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Original Article

Unique associations of the Job Demand-Control-Support model subscales with leisure-time physical activity and dietary energy intake

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Abstract: Leisure-time physical activity (LTPA) and dietary energy intake are two important health behaviours, which at too low or high levels respectively, are associated with overweight and obesity. This study explores associations between subscales of the Job Demand-Control-Support (JDCS) model, LTPA and dietary energy intake. A cross-sectional design sampled current employees (*N*=433) from a South Australian cohort using a computer-assisted telephone interview and a self-completed food frequency questionnaire. In analyses adjusted for sex, age, and sociodemographic variables, higher levels of skill discretion were associated with increased odds for attaining sufficient physical activity (OR=2.45; 95% CI=1.10–5.47). Higher levels of decision authority were associated with reduced odds (OR=0.43; 95% CI=0.20–0.93) for being in the highest tertile of daily energy intake. Higher scores for coworker support were associated with increased odds (OR=2.20; 95% CI=1.15–4.23) for being in the highest tertile of daily energy intake. These findings support the consideration of the individual JDCS subscales, since this practice may reveal novel associations with health behaviour outcomes, thereby presenting new opportunities to improve employee health and wellbeing.

Key words: Energy intake, Diet, Leisure-time physical activity, Obesity, Work stress

Introduction

High prevalence of overweight and obesity is a global phenomenon, and Australia has some of the highest recorded levels of these conditions[1, 2]. National data collected between 2014–15 indicates 63.4% of Australian adults are overweight (body mass index; BMI 25.00–29.99) or obese (BMI $\geq$30)[3]. The energy balance hypothesis, specifically 'positive energy balance', is generally accepted as the biological mechanism that accounts for most overweight and obesity[4]. A positive energy balance, leading to excess weight gain and maintenance, occurs when energy intake is greater than energy expenditure over a sustained period

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of time. The nature of the positive energy balance may be related to either excess energy intake (e.g., consuming too much food), or insufficient expenditure (e.g., too little physical activity), or a combination of these behaviours[4, 5].

Leisure-time physical activity (LTPA) is a useful type of physical activity to consider since recognised guidelines outlining recommended levels have been published, and it may also be more easily modifiable than other types of physical activity such as occupational-related physical activity, which may be limited by job nature or other constraints[6]. The World Health Organization[7] recommend ≥150 min (or ≥75 min vigorous intensity, or equivalent combination) of LTPA per wk for adults. Similarly, the National Physical Activity Guidelines for Australian adults[8] recommend the same amount, with the added stipulation that this is spread over at least five sessions. Previous research suggests both insufficient LTPA[9] and excess dietary energy intake[10] are associated with increased risk of overweight and obesity. However, the relative importance of insufficient LTPA vs. excess dietary intake, remains inconclusive[11–13].

While it is important to recognise the myriad of causal factors and the environmental context that contribute to overweight and obesity[14], researchers can still contribute to improved understanding of this phenomenon through the consideration of specific settings. As paid employment commonly occupies a significant proportion of time over the lifespan, it is important to understand how work factors may impact on health and wellbeing, and in turn how workplaces may promote and sustain good health[15–17]. In this endeavour, the potential associations between psychosocial work factors, particularly work stress, and health outcomes have attracted significant research interest over the past 35 yr[18–21].

There are many ways to conceptualise psychosocial work stress[22], however the Job Demand-Control (JDC) model[23], or its extension the Job Demand-Control-Support (JDCS) model[24], is the most widely tested model. 'Job demands' describe the psychological effort related to workload, organisational constraints on task completion, and conflicting demands[25]. 'Job control' comprises two subscales: 'skill discretion' and 'decision authority'. Skill discretion refers to the level of skill and creativity required on the job and the flexibility an employee has in deciding what skills to use. Decision authority refers to the organisationally mediated potential for employees to make decisions about their work, or simply the type and quantity of decisions entailed in their work[25, 26]. The JDC model proposes that work stress can result due to a discrepancy between job demands and job control—generally when demands are too high and control is too low. The addition of 'social support' (two subscales: 'coworker support' and 'supervisor support') provides a third broad dimension to the model[16, 24]. Support refers to levels of helpful social interaction available on the job, received from coworkers and/or supervisors[16]. Higher levels of social support are proposed to work in a similar way to higher levels of job control to mitigate the effects of high job demands.

Despite the prominence the JDC(S) model, studies vary considerably in their treatment and analysis of the model components. Most researchers combine 'skill discretion' and 'decision authority', and 'coworker support' and 'supervisor support', into the respective 'job control' and 'social support' composites as a preliminary step. Some then elect to consider the broad model constructs (i.e., demands, control, support) independently, while many others use a variety of approaches to calculate a global measure of 'job strain', or construct four categorical job strain groups (i.e., low strain, passive, active, and high strain)[27]. Mixed findings are common in this field and may be a reflection of these operational inconsistencies[28–31]. While the homonymous 'job strain' conceptualisations are traditionally the most prevalent operationalisations of the JDC(S) model, there is increasing consideration of the value in assessing the individual JDCS constructs separately. There may be additional value still in the consideration of the subscales of the two divisible constructs: job control (i.e., skill discretion and decision authority) and social support (i.e., coworker and supervisor support)[32–35]. It has been speculated that in many modern work environments, higher skill discretion may be more beneficial for employee health, while higher decision authority (e.g., too many decisions) may be more detrimental[36]. In a previous study of the present sample, sex and age adjusted analyses suggested higher levels of skill discretion were associated with reduced measures of obesity (i.e., smaller BMI and waist circumference), while higher levels of decision authority were associated with increased measures of obesity (i.e., larger waist circumference)[32]. These findings suggest considering the JDCS model at the subscale level may be worthwhile and improve understanding by revealing more specific mechanisms.

Previous studies considering energy balance-related behaviours and the JDCS model at the subscale level have typically only provided bivariate associations between the two job control subscales (skill discretion and decision authority) and LTPA. Joensuu *et al.*[35] suggested more regular LTPA was reported by employees with higher levels of skill discretion, while no significant differences in LTPA were seen in relation to levels of decision authority. Conversely, Joensuu *et al.*[37] suggested lower levels of LTPA were reported by employees with higher levels of decision authority, but also for those reporting higher levels of skill discretion. With respect to these incongruous findings, it is important to note that LTPA was not the primary outcome of these studies and the relevant analyses did not control or adjust for the effects of sex or age. This is an important limitation since the subjective experiences of work may vary by sex, or men and women may differ systematically in the types of jobs they occupy and the associated psychosocial working conditions[38, 39]. Furthermore, increasing age is often associated with reduced physical activity, as well as changes in diet and increased weight[40, 41]. Nutritional requirements and corresponding recommendations also differ by sex and age; on average men are larger and generally require greater dietary energy intake to maintain homeostasis, while energy requirements generally reduce as age increases[42]. One previous study did consider the individual associations of coworker and supervisor support with LTPA, finding no association in analyses that controlled for sex, age, and sociodemographic variables[43].

Previous research investigating the potential associations between psychosocial work factors and diet is scarce, and there is particularly little on dietary energy intake. One study, which controlled for age and stratified by sex, indicated job strain (ratio of job demands to control) was positively associated with daily intake of dietary fat in men only (i.e., higher job strain, higher dietary fat intake), while social support (composite of coworker and supervisor support) was positively associated with average daily energy intake from diet (kcal/d) for both men and women (i.e., higher support, higher dietary energy intake)[44]. The latter may be surprising since higher levels of stress are generally thought to increase dietary intake[45], while higher levels of support are generally thought to alleviate work stress.

Our review of the literature has identified an exigent need for more research in relation to work stress and diet. In particular, studies that include measurement of total dietary energy intake are especially useful and compatible with the perspective of the positive energy balance hypothesis[46]. Furthermore, the additional inclusion of a credentialed operationalisation of LTPA allows for exploration of potential associations between psychosocial work factors and both energy intake and expenditure-related behaviours[32]. It is important to note that such studies should also employ statistical methods to control for sex and age in their analyses. The aim of this study was to use an approach that adheres to these recommendations, and to investigate the possibility that subscales of the JDCS model may hold unique relationships with LTPA and/or dietary energy intake (kJ/d).

Method

Sample and procedure

The present study used a cross-sectional design drawing a sub-sample from the North West Adelaide Health Study (NWAHS). Demographic and LTPA data were collected using a computer-assisted telephone interview (CATI) at stage 3 of the NWAHS, conducted between June 2008 and August 2010. Dietary data were collected using a self-report food frequency questionnaire mailed to participants during the same timeframe. Workplace and employment-related data were collected during a follow-up CATI, conducted between October and November 2011. The mean time between the two data collection phases was 2.32 yr (*SD*=0.54). To account for this discrepancy, the current study only included participants who reported being with their current workplace for at least 4 yr. Many participants reported considerably longer service than this minimum; the mean time with current workplace was 16.10 yr (min=4, max=46, *SD*=9.48).

Sampling processes related to the NWAHS involved random selection from the Northern and Western suburbs of Adelaide, South Australia, using an electronic telephone directory as detailed previously[47, 48]. Participants were provided with detailed information about the study and required to sign informed consent forms[47]. The initial sample, from stage 1 of the NWAHS (1999–2003), comprised 4,056 adults, while the 2011 CATI was restricted to a subset of participants (initial eligible *n*=1,715; i.e., those not lost to follow-up in earlier stages, and born between 1946–1980 as per requirement of a separate study). The eligible sample was reduced as 302 (17.6%) had not worked in the interim and 47 (2.7%) were not contactable. From the final eligible sample of 1,366, a total of 1,185 (86.7%) interviews were completed. Of these, 433 met criteria for modelling LTPA, and 409 for modelling dietary intake, in the present study (i.e., same workplace for 4 yr, no missing or outlying data for items in the regression models).

Ethics

Data collection was approved by the Adelaide Health Service Human Research Ethics Committee (comprising

The Queen Elizabeth Hospital, Lyell McEwin Hospital, and Modbury Hospital), previously known as Central Northern Adelaide Health Service Ethics of Human Research Committee and North Western Adelaide Health Service Ethics of Human Research Committee.

Measures

Leisure-time physical activity. The first computer-assisted telephone interview (CATI) incorporated six items from the Active Australia questionnaire[8)] to capture data on the type, intensity, frequency, and duration of LTPA over the past week. Questions enquired about low intensity (e.g., walking continuously for at least 10 min), moderate intensity (e.g., lawn bowls, golf, gentle swimming), and vigorous physical activity (e.g., tennis, jogging, cycling, keep fit exercises) that caused a large increase in breathing or heart rate. Two standard Active Australia items relating to vigorous gardening and heavy yard work were excluded to maintain brevity of the telephone interview and to avoid potential confusion with occupational physical activity. The Active Australia questionnaire has established reliability and validity in Australian populations[49, 50)].

In the present study, two definitions of LTPA were calculated—both comprise a three-level categorical variable that classifies participants into one of three groups: 'no activity', 'activity but not sufficient', or 'sufficient activity'. The frequency of activities was multiplied by the average time per session; with vigorous activity time multiplied by two, to account for the greater intensity of vigorous physical activity[8)]. For the first definition, 'sufficient activity' was defined as ≥150 min (or ≥75 min vigorous intensity, or equivalent combination) per week of LTPA. The first definition is consistent with levels of physical activity for adults recommended by the World Health Organization[7)]. The second definition is similar in that 'sufficient activity' is indicated by the same amount of physical activity per week, but it is also more stringent in that it specifies that this must occur over at least five sessions per week. The second definition is consistent with the National Physical Activity Guidelines for Australian adults[8)]. Distribution between LTPA groups for each definition is provided in Table 1.

Daily energy intake (kJ/d) from diet. A self-completed food frequency questionnaire, the Dietary Questionnaire for Epidemiological Studies (DQES v3.1), was mailed to participants to collect data on habitual diet relating to the previous 12 months. Returned forms were forwarded to Cancer Council Victoria for processing and analyses using the Australian Nutrient Data Table (NUTTAB 95)[51)]. The dietary questionnaire comprised 167-items, with most items describing a specific food for which participants rated their consumption using a 10-point frequency scale ranging from *never* to *3 or more times per day*. Portion sizes were accounted for using four questions to calculate a unique portion size factor, which is used to scale up or down portion sizes for different foods, based on whether a person on average indicates median size serves (not scaled), more than the median (scaled up), or less than the median (scaled down)[52)]. Tea and coffee consumption were each reported using a 9-point frequency scale ranging from *never or less than once per month* to *6+ cups per day*. Diet and regular soft-drink consumption were each reported using a 12-point frequency scale ranging from *none* to *10+ glasses per day.* Consumption of alcoholic beverages (beer, wine, and spirits) were each reported using a respective portion estimate and an 8-point frequency scale ranging from *never* to *every day*.

The DQES was developed specifically for measuring dietary intake in Australian adults[52)], and earlier versions have demonstrated validity[53, 54)], despite limitations characteristic of all food frequency questionnaires[55)]. For the present study, the dietary variable of interest is the estimated daily energy intake from diet, expressed as total kilojoules per day (kJ/d), including energy from fibre, alcoholic and non-alcoholic beverages. Distribution between sex-specific tertiles of kJ/d are provided in Table 1, while properties of the continuous kJ/d variable are provided in Table 2.

Psychosocial work factors. A follow-up CATI included items from the Job Content Questionnaire (JCQ)[25)] used to calculate work-related psychological demands, skill discretion, decision authority, coworker support and supervisor support. The JCQ is the recommended and most commonly used instrument for measuring the JDCS dimensions[25, 27)], with established reliability and validity[25, 26)]. The present study utilised a 20-item version and each item was accompanied with a 4-point response scale (e.g., 1=*strongly disagree*, 4=*strongly agree*). In order to build indicators for each dimension of the JDCS model, a sum of the weighted item scores was calculated as per instructions provided in the JCQ user guide[56)]. Psychometric properties of the resulting JDCS subscales used in analyses, including internal reliability estimates, are provided in Table 2.

Other work factors. Work hours were recorded as the average number of hours worked per week in main job over the past month. Employees were classified by job title as either blue or white-collar using the Australian

Table 1. Summary of categorical variables

Variable	Whole sample (%) N=433	Male (%) n=213	Female (%) n=220	Sex differences χ^2 (p)
Daily energy intake (kJ/d) [Tertiles[a]]				
Low [T1: Men ≤8,097, Women ≤7,080]	136 (33.3%)	68 (33.2%)	68 (33.3%)	
Middle [T2: Men 8,098–9,901, Women 7,081–8,618]	137 (33.5%)	69 (33.7%)	68 (33.3%)	
High [T3: Men ≥9,902, Women ≥8,619]	136 (33.3%)	68 (33.2%)	68 (33.3%)	
Missing	24	8	16	–
Leisure-time physical activity (Definition 1)				
No activity	70 (16.2%)	35 (16.4%)	35 (15.9%)	
Activity but not sufficient	144 (33.3%)	69 (32.4%)	75 (34.1%)	
Sufficient activity [≥150 min/wk]	219 (50.6%)	109 (51.2%)	110 (50.0%)	0.932
Leisure-time physical activity (Definition 2)				
No activity	70 (16.2%)	35 (16.4%)	35 (15.9%)	
Activity but not sufficient	187 (43.2%)	97 (45.5%)	90 (40.9%)	
Sufficient activity [≥150 min/wk, ≥5 sessions]	176 (40.6%)	81 (38.0%)	95 (43.2%)	0.532
Psychological demands [Tertiles[b]]				
Low [T1: ≤29]	133 (30.7%)	69 (32.4%)	64 (29.1%)	
Middle [T2: 30–33]	124 (28.6%)	77 (36.2%)	47 (21.4%)	
High [T3: ≥34]	176 (40.6%)	67 (31.5%)	109 (49.5%)	<0.001***
Skill discretion [Tertiles[b]]				
Low [T1: ≤32]	135 (31.2%)	69 (32.4%)	66 (30.0%)	
Middle [T2: 33–36]	149 (34.4%)	82 (38.5%)	67 (30.5%)	
High [T3: ≥37]	149 (34.4%)	62 (29.1%)	87 (39.5%)	0.059
Decision authority [Tertiles[b]]				
Low [T1: ≤32]	141 (32.6%)	60 (28.2%)	81 (36.8%)	
Middle [T2: 33–36]	181 (41.8%)	96 (45.1%)	85 (38.6%)	
High [T3: ≥37]	111 (25.6%)	57 (26.8%)	54 (24.5%)	0.152
Coworker support [Median[b]]				
Low [≤ 9]	288 (66.5%)	148 (69.5%)	140 (63.6%)	
High [≥10]	145 (33.5%)	65 (30.5%)	80 (36.4%)	0.235[f]
Supervisor support [Median[b]]				
Low [≤ 9]	301 (69.5%)	152 (71.4%)	149 (67.7%)	
High [≥10]	132 (30.5%)	61 (28.6%)	71 (32.3%)	0.473[f]
Job nature (ANZSCO[c] code)				
Blue-collar	89 (20.6%)	66 (31.0%)	23 (10.5%)	
White-collar	344 (79.4%)	147 (69.0%)	197 (89.5%)	<0.001[f]***
Household income[d] [Median[b]]				
Up to $80,000	206 (47.6%)	99 (46.5%)	107 (48.6%)	
$80,001+	227 (52.4%)	114 (53.5%)	113 (51.4%)	0.724[f]
Employment type				
Part time	117 (27.0%)	12 (5.6%)	105 (47.7%)	
Full time	316 (73.0%)	201 (94.4%)	115 (52.3%)	<0.001[f]***
Education				
Did not complete high school	94 (21.7%)	39 (18.3%)	55 (25.0%)	
Completed high school	57 (13.2%)	21 (9.9%)	36 (16.4%)	
TAFE[e]/Apprenticeship	38 (8.8%)	23 (10.8%)	15 (6.8%)	
Trade certificate or diploma	119 (27.5%)	77 (36.2%)	42 (19.1%)	
Bachelor degree or higher	125 (28.9%)	53 (24.9%)	72 (32.7%)	<0.001***

Valid column% reported. [a] Sex-specific tertiles, [b] Sample tertiles or median split as specified, [c] Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, [d] Amount in Australian dollars, [e] Technical and Further Education (vocational education and training), [f] Yates' correction for 2×2 table. *p<0.05, **p<0.01, ***p≤0.001.

Table 2. Summary of continuous variables

Variable	Whole sample (N=433)				Male (n=213)		Female (n=220)		Sex differences[b]
		Range							
	M (SD)	Potential	Actual	α	M (SD)	Range	M (SD)	Range	Sig. (p)
Daily energy intake (kJ/d)	8,475 (2,275)	–	3,098–15,005	–	9,006 (2,361)	3,516–15,005	7,942 (2,056)	3,098–13,235	<0.001***
Age (yr)	47.69 (7.97)	–	28–63	–	46.92 (8.42)	28–62	48.44 (7.45)	29–63	0.046*
Work hours (per wk)[a]	37.41 (11.40)	–	0–86	–	41.13 (7.70)	0–65	33.81 (13.14)	0–86	<0.001***
Waist circumference (cm)	93.20 (14.76)	–	61.5–134.4	–	98.87 (12.90)	67.7–134.4	87.71 (14.39)	61.5–128.5	<0.001***
Body mass Index (kg/m^2)	28.32 (5.39)	–	16.94–44.31	–	28.41 (4.52)	17.17–41.91	28.23 (6.14)	16.94–44.31	0.729
Psychological demands	32.37 (5.60)	12–48	15–48	0.64 (5 items)	31.50 (5.16)	15–48	33.21 (5.89)	17–48	0.001***
Skill discretion	35.20 (5.17)	12–48	18–48	0.74 (6 items)	34.89 (5.12)	18–48	35.49 (5.22)	22–48	0.229
Decision authority	35.38 (6.27)	12–48	12–48	0.71 (3 items)	35.89 (6.30)	12–48	34.89 (6.21)	12–48	0.098
Coworker support	9.68 (1.29)	3–12	6–12	0.85 (3 items)	9.59 (1.15)	7–12	9.77 (1.40)	6–12	0.152
Supervisor support	9.18 (1.62)	3–12	3–12	0.80 (3 items)	9.09 (1.50)	3–12	9.27 (1.72)	3–12	0.237

[a]Average hours worked per week in main job over past month, [b]Difference between means for men and women. *p<0.05, **p<0.01, ***p≤0.001.

and New Zealand Standard Classification of Occupations (ANZSCO)[57].

Anthropometric measurements. Participant height, weight, and waist circumference were measured by clinic staff using standardised protocols and were recorded as continuous variables (Table 2). Waist circumference and BMI (weight/height^2) were the variables of interest in a previous study[32], and are provided here to illustrate the representativeness of the sample.

Analyses

Continuous daily energy intake (kJ/d) was divided into sex-specific tertiles, owing to the generally higher intake requirements and subsequent differences in recommended daily intake for men compared to women[42]. Continuous JDCS variables were divided into sample-specific tertiles (psychological demands, skill discretion, and decision authority) and median splits (coworker support and supervisor support) using the most even sample-specific cut points available in the distribution for the respective variables. Median splits were used instead of tertiles for the coworker and supervisor support variables because these scales have a narrower range and reduced variance due to the fewer number of items for these constructs. Whole sample and sex-specific distributions of these categorical variables are provided in Table 1.

Univariate outliers for daily energy intake (kJ/d) were screened using separate box-and-whisker plots for men and women, with interquartile range (IQR) calculated using Tukey's Hinges (Q3–Q1). For men, upper outliers (≥Q3 + [1.5 × IQR]) were determined as values ≥15,170 kJ/d, and lower outliers (≤Q1 − [1.5 × IQR) were determined as values ≤3,034 kJ/d. For women, upper outliers (≥Q3 + [1.5 × IQR]) were determined as values ≥13,411 kJ/d, and lower outliers (≤Q1 − [1.5 × IQR) were determined as ≤2,680 kJ/d. Based on these definitions, six men and nine women were classified as upper outliers, while one woman was classified as a lower outlier. A linear regression using the continuous measure of energy intake (kJ/d) was conducted for the purposes of identifying multivariate outliers; this revealed one additional male outlier case with standardised residuals ≥3. All cases identified as outliers were excluded from all analyses. Cases with missing data for the items in the respective regression models were also excluded. Data on participant educational attainment is presented in Table 1, however household income, an alternative measure of socioeconomic status, was used as a control variable in regression analyses as it was found to account for greater variance in our sample.

Separate multinomial logistic regression analyses were conducted for each model, providing odds ratios (OR) and 95% confidence intervals (95% CI), to determine associations between subscales of the JDCS model and the two definitions of LTPA (Tables 3 and 4), as well as daily energy intake (kJ/d, Table 5). In all analyses, Model 1 comprised crude analyses (i.e., JDCS constructs only, no control variables), Model 2 controlled for sex and age, and Model 3 included additional control variables: household income, working hours and job nature (blue vs. white-collar). Due to our moderate sample size, to preserve statistical power in our main analyses (Tables 3−5), we controlled for sex rather than present results for men and women separately. Supplementary analyses stratified by sex are reported in Appendix 1. All analyses were conducted in IBM SPSS Statistics for Windows (Version 24.0).

Results

Participant occupational and socioeconomic characteristics

A summary of descriptive categorical and continuous variables are provided in Tables 1 and 2 respectively. The sample comprised 433 (*n*=220, 50.8% female), mostly middle-aged (mean age=47.69 yr) employees. The majority of participants (both men and women) were overweight or obese (mean BMI=28.32 kg/m^2). As detailed in Table 1, men (31.0%) were more likely to hold blue-collar positions compared to women (10.5%); men also reported working full-time (94.4%) more often than women (52.3%). As such, men reported greater working hours per week on average (mean=41.13 h) compared to women (mean=33.81 h), as detailed in Table 2. Approximately half of the participants, both men (53.5%) and women (51.4%), reported household income above $80,001 (Australian dollars), while the remaining half reported household income up to $80,000. There were sex differences in the highest level of education attained: for men the most common qualification was a trade certificate or diploma (36.2%), while for women the most common qualification was a bachelor's degree or higher (32.7%). As detailed in Table 1, scores for the JDCS constructs were generally comparable for men and women, with the exception of psychological demands where women (49.5%) were more likely to report scores in the top tertile (i.e., high demands) compared to men (31.5%).

Leisure-time physical activity

Levels of LTPA were comparable between men and women for both LTPA definition 1 ('sufficient activity' defined as ≥150 min per wk of LTPA) and definition 2 ('sufficient activity' defined as ≥150 min per wk, over ≥5 sessions) (Table 1). In the regression analyses, the 'low' tertile was used as the reference group for the respective JDCS constructs, while 'no activity' was used as the LTPA reference group for both LTPA definition 1 (Table 3) and definition 2 (Table 4). The pattern of associations with regression variables was generally consistent for both LTPA definitions and across the three models presented. Across all analyses (Models 1–3; Tables 3 and 4), skill discretion was the only JDCS subscale associated with either definition of LTPA—with generally higher ORs for 'activity but not sufficient' observed for LTPA definition 1 (Table 3), and generally higher ORs for 'sufficient activity' observed for the more stringent LTPA definition 2 (Table 4).

In crude analyses (Model 1; Tables 3 and 4), a positive association was observed between skill discretion and LTPA. Employees reporting scores in the highest tertile of skill discretion (compared to the lowest tertile) were more likely to be in the 'sufficient activity' group (compared to 'no activity' group) for LTPA definition 1 (OR=2.29; 95% CI=1.07–4.87), and LTPA definition 2 (OR=2.63; 95% CI=1.21–5.71). Employees reporting scores in the highest tertile of skill discretion (compared to the lowest tertile) were also more likely to be in the 'activity but not sufficient' group (compared to 'no activity' group) for LTPA definition 1 (OR=3.93; 95% CI=1.72–8.97), and definition 2 (OR=2.95; 95% CI=1.35–6.44). Employees reporting scores in the middle tertile of skill discretion (compared to the lowest tertile) also had a greater likelihood of being in the 'activity but not sufficient' group (compared to 'no activity' group) for LTPA definition 1 (OR=2.99; 95% CI=1.44–6.20), and definition 2 (OR=2.41; 95% CI=1.21–4.79).

In sex and age adjusted analyses (Model 2; Tables 3 and 4), sex did not appear to be directly associated with either LTPA definition, while a negative association was observed between age and LTPA. Employees with higher age (yr) had a reduced likelihood of being in the 'sufficient activity' group (compared to 'no activity' group) for LTPA definition 1 (OR=0.96; 95% CI=0.92–0.99), and definition 2 (OR=0.96; 95% CI=0.92–0.99). Employees with higher age (yr) also had a reduced likelihood of being in the 'activity but not sufficient' group (compared to 'no activity' group) for LTPA definition 1 (OR=0.95; 95% CI=0.91–0.99), and LTPA definition 2 (OR=0.95; 95% CI=0.92–0.99). The addition of sex and age in Model 2, amplified the ORs for the associations between skill discretion and LTPA observed in crude analyses (Model 2 in

Table 3. Crude and adjusted odds ratios [95% confidence intervals] for the association between leisure-time physical activity (definition 1) and psychosocial work factors (N=433)

Variable	Model 1		Model 2		Model 3	
	Activity but not sufficient	Sufficient activity (≥150 min/wk)	Activity but not sufficient	Sufficient activity (≥150 min/wk)	Activity but not sufficient	Sufficient activity (≥150 min/wk)
Psychological demands						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	1.86 [0.86–4.00]	1.65 [0.80–3.40]	1.69 [0.77–3.69]	1.51 [0.73–3.14]	1.88 [0.85–4.14]	1.55 [0.74–3.26]
High	1.06 [0.53–2.13]	1.25 [0.66–2.37]	0.97 [0.48–1.96]	1.16 [0.60–2.24]	1.04 [0.51–2.12]	1.17 [0.60–2.28]
Skill discretion						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	2.99 [1.44–6.20]**	1.63 [0.83–3.20]	3.09 [1.47–6.48]**	1.67 [0.85–3.30]	3.31 [1.56–7.01]**	1.62 [0.81–3.23]
High	3.93 [1.72–8.97]***	2.29 [1.07–4.87]*	3.98 [1.73–9.16]***	2.34 [1.09–5.00]*	4.39 [1.87–10.32]***	2.19 [1.00–4.79]*
Decision authority						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.65 [0.33–1.31]	0.76 [0.40–1.47]	0.64 [0.32–1.31]	0.75 [0.39–1.45]	0.70 [0.34–1.43]	0.72 [0.37–1.40]
High	0.98 [0.40–2.42]	1.33 [0.58–3.07]	0.93 [0.37–2.32]	1.26 [0.54–2.95]	0.99 [0.39–2.50]	1.16 [0.49–2.73]
Coworker support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	0.67 [0.32–1.40]	0.83 [0.42–1.65]	0.65 [0.30–1.38]	0.82 [0.41–1.65]	0.65 [0.30–1.40]	0.79 [0.39–1.62]
Supervisor support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	0.60 [0.28–1.27]	0.71 [0.36–1.41]	0.58 [0.27–1.23]	0.68 [0.34–1.37]	0.59 [0.27–1.27]	0.71 [0.35–1.44]
Sex						
Female (reference)			1.00	1.00	1.00	1.00
Male			0.83 [0.45–1.52]	0.95 [0.54–1.68]	0.89 [0.46–1.74]	1.04 [0.56–1.92]
Age (yr)			0.95 [0.91–0.99]**	0.96 [0.92–0.99]*	0.95 [0.91–0.99]*	0.96 [0.93–1.00]*
Household income						
$80,001+ (reference)					1.00	1.00
Up to $80,000					0.84 [0.45–1.56]	0.60 [0.34–1.07]
Work hours (per wk)					0.98 [0.95–1.01]	0.99 [0.97–1.02]
Job type						
White-collar (reference)					1.00	1.00
Blue-collar					1.42 [0.66–3.06]	0.79 [0.38–1.64]

Reference category: No Activity. *$p<0.05$, **$p<0.01$, ***$p\leq 0.001$. Model 1: Crude analyses. Model 2: Adjusted for sex and age. Model 3: Additionally adjusted for work hours, household income, and job type.

Table 4. Crude and adjusted odds ratios [95% confidence intervals] for the association between leisure-time physical activity (definition 2) and psychosocial work factors (N=433)

Variable	Model 1		Model 2		Model 3	
	Activity but not sufficient	Sufficient activity (≥150 min/wk, over ≥5 sessions)	Activity but not sufficient	Sufficient activity (≥150 min/wk, over ≥5 sessions)	Activity but not sufficient	Sufficient activity (≥150 min/wk, over ≥5 sessions)
Psychological demands						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	1.87 [0.89–3.92]	1.59 [0.76–3.34]	1.68 [0.79–3.56]	1.47 [0.69–3.13]	1.84 [0.86–3.93]	1.51 [0.70–3.24]
High	1.24 [0.64–2.40]	1.12 [0.58–2.16]	1.16 [0.59–2.27]	1.02 [0.52–2.00]	1.23 [0.62–2.43]	1.03 [0.52–2.04]
Skill discretion						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	2.41 [1.21–4.79]*	1.73 [0.86–3.47]	2.45 [1.22–4.93]*	1.77 [0.88–3.59]	2.56 [1.26–5.20]**	1.71 [0.83–3.50]
High	2.95 [1.35–6.44]**	2.63 [1.21–5.71]*	3.02 [1.37–6.65]**	2.65 [1.21–5.79]*	3.24 [1.44–7.26]**	2.45 [1.10–5.47]*
Decision authority						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.75 [0.38–1.46]	0.69 [0.35–1.35]	0.73 [0.37–1.44]	0.69 [0.35–1.36]	0.78 [0.39–1.53]	0.64 [0.32–1.29]
High	1.06 [0.45–2.51]	1.33 [0.57–3.13]	0.99 [0.41–2.37]	1.29 [0.54–3.07]	1.02 [0.42–2.49]	1.17 [0.49–2.82]
Coworker support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	0.70 [0.35–1.43]	0.83 [0.41–1.69]	0.70 [0.34–1.43]	0.81 [0.39–1.67]	0.70 [0.34–1.46]	0.78 [0.37–1.62]
Supervisor support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	0.68 [0.33–1.38]	0.65 [0.32–1.34]	0.65 [0.32–1.34]	0.62 [0.30–1.29]	0.66 [0.32–1.36]	0.66 [0.31–1.37]
Sex						
Female (reference)			1.00	1.00	1.00	1.00
Male			1.00 [0.56–1.80]	0.81 [0.45–1.45]	1.06 [0.56–2.00]	0.91 [0.49–1.72]
Age (yr)			0.95 [0.92–0.99]*	0.96 [0.92–0.99]*	0.96 [0.92–0.99]*	0.96 [0.92–1.00]*
Household income						
$80,001+ (reference)					1.00	1.00
Up to $80,000					0.82 [0.45–1.48]	0.56 [0.31–1.02]
Work hours (per wk)					0.98 [0.96–1.01]	0.99 [0.96–1.02]
Job type						
White-collar (reference)					1.00	1.00
Blue-collar					1.31 [0.63–2.73]	0.69 [0.32–1.50]

Reference category: No Activity. *$p<0.05$, **$p<0.01$, ***$p\leq0.001$. Model 1: Crude analyses. Model 2: Adjusted for sex and age. Model 3: Additionally adjusted for work hours, household income, and job type.

Table 5. Crude and adjusted odds ratios [95% confidence intervals] for the association between sex-specific tertiles of daily energy intake (kJ/d) from diet and psychosocial work factors (N=409)

Variable	Model 1		Model 2		Model 3	
	Middle kJ/d (Tertile 2)	High kJ/d (Tertile 3)	Middle kJ/d (Tertile 2)	High kJ/d (Tertile 3)	Middle kJ/d (Tertile 2)	High kJ/d (Tertile 3)
Psychological demands						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	1.21 [0.65–2.24]	0.93 [0.49–1.78]	1.17 [0.63–2.20]	0.95 [0.49–1.82]	1.13 [0.60–2.13]	0.95 [0.49–1.85]
High	1.10 [0.60–2.00]	1.17 [0.64–2.13]	1.10 [0.60–2.00]	1.21 [0.66–2.21]	1.08 [0.59–2.00]	1.24 [0.67–2.31]
Skill discretion						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.98 [0.53–1.79]	1.78 [0.95–3.32]	0.97 [0.53–1.78]	1.76 [0.94–3.29]	0.98 [0.53–1.83]	1.95 [1.03–3.71]*
High	1.02 [0.53–1.95]	1.40 [0.70–2.79]	1.02 [0.53–1.97]	1.41 [0.71–2.82]	0.97 [0.49–1.90]	1.54 [0.75–3.15]
Decision authority						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.74 [0.41–1.34]	0.71 [0.40–1.28]	0.73 [0.41–1.33]	0.71 [0.39–1.27]	0.75 [0.41–1.37]	0.80 [0.44–1.46]
High	0.73 [0.36–1.47]	0.35 [0.16–0.73]**	0.71 [0.35–1.44]	0.34 [0.16–0.73]**	0.76 [0.37–1.56]	0.43 [0.20–0.93]*
Coworker support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	1.58 [0.84–2.98]	2.25 [1.19–4.25]*	1.58 [0.84–2.98]	2.30 [1.21–4.34]*	1.51 [0.79–2.87]	2.20 [1.15–4.23]*
Supervisor support						
Low (reference)	1.00	1.00	1.00	1.00	1.00	1.00
High	1.48 [0.78–2.79]	1.73 [0.91–3.27]	1.48 [0.79–2.80]	1.74 [0.91–3.29]	1.48 [0.78–2.79]	1.76 [0.92–3.36]
Sex						
Female (reference)			1.00	1.00	1.00	1.00
Male			1.06 [0.65–1.75]	1.18 [0.71–1.95]	1.25 [0.73–2.14]	1.47 [0.83–2.59]
Age (yr)			0.99 [0.96–1.02]	1.01 [0.98–1.04]	0.99 [0.96–1.02]	1.01 [0.97–1.04]
Household income						
$80,001+ (reference)					1.00	1.00
Up to $80,000					1.52 [0.91–2.54]	2.17 [1.28–3.67]**
Work hours (per wk)					0.99 [0.97–1.02]	0.98 [0.95–1.00]
Job type						
White-collar (reference)					1.00	1.00
Blue-collar					0.56 [0.29–1.09]	0.85 [0.44–1.62]

Reference category: Low kJ/day (Tertile 1). *p<0.05, **p<0.01, ***p≤0.001. Model 1: Crude analyses. Model 2: Adjusted for sex and age. Model 3: Additionally adjusted for work hours, household income, and job type.

Tables 3 and 4, for respective ORs and 95% CIs).

In the final, full adjusted analyses (Model 3; Tables 3 and 4), household income (median split: <$80,000 vs. $80,001+), work hours (hours per week), and job type (blue vs. white-collar) were included as additional control variables. None of these additional variables appeared to be associated with LTPA, however the associations previously noted in Models 1 and 2 (Tables 3 and 4) remained significant in this final model (Model 3, Tables 3 and 4 for respective ORs and 95% CIs). The final models were statistically significant for both LTPA definition 1, χ^2 (26, N=433) = 43.97, p=0.015; and definition 2, χ^2 (26, N=433) = 40.99, p=0.031. Pseudo R^2 indicators suggest the full adjusted models as a whole explained between 9.7% (Cox and Snell R^2) and 11.1% (Nagelkerke R^2) of variance in LTPA status for definition 1, and between 9.0% (Cox and Snell R^2) and 10.4% (Nagelkerke R^2) of variance in LTPA status for definition 2.

Additional analyses were conducted to explore the possibility of sex differences in the associations between the JDCS constructs and LTPA. Using sex-stratified multinomial logistic regression models, with the same structure as those presented in Model 3 for Tables 3 and 4 respectively, results indicate potentially divergent associations between the regression variables and LTPA for men (n=213) and women (n=220). Reported in full in Appendix 1, these stratified results are summarised in the Discussion.

Daily energy intake (kJ/d) from diet

Men reported higher daily energy intake on average compared to women (Table 2). The creation of sex-specific tertiles (low, middle, high kJ/d) facilitated unified analyses, whereby men and women were included in the same regression models (Table 5). Sex-specific cut-points used to evenly divide male and female participants into the sex-specific kJ/d tertiles are provided in Table 1. In the regression analyses, the 'low' tertile was used as the reference group for the respective JDCS constructs, while 'low kJ/d' was used as the energy intake reference group for all analyses in Table 5. Across all analyses (Models 1–3; Table 5) the most consistent associations, between daily energy intake (kJ/d) and the JDCS constructs, were observed with decision authority and coworker support.

In crude analyses (Model 1; Table 5), a negative association was observed between decision authority and daily energy intake (kJ/d) from diet. Employees reporting scores in the highest tertile of decision authority (compared to the lowest tertile) had a reduced likelihood (OR=0.35; 95% CI=0.16–0.73) of being in the 'high kJ/d' tertile (compared to 'low kJ/d' tertile). A positive association was observed between coworker support and daily energy intake (kJ/d) from diet. Employees reporting above median scores for coworker support were more likely (OR=2.25; 95% CI=1.19–4.25) to be in the 'high kJ/d' tertile (compared to 'low kJ/d' tertile).

In sex and age adjusted analyses (Model 2; Table 5), considering that the kJ/d tertiles were sex-specific, neither sex nor age appeared to be directly associated with daily energy intake (kJ/d) from diet. The addition of sex and age in Model 2, had minimal influence on the ORs for the associations between daily energy intake (kJ/d) from diet and decision authority, and coworker support (Model 2 in Table 5, for respective ORs and 95% CIs). In the final, full adjusted analyses (Model 3; Table 5), household income (median split: <$80,000 vs. $80,001+), work hours (h per wk), and job type (blue vs. white-collar) were included as additional control variables. Only one of these additional variables—household income, appeared to be associated with daily energy intake (kJ/d) from diet, and the associations previously noted in Models 1 and 2 (Table 5) remained significant in this final model (Model 3, Table 5 for respective ORs and 95% CIs). For household income, employees reporting less than the sample median household income (up $80,000 Australian dollars), were more likely (OR=2.17; 95% CI=1.28–3.67) to be in the 'high kJ/d' tertile (compared to 'low kJ/d' tertile). Model 3 (Table 5) also suggested a potentially curvilinear association between skill discretion and daily energy intake (kJ/d) from diet, whereby employees reporting scores in the middle tertile of skill discretion (compared to the lowest tertile) had a greater likelihood (OR=1.95; 95% CI=1.03–3.71) of being in the 'high kJ/d' tertile (compared to 'low kJ/d' tertile). The final model for daily energy intake (kJ/d) from diet was statistically significant, χ^2 (26, *N*=409) = 44.92, *p*=0.012. Pseudo R^2 indicators suggest the full adjusted model as a whole explained between 10.4% (Cox and Snell R^2) and 11.7% (Nagelkerke R^2) of variance in daily energy intake (kJ/d) from diet.

Additional analyses were conducted to explore the possibility of sex differences in the associations with daily energy intake (kJ/d) from diet. Using sex-stratified multinomial logistic regression models, with the same structure as those presented in Model 3 of Table 5, results indicate potentially divergent associations between the regression variables and daily energy intake (kJ/d) from diet, for men (*n*=205) and women (*n*=204). Reported in full in Appendix 1, these stratified results are summarised in the Discussion.

Discussion

This study comprised a subscale level consideration of the JDCS model in relation to two proximal health behaviours, LTPA and dietary energy intake (kJ/d), which may mediate the potential association between psychosocial work factors and overweight and obesity. This study was the first of its kind to consider these energy balance-related behaviours, using analyses that did not reduce the JDCS subscales into composite or global scores, but which did control for the effects of sex and age, as well as relevant sociodemographic variables. Notably a number of JDCS subscales appear to hold individual associations with LTPA or dietary energy intake (kJ/d). The divergent nature of these associations, particularly for the two subscales of job control (skill discretion and decision authority), suggests that they would have been masked if a broader approach to analyses, such as using a global measure of job strain or the four job strain groups had been used instead. As such, these findings may help explain why previous research investigating the association between job strain and obesity has produced inconclusive findings[58, 59].

With regards to the two subscales of job control, the results of the present study suggest skill discretion is strongly associated with LTPA, while decision authority is not. The positive association between skill discretion and LTPA appears linear, whereby both middle and high levels of skill discretion (compared to low levels) were associated with increased likelihood of attaining 'activity but not sufficient' and 'sufficient activity'. Furthermore, these associations were amplified after controlling for the effects of sex and age, and persisted after controlling for additional sociodemographic variables of household income, work hours, and job type (blue vs. white-collar). This findings is consistent with a previous observation that skill discretion is negatively associated with measures of obesity (i.e., higher levels of skill discretion, smaller BMI and waist circumference)[32]. No other parts of the JDCS model appeared to be associated with LTPA. Additional sex-stratified analyses were conducted to explore potential sex differences, however in these analyses statistical power was reduced since stratifying by sex effectively halved the respective sample sizes. These analyses suggest that the associations between skill discretion and LTPA may be stronger for men as higher ORs were observed in male-specific analyses, and the associations were not significant for women in female-specific analyses. While the association between skill discretion and LTPA was not observed in female-specific analyses, this may due to a weaker association that requires a larger sample to be observed.

While skill discretion was strongly associated with LTPA—an important source of energy expenditure, it did not appear to be clearly associated with dietary energy intake (kJ/d). Instead, results of the present study suggest high levels of decision authority are strongly associated with dietary energy intake (kJ/d). In the negative association between daily energy intake and decision authority, high levels of decision authority (compared to low levels) were associated with reduced likelihood of being in the highest tertile of daily energy intake (compared to 'low kJ/day' tertile). Furthermore this association persisted after controlling for the effects of sex, age, household income, work hours, and job type (blue vs. white-collar). This finding is consistent with the traditional perspective that higher levels of decision authority may be beneficial for employee health, but at odds with emerging evidence that higher levels of decision authority (e.g., too many decisions) may be more likely detrimental in the modern work context[36]. This finding is also surprising since a previous study, using the same sample as the present study, suggested decision authority was positively associated with indicators of obesity (i.e., higher levels of decision authority, higher waist circumference)[32]. There are two important factors to consider in the interpretation of this observation—firstly, the association between skill discretion and LTPA appears stronger than the association between decision authority and energy intake from diet—as such, higher levels of skill discretion may outweigh the influence of higher levels of decision authority. The second important consideration is the potential for measurement error for daily energy intake, discussed further in the limitations section.

The positive association between coworker support and dietary energy intake (kJ/d) was somewhat surprising, wherein high levels of coworker support (compared to low levels) were associated with increased likelihood of being in the highest tertile of daily energy intake (compared to 'low kJ/d' tertile). This association persisted after controlling for the effects of sex, age, household income, work hours, and job type (blue vs. white-collar). While inconsistent with the traditional perspective that higher levels of support are associated with reduced work stress and better health outcomes[60–62], a similar finding was reported by Kawakami *et al.*[44], who found a positive association between daily energy intake and the composite workplace support construct (i.e., combined coworker and supervisor support). Kawakami *et al.*[44] speculated that higher levels of social support may be associated with greater opportunities for employees to eat high-calorie foods together at social gatherings, such as morning teas, perhaps with cake or snacks in communal staff areas.

No other parts of the JDCS model appeared to be clearly associated with dietary intake. Additional sex-stratified analyses were conducted to explore potential sex differences. The only JDCS relevant association to persist in the sex-specific analyses was the positive association between coworker support and energy intake for male employees. However, the model fit for the male-specific analyses was not significant. While associations between energy intake and JDCS model components were generally not observed in sex-specific analyses, these analyses comprised reduced statistical power compared to the main analyses.

Observations in the present study validate the importance of controlling for the effects of sex and age in investigations of this nature. Increasing age was associated with a decreased likelihood of engaging in LTPA, for both LTPA definitions used. The negative association between age and LTPA suggests positive energy balance may increase with age, since age was not associated with a reduction in daily energy intake (kJ/d) in the present sample. With regards to sex differences, additional sex-stratified analyses (Appendix 1) indicate potential differential associations between JDCS model variables and energy balance-related behaviours for men and women. This was particularly salient for LTPA, where associations appeared stronger in male-specific analyses but were not significant in female-specific analyses. It has been previously suggested that men and women may vary in their experiences of work[38, 39]. There was some indication of this in the present study, wherein women were more likely to report high psychological demands compared to men.

Strengths and limitations

This study adhered to recommendations of previous research, which involved including a measurement of total energy intake from diet, alongside a credentialed operationalisation of LTPA. In doing so, this study was able to consider potential associations between psychosocial work factors and both energy intake and expenditure-related behaviours[32]. A further strength was the innovative analysis approach that involved assessing the JDCS model constructs at the subscale level, rather than using composite or global scores, while controlling for sex, age, and other sociodemographic variables. A principal limitation of the study is its cross-sectional design, which prevents assertions of causality. As such, the possibility of reverse causation cannot be ruled out, e.g., the possibility that an employee's ability to participate in LTPA, and/or the extent of their dietary intake could, through unspecified selection processes, influence their exposure to psychosocial work factors. Another limitation related to the design is the timing of the data collection, whereby the psychosocial work factors were measured approximately 2–3 yr after the outcome measures. While this discrepancy was handled to some degree in the analyses by ensuring participants worked in the same workplaces for at least 4 yr (mean 16.10 yr), persons experiencing severe conditions at work may have been more likely to leave in the interim, reducing the generalisability of our results and suggesting that they may be conservative estimates. Nonetheless, there is some evidence to suggest that psychosocial work factors (or perceptions of them) appear relatively stable over an extended period of time[63]. The precision of our estimates would likely have been improved by including additional factors, such as motivation or health status, which are likely to be associated with both LTPA and dietary energy intake. Another limitation was the limited age range of the participants. Since almost all participants were over the age of 30 at the time of the first telephone interview, it is not clear how our results may generalise to younger employees.

The dietary energy intake (kJ/d) values for participants in the present study suggest under-reporting of dietary intake may have occurred. Men reported higher daily energy intake (mean=9,006 kJ/d) compared to women (mean=7,942 kJ/d) (Table 2). However, despite the majority of participants classified as overweight or obese, the average reported dietary energy intake values for these participants are lower than the recommended daily intake for men (10,700–11,300 kJ/d) and women (8,700 kJ/d) of typical height with a healthy BMI (22.0 kg/m^2) and mostly sedentary activity levels[42, 64]. Such under-reporting is common when using food frequency questionnaires[55], and overweight or obese persons may be more likely to under-report[65]. Nonetheless, since the majority of participants in the present study were overweight or obese, these biases may be generally systematic, so relative differences can still be observed.

Another limitation related to the measurement of dietary intake in the present study may be the focus on quantity of dietary energy intake (i.e., kJ/d), and not quality of dietary intake (e.g., macronutrient composition). Previous research suggests that dietary quality (i.e., types of foods and beverages consumed) may influence dietary quantity (i.e., total energy intake)[66]. Although energy is the same, regardless of the macronutrient quality of the food source, some foods types (e.g., sweet, highly processed snacks) may be less satiating (i.e., less satisfying) than others, which may lead to over-consumption[66]. As such, since dietary quality may be associated with total energy intake, future research may benefit from considering the quality of dietary intake alongside quantity of energy intake.

Conclusions

The exploration of the JDCS model at the subscale level has identified several unique associations with two important health behaviours: LTPA and dietary energy intake (kJ/d), which may underpin the potential association between work stress and overweight and obesity. The positive association between skill discretion and LTPA (i.e., higher levels of skill discretion, greater likelihood of LTPA participation) was the single most consistent association observed in the present study. This finding, combined with an earlier finding that skill discretion was negatively associated with indicators of obesity (i.e., higher levels of skill discretion, smaller BMI and waist circumference)[32], suggests interventions to increase skill discretion may result in increased LTPA (proximal factor), and in time this may reduce levels of overweight and obesity (distal factor). Furthermore, older employees may comprise a priority group for intervention, since increasing age was also associated with reduced likelihood of LTPA participation. Male employees may also benefit most from an increase in skill discretion, since male-specific analyses (Appendix 1) suggested stronger associations between skill discretion and LTPA, compared to unisex analyses.

To a lesser extent, decision authority was negatively associated with daily energy intake (kJ/d) from diet (i.e., higher levels of decision authority, reduced likelihood of being in high kJ/day group). However, potential measurement error for diet may inhibit the validity of these observations. Coworker support was positively associated with dietary energy intake (kJ/d) (i.e., higher levels of coworker support, increased likelihood of being in high kJ/d group). While this counterintuitive observation challenges the traditional perspective that support has a protective function, it is consistent with the findings of a previous study[44].

Findings of the present study affirm the importance of controlling for the effects of sex and age in studies of this nature. Age appeared to be directly and negatively related to LTPA participation, while sex-specific analyses (Appendix 1) suggested relationships between JDCS model components, LTPA and dietary energy intake (kJ/d) may vary by sex. Notably, the positive association between skill discretion and LTPA participation appeared more pronounced in male-specific analyses compared to the main unisex analyses. Future research with a greater sample size would be better powered to more effectively explore these sex differences. Novel findings from the present study should encourage further exploration of the unique associations between JDCS subscales and other health outcomes. Consideration of the JDCS model at the subscale level enables the evaluation of more intricate relationships and could uncover uncharted opportunities to improve employee health and wellbeing.

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Appendix 1. Sex-stratified analyses

Leisure-time physical activity: Male-specific analyses

For men, generally the same associations observed for unisex analyses (Tables 3 and 4) persisted in sex-specific analyses, but with greater ORs and the additional observation of two male-specific associations. Male employees with higher age (yr) had a reduced likelihood of being in the ‘sufficient activity’ group (compared to ‘no activity’ group) for LTPA definition 1 (OR=0.92; 95% CI=0.87–0.98), and definition 2 (OR=0.92; 95% CI =0.87–0.98). Male employees with higher age (yr) also had a reduced likelihood of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group) for LTPA definition 1 (OR=0.92; 95% CI=0.87–0.98), and definition 2 (OR=0.92; 95% CI=0.87–0.98). Male employees reporting scores in the highest tertile of skill discretion (compared to the lowest tertile) had a greater likelihood of being in the ‘sufficient activity’ group (compared to ‘no activity’ group) for LTPA definition 1 (OR=4.79; 95% CI=1.12–20.40), and definition 2 (OR=5.21; 95% CI=1.19–22.81). Male employees reporting scores in the highest tertile of skill discretion (compared to the lowest tertile) also had a greater likelihood of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group) for LTPA definition 1 (OR=15.26; 95% CI=3.14–74.27), and definition 2 (OR=9.49; 95% CI=2.14–42.11). Male employees reporting scores in the middle tertile of skill discretion (compared to the lowest tertile) also had a greater likelihood of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group) for LTPA definition 1 (OR=3.62; 95% CI=1.24–10.59), but this observation was no longer significant for definition 2 (OR=2.67; 95% CI=0.99–7.16) as it was in unisex analyses.

Male-specific associations, not observed in unisex or female-specific analyses, comprised a potentially curvilinear association between decision authority and LTPA definition 1 (but not definition 2), whereby male employees reporting scores in the middle tertile of decision authority (compared to the lowest tertile) had a reduced likelihood (OR=0.29; 95% CI=0.09–0.93) of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group). The second male-specific association suggests male employees reporting above median supervisor support (social support) had a reduced likelihood (OR=0.25; 95% CI=0.07–0.88) of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group) for LTPA definition 1, but not definition 2. The model fit for male-specific analyses was statistically significant for both LTPA definition 1, χ^2 (24, N=213) = 47.58, p=0.003; and definition 2, χ^2 (24, N=213) = 46.74, p=0.004. Pseudo R^2 indicators suggest, for men, the full adjusted models as a whole explained between 20.0% (Cox and Snell R^2) and 23.1% (Nagelkerke R^2) of variance in LTPA status for definition 1, and between 19.7% (Cox and Snell R^2) and 22.6% (Nagelkerke R^2) of variance in LTPA status for definition 2.

Leisure-time physical activity: Female-specific analyses

For women, none of the associations with LTPA observed in unisex analyses persisted in sex-specific analyses. A potential female-specific negative association was observed between work hours (h per wk) and LTPA, whereby longer working hours may be associated with reduced likelihood for being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group)—this was consistent across both LTPA definition 1 (OR=0.96; 95% CI=0.93–1.00), and definition 2 (OR=0.97; 95% CI=0.94–1.00). However, the model fit for the female-specific analyses was not significant for either LTPA definition 1, χ^2 (24, N=220)=24.03, p=0.460; or definition 2, χ^2 (24, N=220)=23.13, p=0.512. As such, the potential female-specific observation between work hours (hours per week) and LTPA should be interpreted with caution.

Daily energy intake (kJ/d) from diet: Male-specific analyses

For men, two of the associations observed in unisex analyses persisted in sex-specific analyses. Male employees reporting higher coworker support (above median) had a greater likelihood (OR=2.89; 95% CI=1.06–7.92) of being in the ‘high kJ/d’ tertile (compared to ‘low kJ/d’ tertile). Furthermore, male employees reporting less than the sample median household income (up $80,000 Australian dollars), had a greater likelihood (OR=2.99; 95% CI=1.39–6.45) of being in the ‘high kJ/d’ tertile (compared to ‘low kJ/d’ tertile). However, the model fit for male-specific analyses was not significant for daily energy intake (kJ/d) from diet, χ^2 (24, N=205)=22.97, p=0.522. As such, these potential male-specific observations between regression variables and daily energy intake (kJ/day) from diet should be interpreted with caution.

Daily energy intake (kJ/d) from diet: Female-specific analyses

For women, none of the associations with daily energy intake (kJ/d) from diet observed in unisex analyses remained statistically significant ($p<0.05$) in sex-specific analyses. Nonetheless, two female-specific associations were observed. For female employees, blue-collar workers had a reduced likelihood (OR=0.19; 95% CI=0.05–0.76) of being in the 'middle kJ/d' tertile (compared to 'low kJ/d' tertile). Furthermore, a negative association was observed between daily energy intake (kJ/d) from diet and work hours (h per wk), whereby female employees who worked longer hours had a reduced likelihood (OR=0.97; 95% CI=0.94–1.00) of being in the 'high kJ/d' tertile (compared to 'low kJ/d' tertile). The model fit for female-specific analyses was significant for daily energy intake (kJ/d) from diet, χ^2 (24, N=204)=41.77, p=0.014. Pseudo R^2 indicators suggest the full adjusted models as a whole explained between 18.5% (Cox and Snell R^2) and 20.8% (Nagelkerke R^2) of variance in daily energy intake (kJ/d) from diet for women.