

Modification Effect of Job Demand and Contingent Work Schedule on Overweight and Obesity Among Civil Servants in Taiwan

Po-Chang Tseng^{1,2}, Ping-Yi Lin^{3,4}, Wen-Miin Liang⁵, Wen-Yu Lin^{1,6}, Hsien-Wen Kuo^{1,7}

¹Institute of Environmental and Occupational Health Sciences, National Yang Ming Chiao Tung University, Taipei, Taiwan; ²Health Promotion Administration, Ministry of Health and Welfare, Taipei, Taiwan; ³Department of Nursing, Hungkuang University, Taichung, Taiwan; ⁴Department of Medical Research, China Medical University Hospital, Taichung, Taiwan; ⁵Department of Health Services Administration, China Medical University, Taichung, Taiwan; ⁶Environmental Protection Administration, Executive Yuan, Taipei, Taiwan; ⁷Institute of Public Health, National Defense University, Taipei, Taiwan

Correspondence: Hsien-Wen Kuo, Institute of Environmental and Occupational Health Sciences, National Yang Ming Chiao Tung University, No. 155, Sec.2, Linong Street, Taipei, 112, Taiwan, Tel +886 2-28272294, Fax +886 2-28278254, Email hwkuo@ym.edu.tw

Objective: Evidence indicated that shift work is a contributing factor to risk of obesity and leads to cardiovascular diseases (CVDs), but few researches have examined the moderating effects of job demand and contingent work schedule on overweight and obesity. Thus, we assessed the modification effect of contingent work schedules and job demand on overweight and obesity among Taiwan's civil servants.

Methods: Multistage stratified random cluster sampling was used based on a proportional probabilistic sampling (PPS) in a national survey for civil servants. A total of 20,046 participants from 647 registered governmental institutions were enrolled and anonymously and voluntarily filled out web-based questionnaires.

Results: Compared to fixed work schedule, odd ratios (ORs) of obesity and overweight were 1.63 and 1.78 times in contingent work schedule, respectively. In addition, the modification effects of contingent work schedule and high job demand on overweight and obesity with Rothman's synergy index were 2.43 and 2.56, respectively. Using a hierarchical regression model adjusted for covariates, both high job demand and contingent work schedule were interactively associated with overweight and obesity compared to low job demand and fixed work schedule.

Conclusion: Since precarious schedules affect employee's obesity through work-related stress and unhealthy behaviors, further research is needed to determine whether interventions aimed at modification of work schedule may be useful in combating obesity.

Keywords: workload, overweight/obesity, contingent work schedule, civil servants

Introduction

The US labor market from the 1970s through the 2010s found workers experiencing increasingly precarious employment and higher levels of economic insecurity due to cost cutting in private industries and the retrenchment in employer-provided health insurance, retirement plans, and other fringe benefits.¹ The rise in precarious and contingent employment, respectively in both public and private sectors, could have major implications for workers' health and well-being. Similarly, the bureaucratic process of the public sector in Taiwan has incrementally employed contingent workers in low-wage jobs to assist in a routine operation and flexible work. The operational manner and work schedule may change due to the criticisms and demands of citizens, so requirements for special tasks in public sectors has led to the creation of contingent work positions. Evidence have shown the negative impact of work-related psychosocial factors and job stressors on the health and wellbeing of shift workers.² Fixed work schedules are beneficial for Health, less fatigue, and higher performance but contingent work is still required in public sectors. However, for the contingent worker employed to take on different tasks at a specific time period the circadian clock is frequently interrupted by shift work

and overnight shifts,³ which has obesity-related health consequences. Hence, more evidence-based research needs to be accumulated to examine the link between work schedule or arrangement to risk of adverse health effects.⁴

Previous studies showed shift work was associated with an increased risk of type II diabetes mellitus (T2DM) and cardiovascular diseases (CVDs), which is mainly mediated through BMI and body weight changes.⁵ A total of 28 studies in the meta-analysis indicated the overall odds ratio (OR) of night shift work was 1.23 for obesity/overweight (OR= 1.26 for cross-sectional design and OR=1.10 for cohort design, respectively). Permanent night workers (OR=1.43) had a 29% higher risk for obesity/overweight than rotating shift workers (OR=1.14).⁶ Similarly, permanent and irregular night shift work had greater risks for overweight (OR= 3.94 and 1.56) or abdominal obesity (OR= 3.34 and 1.26) than rotating night shift work among healthcare workers. A great risk of overweight and obesity from stressful work and shift work was contributed to disturbed sleep, social difficulties, or irregular of diet behaviors.^{7,8} Furthermore, higher perceived stress, poor sleep quality, and more persistent fatigue problems was associated with poor health in a study of bus drivers with a split shift work schedule.⁹ However, some previous studies^{10,11} did not find a link between the adverse effects of work schedule on obesity. High physical job demand is a significant risk factor for obesity, but limited studies have examined the effects of contingent work schedule in contributing to this. Currently, “flexible production” has commonly been considered as a positive and necessary modification to improve job efficiencies.³ Contingent work schedule frequently exacerbates poor eating and exercise habits and consequently results in weight gain.¹² Excess weight impacted and contributed the increase of direct and indirect costs for employers, such as annual direct medical and absenteeism costs.¹³ Nowadays, contingent workers in governmental institutions are required by citizens’ demands; little is known the moderating effects of job demand and contingent work schedule on overweight and obesity. Therefore, the objective of this study is to assess the interaction effect of job demand and contingent work schedule on overweight and obesity in civil servants.

Materials and Methods

Study Design and Participants

A National cross-sectional survey for civil servants was conducted by Taiwan’s Health Promotion Administration (HPA). The study protocol was approved by the Institutional Review Board of China Medical University (CMUH105-REC3-091), and the study was conducted in accordance with the Declaration of Helsinki. The multistage stratified random cluster sampling used was based on a proportional probabilistic sampling (PPS). Eligible civil servants were formally registered and employed by government. A total of 20,046 participants from 647 registered governmental institutions were enrolled and returned their questionnaire, with a 35.8% overall response rate. Civil servants anonymously and voluntarily filled out a web-based questionnaires and the informed consent at the time of the study. The reasons for non-response included vacations, requested time off, or having limited time to fill out the questionnaire, and they do not affect the objective of the study.

Data Collection

The questionnaire included demographic data, anthropometric measurements (height, weight and wrist circumference), work schedule, workload, and history of diseases. Fixed work schedule in Taiwan’s civil servants is often from 8:30 AM to 5:00PM Monday-Friday and require a commitment of 40 hours per week. A contingent work schedule is on-call or task-oriented work in some public sectors, which are less rigid than fixed schedules and rotating shift work schedules. Contingent workers in government include temporary employees, contracted employees, day laborers, and freelancers.¹⁴ The Occupational Job Content Questionnaire-Taiwan version was obtained from Cheng’s study.¹⁵ The levels of job demand were measured by eight items including time pressure, high complexity, work pressure, exhaustive work, heavy work, limited time and staff to work, and poorly defined tasks. The Likert scale was used to measure workload: strongly agree (4 points), agree (3 points), disagree (2 points), and strongly disagree (1 point). The maximum score was 32, and a higher score represented a higher job demand level. Scales of job demand were classified into two groups based on the upper tertile (>75%) of scores for the high group and <75% for the low group.

Overweight and obesity was defined using body mass index (BMI) measured by the ratio of weight and height (kg/m^2). Based on the guideline from Taiwan’s Health Promotion Administration for adult men and women, the study considers BMI

(kg/m²) between 18.5 and 24 healthy, overweight is defined as a BMI between 24.1 and 27.0, a BMI of 27–30 is mildly obese, a BMI of 30–35 is moderately obese; and a BMI exceeding 35 is severely obese.¹⁶

Statistical Analysis

SPSS 24 package was used to analyze the data. Chi-square test examined the different demographic data and work characteristics in the fixed and contingent work schedule. The odds ratio (OR) of overweight and obesity were compared in fixed and contingent work schedules. Multiple linear regression was used to examine the interaction effect of contingent work schedule and job demand on body weight and BMI adjusted for age, gender, marital status, education, tobacco smoking, and alcohol consumption. Multiple logistic analysis tested the interaction effects of contingent work schedule and job demand on overweight and obesity adjusted covariates. Modification effect on an additive scale was shown using Rothman's synergy index (RSI). Note that in the absence of interaction as departure from additivity, RSI is 1. If the RSI is >1 it indicates interaction between contingent work schedules and high job demand on overweight and obesity. The hierarchical regression model was used to examine the association between BMI (kg/m²) with contingent work schedule and job demand, adjusted for covariates.

Results

Table 1 examines demographic information in the fixed and contingent work schedules by Chi-square test. Only 2.7% of civil servants were employed with a contingent work schedule: work at night (77.8%) or task-oriented job (22.2%). When compared with fixed schedule workers, contingent workers were significantly more likely to be male (65.8%), age with 35–50 years old (56.0%), education level of senior high school (9.8%), and marital status divorced or widowed (2.3%). Difference of work characteristics in the fixed and contingent workers was shown in Table 2. There are significant differences in work duration and workload in the fixed and contingent workers by Chi-square test. Persons with work duration more than 20 years were lower for contingent schedule workers (7.6%) than in fixed workers (10.2%). High job demand for civil servants with contingent work schedule (40.6%) was almost double than that in fixed workers (20.4%). Prevalence of overweight and obesity were 52.3% and 20.8% in contingent workers higher than those fixed worker with 38.1% and 13.9%, respectively.

Table 1 Demographic Information for Two Groups with Either Fixed or Contingent Work Schedules

| | Fixed Work (N=19844) | Contingent Work Schedule (N=554) | P |
|---------------------------|----------------------|----------------------------------|--------|
| Gender (Men) | 8496(42.7%) | 366(65.8%) | <0.001 |
| Age (years) | | | <0.001 |
| <35 | 6204(31.3%) | 173(31.2%) | |
| 35–50 | 8863(44.7%) | 310(56.0%) | |
| 51–65 | 4777(24.1%) | 71(12.8%) | |
| Education level | | | <0.001 |
| Senior high school | 2848(4.3%) | 54(9.8%) | |
| College | 2767(13.9%) | 139 (25.2%) | |
| Undergraduate | 10,228(51.5%) | 241(43.1%) | |
| Graduate | 6034(30.4%) | 117(21.2%) | |
| Marital status | | | 0.001 |
| Unmarried | 6674(33.5%) | 153(27.5%) | |
| Married | 13,020(65.4%) | 390(70.1%) | |
| Other | 226(1.1%) | 13(2.3%) | |
| Cigarette smoking | 2496(12.6%) | 136(24.5%) | <0.001 |
| Alcohol consumption | 2266(11.4%) | 138(24.9%) | <0.001 |
| Betel nut chewing | 648(3.3%) | 62(8.7%) | <0.001 |
| Sleep time <6 hrs | 7640(38.3%) | 298(53.6%) | <0.001 |
| Physical activity <3 days | 15,525(78.0%) | 459(83.0%) | 0.005 |

Note: P value was tested by Chi-square test.

Table 2 Work Characteristics in Those with Fixed or Contingent Work Schedules

| | Fixed Work (N=19844) | Contingent Work (N=554) | P |
|-------------------------|----------------------|-------------------------|--------|
| Work Duration (years) | | | |
| <3 | 3092(15.5%) | 109(19.6%) | 0.001 |
| 3–10 | 5679(28.5%) | 127(22.9%) | |
| 10–20 | 9120(45.8%) | 277(49.9%) | |
| >20 | 2022(10.2%) | 42(7.6%) | |
| Supervisory position | | | 0.721 |
| Yes | 4206(21.1%) | 121(21.8%) | |
| No | 15,694(78.9%) | 435(78.2%) | |
| Governmental employment | | | 0.549 |
| Central | 8393(42.1%) | 241(43.3%) | |
| Local | 11,556(57.9%) | 315(56.7%) | |
| High job demand | 4054(20.4%) | 225 (40.6%) | <0.001 |
| Overweight | 7546(38.1%) | 289 (52.3%) | <0001 |
| Obesity | 2744(13.9%) | 115 (20.8%) | <0001 |

Note: P value was tested by Chi-square test.

There is a significant difference of overweight, obesity, and BMI in the fixed and contingent work schedules (Table 3). The odds ratios (ORs) of obesity and overweight were 1.63 and 1.78 times in contingent work schedule compared to a group of fixed work schedule, respectively. Levels of BMI were positively associated with contingent work schedule. Compared to the reference group of BMIs with 18.5–24.0, a highly obese person with BMI >35 was 2.91 times in persons with contingent work schedule. Multiple linear regression examined the interaction effect of work schedule and job demand on body weight and BMI adjusted covariates (Table 4). A group of with fixed work schedule and low job demand acted as a reference. Average body weight and BMI in the group with both contingent work schedule and high job demand was higher by 2.6 Kg and 0.72 kg/m² than those of reference group. Similarly, the average body weight and BMI was higher by 1.8 Kg and 0.34 kg/m² in the group with both contingent work schedule and low workload when compared to the reference group.

Table 5 showed the interaction effects of contingent work schedule and job demand on overweight and obesity adjusted for covariates using multiple logistic analysis. The ORs of overweight and obesity were 1.69 times and 1.62 times in a group with contingent work schedule and high job demand compared to a group with fixed work schedule and low workload. If the modification effect of contingent work schedule (A) and high job demand (B) factors is larger (or smaller)

Table 3 Overweight, Obesity, and BMI Correlated with Two Groups Either Fixed or Contingent Work Schedules

| | Fixed Work (N=19844) | Contingent Work (N=554) | OR (95% CI) |
|--------------------------|----------------------|-------------------------|--------------------|
| Obesity | | | |
| No | 17,049(86.1%) | 438(85.9%) | 1 |
| Yes | 2744(13.9%) | 115(14.1%) | 1.63** (1.32–2.01) |
| Overweight | | | |
| No | 12,247(61.9%) | 264(61.5%) | 1 |
| Yes | 7546(38.1%) | 289(38.5%) | 1.78** (1.50–2.10) |
| BMI (Kg/m ²) | | | |
| ≤ 18.4 | 1099(5.6%) | 11(2.0%) | 0.44** (0.24–0.81) |
| 18.5–24 | 11,148(56.3%) | 253(45.8%) | 1 |
| 24–27 | 4802(24.3%) | 174(31.5%) | 1.60** (1.31–1.94) |
| 27–30 | 1815(9.2%) | 78(14.1%) | 1.89** (1.46–2.45) |
| 30–35 | 717(3.6%) | 23(4.2%) | 1.41 (1.092–2.18) |
| >35 | 212(1.1%) | 14(2.5%) | 2.91** (2.96–5.07) |

Note: **p<0.001.

Table 4 The Interaction Effect of a Contingent Work Schedule and Job Demand on Body Weight and BMI Adjusted for Age, Gender, Marital Status, Education, Tobacco Smoking, and Alcohol Consumption Using Multiple Linear Regression

| Work Schedule | Job Demand | Body Weight (kg) | p | BMI (kg/m ²) | p |
|---------------|------------|------------------|-------|--------------------------|-------|
| Fixed | Low | 64.90±0.29 | | 23.49±0.09 | |
| Fixed | High | 65.30±0.33 | 0.400 | 23.63±0.11 | 0.226 |
| Contingent | Low | 66.69±0.66 | 0.004 | 23.83±0.21 | 0.019 |
| Contingent | High | 67.50±0.79 | 0.001 | 24.21±0.25 | 0.003 |

Note: Group with fixed work schedule and low job demand acts as a reference.

Table 5 Interaction Effects of Contingent Work Schedule and Job Demand on Overweight and Obesity Adjusted for Gender, Age, Marital Status, Education, Tobacco Smoking, and Alcohol Consumption Using Multiple Logistic Analysis

| Work Schedule | Job Demand | Overweight | Obesity |
|-------------------------|------------|--------------------|--------------------|
| | | OR (95% CI) | OR (95% CI) |
| Fixed | Low | 1 | 1 |
| Fixed | High | 1.10*(1.02–1.18) | 1.12*(1.01–1.24) |
| Contingent | Low | 1.23(0.98–1.55) | 1.15(0.86–1.53) |
| Contingent | High | 1.79***(1.35–2.38) | 1.67***(1.21–2.31) |
| Rothman's synergy index | | 2.43 | 2.56 |

Note: *p<0.01 **p<0.001.

than the sum of the individual effects of A and B, there is interaction on an additive scale or departure from additivity. Rothman's synergy index were 2.43 for overweight and 2.56 for obesity, representing modification effects of contingent work schedule and job demand on overweight and obesity.

Table 6 indicates BMI (kg/m²) is significantly correlated with contingent work schedule and job demand using hierarchical regression model adjusted for covariates. Using the standardized regression coefficients (β) on the effects of BMI was 0.021 in contingent workers, significantly higher than those in the group with fixed work schedule. Similarly, a group with high job demand was positively associated with BMI (β =0.017) compared to a group with low job demand. Civil servants who smoke or are employed by local government had significantly high levels of BMI (β =0.043 and β =0.027).

Table 6 BMI (kg/m²) Correlated with Contingent Work Schedule and Job Demand Using Hierarchical Regression Model

| | Step 1 | Step 2 | Step 3 | Step 4 |
|--|----------|----------|----------|----------|
| Gender (Male=Ref.) | −0.310** | −0.295** | −0.298** | −0.296** |
| Age (years) | −0.091** | −0.088** | −0.087** | −0.090** |
| Education level (Low=Ref.) | 0.003 | 0.007 | 0.005 | 0.006** |
| Marital status (Unmarried=Ref.) | 0.035** | 0.033** | 0.032** | 0.031** |
| Smoking (No=Ref.) | | 0.043** | 0.043** | 0.043** |
| Alcohol consumption (No=Ref.) | | −0.003 | −0.003 | −0.004 |
| Supervisory position (No=Ref.) | | | −0.014 | −0.013 |
| Governmental employment (Central=Ref.) | | | 0.027** | 0.027** |
| Contingent work schedule (Fixed=Ref.) | | | | 0.021** |
| Job demand (Low=Ref.) | | | | 0.017** |
| R ² | 0.116 | 0.117 | 0.118 | 0.119 |
| ΔR^2 | | 0.001 | 0.001 | 0.001 |
| F | 655.8 | 443.6 | 335.6 | 270.5 |

Note: **p<0.001.

Discussion

Studies on difference between public and private sectors revealed on operation system and management manner, which carry on the impact of the work motivation and career development opportunities.^{17,18} Similarly, there is evidence that the bureaucratic system in Taiwan has less job autonomy and independence in the working environment than in the private sector. Hence, public sector jobs are frequently regarded to be deficient in involvement and participation in decision-making and less concerned with innovation and challenging work but have the benefit of being more secure.¹⁹ Due to economic downturn and the incremental rise in unemployment in Taiwan, modification of governmental structure has involved innovative improvement in public sectors resulting in great struggles due to reduced budgets and downsizing of staff, higher caseloads, and more red tape. Therefore, it is needed to adjust the operational services to meet citizens' demand or downsizing staffs in institutions through installation of contingent jobs to work on-call in offices or night shifts. Although the need to be flexible has been proposed for workplace technical systems, schedules and salaries since at least the late 1970s, the types of work arrangements may be as dangerous as traditional unemployment for workers' health.³ The contingent employees are ready to work certain days, blocks of time, or on-call in offices of governmental institutions as needed, commonly incurring fatigue and burnout from irregular work schedules, indecisive circumstances, and financial frustration. As a result, job characteristics with highly sedentary and repetition are frequently carried out by contingent workers rather than the formal civil servants, which lead to poor dietary behaviors and physical inactivity.¹²

Different forms of non-standard work arrangements such as contingent, part-time contract, unregulated underground work, or home-based work are characterized by variable work schedules, reduced job security, lower wages, hazards at the workplace, and stressful psychosocial working conditions.²⁰ Previous studies^{21–23} indicated that temporary employment negatively impacted an employee's health when that employment arrangement was prolonged over time but no negative effects to health were noted within the duration of one year. In addition, a literature review of 27 studies on contingent workers reported worse working conditions and less job continuity, which produce a chronic stressor leading to mental distress and other health inequalities. Thus, frequent exposure to high work-related stress contributes to unhealthy behaviors and subsequently results in adverse health effects among contingent workers.

Nigatu et al²⁴ study indicated obesity significantly related to lower work functioning scores for output and physical demands in shift-workers that is not found in day and on-call workers. There were not significant associations between shift work and being overweight/obese in health care workers.²⁵ But other evidence showed shift work as an independent risk factor for overweight/obesity among male workers, regardless the effects of dietary habits and physical activity.²⁶ Inconsistency in previous findings took into adjustment for possible confounding factors, including diet quality and food choices, alcohol consumption, levels of occupational, and leisure-time physical activity. In the study, lifestyle factors including tobacco smoking, alcohol consumption, and betel nut chewing significantly associated with risk of overweight and obesity in univariate analysis. Nonetheless, our findings indicated the interaction effect of work schedule and job demand on overweight/obesity adjusted for lifestyle in multivariate analysis adjusted for covariates.

In this study, demographic information in contingent workers were mostly male, younger, low education level, and marital status with divorced or widowed. These workers had a higher percentage of tobacco smoking, alcohol consumption, and betel nut chewing, moreover, less physical activity and short sleep time was also found. Thus, the heavy job demand and unhealthy lifestyle may lead to adverse health effects for contingent workers due to night work shift, irregular diet intake, physical inactivity, and disturbed sleep quality. Contingent workers were frequently exposed high work-related stress and job instability, leading to increased reports of psychological and psychosomatic health complaints.²⁷ Consequently, it links exposure to work-related stress and temporal work schedule was associated with overweight and obesity among civil servants. In this study, high job demand and contingent work increases the likelihood of overweight and obesity compared to low job demand and fixed work schedule, adjusted for covariates. Unhealthy lifestyles and high job demands may contribute to the occurrence of overweight and obese civil servants. A study in Finland indicated that increased job demands (OR =1.52) or job strain (OR =1.53) were associated with weight gain in overweight women, concluding persons with overweight might be at a higher risk of weight gain when facing psychosocial strain in the workplace.²⁸ The work fatigue and overtime may contribute to

weight gain in both sexes.²⁹ There is also an interaction effect between familial obesity predisposition and the psychological job demand environment on obesity.³⁰ This mechanism was explained by melatonin functions acting to regulate the circadian temporal internal order. Workers with shift-work or illuminated environments during the night lead to reduction in melatonin production leading to obesity.³¹ Rotating-shift workers on night shifts had lower melatonin levels in urine during the night compared with day-shift workers.⁸ In addition, contingent arrangements may involve the outsourcing of more dangerous and repetitive work that result in a greater risk of injury, illness, and fatality.¹² An explanation for the putative mechanisms of adverse health effects from job demand in contingent workers is that great psychological job demand may contribute to unhealthy behaviors and subsequently lead to an increase of cortisone levels and abdominal obesity.³² In addition, contingent work arrangements lead to chronic misalignment between endogenous circadian timing system and behavioral cycles, with weight gain, adverse metabolic consequences, and immunological effect.^{33,34} Therefore, contingent work arrangements are a risk factor for illness absence and lower productivity.¹²

Strengths and Limitations

This is the first nation-wide study that examined the interaction effect of job demand and contingent work schedule on the overweight and obesity for civil servants in Taiwan. Workers with contingent schedules and high job demand had an interaction effect on overweight and obesity compared to workers with fixed work schedule and low workload. However, there are several limitations in the study. Firstly, the study was a cross-sectional design, so it is hard to establish causality between the relationship of work schedule and job demand with the risk of overweight and obesity. On the contrary, sometimes temporary workers responded as having better health, but cross-sectional design frequently causes selection bias due to the “healthy worker effect.”³⁵ Secondly, influencing factors of overweight and obesity were not completely collected for each participant, such as diet behaviors and family history. Our findings were consistent to previous studies that lifestyle factors including cigarette smoking, betel nut chewing, sedentary time, physical activity, and sleep hours are correlated with overweight and obesity.³⁶ However, the definitions of physical activity were varied in previous studies. The study defined minutes/week of physical activity considered the frequency (number of minutes performing a physical activity) and days (number of days per week). Levels of physical activity considering >150 minutes/week as the cutoff point to be classified as physically active. In this study, the threshold of physical activity was measured by three or more days per week, which is similar to the guideline from Taiwan’s Ministry of Health and Welfare which defines physically active as over 3 or more times a week for at least 30 minutes. About 80% of Taiwanese adolescents reported engaging in some physical activity but 28.4% of the sample met recommended guidelines.³⁷ Betel nut chewing was significantly associated with general and central obesity in Taiwanese men, higher betel nut consumption revealed dose–response effects.³⁸ Adjusting for risk factors on overweight and obesity using multivariate regression model, the positive association between contingent work schedule and job demand with OR of overweight and obesity is obvious.

Conclusions

There are the interaction effects of contingent work schedule and high job demand on OR of overweight and obesity, with Rothman’s synergy index of 2.88 and 2.58 for overweight and obesity, respectively. Body weight (kg) and BMI (kg/m^2) also is significantly correlated with contingent work schedule and high job demand using hierarchical regression model adjusted for covariates. It is necessary to provide a human-oriented work schedule and strengthen job support to reduce job demand and the effect of overweight and obesity among civil servants with contingent work schedule.

Abbreviations

BMI, Body mass index; OR, Odds ratio; SF-36: HPA, Health Promotion Administration.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics and Consent

The study had ethical approval from the China Medical University (CMUH105-REC3-091). Participants were also informed that the data would be handled confidentially. Information about the study was given to all participants and participation was based on written and oral informed consent.

Acknowledgments

The authors gratefully acknowledge assistance provided by the staff of Taiwan's Health Promotion Administration which provided administrative and budget support. The authors would also like to thank all participants to fill out questionnaire.

Author Contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Funding

This study was supported by funding from Tobacco Health and Welfare Surcharge, Health Promotion Administration, Ministry of Health and Welfare, Executive Yuan, Taiwan, ROC (Civil servants health survey program 2016/B1050406). Disclaimer: The content of this research may not represent the opinion of the Health Promotion Administration, Ministry of Health and Welfare.

Disclosure

The authors declare that they have no competing interests.

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