role. Authors' direct future research efforts towards examination of health behaviours, in particular health protective behaviours that may be moderated and altered by overtime and stress. It is likely that nutrition, physical activity and sleep are the primary behaviours negatively influenced by excess hours spent at work because they require the most conscious effort by an individual. These behaviours should be the target of future health promotion efforts [26].

Occupational characteristics such as rotating shifts, job strain, and uncontrollable stressors in the workday may increase risk for many chronic diseases including obesity. For example, a study by Morse et al. [27] reporting on correctional officer health presented numerous health barriers related to overtime and sleep patterns. Over 80% of participants were overweight or obese and there was a significant association between shift (first, second or third) and BMI ($p<0.01$). Over half of the participants in the study (52%) reported sleeping 6 or less hours per night on average. Overtime work was cited as a barrier to fitting in fitness and healthy eating [27].

A cross-sectional study by Ramey et al. [28] on male police officers reported that officers working night shift were 14 times more likely to sleep 6 hours or less per day ($p<0.001$), with differences in sleep quality. In addition, those with less sleep had a higher percentage of being overweight or obese (88%) compared to those with more sleep (78%), though this did not reach statistical significance. Respondents in this study working day shift reported frequent overtime (53%) and the average work week was 46 hours. Those working non-day shift were more likely to work shifts back-to-back, which may increase job exhaustion, burnout, and sleep deprivation [28].

Numerous studies provide strong evidence of an association between inadequate sleep and obesity risk [8,29-31]. Further clarifying these findings, one meta-analysis concluded that this relationship is not evident for adults who are getting adequate, or longer durations of sleep [30]. Proposed explanations behind the causality of this relationship have been inconclusive. For example, one review article on epidemiological evidence examining short sleep duration and obesity risk questioned the limitations of assuming that there is a causal and linear pathway in which this relationship exists. Other comorbid conditions such as depression, psychosocial issues, age and stress may act as confounding factors in the sleep and obesity relationship. Interactions between external and environmental factors (ex: long work days, commute time) with internal factors may share a complex relationship activating physiological pathways [29]. Other commonly proposed mechanisms attempting to explain this relationship include: changes in eating habits [32], changes in hormone regulation altering serum ghrelin and leptin levels causing increased appetite [33], greater fatigue reducing physical activity levels [34], and physiological changes in inflammatory pathways [35,36] and metabolism [37].

Research to-date has been inconclusive regarding changes in lifestyle behaviours such as increased caloric intake and lack of exercise [32,34]. Rather, studies have demonstrated changes in eating choices, such as a greater proportion of caloric intake from beverages and snacks, which may be associated with sleep loss [32]. It is likely that behavioural changes influencing weight status may be dependent on acute versus chronic sleep deprivation. This finding is important for occupations that are organized by rotating shifts, long working shifts, and frequent overtime hours interfering with sleep duration. There is a need for improved methodology and higher level designs to make inferences about causality through understanding of potential comorbidities and mechanisms. This would allow researchers to draw conclusions and propose that modification of sleep patterns would exhibit weight loss or protection against obesity progression [38,39].

One cross-sectional study by Tsuboya et al. [40] investigating coronary heart disease risk and working hours conducted in Japan reported dose-response associations among overtime work with sleep deprivation and psychological stress. The study was unable to report associations with overweight or obesity, but contributes this contradicting finding to the low incidence of these health conditions in the population studied [40].

A study titled the "Shift Length Experiment" by Amendola et al. [41] examined police officers working different shift lengths and the effect on important health and safety outcomes. The researchers found that individuals working 10-hour shifts got more sleep, worked less overtime and had higher rated work quality of life compared to those working 8-hour shifts. The group working 12-hour shifts displayed similar results, however, negative outcomes such as decreased alertness on the job suggest this may not be the best solution for health and safety initiatives. This study demonstrates important findings for use in changing organizational policies in the public safety sector. Both employees and employers may see immediate and long-term benefits from changing shift rotations. This study proposes that 4 days of 10-hour shifts may be a cost-effective solution to reduce sleep deprivation and mandated overtime, and improve the health, safety, and quality of life for employees [41].

In conclusion, numerous studies have demonstrated concerning associations among poor sleep and long working hours with elevated risk of obesity and chronic disease. It is vital that future research explores the relationships among sleep, overtime work and obesity in high stress occupations that may exhibit differing effects than the general population. With understanding of the health outcomes associated with poor sleep and excess working hours, development of health promoting policies and initiatives may provide cost savings to employees and employers. Organizational health change may benefit from reducing job strain and burnout by considering innovative shift practices that reduce mandated overtime to decrease fatigue, obesity and injuries in the workplace. Utilizing a Total Worker Health approach, shift assignments such as 4-day, 10-hour shifts or allowance of split overtime shifts may improve health and safety in the workplace.

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