1.25	0.93–1.66
Time						
Cycle 3	3.91**	2.78–5.49	3.87**	2.78–5.40	3.86**	2.75–5.42
Cycle 4	5.33**	3.79–7.49	5.12**	3.67–7.15	5.23**	3.73–7.36
Cycle 5	6.75**	4.53–10.06	6.50**	4.44–9.53	6.63**	4.45–9.87
Cycle 6	8.49**	5.59–12.87	7.97**	5.31–11.95	8.45**	5.56–12.80
Cycle 7	11.19**	7.24–17.29	10.55**	6.94–16.06	11.11**	7.19–17.16
Cycle 8	12.51**	7.85–19.96	11.93**	7.58–18.78	12.56**	7.87–20.07
Random part						
σ^2 Individuals	4.86**	3.41–6.30	4.85**	3.38–6.31	4.82**	3.38–6.26
Goodness-of-fit						
χ^2(df)	486.37 (30)		393.60 (17)		496.50 (31)	

*p<0.05, **p<0.01.

jointly the contribution of work and non-work factors. Second, and consistent with a previous study,[21] physical activity helps in reducing obesity risk for both men and women. Third, hypertension exposes men and women to approximately the same obesity risk. This result accorded with new research on the role of abdominal obesity in cardiovascular diseases and the link between obesity and hypertension.[57] In a population-based study in Croatia, however, no difference between men and women regarding the role of hypertension was found.[58] Fourth, psychotropic drug use had an overall impact on obesity risk. Although research has shown that on average men use psychotropic drugs less than women do, men also see physicians less often, which affects how many antidepressant prescriptions are written for them.[59] Taken together, these dynamics differentiate men in non-negligible ways. Indeed, it turns out that weight gain is known to be one of the side effects of psychotropic drugs,[60] as psychotropic medications tend to stimulate appetite.[61]

Finally, the results of this study show the expected mediation effect for psychological distress to be not statistically significant, because few work factors associated with obesity. Consequently, the association work factors have on obesity could not be mediated by psychological distress. Overall, psychological distress tended to decrease obesity risk and the association was not moderated by gender. Systematic reviews examining associations between mental health problems and obesity notably among community samples of adults shed additional light on our results. First, there might be specific pathways through which psychopathology becomes a risk

factor for obesity, with risk-pattern associations being more consistently evidenced by studies measuring severe psychopathology such as depression, bipolar disorders,[62 63] compared to prepathological conditions such as psychological distress.[64 65] Severe psychopathology such as depression may more acutely trigger biological pathways pertaining to a dysregulation of the neuroendocrine system (eg, cortisol, insulin) associated with obesity.[63] One might also speculate that obesity could be a concomitant of the medications that severe expressions of psychopathology often require.[62] Hence, that psychological distress as a prepathological mental health condition acted as a protective factor in time for obesity in our study, in spite of the small magnitude of the effect observed, invites us to reconsider the dose–response association for mental health problems to negatively impact on obesity risk in working populations. Such hypothesis would be in line with findings from a recent meta-analysis[65] reporting less psychological distress among moderately obese individuals (class I with a BMI range between 30 and 34.99 kg/m^2) as opposed to their normal weight counterparts among a sample of cross-sectional studies. Examination of gender differences further indicated that this association stood only for men, while obese women tended to experience more psychological distress than normal weight women. While we did not replicate such gender-based differences, our results add a novel outlook at causal patterns. Second, the specific temporal sequence between obesity and psychological distress examined might also explain the absence of association with obesity in our study. Systematic reviews also support emerging trends in the literature where the onset of mental health problems appears as a consequence of social isolation, stigma and discrimination experienced by obese individuals, which we did not assess in our study.[66] Future efforts in research should aim at clarifying both the nature of the psychopathology and directionality linking mental health and obesity among representative samples of the working population.

This study has limitations. First, the BMI measure we used is derived from self-reported data, although it has been corrected to minimise gender response bias.[36] Second, we did not control for high levels of exposure to physical and chemical risks (eg, dirt, humidity, low light, solvents, gas, irritating substances, heat, cold, mould, noise, vibration), although the literature seems to show that these factors lead to weight gain among men.[23] Third, the measure we used for physical activity was based solely on the duration that respondents assigned to it for the 3 months preceding the survey. It does not measure the intensity of physical effort, nor does it yield information about periods when physical activity slackened. Physical activity is indeed a good method for losing weight, but once weight is lost it is often regained when exercise levels drop off.[67] Fourth, as many variables were simultaneously regressed, there was a risk of overadjustment. However, the sample size was large enough to provide a strong adjustment of variables in the models. Fifth, the strength of associations found in this study is relatively low, which is an indication that the possible causal mechanisms need to be further studied. Last, we cannot rule out the possibility of a common method variance bias, because all measurements were based on one source. This may not have influenced the relationship between independent variable and obesity risk, because the sample was selected as free of obesity at cycle 1 of the NPHS.

CONCLUSION

The results of this study suggest that good mental health (ie, low psychological distress), non-work factors (ie, living in couple, child-related strains) and individual characteristics (ie, physical inactivity, hypertension and psychotropic medication) are predictive factors of obesity for both men and women, while work factors (ie, low decision authority) only contribute to additionally predict women's obesity risk. Contrary to what we anticipated, psychological distress did not mediate the relationship between work factors and obesity risk. Combined with our past efforts in occupational mental health based on the longitudinal cohort of the NPHS,[44 68] this study is an important first step in understanding the complex interplay between obesity and psychological distress as concomitant health outcomes of concern among Canadian workers.

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