Exploring Novel Associations Between Psychosocial Work Factors, Obesity, and Energy Balance-Related Behaviours

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ABSTRACT

In many parts of the world, including Australia, the majority of the adult population is overweight or obese – presenting a significant risk to health and wellbeing. The positive energy balance hypothesis states excess weight is caused by consuming greater dietary energy than is required for functioning and physical activity. While this hypothesis describes the main biological mechanism for weight gain, it does not explain why individuals engage in excess dietary intake and/or insufficient physical activity. The biopsychosocial model advocates the additional consideration of psychological and social factors within various settings.

The aim of this research was to provide a better understanding of how psychosocial work factors may be associated with overweight and obesity, as well as two important energy balance-related behaviours: leisure-time physical activity (LTPA) and habitual diet. The Job Demand-Control-Support (JDCS) model is most prevalent in the study of psychosocial work factors, yet there is considerable inconsistency in how it has been operationalised. Previous research suggested equivocal associations between psychosocial work factors and obesity – with some studies reporting associations and others not. Concomitantly, evidence emerged to suggest the two subscales of job control (skill discretion and decision authority) may hold differential associations with some health outcomes, but no previous research had considered the potential for these to hold differential associations with obesity.

In study one, cross-sectional analyses of data from 450 South Australian employees revealed the two subscales of job control were the only components of the JDCS model associated with measures of obesity. Notably, these associations were in opposite directions. Higher levels of skill discretion were associated with reduced waist circumference and body mass index (BMI), while higher levels of decision authority were associated with elevated waist circumference. It was important to consider the behaviours that may underpin these associations. Study two comprised a systematic review of studies that consider the associations of LTPA and/or habitual diet with psychosocial work factors within the JDCS model. After screening records (n = 6,863), 31 studies meeting inclusion criteria were summarised. There was general support for a negative association between various conceptualisations of work stress within the JDCS model and LTPA; particularly lower job control and lower LTPA. There was some suggestion of an association between work stress and poorer diet, but insufficient studies to draw strong conclusions.

Study two revealed no previous studies had considered the potential for the two subscales of job control to hold unique associations with LTPA or diet. As such, study three employed a similar methodology to study one, but with LTPA (3 categories: no activity, activity but not sufficient, sufficient activity) and dietary energy intake (kJ/day) as the outcomes. Analyses suggested higher levels of skill discretion were associated with increased LTPA, but not associated with diet. Conversely, decision authority was not related to LTPA, but higher levels of decision authority were associated with reduced dietary energy intake. Surprisingly, higher coworker support was associated with increased dietary energy intake.

The findings of this thesis suggest the two subscales of job control may be uniquely associated with obesity and energy balance-related behaviours. As such, future research should consider operationalising the JDCS model at the subscale level, since this may reveal novel associations with obesity and other health outcomes – presenting new opportunities to improve employee health and wellbeing. Further implications of this research, as well as limitations and recommendations for future research, including the need for replication, are discussed in the final chapter.

DECLARATION

I, Christopher Bean, certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. I acknowledge that copyright of published works contained within this thesis resides with the copyright holder(s) of those works. I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

Christopher Bean

Signed: ________________________ Date: _________________

ACKNOWLEDGEMENTS

This thesis was produced over a five-year period, providing the foundation of my professional training for both research and practice, in the field of Health Psychology. It has been a fully enriching, sometimes daunting, but ultimately rewarding experience, which I feel privileged to have had the opportunity to pursue. According to a popular proverb, “it takes a village to raise a child”. I feel that a similar sentiment applies to the evolution of a PhD thesis, and as such, I would like to acknowledge and thank all those who have helped to make this work a reality. First and foremost, thanks to my supervisors, Professor Helen Winefield, Dr Charli Sargent, and Dr Amanda Hutchinson. Thank you for your unwavering support, advice, and mentorship. Thank you for believing in my abilities and helping me to both extend and realise them.

The School of Psychology at the University of Adelaide has provided a nurturing environment over the course of my research and training activities. I would like to thank the lecturers, researchers, and administrative staff, as well as my fellow students – who have proved a tremendous source of inspiration and support during this time. I would also like to acknowledge the participants, investigators, and other team members associated with the North West Adelaide Health Study (NWAHS), which has provided data for two of the studies included in this thesis.

Finally, I must thank my family, especially my parents Julia and Graham, and my sister Hayley. Thank you for providing a warm home, abundant reassurances, and countless other expressions of love and support. To my grandparents, extended family and friends around the world, thank you all for your support and encouragement always.

OVERVIEW

Outline of Thesis

This thesis describes research conducted to explore the nature of overweight and obesity and the potential association with psychosocial work factors. This thesis focuses on the Job Demand-Control (JDC) model, or in its extended form the Job Demand-Control-Support (JDCS) model, and how the various components of this model are associated with measures of obesity, specifically waist circumference and body mass index (BMI). Furthermore, this thesis considers the potential mechanisms that may underpin these associations – that is, the potential associations between components of the JDCS model and energy balance-related behaviours, specifically leisure-time physical activity (LTPA) and habitual diet.

Chapter 1 presents the introductory literature, defining key concepts, rationale, and context of the research. Chapter 2 presents the manuscript of the first study, which considers how two measures of obesity (waist circumference and BMI) are associated with components of the JDCS model at the subscale level. Chapter 3 presents the manuscript for study two, which comprises a systematic review of peer-reviewed literature reporting on the associations between psychosocial work factors within the JDCS model and LTPA and/or habitual diet. Chapter 4 presents the manuscript for the third and final study of the present thesis, wherein the sample from study one is revisited to assess the potential associations between components of the JDCS model at the subscale level, and LTPA and dietary energy intake (kJ/day). Chapter 5 concludes this thesis, providing an overview of the findings, discussion of the implications and limitations of this research, as well as recommendations for future research.

This is a thesis by publication, which requires manuscripts comprising the research chapters to be prepared in the style of a journal article, the publication status of which may be either: prepared for submission, submitted for publication, or accepted for publication. This format was chosen to facilitate timely dissemination of the research findings. Consequently, each manuscript is formatted according to publication guidelines of the respective journals, but generally the APA 6 style has been adhered to. At the time of submission, one manuscript (Study One) has been published and two (Studies Two and Three) are under review.

References for all chapters are provided at the end of the thesis and a copy of the published manuscript (reported in Chapter 2) is included as Appendix A. Tables, figures, and chapter-specific appendices are numbered consecutively within each chapter.

Published Works

Chapter 2: Paper One

Bean, C. G., Winefield, H. R., Sargent, C., & Hutchinson, A. D. (2015). Differential associations of job control components with both waist circumference and body mass index. *Social Science & Medicine, 143*, 1-8. doi: http://dx.doi.org/10.1016/j.socscimed.2015.08.034

Under Review

Chapter 3: Paper Two

Bean, C. G., Hutchinson, A. D., Winefield, H. R., & Sargent, C. (2016). Associations between work stress, leisure-time physical activity, and diet: A systematic review of studies that use the Job Demand-Control(-Support) model. *Manuscript submitted for publication in a peer-reviewed journal, University of Adelaide, Australia.*

Chapter 4: Paper Three

Bean, C. G., Winefield, H. R., Hutchinson, A. D., Sargent, C., & Shi, Z. (2016). Unique associations of the Job Demand-Control-Support model subscales with leisure-time physical activity and dietary energy intake. *Manuscript submitted for publication in a peer-reviewed journal, University of Adelaide, Australia.*

Peer-Reviewed Conference Presentations

Bean, C.G., Winefield, H. R., Sargent, C., & Hutchinson, A. D. (2014, March). *Which psychosocial work factors are associated with waist circumference in South Australian employees?* Poster presented at the 12th International Congress on Obesity, Kuala Lumpur, Malaysia.

Bean, C.G., Winefield, H.R., Sargent, C., & Hutchinson, A.D. (2014, July). *The psychosocial work environment and measures of obesity in South Australian employees*. Paper presented at the 28th International Congress of Applied Psychology, Paris, France.

Bean, C.G., Winefield, H.R., Sargent, C., & Hutchinson, A.D. (2014, September). *The Demand-Control-Support model and measures of obesity in South Australian employees*. Paper presented at the 5th Congress of the International Commission on Occupational Health – Work Organisation and Psychosocial Factors, Adelaide, Australia.

Bean, C.G., Winefield, H.R., Hutchinson, A.D., & Sargent, C. (2015, May). *How might work stress contribute to obesity? A systematic review: Work stress and energy balance-related behaviors.* Poster presented at the 11th International Conference on Occupational Stress and Health (Work, Stress, and Health), Atlanta, USA.

Outline of Candidature

The present thesis was produced to fulfil the requirements of a combined Doctor of Philosophy/ Master of Psychology (Health) degree undertaken at the University of Adelaide, South Australia. This program combines a full Psychology Masters (Health) course load (equivalent 2 years fulltime) and a full research program for a Doctor of Philosophy (equivalent 3 years fulltime), and stipulates that the research undertaken must adopt a health psychology focus. All courses and practical requirements of the Masters component of the program, comprising seven postgraduate courses and three placements (with a combined total of 1,000 placement hours) were completed successfully. The following thesis is submitted to fulfil the requirements of the Doctor of Philosophy degree.

CHAPTER 1: INTRODUCTION AND AIMS OF THESIS

1.1 Preamble

This chapter provides a broad introduction to core concepts explored in this thesis. The issue of obesity and its causes are discussed in-depth, as well as the nature and importance of the workplace and psychosocial work factors, and how these areas of interest may be related to one another. Firstly, overweight and obesity are defined and the practicalities of their measurement are discussed. This is followed in Section 1.2 by references to the global prevalence of overweight and obesity, as well as why this is of concern – i.e., consequences of overweight and obesity. The main purpose of this thesis is to explore psychological stress at work and how this may be associated with overweight and obesity. To do this, it is necessary to provide a broad outline of the most relevant biological and theoretical underpinnings of both obesity and stress. Section 1.3 defines the concept of food energy; where it comes from, how it is measured, and how it is used by the body. Another key concept explained in this section is energy balance, and specifically how sustained positive energy balance leads to obesity. Section 1.4 provides an overview of energy balance-related behaviours (e.g., diet and physical activity) and their measurement. Section 1.5 introduces the field of health psychology and the biopsychosocial model, followed by a discussion of systems thinking and an exploration of causation, and how these concepts apply to understanding health and illness. This is followed in Section 1.6 by an appreciation of the greater context of obesity, and realisation that efforts to reduce obesity should refocus on *why*, rather than *how* obesity happens – i.e., the need to look beyond positive energy balance. Section 1.7 provides a brief conceptual overview of stress as it applies to the human condition, basic biological and psychological principles of stress, along with an introduction to how stress can influence health and energy balance-related behaviours. Section 1.8 introduces the field of occupational health psychology and focuses discussion to the significance of work, and specifically stress at work, as a meaningful segment in a pragmatic approach to the study of the complex aetiology of obesity. Specifically, Sections 1.8.4a and 1.8.4b describe the Job Demand-Control (JDC) and Job Demand-Control-Support (JDCS) models of work stress, and the latter section presents evidence to suggest the broad construct of job control requires closer scrutiny. The final section of this chapter provides a summary of the core concepts and flags an identified gap in the literature – that is, the need for more careful consideration of the JDCS model subscales. Moreover, Section 1.9 highlights the original contributions of this thesis, outlines its context and scope, as well as presenting the specific aims of this thesis.

1.2 Overweight and Obesity

1.2.1 Definition and Measurement

The terms ‘overweight’ and ‘obesity’ both refer to elevated fat mass in the body. These terms are frequently grouped together and often observed interchangeably in day-to-day conversation. According to the World Health Organization [WHO] (2013) ‘overweight’ refers to a *moderate* grade, while ‘obesity’ refers to a *severe* grade, of abnormal or excessive fat accumulation that presents a risk to the health of an individual. The validity of this dichotomy is somewhat contentious since there is no steep delineation between health and disease at a definite body fat mass; nonetheless it is important for the definition of obesity to approximate a point where elevated risks are apparent (Björntorp, 2005). ‘Overweight’ is sometimes referred to as a ‘pre-stage’ of obesity or ‘pre-obesity’ (Webber et al., 2014), since to become obese, an individual must first progress from overweight – and people often do, especially with increasing age (Hillemeier et al., 2011; Wannamethee, Shaper, & Walker, 2005).

There are a variety of options for measuring obesity but little agreement on what could be considered a gold-standard (O'Neill, 2015). Hu (2008) details a variety of alternative approaches and their respective strengths and weaknesses. It is important to acknowledge the difference between: (i) body composition assessments, which attempt to distinguish between fat mass (FM) and fat-free mass (FFM) (e.g., skeletal muscle, bone, water) in the body; and (ii) anthropometric measures, which cannot directly measure body composition. The latter include common ‘field measures’, such as body mass index (BMI), waist circumference, waist-to-hip ratio, skinfold thickness, and bioelectrical impedance (BIA). Body composition assessments or ‘laboratory measures’ include underwater weighing, air-displacement plethysmography, isotope dilution (hydrometry), dual energy X-ray absorptiometry (DEXA), computed tomography (CT), and magnetic resonance imaging (MRI) (Hu, 2008). The highest levels of accuracy are provided by CT and MRI, which allow researchers to distinguish between whole-body fat mass as well as lean muscle mass and bone mass; however their high cost, technical complexity and associated cumbersome equipment typically prohibit their application in large scale studies or community assessment (Björntorp, 2005; Hu, 2008; O'Neill, 2015).

In spite of technological innovations in the assessment of body composition, the simplicity and accessibility of anthropometric measures, particularly weight and height, ensure they are the most prevalent measures used in epidemiological obesity research (Hu, 2008). Related to the concept of body composition, and an important distinction in the measurement of obesity, is ‘overall obesity’ versus ‘central obesity’. This is important because obesity is a heterogeneous disorder, whereby affected individuals can vary in their body fat distribution, metabolic profile and resulting elevated health risks (Ibrahim, 2010). Overall obesity refers to the presence of generally subcutaneous adipose tissue (i.e., fat mass under the skin) dispersed around the body, whereas central obesity (also known as abdominal obesity) refers to the presence of relatively concentrated visceral adipose tissue (i.e., fat mass around the internal organs) found in the abdominal cavity (Després & Lemieux, 2006). The accumulation of fat around the waist (proximal to the internal organs) poses a greater risk to health than fat deposited elsewhere in the body, such as the hips (Després & Lemieux, 2006; Ibrahim, 2010; Ritchie & Connell, 2007).

BMI is the most commonly used measure of obesity and is a measure of weight adjusted for height. Calculated by weight/height^2 and expressed in units of kg/m^2, BMI is a measure of overall obesity (Wang, Rimm, Stampfer, Willett, & Hu, 2005). Despite its common usage, BMI is an imperfect measure of 'fatness' since it does not directly measure body composition or fat mass (Flegal et al., 2009; Mooney, Baecker, & Rundle, 2013). An emerging popular alternative is waist circumference, which provides an approximate measure of fat accumulation around the waist, providing an indication of central obesity (Hu, 2008; Janssen, Katzmarzyk, & Ross, 2004). Waist circumference is measured using a soft tape measure placed around the point between the lowest rib and the top of the iliac crest following a normal respiration, and is expressed in centimetres (cm) (WHO, 2008). Although waist circumference and BMI are highly correlated and both show a similar association with mortality (Pischon et al., 2008), waist circumference is superior for detecting cardiovascular risk factors (Lee, Huxley, Wildman, & Woodward, 2008), and type 2 diabetes (Wang et al., 2005).

In the first study (Chapter 2, Study One) we elected to look at both BMI and waist circumference concurrently. We felt it was important to include BMI as to allow for comparison with previous research, which typically uses BMI as the only measure of obesity. Furthermore, using both BMI and waist circumference measures enables a comparison between the two, to see which displays the strongest relationships with the variables under investigation.

According to the WHO (2013), ‘overweight’ is indicated by a BMI of 25.00 to 29.99kg/m^2, while ‘obesity’ is indicated by a BMI ≥30kg/m^2. A BMI of 18.5 to 24.99kg/m^2 is considered to be within a ‘normal’ or ‘healthy’ range, while a BMI below 18.5 kg/m^2 is considered ‘underweight’. Classification using waist circumference varies by sex and ethnicity. For Caucasian men, a waist circumference >94cm is considered to represent an increased risk of metabolic complications, while >102cm represents a substantially increased risk. For Caucasian women, >80cm is considered to represent an increased risk of metabolic complications, while >88cm represents a substantially increased risk (WHO, 2008). Figure 1 depicts waist circumferences representing normal, overweight, and obese body shapes.

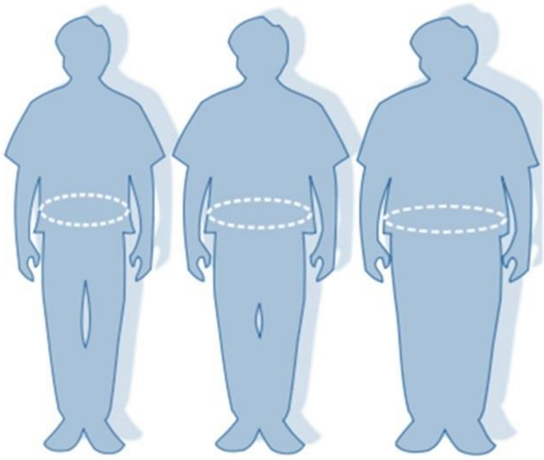

Figure 1. Illustration of waist circumference: ‘healthy’, ‘overweight’, and ‘obese’. Adapted from: Dietary Guidelines Advisory Committee (2000); Infographic: FDA/Renée Gordon.

1.2.2 Prevalence and Consequences

Reports of the ‘global obesity crisis’ are highly prevalent in both scientific literature and popular media (Saguy, Frederick, & Gruys, 2014). There is good cause for concern; worldwide, prevalence of obesity has more than doubled since 1980 (WHO, 2013). According to the latest age-standardised figures released by the Australian Bureau of Statistics (2015a) , 70.8% of men and 56.3% of women in Australia are overweight or obese, including 27.9% obese in both men and women. Similar figures are seen internationally, such as in the United States where 73.9% of men and 63.7% of women are overweight or obese, including 35.3% of men obese and 35.8% of women obese (Flegal, Carroll, Kit, & Ogden, 2012); and the United Kingdom where 67% of men and 57% of women are overweight or obese, including 26% of men and 24% of women obese (Moody, 2014). Despite the incidence of obesity slowing in developed countries over the past decade (i.e., a reduction in rate of new cases), projections indicate prevalence (i.e., the number of overall cases) will continue to rise (Ng et al., 2014). Once considered a 'disease of affluence', rapid increases in rates of overweight and obesity are now widely documented around the world, including in the poorest countries of sub-Saharan Africa and South Asia (Ng et al., 2014; Popkin, Adair, & Ng, 2012).

In a widely cited paper, Kopelman (2000, p. 635) urged that obesity should "… no longer be regarded simply as a cosmetic problem affecting certain individuals, but an epidemic that threatens global wellbeing". While some baulk at the phrasing of an 'obesity epidemic' (Basham, Luik, Jeffery, & Sherwood, 2008), obesity represents a leading cause of morbidity, disability and premature death, furthermore increasing the risk for a wide range of chronic diseases (Antonanzas & Rodríguez, 2010; Konnopka, Bödemann, & König, 2011; World Health Organization, 2009). In 2012, overweight and obesity were estimated to account for 3.4 million deaths, 4% of years of life lost, and 4% of disability-adjusted life-years (DALYs) globally (Lim et al., 2012). Elevated levels of body fat represent a risk factor for a myriad of illnesses including type 2 diabetes (Freemantle, Holmes, Hockey, & Kumar, 2008), cardiovascular disease (Asia Pacific Cohort Studies, 2004; Canoy et al., 2013), high blood pressure (Mathieu, Poirier, Pibarot, Lemieux, & Després, 2009; Rahmouni, Correia, Haynes, & Mark, 2005), osteoarthritis (Felson, Anderson, Naimark, Walker, & Meenan, 1988; Grotle, Hagen, Natvig, Dahl, & Kvien, 2008), and some cancers (Vucenik & Stains, 2012). Beyond the human cost of the high prevalence of overweight and obesity, there are also significant financial costs for society in terms of health care costs and government subsidies (e.g., disability pension, mobility and sickness allowance, and unemployment benefit) (Colagiuri et al., 2010).

1.3 Food Energy

1.3.1 Definition

Energy from food and beverages provides fuel for the body, so it can maintain homeostasis as energy is used throughout the day. Energy is expended through bodily functions, including metabolic processes, physiological functions, muscular activity, heat production, growth and synthesis of new tissues, as well as engaging in physical activity (National Health and Medical Research Council [NHMRC], 2006). According to the international system of units, energy is measured in kilojoules (kJ; 1000 joules), while an older unit, often used in food-related contexts, is the kilocalorie (kcal); 1 kcal is equal to 4.18kJ. The matter is further complicated since 'calorie' refers to two units of energy: small calorie (gram; 'cal') or large calorie (kilogram; 'Cal'), however in food-related contexts, the word 'calorie' is typically used to refer to kilocalories.

1.3.2 Energy Intake and Requirements

At the physiological level, energy intake is essentially promoted and controlled by the endocrine regulation of appetite, which involves a complex series of mechanisms such as the gut-brain axis and numerous circulating hormones, peptides and steroids; such as leptin, ghrelin, insulin, neuropeptide Y and peptide YY (Adam & Epel, 2007; Batterham & Bloom, 2003; Coll, Farooqi, & O'Rahilly, 2007; Holzer, Reichmann, & Farzi, 2012). Since the focus of this thesis is psychological in nature, the emphasis is on behavioural manifestations of appetite, particularly diet (Section 1.4.2). When foods and beverages are consumed, energy from them is released following digestion through a process of ‘oxidation’ (Alberts et al., 2002). The main sources of energy are carbohydrates, proteins, fats, and alcohol (Willett & Sampson, 2013). Energy density is the amount of energy per mass or volume of food. Allowing for intestinal absorption and for the nitrogenous parts of protein which cannot be completely oxidised, the average estimation of energy density ranges from approximately 16.7kJ/g (4kcal/g) for carbohydrates or protein, to 29.3kJ/g (7kcal/g) for alcohol, and 37.7kJ/g (9kcal/g) for fats (Food and Agriculture Organization, World Health Organization, & United Nations University, 2004).

The Australia New Zealand Food Standards Code (Food Standards Australia New Zealand, 2016) suggest 8,700kJ/day (2,080 kcal) as a reference level for recommended daily energy intake for adults. However it is important to note that energy intake requirements vary with age, gender, body size and activity levels (NHMRC, 2006). The average Australian man is 175.6cm tall, while the average Australian woman is 161.8cm (ABS, 2012). Assuming a healthy BMI of 22.0kg/m^2, with a mostly sedentary lifestyle (e.g., students, laboratory assistants; physical activity level [PAL] 1.6), the estimated energy requirements for a typical man aged 19-30 (using the closest published reference height and weight: 180cm, 71.3kg) is 11,800kJ/day (2,820kcal), while for a typical woman aged 19-30 (using the closest published reference height and weight: 160cm, 56.3kg) is 8,800kJ/day (2,100kcal) (NHMRC, 2006). Estimated energy requirements reduce with age. Using the same reference heights, weights and activity levels, the same man aged 31-50 would require an estimated 11,300 kJ/day (2,700kcal), while the same woman 8,700kJ/day (2,080kcal); the same man aged 51-70, 10,400kJ/day (2,480kcal), and same woman 8,300kJ/day (1,980kcal); and aged over 70 the same man would require an estimated 9,500kJ/day (2,270kcal), while the same woman only 7,400kJ/day (1,770kcal) (NHMRC, 2006).

1.3.3 Energy Expenditure

Energy expenditure can be divided into three main categories: (i) basal or resting metabolism, (ii) the thermogenic effects of food (i.e., heat increment of feeding), and (iii) the energy expenditure associated with physical activity (Blaxter, 1989; Speakman & Selman, 2003). The latter can be subdivided into energy that is used specifically for exercise, and energy that is not, i.e., non-exercise activity thermogenesis (NEAT). This NEAT category includes energy expended for activities other than sleeping, eating or sports-like exercise; and includes minor movements and general ambulatory activity (e.g., walking to work, typing, gardening, and fidgeting) (Levine, 2002; Speakman & Selman, 2003).

Basal metabolism refers to the energy required for the maintenance of a set of functions necessary for life, such as cell metabolism, synthesis and metabolism of enzymes and hormones, transporting of substances around the body, ongoing functioning of muscles including the heart, maintenance of body temperature, and brain function (NHMRC, 2006). The amount of energy an individual requires for this purpose over a defined period of time is called their basal metabolic rate (BMR). Resting metabolic rate (RMR) is a similar concept to BMR and reference to these terms can often be observed interchangeably, although BMR actually refers to a more precise measurement. RMR is often used in place of BMR as it is easier to measure, and values for RMR and BMR typically differ by less than 10% (Jennett, 2008). RMR is equivalent to the energy expended while sitting quietly and in epidemiological studies is often calculated as roughly equivalent to 1kcal per kilogram of body weight per hour (Matthews, 2002).

In terms of overall energy expenditure, RMR is quantitatively most important, representing about 45-70% of daily energy expenditure, depending on age, gender, body size and composition (NHMRC, 2006; Willett, 2013). Physical activity typically accounts for around 20% of energy expenditure, while the remaining 10% is attributed to thermogenesis (i.e., the amount of energy expenditure due to the cost of processing food for use and storage) (McArdle, 2007). While RMR typically accounts for the greatest amount of intrapersonal energy expenditure, physical activity is the most important determinant of between-person variation in total energy expenditure (Hu, 2013).

1.3.4 Energy Balance

The phrase ‘energy balance’ refers to the relationship between the quantity of energy consumed (input) through food and beverages, and the quantity of energy used by the body for daily functioning (i.e., basal metabolism and the thermogenesis) and physical activity (output). When input and output are balanced, the resulting energy balance is neutral and weight should remain stable over time (Figure 2.1). A negative energy balance occurs when energy intake is insufficient commensurate to the amount of energy expenditure, resulting in weight loss over time (Figure 2.2). At the most basic level, excess fat accumulation leading to overweight and obesity results from a sustained positive energy balance – that is, energy intake from food and beverages is greater than energy expenditure from daily functioning and physical activity (Figure 2.3) (Faith & Kral, 2006).

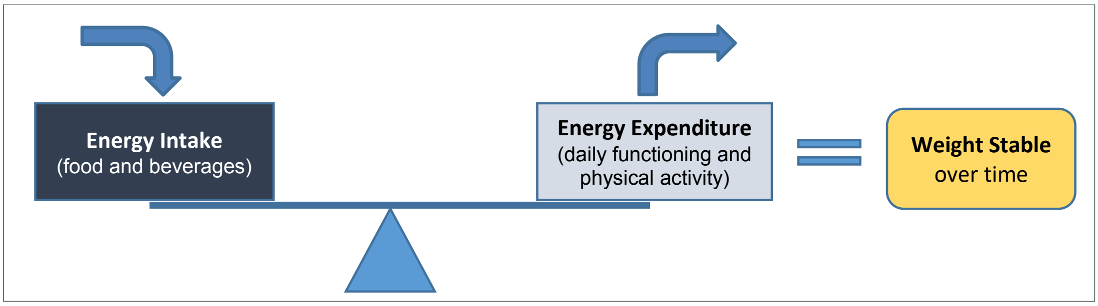

Figure 2.1. Neutral Energy Balance. When energy intake and energy expenditure are balanced, weight remains stable over time.

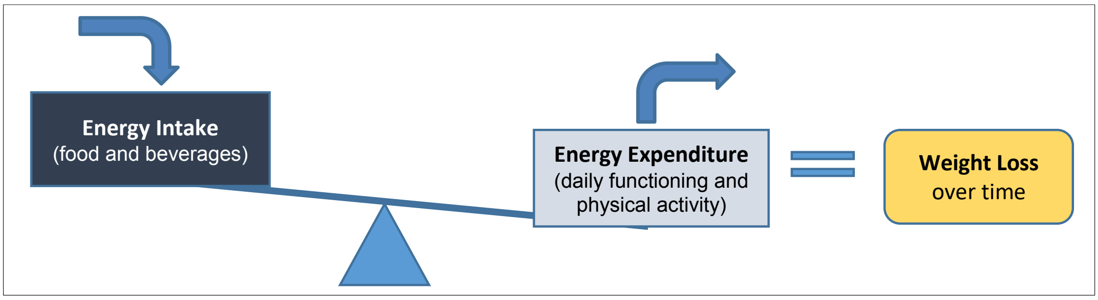

Figure 2.2. Negative Energy Balance. When energy intake is less than energy expenditure, weight loss occurs over time.

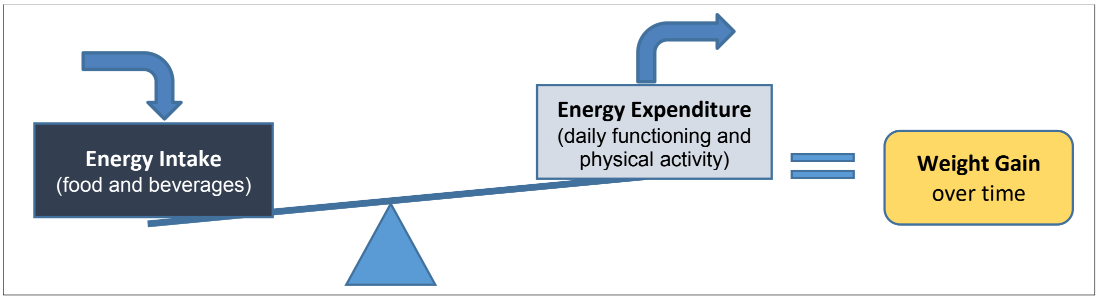

Figure 2.3. Positive Energy Balance. When energy intake is greater than energy expenditure, weight gain occurs over time.

1.4 Energy Balance-Related Behaviours

1.4.1 Definition

Energy balance-related behaviours include those on both sides of the energy balance, i.e., energy intake and energy expenditure (Te Velde et al., 2012). The relative importance of changes in energy intake versus energy expenditure associated with physical activity, in explaining fat accumulation, has been subject to considerable debate (Blair, Archer, & Hand, 2013; Hill & Peters, 2013; Luke & Cooper, 2013; Prentice & Jebb, 2004; Swinburn, 2013). Nonetheless, to fully understand the aetiology of obesity, it is important to consider both sides of the energy balance equation.

1.4.2 Eating and Dietary Intake

The study of eating behaviours and dietary patterns enables us to understand the energy intake arm of energy balance. Eating behaviours describe those related to eating; including modes, preferences, food choices and patterns of eating. Elsner (2002) describes eating behaviours as the "thoughts, actions, and intents that an organism enacts in order to ingest solids or liquids" (p. 18). It has been suggested that if eating was controlled simply by homeostatic mechanisms, most people would be around their ideal body weight, and eating would be considered to be like breathing; a necessary but unexciting part of life (Saper, Chou, & Elmquist, 2002). In reality, eating is a multi-sensory experience, and food choice and consumption are complex behaviours influenced by many factors (Sharp, Hutchinson, Prichard, & Wilson, 2013; Spence, 2015; Wansink, Painter, & North, 2005). Salient influences include: food attributes (e.g., appearance, taste and texture) (Levitan, Zampini, Li, & Spence, 2008; Zampini, Sanabria, Phillips, & Spence, 2007), environmental factors (e.g., cost and availability) (Jetter & Cassady, 2006), sociocultural factors (e.g., tradition, feasting and celebration) (Kolodinsky et al., 2008; Ulijaszek, 2007), physiological factors (e.g., satiety) (Bellisle, Drewnowski, Anderson, Westerterp-Plantenga, & Martin, 2012), and psychological factors (e.g., stress, self-efficacy, attitudes to food) (Babicz-Zielinska, 2006; Tomiyama et al., 2012).

Dietary patterns refers to "the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed" (United States Department of Agriculture, 2014, p. 2). There are a variety of methods for measuring diet, including short-term recall and diet records or journals; however, such methods are generally expensive (e.g., high data entry and processing costs) and unrepresentative of normal intake if only a short number of days are assessed (Willett, 2013).

The direct measurement of energy intake is impractical for large-scale research activities; instead, food frequency questionnaires (FFQs) are the primary method for measuring dietary intake in epidemiological studies. Basic FFQs comprise two components: a food list and a frequency response question for participants to report how often each food is eaten over the study period. Questions related to more detailed information about quantity and composition may also be used. The core principle of the FFQ approach is that average, long-term diet (e.g., months or years), is the more important construct, rather than intake over a specific short period. Compared to exacting dietary records, the FFQ approach sacrifices precise intake measurements for more crude information relating to an extended length of time (Willett, 2001, 2013). This may be especially pertinent for the study of obesity aetiology since excess fat accumulation occurs over time. FFQs are typically self-administered and are popular because they are easy for participants to complete and processing is often computer-automated, providing time and cost savings (Willett, 2013). Depending on the complexity of the questionnaire, researchers may be able to compute an estimate of specific nutrient intake as well as overall daily energy intake (e.g., kcal or kJ/day) (Willett, 2013). The term FFQ does not refer to a specific questionnaire; researchers may elect to develop their own questionnaire or use a pre-existing design, many of which are listed on the National Cancer Institute (2013) Dietary Assessment Calibration/Validation Register.

1.4.3 Physical Activity and Exercise

The WHO (2014) definition of physical activity as “any bodily movement produced by skeletal muscles that requires energy expenditure” is based on the noted work of

Caspersen, Powell, and Christenson (1985). The term ‘physical activity’ should not be confused with ‘exercise’, which is a specific type of physical activity that is “planned, structured, repetitive, and aims to improve or maintain one or more components of physical fitness” (WHO, 2014). Physical activity is a complex behaviour that presents measurement challenges owing to its many dimensions, such as type, duration, frequency, and intensity (Hu, 2013). As with dietary assessment, epidemiological studies are typically interested in long-term habitual patterns of physical activity. Broad categories of physical activity include ‘occupational’ (i.e., performed regularly as part of a person’s job), ‘leisure-time’ (e.g., exercise, recreation, or hobbies), ‘household’ (e.g., shopping, laundry, cleaning), and ‘transportation’ (Ainsworth et al., 2000).

An extensive overview of common methods for assessing physical activity and energy expenditure, including the strengths and limitations of approaches such as diaries, accelerometers, heart rate monitors, doubly labelled water, and indirect calorimetry, are provided in Hu (2013). Physical activity questionnaires are most commonly employed to assess levels of habitual physical activity in epidemiological studies since they are relatively inexpensive and impose low burden on participants. Although typically much shorter in form, physical activity questionnaires are analogous to FFQs in their objectives and time frames – that is, measurement of habitual or long-term patterns (i.e., over the past several months to one year) (Welk, 2002). Such questionnaires are designed to draw information on multiple dimensions of physical activities: type, frequency, duration and intensity (Welk, 2002). Despite their widespread use, it is important to acknowledge such questionnaires also have well-recognised limitations and are prone to both random and systemic errors (Shephard, 2003). For example, influenced by cultural and social desirability factors, participants tend to over-report their levels of physical activity (Shephard, 2003). The International Physical

Activity Questionnaire (IPAQ) has been developed to collect physical activity information in a standardised way across nations (Craig et al., 2003).

Physical activity may be classified as ‘aerobic’ (i.e., “requiring free oxygen”, colloquially referred to as ‘cardio’), or ‘anaerobic’ (i.e., “without oxygen”, also referred to as resistance or strength training). ‘Aerobic’ activity is typified as involving continuous motion, such as walking, jogging, cycling and swimming; whereas anaerobic activities, such as weight lifting, lead to increased muscle size and strength (Hu, 2013). Energy expenditure from physical activity depends on the duration and intensity of the activity. Intensity can be defined in either absolute or relative terms (Fletcher et al., 2001).

Metabolic Equivalent Tasks (METs) are commonly used to measure absolute intensity, providing an estimate of energy expenditure from the amount of oxygen required. The total physical activity for a person is often expressed as MET-hours per day or per week. One MET is quantified as 3.5ml of oxygen uptake per kilogram of body weight per minute, or roughly 1kcal per kilogram of body weight per hour (Hu, 2013). Accordingly, absolute physical activity energy expenditure can be calculated by multiplying MET-hour by RMR (i.e., the energy expended by sitting quietly) (Matthews, 2002). Since one MET is equivalent to RMR, one MET is approximately 60kcal/hour for a subject weighing 60kg. Despite the provision for taking into account a person’s weight, in practice, METs are typically used as relative measures of physical activity (to avoid confounding by body mass), meaning in epidemiological studies, all participants generally receive the same MET value for the same activity (Hu, 2013). According to a widely used compendium of MET values, one hour of running is equivalent to 7 METs and one hour of brisk walking is equivalent to 4 METs (Ainsworth et al., 1993; Ainsworth et al., 2000).

Relative intensity refers to “the relative percentage of maximal aerobic power that is maintained during exercise” (Fletcher et al., 2001, p. 25). Relative intensity is typically expressed as percentage of maximal oxygen uptake (VO_2 max), or percentage of maximum heart rate (HR max) (Welk, 2002). VO_2 max refers to the maximum amount of oxygen uptake during exercise expressed in millimetres (in one minute per kilogram of body weight) (Hu, 2013). There is a positive linear relationship between oxygen uptake and heart rate. Activities around 40% to 60% of VO_2 max are generally classified as moderate intensity and correspond to an absolute intensity of 4 to 6 METs for middle-aged persons (Hu, 2013).

An approximation of total energy expenditure from physical activity can be derived from questionnaire data. Assuming the thermogenic effects of food (i.e., the heat increment of feeding) account for 10% of total daily energy expenditure (McArdle, 2007), an estimate of daily energy expenditure from physical activity can be calculated as follows: physical activity energy expenditure (kcal/day) = (total daily energy expenditure x 0.9) – RMR (Hu, 2013).

The Physical Activity Level (PAL) is calculated as total energy expenditure divided by BMR, over a 24-hour period, and is a way of expressing total energy expenditure as a multiple of BMR. A mostly sedentary person (e.g., office worker getting little or no exercise) would have a PAL of around 1.40 to 1.69, whereas a moderately active person would have a PAL of around 1.70 to 1.99 (Food and Agriculture Organization et al., 2004). While the PAL measure is not often used in epidemiological literature, it is commonly used in literature pertaining to energy requirements (e.g., Section 1.3.2) (Hu, 2013).

1.5 Health Psychology

1.5.1 Definition

Research in psychology comprises the systematic study of mental processes and behaviour (Bargh & Ferguson, 2000). The field of health psychology is a sub-discipline encompassing both the theories and practice relating to the promotion and maintenance of health, the causes and detection of illness, the prevention and treatment or management of illness, and the improvement of health care systems and health policy (Matarazzo, 1980). Health psychologists specialise in understanding the relationships between psychological factors (e.g., thoughts, feelings, behaviours, attitudes, beliefs) and health and illness. There are two main domains of health psychologists: health promotion (i.e., research and promotion of healthy lifestyles and prevention of illness – e.g., this thesis) and clinical health practice (i.e., application of psychology to illness assessment, treatment, and rehabilitation) (Caltabiano & Ricciardelli, 2013; Lyons & Chamberlain, 2006).

1.5.2 Emergence of the Biopsychosocial Model

Central to the conceptualisation of health psychology is the biopsychosocial model, but to understand the context of its evolution it is important to first understand its predecessor: the biomedical model of health and disease, which has prevailed in medicine for over 200 years (Lyons & Chamberlain, 2006). Rooted in dualism, the biomedical model posits the body as separate from psychological and social processes of the mind (Lyons & Chamberlain, 2006; Martin et al., 2014). Furthermore, health and disease are seen as physical or biochemical in nature; as such, it suggests all disease and physical disorders can be attributed to disturbances in physiological processes arising from injury, biochemical imbalances, bacterial or viral infection, and so on (Lyons & Chamberlain, 2006). This reductionist approach has been highly valuable, yet the biomedical model has, to some extent, become a victim of its own success. At the beginning of the 20th century, people became ill and died primarily from acute illness; the leading causes of death were tuberculosis, pneumonia, influenza and diarrhoea (Johnson, 2013; Lyons & Chamberlain, 2006). The biomedical model is well-suited to infectious disease, and produced germ theory, which essentially facilitated the eliminated infectious diseases as the primary cause of death; propelling life expectancy in the United States from 47 years in 1900 to 77 years in 2000 (Centers for Disease Control and Prevention, 2003).

However, towards the end of the 20th century, the primary cause of illness and death shifted from acute to chronic illnesses (e.g., cardiovascular disease, cancers and diabetes) (Centers for Disease Control and Prevention, 2009; Donaldson, 2000; Johnson, 2013). These are sometimes referred to as ‘lifestyle diseases’, since everyday behaviour such as unhealthy diet, lack of physical activity, and smoking, place individuals at increased risk of developing these chronic illnesses. While the biomedical model has served as a useful framework for infectious diseases, it is not well-suited to the understanding of chronic illnesses which are multiply determined and implicate psychological, behavioural, and social factors in their development (Lyons & Chamberlain, 2006). Carroll (1992, p. 2) noted that “… to isolate disease and treatment as topics only for the attention of medicine and biology is to misunderstand the nature of most contemporary illness”.

The biopsychosocial model (Figure 3) was first described by George Engel in 1977 and constructed to acknowledge the dimensions missing from the biomedical model (Engel, 1977, 1980). It embodies a holistic approach to health and wellbeing, proposing that health (and illness) arise from the complex interplay of biological, psychological, and social factors (Martin et al., 2014). The model illustrates that each component can be understood as a ‘holon’, i.e., whole in themselves, and simultaneously part of other wholes (Koestler, 1967). In many instances, especially for chronic disease, a proper understanding of health or illness cannot be obtained without acknowledging significant overlap between these influences

(Green & Johnson, 2013). For example, biological factors such as age and genetic predisposition, behavioural factors such as smoking, and social conditions such as social support or cultural norms, may all contribute to the development and management of chronic illness such as cardiovascular disease.

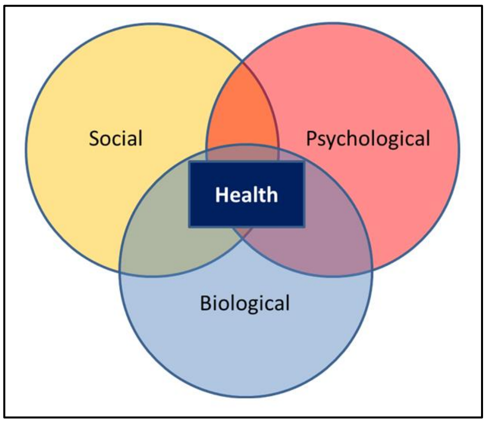

Figure 3. Venn Diagram of the Biopsychosocial Model. Adapted from Green and Johnson (2013). Health or illness is placed in the centre of the model and is understood to be inextricably linked to biological, psychological, and social influences working interactively.

1.5.3 Causation and Systems Thinking in Health and Illness

In the most general sense, to give the cause of something is to say why it is the way it is; i.e., 'cause and effect' (Mackie, 1980). Causal knowledge is an indispensable element in science, since causal assertions are embedded in both the results and the procedures of scientific investigation (Mackie, 1965). Mackie (1980) provides a worthwhile discussion of the meaning of causal statements and ways in which we arrive at casual knowledge. Crane (2013, p. 5) introduces the complexity of cause and effect using the example of Julius Caesar's untimely death:

> *"The cause of Caesar's death was that his heart stopped; but he also died because he was stabbed; if he had been strong as an ox maybe he would have been able to escape his assassins; and maybe he also died because he was ambitious. What general reason is there to think that every event has only one immediate cause?"*

In understanding health and illness, few chronic diseases could be interpreted as "one microbe, one illness" in nature; instead, there are typically multiple interacting causes and contributing factors (Borrell-Carrio, Suchman, & Epstein, 2004, p. 576). This is illustrated in an example outlined by Borrell-Carrio et al. (2004): over time obesity may lead to both diabetes and arthritis; both obesity and arthritis restrict physical activity, in turn adversely affecting blood pressure and cholesterol levels; and all of these, (with the possible exception of arthritis), contribute to both stroke and coronary artery disease. Furthermore, some of the effects, such as depression after a heart attack or stroke, can then become causal contributors – such as via changes in health behaviours, increasing the likelihood of a second similar event (Whooley et al., 2008). Such observations call for models of circular causality, which can describe how a series of feedback loops may sustain a specific pattern of behaviour over time (Mackie, 1965). 'Complexity science' refers to a new approach to science and efforts to understand these complex recursive and emergent properties of systems (Bar-Yam, 2002; Borrell-Carrio et al., 2004).

In contrast to the circular view, structural causality describes a hierarchy of unidirectional cause and effect relationships (Borrell-Carrio et al., 2004). This approach requires necessary causes, precipitants, sustaining forces, and associated events, and is most compatible with the biomedical model. For example, a necessary cause for tuberculosis is a mycobacterium, a precipitant may be low body temperature, and low caloric intake may be a sustaining force. Borrell-Carrio et al. (2004) state that while complexity science can help facilitate understanding and is especially useful for guiding epidemiological research, in a clinical situation a structural model is typically what guides practical action. However, this idea may be partly due to the dogmatic pervasiveness of the biomedical model (Wade & Halligan, 2004), since as discussed in Section 1.5.4, such structural causation models are not well-suited to the understanding of chronic or 'lifestyle' diseases.

The intuitive Venn representation (Figure 3) is a popular tool for introducing the concept of the biopsychosocial model; however it is also an oversimplification of Engel's vision of a systems approach to understanding health and illness (Engel, 1980). Inspired by the earlier works of Weiss and von Bertalanffy, Engel (1980) notes that nature can be observed as an ordered hierarchical continuum of systems, which can be represented schematically in a vertical stack to emphasise the hierarchy (Figure 4), or using a nest structure (Figure 5) to emphasise the continuum. Engel (1980) states that there are actually two hierarchies: the single individual (person) represents the highest level of the organismic hierarchy, while simultaneously representing the lowest unit of the social hierarchy. Engel (1980, p.537) stresses that "… nothing exists in isolation. Whether a cell or a person, every system is influenced by the configuration of the systems of which each is a part, that is, by the environment". As with the Venn diagram of the biopsychosocial model (Figure 3), in this more elaborate systems representation (Figures 4 and 5), each level or system can be understood as whole in themselves, and simultaneously part of other wholes or systems, all interacting as a component of a higher-level system.

Each level of the hierarchy represents a system of sufficient persistence and uniqueness to warrant its own title, and each system or level features distinctive qualities and relationships; furthermore, each level requires unique criteria for its study – the training and methods used for the study of cells is clearly different to those required for the study of a person's behaviour or community features. Perhaps as an insurance against the overwhelming prospect of this systems approach, Engel (1980, p.537) suggests "in scientific work the investigator generally is obliged to select one system level on which to concentrate, or at least at which to begin, [their] efforts… [yet] the systems-oriented scientist will be aware that the task is always a dual and complementary one" (i.e., to work at one level while at the same time appreciating the greater context).

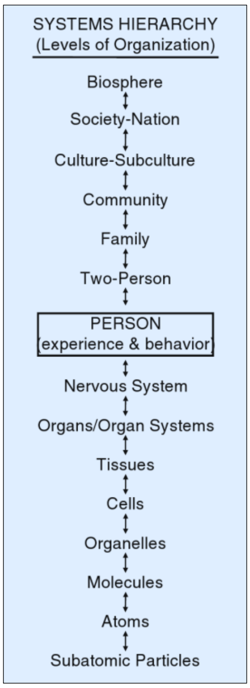

Figure 4. Hierarchy of Natural Systems. Adapted from Engel (1980). Each level in the hierarchy represents an organised dynamic whole, while simultaneously a component of a higher system. As a hierarchy, more complex, larger units are superordinate to the less complex, smaller units.

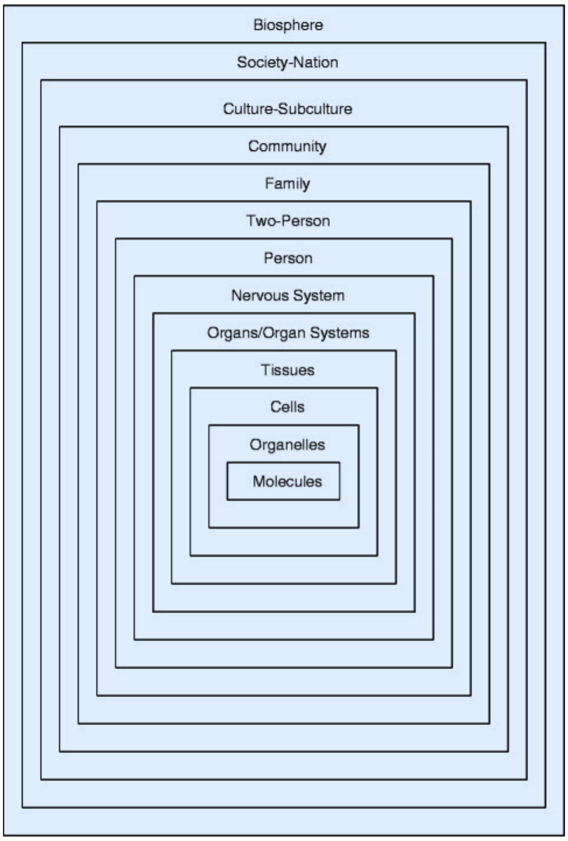

Figure 5. Continuum of Natural Systems. Adapted from Engel (1980). Each level in the continuum represents an organised dynamic whole. The continuum depiction emphasises that each level is simultaneously a component of a higher system.

1.5.4 Criticisms and Enduring Value of the Biopsychosocial Approach

The biopsychosocial model has been a chief influence in the establishment and development of health psychology, but it has also received considerable criticism, and debate as to whether the biopsychosocial approach is really a model or just a theory (Green & Johnson, 2013). Álvarez, Pagani, and Meucci (2012) praised the contribution of the biopsychosocial model as a perspective and an approach to clinical practice, but bemoaned its deficiencies as a clinical-decision making model or clinical method. Chur-Hansen and Koopowitz (2002, p. 305) state that while the model receives frequent “lip service” in psychiatry, it is rarely realised in teaching or clinical practice. McManus (2005, p. 2169) suggested the need for biopsychosocial medicine to transcend the vague and aspirational inclusivity of its name, and to create a more practical model; "… arm-waving and the inclusion of everything ultimately says and does little of practical consequence". Gatchel and Turk (2008, p. 2831) argue criticisms of the biopsychosocial model have been largely overblown and are akin to "creating and then attacking a straw person". Green and Johnson (2013) suggest that the biopsychosocial model is better interpreted as a theory rather than a model, but defended the biopsychosocial approach, asserting that is not intended to account for the shortcomings of all other theories or models; instead it simply provides another way to understand the interactions between variables that affect health. Marks (2002) similarly argues that the biopsychosocial model is best understood as a way of thinking about health and illness which functions heuristically to justify and legitimate research. Suls and Rothman (2004, p. 119) echo these sentiments, stating that "as a guiding framework, the biopsychosocial model has proven remarkably successful as it has enabled health psychologists to be at the forefront of efforts to forge a multilevel, multi systems approach to human functioning", but also caution that it should be considered a work in progress.

Engel's (1977, 1980) pioneering application of a systems thinking and holistic approach to understanding of health and illness provide the foundation for the development of disease–specific aetiological models. Through the biomedical lens, our understanding of the aetiology of obesity primarily rests at the cause and effect implication of positive energy balance. The core principles of the biopsychosocial model represent the genesis for far more advanced ecological models of disease such as the UK Government Office for Science's Foresight obesity system map – discussed in upcoming Section 1.6.3.

1.6 Beyond Positive Energy Balance: The Greater Context of Obesity

1.6.1 Shortcomings of Current Approaches: Diets and Exercise are not the (Whole) Answer

The consequences of obesity, as discussed in Section 1.2.2, provide an overwhelming impetus for reducing both the incidence and prevalence of obesity. In spite of this, effective and sustainable strategies remain elusive at both policy and individual levels (Booth, Prevost, Wright, & Gulliford, 2014; Cooper et al., 2010; Fildes et al., 2015; Gill et al., 2010; Katan, 2009; Mann et al., 2007). Typical approaches to reducing levels of overweight and obesity focus on encouraging individuals to reduce their food portions, choose less calorie-dense substitutes, and increase rates of physical activity (i.e., correct the positive energy balance) (Gill et al., 2010; Hutchinson & Wilson, 2012). The Australian Government's (2013) 'Shape Up Australia' public health campaign is characteristic of such attempts – a central message of which is "unhealthy eating and not enough physical activity can lead to overweight and obesity" (Australian National Preventive Health Agency, 2013, p. 1). While these approaches are well intentioned, in light of the increasing prevalence of overweight and obesity both internationally and domestically, they appear to be largely ineffective. Globally, not one country has reported significant decreases in obesity prevalence over the past three decades (Ng et al., 2014). Simply telling people to "eat less, move more" does not work because such messages fundamentally ignore the greater context.

Restricting dietary energy intake and/or engaging in increased physical activity can lead to a negative energy balance, leading to weight loss over time (Jeffery, Wing, Sherwood, & Tate, 2003; Sacks et al., 2009). However, maintaining lifestyle change and weight loss is very difficult in the context of an 'obesogenic environment' (discussed in Section 1.6.2). Following analyses of 31 long-term studies, Mann et al. (2007) found that many calorie-restricting diets can produce short-term results: dieters can typically lose 5 to 10% of their body weight, however the majority regain the lost weight within four to five years, and one to two thirds regain more weight that they had initially lost. In other words, calorie-restricting diets can produce weight loss, however this weight loss is typically not sustainable over time. Similarly, exercise interventions for weight loss can be effective if sustained, however long-term adherence is typically poor (Linke, Gallo, & Norman, 2011). Commonly cited barriers to regular exercise include perceived lack of time and lack of access to suitable facilities (Linke et al., 2011; Trost, Owen, Bauman, Sallis, & Brown, 2002; Wendel-Vos, Droomers, Kremers, Brug, & Van Lenthe, 2007).

While diet and exercise comprise the cornerstones of current approaches to treating obesity, these approaches assume such individual lifestyle changes are a generally accessible and valid option; however, in reality they have been shown to be largely ineffective in preventing the obesity epidemic (Bray, 2004). An interesting alternative is the 'fluoride hypothesis for obesity', which suggests changes can be made in the environment which will reduce the epidemic of obesity, in a similar way as fluoridation of water supplies reduced the incidence of dental disease (Bray, 2004). In other words, 'fluoride-like' strategies could work to produce meaningful improvements at a societal level, without the personal effort associated with conscious changes in individual lifestyle.

1.6.2 Obesogenic Environment and Putative Contributors

Despite the majority of adults in many parts of the world, including Australia, the United Kingdom, and the United States, being classified as overweight or obese, it seems they find no "majority privilege [in being]…fat" (Incollingo Rodriguez, Tomiyama, & Ward, 2015, p. 1030). It is a commonly held view that overweight and obese individuals are responsible for their weight (Jou, 2014). Moreover, overweight and obesity are often associated with perceptions of low competence (Levine & Schweitzer, 2015). Weight stigma and bias has been demonstrated in a variety of domains, such as in popular media (Puhl, Moss-Racusin, Schwartz, & Brownell, 2008), among health professionals (Tomiyama, Finch, Belsky, et al., 2015), and in the workplace (Giel, Thiel, Teufel, Mayer, & Zipfel, 2010). Views that are generally biased towards individual responsibility fail to adequately acknowledge the wider context and the pervasive obesity promoting effects of modern societies, often referred to as 'obesogenic environments' (Brownell, 2005; Zimmet et al., 2011).

While positive energy balance represents the biological mechanism (i.e., the 'how'), it cannot explain the aetiology of obesity (i.e., the 'why'), since energy imbalance occurs within the context of environmental, social, cultural, and genetic factors (Faith & Kral, 2006; Wadden, Brownell, & Foster, 2002). Preeminent obesity researcher Albert Stunkard (1959, p. 294), recognised early on the benefits for advancing understanding of obesity if it were "… found to represent, not one disease, but the end stage of a variety of different conditions with differing aetiologies". It is often suggested that progressive improvements in the standard of living in developed and developing countries, including the abundance of enticing, cheap and calorie-dense food (Finlayson, King, & Blundell, 2007), have resulted in widespread over-nutrition coupled with sedentary lifestyles and an evolutionary physiological heritage that is maladaptive in these contexts (Bray, 2004; Ulijaszek, 2007). Tom Frieden, Director of the Centers for Disease Control and Prevention, has been quoted as saying "… if you go with the flow in America today, you will end up overweight or obese" (Ambinder, 2010, p. 72). Furthermore, Brownell (2005, p. 433) states "… in the absence of a 'toxic' food and physical activity environment, there would be virtually no obesity".

While a small number of individuals may be genetically predisposed to overweight or obesity, the rapid rise in prevalence over the past 30 years appears largely the result of environmental, social and cultural influences, rather than changes in the genetic endowment of the population (Flier & Elmquist, 2004). From an epigenetic perspective, it is important to consider the potential for the environment to influence the expression of genes – as such, the contribution of genetics cannot be dismissed, although our understanding is limited since the field of epigenetics is still largely in its infancy (Jebb, Kopelman, & Butland, 2007). Emerging evidence suggests the influence of genes on BMI is moderated by individual and macro-level measures of socioeconomic status, whereby genetic factors appear less influential at high levels of socioeconomic status (Dinescu, Horn, Duncan, & Turkheimer, 2015). There is great complexity in attempting to untangle these effects since "… choice of lifestyle for the population at large, or individuals, is neither a pure product of genetics nor freewill, but a melting pot, heated and stirred by the influence of the wider environment" (Jebb et al., 2007, p. vii).

With regard to putative contributors of obesity, McAllister et al. (2009) and Keith et al. (2006) lament the 'hegemony of the big two': (i) marketing practices of energy-dense foods, and (ii) institutionally-driven declines in physical activity; the two most commonly suggested reasons for increases in the prevalence of obesity. While acknowledging that both most likely contribute to obesity, McAllister et al. (2009) and Keith et al. (2006) question their dominance in program funding and public efforts to reduce obesity. Keith et al. (2006) presented evidence in support for ten additional putative contributors for the increased prevalence of obesity. These are: 1. insufficient sleep, 2. endocrine disruptors (e.g., pesticides), 3. reduced variability in ambient temperature (i.e., increased prevalence of air-conditioning), 4. decreased rates of smoking (smoking suppresses appetite), 5. increased use of medications associated with weight gain (e.g., atypical antipsychotics), 6. proportional increases in age groups and ethnicities that tend have more obesity, 7. later age of pregnancy (may increase risk for children), 8. intrauterine and intergenerational effects (e.g., differences in fetal nutrition associated with placental factors in obese mothers), 9. greater fecundity among those with obesity, and 10. assortative mating (i.e., tendency for individuals with similar genotypes and/or phenotypes to mate with one another). This list goes some way to demonstrate the extent of the broader potential contributors to the obesity epidemic; however it is in no way all-inclusive. Novel findings continue to emerge, such as the potential role of gut microbiota in metabolic abnormalities (Nieuwdorp, Gilijamse, Pai, & Kaplan, 2014; Suez et al., 2014), and the potential behavioural influence of different types of television programs (e.g., exposure to weight-loss reality television) (Bourn, Prichard, Hutchinson, & Wilson, 2015). Keith et al. (2006) suggest the disproportionate attention paid to food marketing practices and reduced physical activity has led to the relative neglect of other plausible mechanisms, and the production of well-intended but likely ill-founded proposals for reducing obesity rates.

1.6.3 Systems Perspective of Obesity Aetiology

A variety of conceptual models have been developed in attempts to illustrate the complex aetiology of obesity (Bray, 2004; Kumanyika, 2001). One of the most comprehensive and complex models is the obesity system map produced by the Foresight Programme of the UK Government Office for Science (Figure 6) (Butland et al., 2007). The purpose of this system mapping is to demonstrate how factors in the wider system impact on the core balancing loop, and in the case of obesity, create a systemic bias towards the accumulation of energy. The Foresight report authors use Wilson's (1990, p. 24) definition of a system: "a structured set of objects/or attributes together with the relationships between them". In this sense, the Foresight obesity system is pragmatically defined as the "collection of all the relevant factors and all their interdependencies that determine the energy balance for an individual or group of people" (Butland et al., 2007, p. 151).

The obesity system map represents a causal loop model and aims to improve insight into the underlying structure of the complex aetiology of obesity. Within this map, system elements (i.e., factors or variables) are represented by boxes, and the causal relationships between two variables are represented by arrows, where the variable at the tail of the arrow has a causal effect on the variable at the point. The qualitative model features 108 variables, some measureable (e.g., ambient indoor temperature), while others are less easily quantified (e.g., desire [for producers] to differentiate food offerings). The extent of relationships between the system variables are illustrated using over 300 solid or dashed lines, indicating positive and negative influences respectively. Notably, all variables are interconnected; some have many inputs, while others have many outputs.

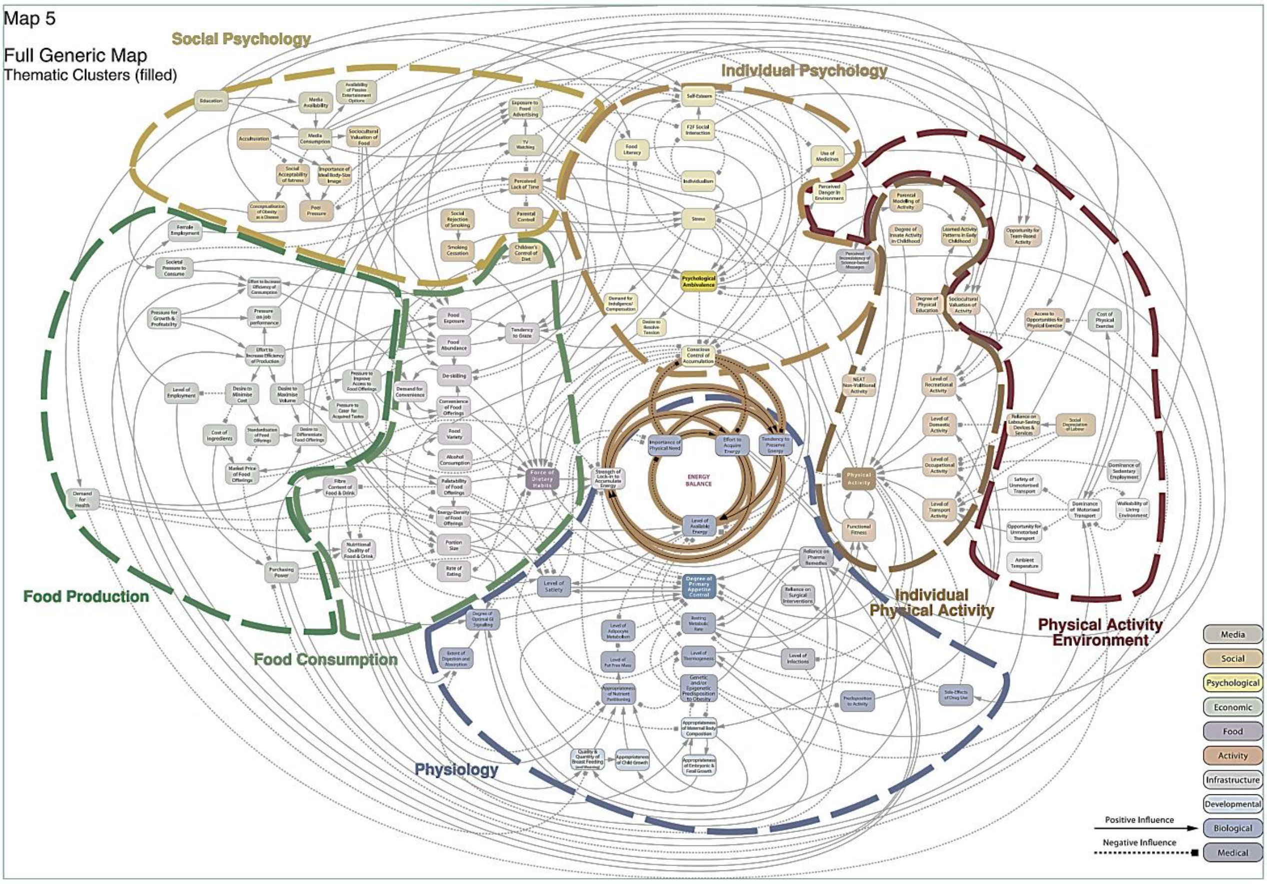

Figure 6. Obesity System Map. Adapted from Foresight report (Butland et al., 2007), and provided here as a heuristic illustration of the complex context of obesity development and maintenance. Energy balance is in the innermost centre and shown to be tangled in a web of distal and proximal causal factors. Consult p.84 of Foresight report to see full-size (A3) map.

The map contains seven interconnected key themes or subsystems, the salient features of which are outlined in Table 1. An important example of the possible consequences of this interconnection is provided in the way individuals who undertake exercise may display compensatory behaviour such as allowing themselves energy-dense snacks as a 'reward'. While its image serves as a heuristic tool to reinforce the complexity of obesity aetiology (Figure 6), it is clearly difficult to reproduce the original Foresight map due to its sheer size. Consequently, Finegood, Merth, and Rutter (2010) have produced a condensed version using the seven thematic clusters where the number of connections between and within each thematic cluster is represented by the thickness of the connecting clines and cluster boarders (Figure 7).

Table 1 *Thematic clusters within the Foresight obesity system map*

Cluster	Salient Features
Physiology	A mix of biological variables, including genetic and/or epigenetic predisposition to obesity, hormonal and metabolic activities, side effects of medications, and level of satiety. An important feature is a reinforcing loop that endeavours to preserve the appropriate body composition from one generation to another.
Individual Activity	Variables related to an individual's or group's level of recreational, domestic, occupational and transport activity. Includes consideration of parental modelling, functional fitness and NEAT non-volitional activity.
Physical Activity Environment	Variables which may encourage or discourage physical activity, including perceived safety of the environment, costs of physical activity, labour-saving devices, dominance of sedentary employment, ambient temperature, and sociocultural valuation of activity.
Food Consumption	Includes features of the food market, such as food abundance, nutritional quality of food and drink, energy density of food, and portion size. Also includes variables such as rate of eating, force of dietary habits and tendency to graze.
Food Production	A variety of characteristics of the food industry, including desire to minimise costs, differentiate offerings, maximise volume, and pressure for growth and profitability.
Individual Psychology	Contains a number of personal psychological variables including self-esteem, stress, desire to resolve tension, demand for indulgence, and level of food literacy.
Social Psychology	Captures variables that have influence on a societal level, including sociocultural valuation of food, social acceptability of fatness, acculturation, media consumption, television watching, and perceived lack of time.

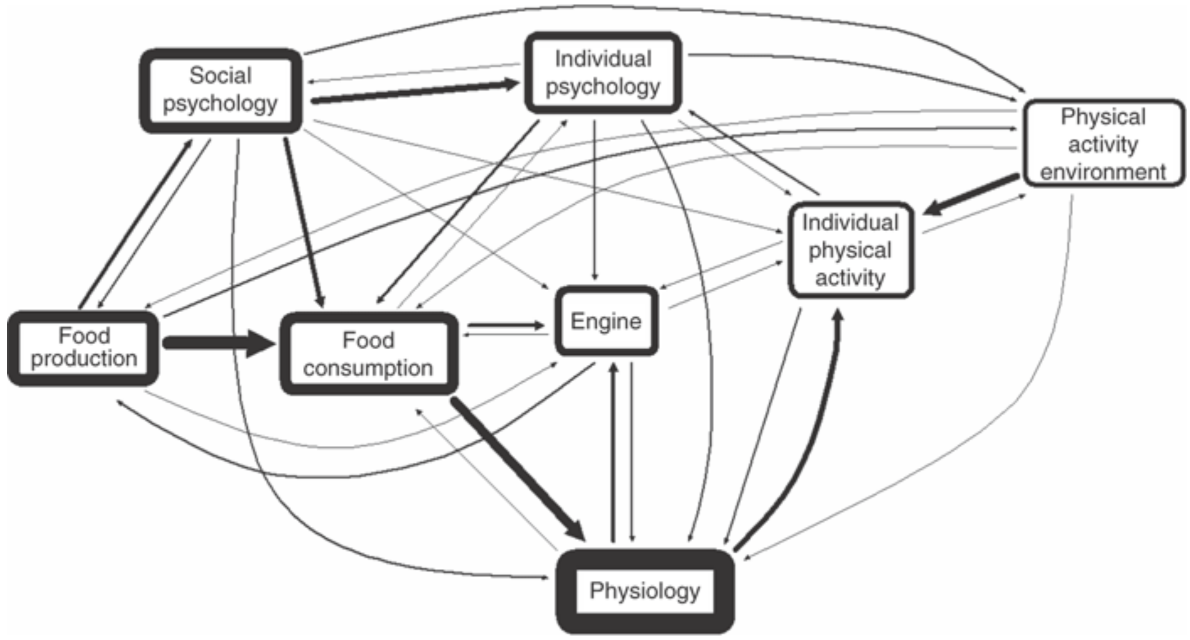

Figure 7. Condensed Obesity System Map. Reproduced from Finegood et al. (2010). The number of individual connections between variables in each cluster is represented by the thickness of the connecting lines. Each cluster's border thickness represents the number of connections within it. Energy balance is encapsulated within the centre 'engine'.

The system map features both positive and negative causal relationships. A positive causal relationship implies that both variables will move in the same direction; whereas a negative relationship implies that as one variable increases, the other will decrease, and vice versa. Feedback loops are another important part of the system. These feedback loops may be reinforcing (i.e., positive) or balancing (i.e., tending negative) in nature. Reinforcing loops capture exponential growth, while balancing loops encourage the system towards equilibrium. An example of a reinforcing loop: if there is an increase in consumer demand for convenience, food manufacturers are likely to respond by increasing the convenience of their food offerings (owing to pressure for growth and profitability). If consumers then habituate themselves to these convenience offerings, personal cooking skills will likely diminish. Therefore an increase in the convenience of food offerings contributes to the loss of cooking skills, and in turn increases the demand for convenience products. This feedback loop continues until compromises on taste or price soften the dynamic. An example of a balancing loop: when an individual's level of available energy is depleted, they will experience a physical need for energy. The greater the energy need, the more effort is invested in acquiring energy or preserving existing energy. Consequently, higher levels of available energy dampen the physical need for energy, and so the system remains in equilibrium.

The 'whole systems' view of the determinants of energy balance provided by the Foresight map represents the most comprehensive of its kind to date. Still, the authors note that additional work is needed to continue to update and refine the map as a strategy development tool for policy making and other potential users. The Foresight map does not specify stress at work, however the thematic clusters most relevant to this thesis include: individual activity (includes occupational activity), food consumption (includes energy density of food and force of dietary habits), individual psychology (includes stress), and social psychology (includes perceived lack of time).

The ambitious goal of the Foresight obesity map was to provide "the sum of all the relevant factors and their interdependencies that determine the condition of obesity for an individual or a group of people" (Vandenbroeck, Goossens, & Clemens, 2007, p. 2). While the notion of demonstrating "*all* the relevant factors" is surely overambitious, the map does effectively highlight and reinforce the complexity of obesity – presenting it as an emergent property of a complex system and subject to widely diverse influences (Finegood et al., 2010).

1.7 Stress and Health

1.7.1 Definition and Conceptualisation

The human experience of stress as discussed in this thesis may be generally understood as the response of the mind and body, following the appraisal of real or perceived, threats or demands of a situation, or features of the environment (Folkman, 2011). A 'stressor' refers to a stimulus or situational interaction that may evoke a potential stress response. Defining and conceptualising stress as a phenomenological construct presents many challenges – attempts to do so reveal it to be a multifaceted and 'slippery' construct (Keil, 2004; Lobel & Dunkel Schetter, 1990). In spite of these challenges, stress has dominated research on the psychology–disease relationship (Caspi et al., 2003; Chrousos & Gold, 1992; Cohen, Kamarck, & Mermelstein, 1983; Maslach, Schaufeli, & Leiter, 2001; Shonkoff et al., 2012). It is commonly acknowledged that stress is a ubiquitous part of modern life, and there is evidence to suggest relatively high societal perceptions of stress in recent times (American Psychological Assocation, 2015; Casey & Pui-Tak Liang, 2014; Health and Safety Executive, 2014; Lobel & Dunkel Schetter, 1990).

While stress is generally referred to with a negative connotation, it is not categorically noxious. Eminent stress researcher Hans Selye (1979, p. 6) was well aware of the potential for stress to be implicated in the cause of disease, suffering and death; yet he also advocated the duality of the construct, urging "stress is the spice of life: it can be a great stimulus to achievement". This positive type of stress, or more accurately response to stress, is referred to as 'eustress', while its destructive counterpart is referred to as 'distress' (Selye, 1956). These ideas were advanced by Lazarus (1966) who defined eustress as a positive cognitive response to stress that is healthy, or provides feelings of fulfilment or other positive experience. In recent decades, there appears to have been a semantic shift from the understanding of stress as an important and inevitable part of life to its use as synonym for distress (Le Fevre, Matheny, & Kolt, 2003). Furthermore, some authors assert the concept of eustress has been largely ignored in contemporary literature (Kupriyanov & Zhdanov, 2014; Le Fevre et al., 2003). While the concept of eustress is somewhat aligned with renewed interest in optimal human functioning, concurrent with emerging popularity of positive psychology (Seligman & Csikszentmihalyi, 2000), psychology and related fields have been predominately oriented to the negative aspects of stress (Dunkel Schetter & Dolbier, 2011).

Arousal describes the physiological and psychological state of awareness, where a person is awake or alert to stimuli, and plays an important role in regulating attention and information processing (Pfaff, 2006). An increase in arousal is both a bodily and cognitive response to the perception of stress (Jamieson, Nock, & Mendes, 2012). The concept commonly referred to as the ‘Yerkes-Dodson law’ (Yerkes & Dodson, 1908), suggests that there is an inverted ‘U’-shape’ relationship between arousal and performance. The law states that the optimal stress or arousal state decreases with increasing task difficulty (Hebb, 1955; Teigen, 1994). While the validity of this ‘law’ has been challenged (Jensen & Toates, 1997; Robbins, 1997), as a descriptive shorthand, it draws attention to the question of why and how performance fluctuates when animals are exposed to stressful stimuli (Mendl, 1999).

A highly important distinction in the conceptualisation of stress is that between ‘acute stress’, which describes stress which is experienced in the short term, and elicits a short-term response and effect; and ‘chronic stress’ which describes stress which is experienced over the longer term and is characterised by prolonged effects. The implications of these differences are discussed further in the following section.

1.7.2 Basic Biology of Stress

Homeostasis comprises various processes which endeavour to preserve the stability of the body's internal environment (i.e., system default) in response to changes in external conditions (Cannon, 1932). These efforts involve multiple automatic inhibition mechanisms (i.e., negative feedback or equilibrating responses) to suppress disquieting influences; ultimately some influences can be controlled and others cannot (West, 2010). In a bodily sense, ‘stress’ may be defined as a state of threatened homeostasis. An intricate repertoire of biological and psychological responses is activated under stressful situations, which endeavours to provide an adaptive (i.e., helpful) stress response, aimed at re-establishing the challenged system equilibrium (Kyrou & Tsigos, 2007).

Acute stress is commonly associated with the ‘fight or flight’ response, first coined by Cannon (1915). This response essentially describes how animals respond to the perception of acute stress with a general discharge of the sympathetic nervous system, which primes the body for fighting or fleeing (e.g., running away from the stressor). This response represents the ‘anti-shock’ phase of the initial stage (‘alarm’) in the three stage General Adaptation Syndrome (GAS) model (Selye, 1978). Following the perception of a stressful event, a surge of activities are evoked in the nervous, cardiovascular, endocrine, and immune systems (Schneiderman, Ironson, & Siegel, 2005). The second and most active stage of the GAS model is ‘resistance’, where arousal soars, along with efforts to actively cope with the stressor, this stage is characterised by increased secretion of glucocorticoids (particularly cortisol), intensifying the systemic response and level of resistance to the stressor. Observable effects typically include increased heart rate, dilated pupils, tunnel vision, shaking, dry mouth, bladder relaxation, and slowed digestion (Boyle, 2002). In the context of an acute stressor (i.e., short term), these biological effects are generally adaptive as they are geared towards immediate self-preservation.

Stress hormones are produced in unison by the sympathetic nervous system (SNS) and the hypothalamic-pituitary adrenocortical (HPA) axis. The SNS stimulates the adrenal medulla (the innermost part of the adrenal gland – part of the endocrine system located above the kidneys) to produce catecholamines (e.g., epinephrine), while the paraventricular nucleus of the hypothalamus (a portion of the brain located below the thalamus, part of the limbic system) produces corticotropin-releasing factor (CRF), stimulating the pituitary (an endocrine gland protruding off the bottom of the hypothalamus) to produce adrenocorticotropic hormone (ACTH), which then stimulates the adrenal cortex (located along the perimeter of the adrenal gland) to secrete cortisol. Catecholamines and cortisol work together to temporarily increase sources of available energy by converting glycogen (i.e., glucose reserves predominately found in liver and muscle cells) to free energy/glucose (i.e., blood sugar). Another strategy used to increase available sources of energy is lipolysis, which involves breaking down fats into useable sources of energy. Elaboration of these processes are beyond the scope of this thesis but are illustrated in greater depth elsewhere (Adam & Epel, 2007; Incollingo Rodriguez, Epel, et al., 2015; Preedy, 2012; Schneiderman et al., 2005).

In addition to 'ramping-up' availability of free energy, non-immediately essential processes such as digestion are paused during the active phase of the acute stress response to improve system efficiency and concentrate performance. This diversion of energy is facilitated by increasing blood pressure through one of two distinct hemodynamic mechanisms: (i) myocardial (i.e., increased cardiac output) or (ii) vascular constriction (i.e., narrowing of blood vessels, thereby increasing blood pressure – akin to how squeezing a hose increases water pressure) (Schneiderman et al., 2005). There is some evidence to suggest specific situational parameters of a stressor are associated with which hemodynamic mechanism is employed (i.e., situational stereotypy) (Saab et al., 1992; Saab et al., 1993). Stressors that require active coping (i.e., require an individual to do something) are associated with myocardial responses, whereas stressors which require more vigilant coping strategies (e.g., viewing a distressing video) tend to be associated with vascular response

(Schneiderman et al., 2005). These mechanisms demonstrate some of the ways that stress 'gets under the skin'.

This second stage of the GAS model is physically and psychologically taxing, and resources become depleted over time, leading to the final stage in the model. This stage may either be best described as 'exhaustion' or 'recovery', depending on how effectively the stressor was handled in the resistance stage. The main difference being that exhaustion implies decompensation (i.e., some irrecoverable deterioration). Either way, assuming the organism has survived the stressor, the parasympathetic nervous system (PNS or PSNS) (located in the spinal cord and the medulla/hindbrain) is called into action, and attempts to restore homeostasis by counteracting the effects of the SNS, through restorative 'rest and digest' functions (McCorry, 2007). If stress is acute, the multi-stage bodily response is generally considered adaptive and contained, but if stress is unrelenting or chronic, the extended bodily response is generally considered maladaptive and deleterious as the body is fighting an 'uphill battle' as it struggles to restore homeostasis; effects are especially noted for older people or people who have impaired immunity (Schneiderman et al., 2005).

While the acute stress response can be defined somewhat clearly, the chronic stress response remains comparatively abstract. Traditionally there has been a disproportionate focus on the study of specific and acute stressors and less on chronic stress (McEwen & Stellar, 1993; Thoits, 2010). However, a growing body of evidence suggests that it is chronic stress that is most hazardous (Thoits, 2010); associated with increased vulnerability to diet-related metabolic risk (e.g., abdominal adiposity, insulin resistance) (Aschbacher et al., 2014), depression (Hammen, 2005), and poorer prognosis for cancer (Reiche, Nunes, & Morimoto, 2004), and heart disease (Maddock & Pariante, 2001). Exposure to chronic stress also appears to change subsequent HPA reactivity to acute stressors (Roth et al., 2012). Furthermore, the experience of chronic stress is the most common explanation for how adverse work environments contribute to disease in employees (Taylor, Repetti, & Seeman, 1997).

‘Allostasis’ refers to an alternative conceptualisation of the processes outlined in to the GAS model, and represents a more general description of the collective processes that endeavour to maintain stability or homeostasis, through physiological or behavioural change (Juster, McEwen, & Lupien, 2010). Where the GAS model is best suited to illustrating the acute stress response, allostasis is better suited to illustrating chronic responses to stress. ‘Allostatic load’ refers to the ‘wear and tear’ caused to the body from repeated activation of compensatory physiological mechanisms in response to chronic stress (Maestripieri & Hoffman, 2011). The extent of allostatic load has been associated with accelerated ageing, reduced longevity, and impaired health (Maestripieri & Hoffman, 2011; McEwen, 2007).

More recently, the study of telomeres has been gaining traction as a new approach for understanding the cellular and molecular substrates of stress and stress-related ageing processes over the lifespan (Shalev et al., 2013). Inside the nucleus of cells, genes are arranged along twisted, double-stranded molecules of deoxyribonucleic acid (DNA) called chromosomes. Telomeres form the protective casing or ‘caps’ found at the ends of chromosomes and have been likened to the plastic tips on shoelaces, as they work similarly to prevent chromosome ends from ‘fraying’ (Nyatanga, 2009). Repairing damage caused by exposure to stress involves cell division but there is a finite limit on the number of times a cell can divide (Counter, 1996). Exposure to stress increases the rate of cell division and each time a cell divides the length of its telomeres is shortened (Shalev et al., 2013). ‘Telomerase’ is an enzyme that can replenish the telomere ‘caps’, but its reserves are depleted through repeated exposure to chronic stress and cortisol (Shalev et al., 2013). When the telomeres eventually become too short, the cell often dies or becomes pro-inflammatory; evoking the ageing process and associated health risks. A seminal study measured the rate of telomere shortening in biological mothers of a chronically ill child (i.e., caregivers; under chronic stress of caregiving) compared with biological mothers of a healthy child (i.e., controls). Average perceived stress was significantly higher in caregivers compared to the controls; furthermore while differences were not observed between groups, within the caregiving group, there was an inverse relationship between the years of caregiving and mother's telomere length, even after controlling for mother's age (i.e., longer exposure to chronic stress via caregiving role associated with shorter telomeres) (Epel, Blackburn, et al., 2004). More recently, increased telomerase activity has been associated with greater cortisol increases in response to stressors, as a well as variation in psychological responses (i.e., greater perception of threat) (Epel et al., 2010).

1.7.3 Psychological Perspectives on the Study of Stress

Sources of stress may be predominately psychological in nature (e.g., pressure to meet a deadline), physical/somatic (e.g., substance-related or broken bone), or a combination of the two (e.g., violent interpersonal confrontation). Since the stress response involves psychological and biological mechanisms, references to psychological stress (i.e., where the source of stress is psychological in nature), can be confusing if context is insufficient. As such, psychological stress is sometimes referred to as 'social stress' or 'emotional distress' as opposed to 'physical stress', although these phrases too can have distinct meanings (Krieger, 2001). Throughout this thesis, references to psychological and psychosocial stress imply stress where the source is predominately psychological in nature.

Over the past 30 years, there have been three broad lenses applied to the study of stress: (i) stimulus-based, (ii) response-based, and (iii) a transactional (interactive) approach (O'Connor, Jones, & Conner, 2011). The stimulus-based approach (also known as the engineering approach) views stress as originating from a stimulus or event in a person's environment; an input which produces a homogeneous response, with a linear concept of the relationship between the intensity of the stressor and the response (O'Connor et al., 2011). A limitation of this approach is its underlying assumption that undemanding situations are void of stress; contrary to this view, monotonous undemanding working conditions have been demonstrated to be potentially stressful (Charles, Loomis, & Demissie, 2009). A further assumption of the stimulus-based approach is that individuals function unconsciously or automatically, without consideration given to the mediating psychological processes (e.g., appraisal) (Rabkin & Struening, 1976). This limitation also applies to the response-based approach which focuses on the outcomes or consequences of exposure to a stimulus or events, and tends to focuses on the physiological reactions such as changes in blood pressure, heart rate, and stress hormones (O'Connor et al., 2011). The limitations of these two approaches give rise to the contemporary dominance of the transactional approach that endeavours to explain why exposure to similar stressors can result in different responses between individuals or the same individuals at different times. Using the transactional approach, stress is defined as neither a product of a person nor of the environment. Rather, stress is “a particular relationship between a person and their environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her wellbeing” (Lazarus & Folkman, 1984, p. 19). The nature of the transactional approach focusses attention on the processes of appraisal and coping (outlined later in the following section); which are seen as critical mediators of stressful person-environment interactions and their immediate and long-range outcomes (Folkman, Lazarus, Dunkel Schetter, DeLongis, & Gruen, 1986).

1.7.4 Daily Hassles, Appraisal, and Coping

Early stress research tended to focus on the impact of major life events, such as divorce, moving home, and unemployment, as exemplified by the Social Readjustment Rating Scale (Holmes & Rahe, 1967); used to calculate a life events score with higher scores conceived to contribute to illness (Rabkin & Struening, 1976). However, this approach received criticism for two main reasons: firstly, it provided no insight into the processes through which life events may impact health outcomes (Kanner, Coyne, Schaefer, & Lazarus, 1981). Secondly, such major life changes are rare compared to stress that stems from recurrent day-to-day problems or chronic conditions which comprise the ongoing stresses and strains of daily living; described as 'daily hassles' (Kanner et al., 1981). More specifically, daily hassles have been defined as "events, thoughts, or situations which, when they occur, produce negative feelings such annoyance, irritation, worry or frustration, and/or make you aware that your goals and plans will be more difficult or impossible to achieve" (O'Connor et al., 2011, p. 1620). Since hassles are largely a universal experience, their impact is considered to depend on factors such as chronically high frequency or the heightening of hassles during a given period (Kanner et al., 1981). Uplifts are essentially the counterpart to hassles: "positive experiences such as the joy derived from manifestations of love, relief on hearing good news" (Kanner et al., 1981, p. 6). As is characteristic of most research of stress, the positive notion of uplifts has received far less attention than the negative notion of daily hassles – however there may be some rationale for this; early research supported the idea that daily hassles were more strongly associated with somatic health compared to life event scores, while uplifts made little contribution to health that was independent of hassles (Delongis, Coyne, Dakof, Folkman, & Lazarus, 1982). With reference to work stress (discussed further in Section 1.8.3), enduring features of the workplace such as job design can determine the occurrence of daily hassles and/or uplifts (e.g., in interactions with superiors, coworkers or peers) (Håkonsson, Obel, & Burton, 2008).

Appraisal describes the unique way in which a person evaluates if and how a potential stressor is relevant to their own wellbeing, and has been conceptualised as a two-step cognitive process (i.e., primary appraisal and secondary appraisal) (Folkman et al., 1986; Lazarus & Folkman, 1984). In primary appraisal, a person evaluates what they have at stake from a potentially stressful situation, and involves cognitions such as: what could be the potential harm or benefit caused by the stressor – with respect to commitments, values, or goals? Is my health or wellbeing, or that of a loved one threatened? Is there potential harm or benefit to self-esteem? (Folkman et al., 1986). In secondary appraisal, a person considers the resources and abilities they have to cope with the stressor (i.e., coping potential). Resources may be internal (e.g., strength, determination) or external (e.g., monetary, social support). Lazarus and Launier (1978) assert that the two-step appraisal process should not be viewed as linear, rather it is necessary to assess both steps of the appraisal 'equation' to understand how the potential stressor is perceived. In this sense, appraisal depends upon the balance of power between the stressor demands and the resources available within and around that person (Lazarus & Launier, 1978). It is this interactive process which gives name to the transactional model of stress and coping (Lazarus & Folkman, 1984). Lazarus and Launier (1978) outline three main ways in which a potential stressor can be framed: as a loss (or harm), a threat, or a challenge. A loss is defined as damage that has already occurred (e.g., accidental injury or the death of a loved one). Threat also implies damage (i.e., physical or psychological) that is anticipated and may or may not be inevitable. Challenges are different in that they are generally seen positively or in an optimistic light; although as with any potential stressor, they still call for exceptional effort (McCrae, 1984). Both challenges and threats are likely to be chronic, whereas losses are typically acute (McCrae, 1984). Primary and secondary appraisals converge to determine whether a person appraises a potentially stressful situation as significant and whether it is interpreted as primarily: (a) threatening (i.e., involves possibility of harm or loss), or (b) challenging (i.e., possesses the opportunity for mastery or benefit) (Folkman et al., 1986). These two styles of appraisal draw comparison to 'distress' and 'eustress' respectively; which are similar but distinct concepts.

The transactional model proposes that appraisal interacts with an individual's coping processes, which will in turn contribute to subsequent appraisals. Coping has been defined as "the person's constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the person's resources" (Lazarus & Folkman, 1984, p. 141). This definition is marked by three key features: firstly, it is process oriented as opposed to trait oriented, which means instead of focusing on what the person usually does, it focuses on what a person actually thinks and does in a specific stressful encounter, and how this changes as the encounter unfolds. Secondly, coping is seen as contextual and influenced through an individual's unique appraisal. Finally, no a priori assumptions are made about what represents good or bad coping; "coping is defined simply as a person's efforts to manage demands, whether or not the efforts are successful" (Folkman et al., 1986, p. 993).

1.7.5 Types of Stress and Energy Balance-Related Behaviours

As acknowledged previously (Section 1.7.1), high perceptions of stress appear to be somewhat ubiquitous in contemporary culture. Some researchers have noted the concurrent apparent rise in societal perceptions of stress, and objective increases in obesity prevalence, suggesting the two phenomena could be connected (Adam & Epel, 2007; Groesz et al., 2012; Tomiyama et al., 2012). Stress can influence health through two seemingly distinct pathways: (i) complex biological processes (e.g., autonomic and neuroendocrine pathways, as discussed in Section 1.7.2), and (ii) changes in lifestyle or health behaviours. The focus of this thesis is the latter, although it is interesting to note evidence of interaction between these pathways, particularly with reference to the development and maintenance of obesity. When under stress, adequate regulation of energy and food intake is important for survival, and the mechanisms orchestrating this process appear to involve functions of the HPA axis infringing on the endocrine regulation of appetite (Adam & Epel, 2007). Chronic stressors may result in an overdrive for highly palatable food (high fat and sweet), since consumption of this kind can directly or indirectly calm activity of the HPA axis (Dallman et al., 2003; Ulrich-Lai, Ostrander, & Herman, 2011). It has been suggested that through experience, many people have learned how such foods can work in this way, and engage in such non-homeostatic consumption (e.g., 'comfort eating') as a way of 'self-medicating' with high fat and/or sweet food (Dallman et al., 2003; Pecoraro, Reyes, Gomez, Bhargava, & Dallman, 2004; Tomiyama, Dallman, & Epel, 2011; Tomiyama, Finch, & Cummings, 2015). Furthermore, stress induced cortisol exposure may impair activity in the right prefrontal cortex, thereby impeding reflective cognition and inhibiting this manner of control over eating (Alonso-Alonso & Pascual-Leone, 2007). Moreover, there is some evidence to suggest the physiological stress response could influence the way such foods are processed by the body, favouring the accumulation of visceral fat in response to chronic stress (Aschbacher et al., 2014; Fu et al., 2010; Kuo et al., 2007). As such, while the biological and behavioural pathways linking stress with obesity may at first appear to be distinct, there is a growing body of evidence to suggest they conspire in the association between stress and excess fat accumulation.

As discussed in Section 1.4, energy balance-related behaviours are specific health behaviours relating to the consumption of food and beverages on the input side, and physical activity as part of the output side of energy balance. While physical activity is not usually the largest source of energy expenditure (see Section 1.3.3), it is the most important determinant of between-person variation in total energy expenditure (Hu, 2013). The relationships between stress and physical activity have largely been framed around the positive effects of increased exercise in buffering the perception or effects of stress. There is some evidence to suggest that exercise can buffer the negative impact of stress (Puterman et al., 2011), however most free-living persons experiencing elevated stress are less likely to engage in exercise than those who are not (Aldana, Sutton, Jacobson, & Quirk, 1996; Penedo & Dahn, 2005; Schnohr, Kristensen, Prescott, & Scharling, 2005). Stress is associated with a heterogeneous influence on eating in humans and different types of stress generally display different directions of association (Adam & Epel, 2007; O'Connor et al., 2011; Torres & Nowson, 2007). Overall, the majority of people (estimated ~50-70%) tend to increase their food intake in response to a variety of types of stress; a smaller subgroup (estimated ~20-40%) appear to decrease their food intake and may lose weight during or following stress; while the smallest minority (~10-20%) do not appear to change their food intake during stressful periods (Adam & Epel, 2007; Dallman, 2010; Tomiyama et al., 2011; Yau & Potenza, 2013).

Some research supports the concept of a mediating role of differences in eating style, while other research emphasises the importance of different types of stress (i.e., similar to the 'person-situation debate'). Three different styles of eating behaviour are often distinguished in the literature: 'restrained', 'emotional', and 'external' eating (Van Strien, Frijters, Bergers, & Defares, 1986). Restrained eating is colloquially referred to as 'dieting', and describes the deliberate restriction of food intake with the intention to reduce or maintain weight; an alternative description suggests restrained eaters may be characterised as persons who have dieted and failed many times (Ricciardelli & Williams, 1997). Emotional eating describes eating in response to emotional arousal, while external eating describes eating in response to external food-related cues, such as the presence or smell of food, regardless of homeostatic need. The study of potential relationships between differences in eating styles and food intake has primarily focused on the ‘restrained’ versus ‘unrestrained’ styles (Anschutz, Van Strien, Van De Ven, & Engels, 2009; Stunkard & Messick, 1985). The restraint theory hypothesises that the biological autonomic regulation of appetite is disrupted by conscious cognitive control; furthermore this unnatural attempt to control can be counterproductive as efforts become exhausted, leaving restrained eaters vulnerable to losing control over their eating, when their ability or motivation to restrict food intake is impaired (Herman & Polivy, 1984). Research examining the potential for associations between restrained eating style and obesity has yielded considerably mixed findings, some suggest positive relationships, while others suggest negative or non-significant relationships (Konttinen, Haukkala, Sarlio-Lähteenkorva, Silventoinen, & Jousilahti, 2009). Perhaps because of these unreliable findings, consideration of eating styles is often excluded from large epidemiological studies that investigate the association between work stress and obesity or diet (Brunner, Chandola, & Marmot, 2007; Jääskeläinen et al., 2015).

The chronicity of stressors may be an important determinant in the relationship between stress and eating. When offered a calorie-dense diet, rats exposed to acute stress in the form of daily pinch sessions ate more during the stressor, but subsequently ate less during a 24-hour rest period to compensate for the ingestion of the excess calories, and so did not gain weight (Levine & Morley, 1981). In contrast, rats exposed to chronic stress in the form of a prolonged tail pinch also ate more, but did not display the compensatory reduction in subsequent feeding, resulting in weight gain (Levine & Morley, 1981; Rowland & Antelman, 1976). The latter scenario has been suggested to be similar to the contemporary experience of many humans: exposure to chronic stress in the context of an obesogenic environment with easily assessable, calorie-dense and highly palatable food (Adam & Epel, 2007).

During their review of the literature, O'Connor et al. (2011) identified four main types of stress studied in relation to eating: ego-threatening, interpersonal, physically-threatening, and work-related. Another valuable model of chronic stress is that associated with caregiving (Aschbacher et al., 2014; Epel, Blackburn, et al., 2004). These types of stress are listed with examples and their apparent typical influence on food intake in Table 2. Overall, research suggests that stressors of a psychological or ego-threatening nature (e.g., threat to a person’s self-image or self-esteem) display distinct effects from those that elicit physical fear. Physically threatening stressors are commonly associated with a decrease in eating, whereas ego-threatening, work-related, and interpersonal stressors are often associated with increases in eating, without any corresponding increase in physical activity or homeostatic caloric need (Lattimore & Caswell, 2004; Oliver, Wardle, & Gibson, 2000; Oliver, Huon, Zadro, & Williams, 2001). However, these generalisations and results presented in Table 2 should be interpreted with caution since most require a closer reading of the individual studies, for example many effects were only seen in specific eating styles (e.g., restrained vs. unrestrained) and different styles appear to have different influences on the interaction between stress and eating; however, some effects were observed regardless of eating style (e.g., O’Connor et al., 2008).

Table 2 Common types of stressors and apparent typical influence on food intake

Type of Stressor	Definition	Apparent Typical Influence on Food Intake	
Ego-threatening	Stress related to fear of failure and/or negative evaluation (e.g., sitting an exam). *May be acute or chronic.*	↑ Increase	(Epel, Jimenez, et al., 2004; Heatherton, Herman, & Polivy, 1991, 1992; O'Connor, Jones, Conner, McMillan, & Ferguson, 2008; Wallis & Hetherington, 2004)
Interpersonal	Stress related to relationships or communication between people, especially with a sense of social hostility (e.g., argument with a partner). *May be acute or chronic*	↑ Increase	(O'Connor et al., 2008; Tanofsky-Kraff, Wilfley, & Spurrell, 2000)
Physically threatening	Stress related to the threat of facing physical harm (e.g., being chased by a wild animal or threat of electric shock). *Typically acute.*	↓ Decrease	(Heatherton et al., 1991, 1992; O'Connor et al., 2008)
Work-related	Stress originating from interaction with the work environment and/or work-related tasks (e.g., meeting a deadline). *Typically cumulative or chronic.*	↑ Increase	(Hellerstedt & Jeffery, 1997; Jääskeläinen et al., 2015; Lallukka et al., 2004; O'Connor et al., 2008; Steptoe, Lipsey, & Wardle, 1998; Wardle, Steptoe, Oliver, & Lipsey, 2000)
Caregiving	Stress associated with ongoing caregiving role (e.g., caring for a child with chronic illness, parent/spouse with dementia). *Typically chronic.*	↑ Increase	(Aschbacher et al., 2014)

1.8 Occupational Health Psychology

1.8.1 Definition

Occupational health psychology is a relatively young field concerned with the science and practice of psychology related to workplace, and the safety, health and wellbeing of workers (Leka & Houdmont, 2010; Quick, 1999). Traditionally, the focus of occupational health and safety has been on managing physical, biological, and chemical risks in the workplace (Sauter & Hurrel, 1999). However, around the mid-1980s, there was a growing recognition of the costs of psychological risks, particularly stress-related problems, and confluent with radical changes to the organisation of work, technological advancements, deregulation and an increasingly competitive global market (Navarro, 2007; Sauter, Hurrel, Fox, Tetrick, & Barling, 1999). Consequently, the term 'occupational health psychology' was coined in 1990 by Jonathan Raymond, a psychologist working in a school of public health (Raymond, Wood, & Patrick, 1990). Despite its modern conceptualisation, the ideological roots of occupational health psychology can be traced to at least the mid nineteenth and early twentieth centuries (e.g. Engels, 1845; Mayo, 1923, 1933; Münsterberg, 1913; Taylor, 1911).

While the contemporary field is quintessentially interdisciplinary, the exact definition of its key features and location amongst related fields is less clear; there is large overlap but noted divergence between European and North American perspectives (Leka & Houdmont, 2010). The European perspective generally draws on the contributions of health psychology, industrial/organisational psychology, social and environmental psychology (Cox, Baldursson, & Rial-González, 2000); whereas the North American perspective is somewhat broader, with key additional influences including public health, management, medicine (including preventative and behavioural medicine), political science, as well as occupational health and safety (Adkins, 1999; Raymond et al., 1990). In spite of these definitional differences and reported absence of a 'shared heritage', there is broad agreement amongst the international community regarding the overall nature of the discipline (Leka & Houdmont, 2010), and endorsement of a shared vision focused on the creation of "healthy workplaces in which people may produce, serve, grow, and be valued" (Quick et al., 1997, p. 3).

1.8.2 Work: Functions and Significance

The focus of this thesis is paid employment; although it is important to acknowledge many people undertake considerable amounts of purposeful work that is unpaid, for example engaging in volunteering, caring for family members, and running households (Winefield, 2013). While these represent valuable contributions to societal and individual wellbeing, they are outside the scope of this thesis. As the world of paid work occupies such a large amount of time over the lifespan for the majority of adults, it is an important endeavour to understand how work impacts on health and wellbeing, and how workplaces can promote and sustain good health (Karasek & Theorell, 1990; Winefield, 2013). Gordon and Schnall (2009, p. 3) propose “a good society must have as a moral basis the well-being of its working people”.

Employment comes in many different forms, such as: full-time and part-time, permanent or casual, contracted or precarious (Winefield, 2013). In recent decades, there has been a shift towards an increasing proportion of casual and short-term contract work, which is generally less stable or reliable than a permanent position; although may be more acceptable for younger employees (Matthews, Delfabbro, & Winefield, 2015). In addition to providing financial rewards, satisfying work provides many other benefits. Jahoda (1982) proposed work also fulfils five key functions: (i) time structure (i.e., regular time demands to help individuals organise use of their time), (ii) social contacts (i.e., contact with others outside the home), (iii) participation in collective purpose (i.e., a sense of purpose and fulfilment from engagement in something useful), (iv) status and identity (i.e., an important source of personal identity often linked with self-esteem), and (v) regular activity (i.e., learning opportunities which help keep mind and body active) (Fryers, 2006; Winefield, 2013). However, the relationship between employment and wellbeing is not straightforward. Work may be unsafe physically or emotionally (e.g., bullying or harassment), or threaten worker health in other ways such as intruding excessively on time and energy resources necessary for other aspects of the worker’s life (e.g., psychosocial stress) (Neall & Tuckey, 2014; Semmer et al., 2015; Tuckey & Neall, 2014; Winefield, 2013). While unemployed persons (i.e., those without a job and actively seeking work) typically experience poorer health and wellbeing (Janlert, Winefield, & Hammarström, 2015; Strandh, Winefield, Nilsson, & Hammarström, 2014), there is some evidence to suggest persons employed in jobs of poor psychosocial quality, such as those with excessively high demands, a large imbalance between effort and reward, and poor job security, may experience even worse health and wellbeing outcomes than those who are unemployed (Butterworth et al., 2011).

1.8.3 Stress at Work, Models of Work Stress, and Implications

Work-related stress or just 'work stress' may be broadly defined as stress associated with an employee's experiences of their job or workplace characteristics, and has previously been identified as the single most researched area published in the flagship *Journal of Occupational Health Psychology* (Macik-Frey, Quick, & Nelson, 2007). Rapid changes in modern work environments brought on by industrialisation, technological advances and organisational restructuring, have all been associated with elevated levels of work stress (Conner & Douglas, 2005; De Jonge & Kompier, 1997; Härmä, 2006; Srivastava, 2010). As with the complexity of the more general concept of psychological stress (discussed in Section 1.7.1), the growing research interest over the past 35 years has established similar complexity of the related work stress construct (Daniels, Le Blanc, & Davis, 2014; Maslach et al., 2001; Van der Doef & Maes, 1999). The matter is further complicated since important terminology in this area has at times been used vaguely or inconsistently in the literature, as such some foundational definitions are offered here. The phrase 'work stress' is often used rather loosely to refer to both sources of stress at work, as well as the associated psychological outcomes (Winefield, 2013). This is likely related to fundamental differences in how researchers conceptualise stress; such as a stimulus or response-based view versus the transactional approach (discussed in Section 1.7.3). Throughout this thesis, 'work stress' is generally used to describe the latter. 'Job strain' is another term that is used to refer to both the conducive processes or experiences of stressful work features, as well as the outcome of such work features (Karasek & Theorell, 1990; Tuckey, Searle, Boyd, Winefield, & Winefield, 2015). 'Burnout' describes an end outcome following the "prolonged response to chronic emotional and interpersonal stressors on the job… defined by the three dimensions of exhaustion, cynicism, and inefficacy" (Maslach et al., 2001, p. 397). 'Psychosocial risk factors at work' refer to those "aspects of work organisations that are of human design and construction, that have the potential to cause psychological or physical harm" (Dollard, Tuckey, Shimazu, Nordin, & Brough, 2014, p. 4).

There are many ways to conceptualise work stress and related concepts, including more general measures such as length of work hours (Härmä, 2006; Van der Hulst, 2003), stress associated with type of hours worked (e.g., shift-work) (Harrington, 2001; Srivastava, 2010), work-life balance (Kalliath & Brough, 2008), and work-related daily hassles (Steptoe et al., 1998); to more specific constructs such as job design (De Lange, Taris, Kompier, Houtman, & Bongers, 2003; Humphrey, Nahrgang, & Morgeson, 2007). It is noted with relevance to this thesis, that shift work and especially night work may be associated with stress-related changes in eating behaviour and changes in regulatory hormones, ultimately increasing risk for obesity (Amani & Gill, 2013; Heath et al., 2012). Nonetheless, consideration of shift work, circadian disruption and sleep in relation to stress and obesity are beyond the scope of the studies that comprise this thesis. Western research on psychosocial factors at work has typically focused on internal organisational factors to investigate worker health and wellbeing (Daniels et al., 2014; Dollard et al., 2014). 'Job design' has been particularly dominant in the literature and refers to the specification of employee activities, such as the duties and tasks required to perform their work, and how these are structured and scheduled (Morgeson & Humphrey, 2008). The construct of job design is considered to tap characteristics of work that are relatively objective and stable over time, and therefore such models do not typically take into account individual daily variations in factors such as perceptions of hassles, mood or working hours (O'Connor et al., 2011).

The literature features a variety of models for assessing psychosocial work factors associated with job design; while each has distinct theoretical underpinnings they also share many similar concepts. The Job Characteristics Model (JCM) (Hackman & Oldham, 1976), the Job Demand-Control(-Support) Model (JDC/JDCS) (Johnson & Hall, 1988; Karasek, 1979; Karasek & Theorell, 1990), the Vitamin Model (VM) (Warr, 1987, 2007), and the Effort-Reward Imbalance model (ERI) (Peter & Siegrist, 1997; Siegrist, 1996) have collectively been referred to as the ‘modern classics’ of job design (Daniels et al., 2014). Further contemporary models include the Job Demands-Resources Model (JD-R) (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001), and the Demand-Induced Strain Compensation (-Recovery) model (DISC-R) (De Jonge, Demerouti, & Dormann, 2014; De Jonge & Dormann, 2003). Within each of these models, increased risk for work stress is usually indicated by a single or combination of psychosocial work factors, such as high job demands, low job control or autonomy, inability to use skills on the job, provision of insufficient resources, and poor social support from supervisors or colleagues (Karasek, 1979; Muchinsky, 2012). All of these models share the idea that health at work can be improved and absence from work can be reduced by changing certain generic features of work (Daniels et al., 2014).

Such models of work stress at the job design level focus on the somewhat immediate interface between the employee and the organisation of their work. These models compete for dominance in the literature and in this respect the Job Demand-Control(-Support) model is the most widely tested (Eller et al., 2009; Nyberg et al., 2012). A departure from the focus on job design is the notion of Psychosocial Safety Climate (PSC), which represents a shift to recognise and model the contextual factors higher up the systemic hierarchy of the work environment; considered a presage, or force that may influence the expression of job design through mediating and moderating processes (Dollard & Bakker, 2010). In this sense, PSC complements rather than competes with existing job design level models of work stress. The essence of each of the models discussed in this section, and the conditions under which each generally predicts to be conducive to work stress, are summarised in Table 3.

There are many reasons to monitor work stress, not least the financial ones (Jauregui & Schnall, 2009). The costs for employees, organisations, and society are substantial – estimated to be as high as $300 billion per year in the United States (Rosch, 2001), with similar per capita estimates in Australia (McTernan, Dollard, & LaMontagne, 2013; Medibank Private, 2008) and the United Kingdom (MacKay, Cousins, Kelly, Lee, & McCaig, 2004). Psychological outcomes of work stress typically include distress, anxiety and depression (McTernan et al., 2013; Melchior et al., 2007), burnout (Maslach et al., 2001), and low commitment to employers (Barak, Nissly, & Levin, 2001). In terms of employee behaviour, high levels of work stress tend to be associated with increased absenteeism (Godin & Kittel, 2004), reduced productivity (e.g., “presenteeism”) (Cooper & Dewe, 2008), and in extreme cases, potential for retaliatory actions such as theft or sabotage (Chen & Spector, 1992). Work stress has also been implicated in employee physical health; contributing to chronic pain (Herr et al., 2015), cardiovascular disease (Bosma, Peter, Siegrist, & Marmot, 1998), and deleterious health behaviours (Siegrist & Rödel, 2006). Of particular relevance to this thesis, the potential relationships between work stress and obesity have received notable interest, yet findings have been generally inconsistent. Some studies suggest a positive relationship in which elevated stress in the workplace is associated with increased obesity (Block, He, Zaslavsky, Ding, & Ayanian, 2009; Brunner et al., 2007; Hellerstedt & Jeffery, 1997), some have found no significant association (Brisson, Larocque, Moisan, Vezina, & Dagenais, 2000; Ostry, Radi, Louie, & LaMontagne, 2006), while others suggest a curvilinear

‘U’-shaped association (Nyberg et al., 2012). One possible explanation for the unreliable nature of these findings is an oversimplification of the JDCS model construct of job control, which researchers often propose as a panacea for mitigating the stress associated with high job demands. This issue is discussed further in the following Section 1.8.4b.

Table 3 Conditions conducive to stress according to prominent models of work stress.

Model	Work stress generally theorised to occur when there is…
Job Characteristics Model (JCM)	… a lack of work motivation due to deficiencies among five core job characteristics: skill variety; task identity; task significance; autonomy; feedback from job. Heightened when employee exhibits high growth need.
Job Demand-Control (JDC), and **Job Demand-Control-Support (JDCS)**	… a mismatch between job demands (psychological) on one side and job control (i. skill discretion, ii. decision authority) on the other side of the equation. Social support (i. supervisor support, ii. coworker support) was later added to the original model and is generally considered to counter stress alongside job control. Social support is not always included and the model is sometimes referred to simply as the "Demand-Control model" or similarly worded variation.
Vitamin Model (VM)	… too much or too little of certain job characteristics; divided into two categories: those with 'constant effect' (CE), and those described as having 'additional decrement' (AD). CE job characteristics (physical security, availability of money, valued social position, supportive supervision, career outlook and equity) follow a monotonic pattern – the more the better, until a theorised plateau. AD characteristics (opportunity for control, skill use, variety, externally generated goals [e.g., demands], environmental clarity [e.g., role clarity], and interpersonal contact) are suggested to follow a curvilinear pattern – too little or too much are considered problematic.
Effort Reward Imbalance (ERI)	… a disproportionate level of effort expanded at work in relation to the level of rewards gained from work. Specifically the combination of high effort and low rewards. Effort comprises two components: extrinsic (e.g., work demands) and intrinsic (e.g., personal drive/commitment). Rewards comprise three components: money, esteem, and security/career opportunities.
Job Demands-Resources (JD-R)	… a mismatch of high job demands and low job resources. Demands and resources may be physical, psychological, social or organisational in nature, and may be occupation specific. Job resources are assumed to be motivational, while job demands may be motivational or health impairing, depending on their level and interplay with job resources and personal resources.
Demand-Induced Strain Compensation Recovery (DISC-R)	… an unfavourable match between job demands and job resources and corresponding job-related outcomes. Each of these constructs may be specified as cognitive, emotional, or physical in nature. A triple matching principal (TMP) suggests the strongest interactive relationships are found between matching demands and resources and outcomes. The more recently added recovery component focuses on the concept of detachment from work and may also be conceptualised as cognitive, emotional, or physical in nature. The form of recovery needed may correspond to the nature of the job demand experienced (i.e., cognitive, emotional, or physical).
Psychosocial Safety Climate (PSC)	… an organisational culture (climate) that encourages profits or productivity over welfare or human needs. PSC is measured in terms of policies, practices and procedures for the protection of psychological health. PSC is typically used in conjunction with a measure of work stress at the job design level and may be involved in the moderation of effects observed at this level.

1.8.4a Evolution of the Job Demand-Control(-Support) Model

As noted in the previous section, the Job Demand-Control(-Support) model is the most widely tested model of work stress, and it has made a significant contribution to the cause of advancing the health of workers (Daniels et al., 2014; De Lange et al., 2003; Van der Doef & Maes, 1999). It is also the model employed in the two original studies featured in this thesis (Papers One and Three), and as such, this section takes a closer look at the evolution of this model. In Section 1.8.4b, some underlying assumptions of the model are explored, specifically with regard to job control, and why and how these assumptions have been challenged.

The first version of what was to become more widely known as the Job Demand-Control (JDC) model appeared as the ‘Job strain model’ and featured two components: job demands and decision latitude (job control) (Karasek, 1979). ‘Job demands’ are primarily related to expending psychological effort related to work load, organisational constraints on task completion, and conflicting demands (Karasek et al., 1998). The ‘decision latitude’ component is now more commonly referred to as ‘job control’, and was originally conceptualised as comprising the combination of two subtypes of job control: 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 (opportunity to use skills, similar to job variety). ‘Decision authority’ refers to the organisationally mediated potential for employees to make decisions about their work, or simply the quantity of decisions entailed in their work (similar to autonomy) (De Araújo & Karasek, 2008; Karasek et al., 1998). The two broad components of job demands and job control can be combined to produce four major classes of jobs (high strain, active, low strain, and passive) defined by their unique combinations of high or low job demands and high or low job control (Figure 8). The model predicts an interaction between job demands and job control, wherein job demands are potentially deleterious only when job control is low (Kain & Jex, 2010; Karasek, 1979). As such, 'high strain' jobs are defined by high demands coupled with low control; common examples include assembly line and hospitality workers. 'Active jobs' feature both high demands and high control and are often considered high-prestige occupations, such as public officials, physicians and managers. 'Passive jobs' comprise those with both low demands and low control, such as clerical workers or cleaners. 'Low strain' jobs feature the combination of low demands and high control and are often considered to be highly skilled and somewhat self-paced jobs, for example an architect or craftsperson (Karasek, 1979; Karasek et al., 1998).

Two key hypotheses relating to the JDC model are: (i) the strain/buffer hypothesis, and (ii) the active learning hypothesis (Daniels et al., 2014; De Lange et al., 2003). The first proposes that psychological strain, associated stress response, and health manifestations, are particularly related to the combination of high job demands and low job control (See diagonal A in Figure 8). When workers can cope with the job demands (i.e., via active coping, facilitated by high control), the stress response will not be prolonged and workers have the opportunity to recover their mental and physical energy (De Lange et al., 2003). However, if workers cannot cope with the job demands, recovery is impeded, and the stress response becomes prolonged and deleterious to health (Daniels et al., 2014). Reducing job demands is not a straightforward response since too low demands could lead to under-stimulation and boredom (Daniels et al., 2014), furthermore employees need to attain a certain level of performance in their work owing to the pressures of competitive global markets; as such the JDC model predicts that the adverse effects of high demands can mitigated by increasing job control (De Jonge, Dollard, Dormann, Le Blanc, & Houtman, 2000). High levels of job control are hypothesised to buffer against the adverse impact of job demands on psychological and physical health (Van der Doef & Maes, 1999). The second hypothesis –

active learning – proposes that positive outcomes such as job motivation, experienced meaningfulness, as well as learning and development opportunities will be encouraged when job demands and job control are both high (See diagonal B in Figure 8) (De Jonge & Kompier, 1997). Despite the overall popularity of the model, this second hypothesis has received far less attention (Häusser, Schulz-Hardt, & Mojzisch, 2014; Taris & Kompier, 2005).

The Job Demand-Control-Support (JDCS) model (Johnson and Hall, 1988), also known as the 'iso-strain model', is a commonly recognised and endorsed extension of the original JDC model (Brough & Pears, 2004; Karasek & Theorell, 1990). The JDCS builds on the original foundation by adding a third dimension of workplace social support (Figure 9). In the work context, social support refers to "overall levels of helpful social interaction available on the job from both coworkers and supervisors" (Karasek & Theorell, 1990, p. 69). Social support is suggested to work in a similar way to job control to help mitigate the effects of high job demands. It is usually hypothesised that socially isolated workers (low support) experiencing high job demands and low job control (a combination referred to as 'iso-strain') are at greatest risk for poor psychological and physical health outcomes (Brunner et al., 2007; De Jonge & Kompier, 1997; Janssen, Bakker, & de Jong, 2001; Johnson & Hall, 1988).

Since the launch of the JDC model, most research has supported the major premise that demands are positively related to strain and that control is negatively related; however there has been considerably less support for the idea of an interaction between job demands and job control (i.e., the 'job strain' construct) (De Lange et al., 2003; Van der Doef & Maes, 1999). One reason often cited for this is common disagreement regarding the correct way to test the model and there are no definitive guidelines for how to compute a 'job strain' score (Courvoisier & Perneger, 2010). Some researchers believe that a proper test of the model requires a statistical interaction between job demands and job control (Spector, 1987).

However, Karasek (1979) argues that such a statistical interaction is unnecessary, and that if job demands and job control each exert independent main effects on strain in expected directions, then this still supports the underlying principle of the model. While there is some evidence supporting the synergism or interactive strain/buffer hypothesis, especially for the 'iso-strain' construct where social support is included in the expanded JDCS model (Janssen et al., 2001), there is generally more evidence to support the idea that these constructs (job demands, job control and social support) often hold separate associations with outcome variables and may not reinforce the effects of the other (i.e., lack of demand-control-support interaction) (De Jonge & Kompier, 1997; De Lange et al., 2003; Jääskeläinen et al., 2015; Muhonen & Torkelson, 2003).

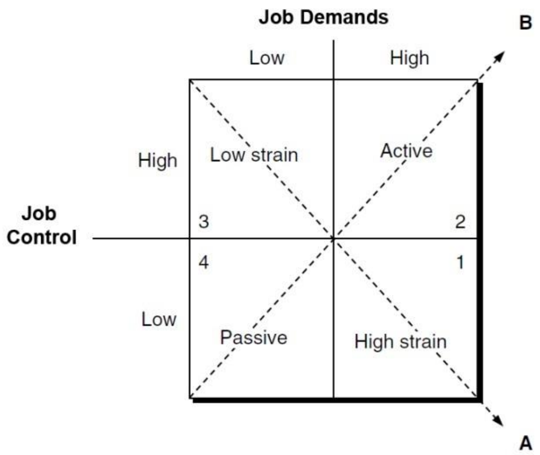

Figure 8. The Job Demand-Control Model (JDC). Adapted from Karasek (1979). Identifies four major classes of jobs: high strain, active, low strain, and passive; each defined by different pairings of high or low job demands and control.

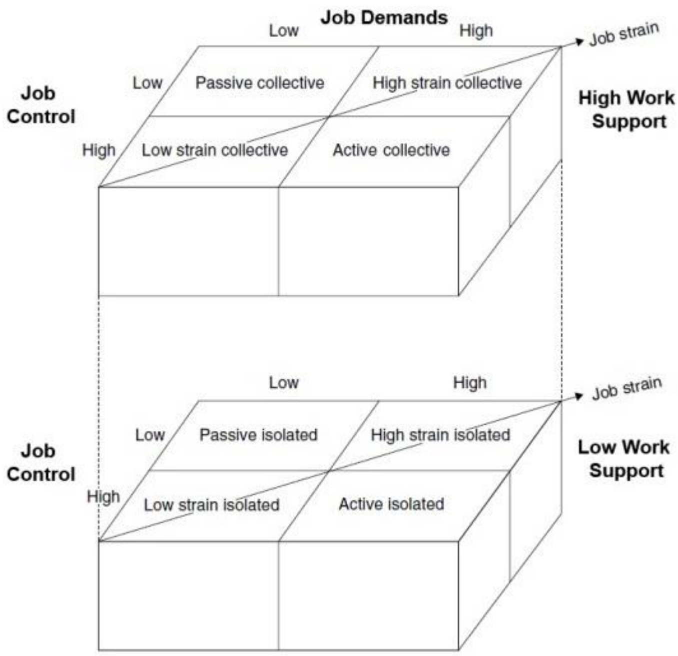

Figure 9. The Job Demand-Control-Support Model (JDCS). Adapted from Johnson and Hall (1988). Extends the JDC with a third dimension of social support at work (high or low).

1.8.4b Revisiting Job Control as a Broad-brush Panacea

As discussed in the previous section, the Job Demand-Control(–Support) (JDC[S]) model posits that the degree of control an employee has in their work is a crucial dimension in determining health (Karasek et al., 1998). Different studies vary in their treatment and analysis of the JDC(S) model variables: some elect to consider the broad constructs (demands, control, support) independently, while many use a dichotomised measure of job strain (i.e., job strain present, yes/no). This job strain variable is a composite of the two (demands, control) or three (demands, control, support) broad constructs, thereby representing a global measure of strain, which is in-keeping with the theorised strain/buffer interaction between the constructs. The most common method for calculating the presence of job strain is the quadrant approach, where the demand and control scales are split at the median and job strain is indicated by the combination of above median demands and below median support (Courvoisier & Perneger, 2010). When including social support, iso-strain is indicated by the addition of below median support. Notably, all of these typical approaches to the treatment and analysis of the model variables involve merging the two subscales of job control (skill discretion and decision authority) as a preliminary step.

While the practice of combining the two job control components is most common, it has also received criticism for confounding the measurement of job control with the measurement of job complexity (Mansell & Brough, 2005). It has been argued that these two components of job control (skill discretion and decision authority) are theoretically distinct concepts and there is emerging evidence that they may be differentially associated with health outcomes. Joensuu et al. (2012a) found that the two components of job control displayed differential associations with mortality, finding employees with high levels of skill discretion experienced lower all-cause mortality, while high levels of decision authority were associated with elevated risks of all-cause, cardiovascular, and alcohol-related mortality. To understand these surprising findings, Joensuu et al. (2012b) suggest that while the benefits of increased decision authority are conceivable when considered in the historical context of growing industrialisation, these benefits are less obvious in the contemporary work environments which feature greater global competition. Joensuu et al. (2012a) also suggest that stress may result from the perception of too much responsibility associated with too high levels of decision authority; in other words, too much decision authority may be perceived as a burden – challenging a long-held assumption that increased job control can mitigate the potentially adverse effects of high job demands (De Jonge, Dollard, et al., 2000). Earlier work by De Jonge, Reuvers, Houtman, Bongers, and Kompier (2000) also suggested differential effects for the two components of job control, but unlike Joensuu et al. (2012a), their results suggest decision authority was negatively associated with psychosomatic health complaints and sickness absence, whereas skill discretion was not a significant predictor. De Jonge, Reuvers, et al. (2000) noted that skill discretion and decision authority exerted opposite effects on these outcome variables, suggesting that the two components should be analysed separately.

Interestingly, around the same time as the popularity of the JDC model started to gain traction, Folkman (1984, p. 839) noted some relevant observations in the related area of personal control and stress: "laboratory and field research indicates that the relationships between personal control and stress, coping, and adaptational outcomes are more complex than was once assumed". Previously Averill (1973, p. 286) noted "it is almost axiomatic to assume that personal control over an impending harm will help to reduce stress reactions… [however] … the stress-inducing or stress-reducing properties of personal control depends upon such factors as the nature of the response and the context in which it is embedded and not just upon its effectiveness in preventing or mitigating the impact of potentially harmful stimulus". In summary of the literature at the time, Folkman (1984) noted that in the context of personal control, believing an event is controllable does not always lead to a reduction in stress; moreover, believing an event is uncontrollable does not always lead to an increase in stress (Averill, 1973; Thompson, 1981). Folkman (1984) also presented a theoretical formulation for how believing one has control in a stressful situation may actually heighten the perception of threat.

1.9 Summary

1.9.1 Overview and Scope

This chapter has provided an introduction to the core concepts featured throughout this thesis. The nature of this introduction has been intentionally broad, owing to the importance of appreciating the wide influence of interactive systems on health and wellbeing, as advocated by the biopsychosocial approach and complexity science. A more specified and focused approach to the literature relevant to each of the three studies comprising this thesis is provided in their respective chapters.

Obesity is a significant global problem. In many parts of the world, including Australia, the United States, and the United Kingdom, the majority of adults are now overweight or obese. There are also reports of rapid increases in rates of overweight and obesity in many developing countries. This high prevalence of excess fat accumulation represents significant challenges for individuals and societies in terms of both human and financial costs. Positive energy balance over time (i.e., consuming more energy from food than is required for daily functioning and physical activity) represents the main biological reason for 'how' obesity happens. But the much more important questions are the 'why' ones: *why* is there a positive energy balance? And *why* is the positive energy balance maintained over time? Especially in light of prevalent weight stigma and many other multifaceted impetuses for reducing levels of overweight and obesity; present at both individual and societal (policy) levels. To answer these questions, we must acknowledge, but ultimately look beyond, simply the role of positive energy balance.

Health psychology takes a holistic approach in trying to understand health and illness, grounded in a biopsychosocial perspective; it provides a well-suited overarching framework for the study of obesity, which is conceptualised as a diverse condition, with many complex and tangled causes, contributors, and effects. Efforts to reduce obesity have generally focused on encouraging reduced energy intake (i.e., eating less) and increased physical activity (i.e., moving more). While restricting dietary energy intake and/or increasing physical activity can create negative energy balance, leading to weight loss over time, maintaining lifestyle change and weight loss is very difficult in the context of an 'obesogenic environment'. As demonstrated by the sheer volume of interactive factors in the Foresight obesity systems map, there are many important components of obesity aetiology that are clearly beyond the scope of this thesis. Nonetheless, it serves as a useful reference to illustrate the complexity of the situation and the context of this thesis. From a pragmatic point of view, researchers must simultaneously acknowledge the greater contextual factors, while focusing their own research on meaningful yet manageable domains, such as the workplace. Within the scope of this thesis, the focus is on paid employment, and specifically the role of work stress at the job design level.

Stress is a complex construct involving both psychological and physiological mechanisms. The evidence regarding the relationships between stress and eating suggest most (but not all) people tend to increase their intake of food, especially highly palatable (high fat and sweet) food, in response to most (but not all) types of stress – especially chronic types of stress (such as work stress). Interestingly, these behavioural responses may interact with physiological responses, which appear to encourage the accumulation of especially harmful visceral fat (i.e., centralised around the internal organs).

Occupational health psychology is a relatively young field that considers psychology related to the workplace, and the safety, health and wellbeing of workers. Paid employment serves many important functions for wellbeing beyond just financial rewards. However, the relationships between employment and wellbeing are not straightforward since there are many ways that work can be unsafe, stressful, and deleterious to health. Stress at work has received considerable research attention. The most common models of work stress compete at the level of job design, of these, the Job Demand-Control (JDC) model, and its extension the Job Demand-Control-Support (JDCS) model, appear to be the most widely used. Interestingly there is considerable disagreement regarding the best ways in which to apply these models and analyse data to test effects. On the background of these inconsistencies, previous research investigating the possible associations between work stress and obesity has yielded mixed findings; some suggest a positive relationship, others have found no significant association, while others indicate curvilinear associations.

An identified gap in the literature relates to emerging evidence that the two components of job control (skill discretion and decision authority) in the JDCS model appear to display differential associations with other related health outcomes (mortality, psychosomatic health complaints, and sickness absence). Aside from a very small number of studies that have advocated for their effects to be considered separately, the vast majority of research appears to have overlooked that skill discretion and decision authority are theoretically distinct concepts; as such they are commonly combined into a composite measure of job control. Job control is often then further ‘boiled down’ into a global measure of ‘job strain’ or ‘iso-strain’. The few studies that have demonstrated differential associations for skill discretion and decision authority have not previously considered associations with measures of obesity; however their findings suggest that previous research using the broad JDC(S) model constructs to consider relationships between work stress and obesity may be missing more nuanced differential associations involving the two components of job control. Testing the potential for differential associations of skill discretion and decision authority with measures of obesity (Chapter 2, Study One) and energy balance-related behaviours (Chapter 4, Study Three) represent two important original contributions of this thesis.

1.9.2 Specific Aims of this Thesis

When looking at the wide system of factors that cause and maintain obesity, work stress is just a small part of a very large and tangled network of interactive factors. On the other hand, work is a fundamental part of life for many, so it is important to find innovative ways of extending our understanding of how factors at work may be implicated in the development and maintenance of obesity. Furthermore, it is important to challenge the status quo and explore unexpected or counterintuitive findings with curiosity.

The first study to be reported here is an original investigation, taking a closer look at the most popular model of work stress in relation to overweight and obesity. This study represents the first of its kind to consider whether the two components of job control in the JDCS model (i.e., skill discretion and decision authority) are uniquely associated with measures of obesity. The specific aims of the first study are to: (a) investigate the possibility that separate components of the JDCS model, specifically skill discretion and decision authority, may display unique relationships with measures of obesity; and (b) test these associations using measures of both central obesity (waist circumference) and overall obesity (BMI), providing a comparison of these two measures.

The second study comprises a systematic review of studies investigating work stress and energy balance-related behaviours; i.e., through what mechanisms might work stress be associated with overweight and obesity? The specific aims of the second study are to: (a) identify peer-reviewed original journal articles that report on the association between favourable or unfavourable psychosocial work factors (i.e., work stress) (within the JDC[S] model) and leisure-time physical activity (LTPA) and/or habitual diet; (b) detail the methods used in these studies and highlight common or divergent approaches (i.e., conceptualisation of JDC(S) variables, LTPA and diet measurement tools, analyses used); and (c) provide a summary of previous findings and make recommendations for future research.

The third study is the last in this thesis and is another original investigation, informed by the systematic review and following on from the novel findings of the first study. This last study explores whether the two components of job control (skill discretion and decision authority), as well as the other components of the JDCS model (job demands and social support) are uniquely associated with two energy balance-related behaviours (i.e., LTPA and diet). The specific aim of study three is to investigate the possibility that subscales of the JDCS model hold unique relationships with LTPA (3 categories: no activity, activity but not sufficient, sufficient activity) and/or dietary energy intake (kJ/day).

Taken as a whole, the overarching aim of this thesis is to provide a clearer understanding of how psychosocial work factors may be associated with overweight and obesity. This introduction has explored and exposed methodological inconsistencies in the application of the JDC(S) model that may partly explain mixed findings in previous research. This thesis takes a more specific approach to assessing how components of the JDCS model may be associated with obesity, as well as the relative contributions of energy balance-related behaviours. These insights will assist in the formulation of more informed strategies to help reduce both the incidence and prevalence of overweight and obesity. Such policies would likely need to be ‘fluoride-like’ to be sustainable over the long term – that is, subtle changes in the environment, such as the fine-tuning of job design characteristic to improve employee experiences of their work and work stress, which in turn should produce health improvements (e.g., a reduction in levels of obesity). Importantly, these improvements would not rely on the conscious effortful modification or control of behaviours of individuals immersed in an ‘obesogenic environment’ – a context which relentlessly conspires against healthful energy balance-related behaviours. In other words, policy level changes to modify the context and undermine the ‘obesogenic environment’, so that an individual’s context becomes more conducive to sustained healthful energy balance-related behaviours (i.e., ‘eating less and moving more’), which over time, would lead to a reduction in overweight and obesity at the societal level.

CHAPTER 2: PAPER ONE

2.1 Preamble

This first study uses the most commonly tested model of work stress, the Job Demand-Control-Support (JDCS) model, to explore how various psychosocial work factors may be associated with waist circumference (higher values imply central obesity) and body mass index (BMI, higher values imply overall obesity). In light of emerging evidence that the two components of job control (skill discretion and decision authority) could have differential associations with related health outcomes, components of the JDCS model were analysed at the subscale level. This study was the first of its kind, with analyses controlling for sex and age, to consider differential effects of the two components of job control in relation to obesity. The sample comprised a reasoned subset of workers from an original cohort of randomly selected South Australian participants; consequently findings should be reasonably generalisable to other employees in predominantly Western cultures.

Differential associations of job control components with both waist circumference and body mass index

- PAPER ACCEPTED FOR PUBLICATION[1] -

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[1] Please see Appendix A at the end of this thesis for a reprint of the published paper

2.2 Statement of Authorship

Title of Paper	Differential associations of job control components with both waist circumference and body mass index.
Publication Status	☑ Published ☐ Accepted for Publication ☐ Submitted for Publication ☐ Unpublished and Unsubmitted w ork w ritten in manuscript style
Publication Details	Bean, C. G., Winefield, H. R., Sargent, C., & Hutchinson, A. D. (2015). Differential associations of job control components with both waist circumference and body mass index. *Social Science & Medicine, 143*, 1-8. doi: http://dx.doi.org/10.1016/j.socscimed.2015.08.034

Principal Author

Name of Principal Author (Candidate)	Christopher G. Bean		
Contribution to the Paper	Responsible for the primary authorship of this paper, and collaborated with co-authors in its conceptualisation and design. Conducted all statistical analyses, and took the lead role in interpreting the results, and writing and revising the manuscript. Served as corresponding author and responsible for manuscript submission, revisions, and responses to journal reviews.		
Overall percentage (%)	85%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Helen R. Winefield		
Contribution to the Paper	Supervised the research that led to this publication, facilitated access to the dataset used for analyses, and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Charli Sargent		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Amanda D. Hutchinson		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

2.3 Paper One

Abstract

The Job Demand-Control-Support (JDCS) model is commonly used to investigate associations between psychosocial work factors and employee health, yet research considering obesity using the JDCS model remains inconclusive. This study investigates which parts of the JDCS model are associated with measures of obesity and provides a comparison between waist circumference (a measure of central obesity) and body mass index (BMI, a measure of overall obesity). Contrary to common practice, in this study the JDCS components are not reduced into composite or global scores. In light of emerging evidence that the two components of job control (skill discretion and decision authority) could have differential associations with related health outcomes, components of the JDCS model were analysed at the subscale level. A cross-sectional design with a South Australian cohort (N = 450) combined computer-assisted telephone interview data and clinic-measured height, weight and waist circumference. After controlling for sex, age, household income, work hours and job nature (blue vs. white-collar), the two components of job control were the only parts of the JDCS model to hold significant associations with measures of obesity. Notably, the associations between skill discretion and waist circumference (b = -.502, p = .001), and skill discretion and BMI (b = -.163, p = .005) were negative. Conversely, the association between decision authority and waist circumference (b = .282, p =.022) was positive. These findings are significant since skill discretion and decision authority are typically combined into a composite measure of job control or decision latitude. Our findings suggest skill discretion and decision authority should be treated separately since combining these theoretically distinct components may conceal their differential associations with measures of obesity, masking their individual importance. Psychosocial work factors displayed stronger associations and explained greater variance in waist circumference compared with BMI, and possible reasons for this are discussed.

Keywords: Australia; decision authority; job control; job strain; obesity; psychosocial stress; skill discretion; work stress

Introduction

The terms ‘overweight’ and ‘obesity’ correspond to moderate and severe grades of abnormal or excessive fat accumulation that present a risk to the health of an individual (World Health Organization, 2013). Reports of the global obesity crisis are widespread in both scientific literature and mass media (Saguy et al., 2014). The situation is particularly precarious in Australia where 70.3% of men and 56.2% of women are overweight or obese, including 27.5% obese in both men and women (Australian Bureau of Statistics, 2013). Typically measured using body mass index (BMI), and more recently waist circumference, elevated measures of obesity represent a risk factor for a myriad of illnesses including type 2 diabetes (Freemantle et al., 2008), cardiovascular disease (Asia Pacific Cohort Studies, 2004; Canoy et al., 2013), high blood pressure (Mathieu et al., 2009; Rahmouni et al., 2005), osteoarthritis (Felson et al., 1988; Grotle et al., 2008), and some cancers (Vucenik & Stains, 2012). There are also significant financial costs for society in terms of health care costs and government subsidies (Colagiuri et al., 2010). Despite the overwhelming impetus for reducing the incidence and prevalence of obesity, effective and sustainable strategies remain elusive at both policy and individual levels (Cooper et al., 2010; Gill et al., 2010; Mann et al., 2007). Simplistically, excess fat accumulation results from a sustained positive energy balance – that is, energy intake from calories in food and beverages is greater than energy expenditure from daily functioning and physical activity (Faith & Kral, 2006). However, it is crucial to acknowledge that this energy imbalance occurs within the context of environmental, social, cultural and genetic factors (Faith & Kral, 2006).

The breadth of the obesity system map presented in the UK government Foresight report (Butland et al., 2007) and similar ecological models demonstrate the unwieldy nature of potential aetiological pathways. From a pragmatic standpoint, researchers must simultaneously acknowledge the greater contextual factors, while focusing their own research on meaningful domains, such as the potential roles of employment and psychosocial work factors. Employment is a fundamental part of life for many (Karasek & Theorell, 1990), and work stress has been an increasingly popular area of research over the past 25 years. The Job Demand-Control (JDC) model (also known as the job strain model) is the most widely tested model of work stress (Nyberg et al., 2012) and features two broad constructs: job demands and job control. Job demands captures psychological stressors associated with work load, organisational constraints on task completion, and conflicting work demands (Karasek et al., 1998). Job control (also referred to as decision latitude), comprises two subscales: skill discretion and decision authority (Karasek & Theorell, 1990), which are theoretically disticnt concepts (De Jonge, Reuvers, et al., 2000). Skill discretion assesses the level of skill and creativity required on the job and the flexibility an employee is permitted in deciding what skills to use (opportunity to use skills, similar to job variety). Decision authority assesses the organisationally mediated potential for employees to make decisions about their work (opportunity to make decisions, similar to autonomy) (De Araújo & Karasek, 2008; Karasek et al., 1998).

According to the JDC model, job strain occurs when employees experience high psychological demands coupled with low levels of control (Karasek & Theorell, 1990; Theorell & Karasek, 1996). While job demands may be difficult to reduce owing to the pressures of competitive global markets, the JDC model predicts that the adverse effects of high demands can be mitigated by increasing employee control (De Jonge, Dollard, et al., 2000). The JDC model posits that the degree of control an employee has in their work is a crucial dimension in determining health (Karasek et al., 1998). The Job Demands-Control-Support (JDCS) model (Johnson & Hall, 1988), also known as the iso-strain model, extends the original JDC model by adding two measures of social support: coworker support and supervisor support. It is usually hypothesised that socially isolated workers (low support) experiencing high job strain are at greatest risk for poor health outcomes (Brunner et al., 2007). It is reasonable to propose that work stress could be positively related to obesity, since previous research suggests most people (but not all) increase their food intake, especially of highly palatable (high fat and sweet) foods when exposed to stress (Adam & Epel, 2007; Epel, Lapidus, McEwen, & Brownell, 2001; Epel, Jimenez, et al., 2004; Groesz et al., 2012), and long-term adaptation to chronic stress may result in greater visceral fat accumulation via excess consumption of calorie-dense food (Tomiyama et al., 2011).

Studies vary in their treatment and analysis of the JDCS model variables: some elect to consider the broad constructs (demands, control, support) independently, while many others use the dichotomised global measure of job strain (i.e., job strain present, yes/no). The most common method for calculating presence of job strain is the quadrant approach, where the demand and control scales are split at the median and job strain is indicated by the combination of above median demands and below median control (Courvoisier & Perneger, 2010). When including social support, iso-strain is indicated by the addition of below median support. It should be noted that all of these typical approaches involve merging the two subscales of job control (skill discretion and decision authority) as a preliminary step.

Despite the workplace, and specifically psychosocial work factors appearing to be a sensible domain for obesity researchers to consider, evidence for an association between psychological work stress and measures of obesity has been inconsistent and inconclusive. Some studies suggest a positive relationship in which elevated stress in the workplace is associated with increased obesity (Block et al., 2009; Brunner et al., 2007; Hellerstedt & Jeffery, 1997). However, other studies have found no significant association between work stress and measures of obesity (Brisson et al., 2000; Ostry et al., 2006).

It has been suggested that small sample sizes may have contributed to earlier mixed findings (Fransson et al., 2012), however a pooled analysis of 160,000 adults from 13 cohort studies which examined the relationship between job strain and BMI, suggested a ‘U’-shaped cross-sectional association between job strain and BMI, whereby job strain was associated with both underweight and obesity (Nyberg et al., 2012). Despite the large sample size of the pooled analysis, Nyberg et al. (2012) suggested that since the associations were relatively modest, interventions to reduce job strain would likely be ineffective for reducing obesity at the population level. The inconclusive results yielded by Nyberg et al. (2012) suggest methodological issues other than sample size need to be considered. Notably, there are methodological concerns regarding the conceptualisation and calculation of job control and therefore job strain.

The practice of combining the two job control components (skill discretion and decision authority) to create a composite index of job control (decision latitude) is most common, however the practice has been criticised for confounding the measurement of job control with the measurement of job complexity (Mansell & Brough, 2005). Furthermore, Joensuu et al. (2012a) provided evidence that the two components of job control have differential associations with mortality, finding employees with high levels of skill discretion experienced lower all-cause mortality, while high levels of decision authority were associated with elevated risks of all-cause, cardiovascular, and alcohol-related mortality. More recently, Joensuu et al. (2014) reported that high decision authority can be associated with either higher or lower all-cause mortality, depending on gender and socioeconomic position. Earlier work by De Jonge, Reuvers, et al. (2000) also suggested differential effects for the two components of job control, but unlike Joensuu et al. (2012a), their results suggest decision authority was negatively associated with psychosomatic health complaints and sickness absence, whereas skill discretion was not a significant predictor. De Jonge, Reuvers, et al. (2000) noted that skill discretion and decision authority exerted opposite effects on these outcome variables, suggesting that the two components should be analysed separately. These studies suggest that previous research considering obesity and work stress using the JDCS model may be missing differential associations of the two job control components with measures of obesity.

In addition to the concerns regarding the appropriate treatment of the JDCS variables, most studies investigating the association between work stress and obesity have used BMI which is a measure of weight adjusted for height. Despite its common usage, BMI is an imperfect measure of fatness since it does not directly measure body composition or fat mass (Flegal et al., 2009). As such, BMI is referred to as a measure of overall obesity (Wang et al., 2005). An alternative is waist circumference which provides a measure of fat accumulation around the waist and is a measure of central obesity (Janssen et al., 2004). It is suggested that the accumulation of fat around the waist may present a greater risk to health than fat deposited elsewhere in the body. Although waist circumference and BMI are highly correlated and both show a similar association with mortality (Pischon et al., 2008), waist circumference is superior for detecting cardiovascular risk factors (Lee et al., 2008), and type 2 diabetes (Wang et al., 2005). Furthermore, waist circumference may be especially suitable for the present study since the psychobiological chronic stress network, through a variety of physiological and behavioural mechanisms, implicates abdominal (i.e., central obesity) rather than overall obesity (Dallman, Pecoraro, & La Fleur, 2005; Tomiyama et al., 2011).

Two significant issues have been identified with previous research in this area: firstly, the common practice of merging the job control subscales, skill discretion and decision authority, into a composite measure of job control, and often further reducing the demand-control-support measures into a dichotomised measure of job strain. The second significant issue is the high prevalence of BMI for the measurement of obesity, despite evidence that waist circumference represents a better indicator of health risk. Therefore, alongside emerging evidence that the two JDCS components of job control (skill discretion and decision authority) display differential associations with related health outcomes, the aims of the current study were to:

(a) investigate the possibility that separate components of the JDCS model, specifically skill discretion and decision authority, may display unique relationships with measures of obesity;
(b) test these associations using measures of both central obesity (waist circumference) and overall obesity (BMI), providing a comparison of these measures.

We have chosen to measure BMI alongside waist circumference for two reasons: firstly, to allow for comparison with previous research which commonly uses this as the only measure of obesity; secondly, to enable comparison between BMI and waist circumference in the present study, to see which displays the strongest relationships with the variables under investigation.

Method

Research Design

The present study employed a cross-sectional study design and was part of a larger longitudinal study: the North West Adelaide Health Study (NWAHS). Demographic, waist circumference, height and weight data were collected in a clinic setting at stage 3 of the NWAHS, conducted between June 2008 and August 2010. Workplace and employment-related data were collected during a later computer-assisted telephone interview (CATI), conducted between October and November 2011. The mean time between the collection of the two sets of data was 2.32 years (*SD* = 0.54). To account for this discrepancy, inclusion for the current study required participants to have been working in the same workplace for at least 4 years. This ensured that at the time of the telephone interview, all participants were working in the same workplace as they were during stage 3 of the NWAHS. The mean time participants reported being with their current workplace was 16.10 years (min = 4, max = 46, *SD* = 9.48).

Original sampling and data collection processes involved random selection from the northern and western suburbs of Adelaide, South Australia, using the Electronic White Pages telephone directory, as detailed previously (Grant et al., 2006; Grant et al., 2009). From the initial sample of 4056 adults recruited in stage 1 of the NWAHS (1999-2003), the 2011 CATI focussed on a subset of participants (initial eligible *n* = 1715; i.e., those not lost to follow-up in earlier stages, and born between 1946 and 1980 as per requirement of a separate study). The eligible sample was reduced as 302 (17.6%) had not worked in the last 3 years and 47 (2.7%) were not contactable. From the final eligible sample of 1366, a total of 1185 (86.7%) interviews were completed. Of these, 450 met criteria for the present study (i.e., same workplace for 4 years, no missing data for the items in the regression model).

Ethics

Data collection was approved by the Adelaide Health Service Human Research Ethics Committee (comprising The Queen Elizabeth Hospital (TQEH), Lyell McEwin Hospital (LMH), and Modbury Hospital), previously known as Central Northern Adelaide Health Service Ethics of Human Research Committee (TQEH & LMH) and North Western Adelaide Health Service Ethics of Human Research Committee.

Measures

The Job Content Questionnaire (JCQ) (Karasek et al., 1998) was used during a computer-assisted telephone interview to collect data on work-related psychological demands, skill discretion, decision authority, coworker support and supervisor support. The JCQ is the most commonly used instrument to capture the JDCS model variables (Courvoisier & Perneger, 2010) and has established reliability and validity (De Araújo & Karasek, 2008; Karasek et al., 1998). Psychometric properties including internal reliability estimates are provided in Table 2. The version used in this study contained 35 items with a 4-point response scale (e.g., 1 = *strongly disagree*, 4 = *strongly agree*). In order to build indicators for each subscale of the JDCS model, a sum of the weighted item scores was calculated according to the JCQ user guide (Karasek, 1985).

Participant height, weight and waist circumference were measured by clinic staff using standardised protocols and were recorded as continuous variables (see Table 2). Waist circumference is the distance around the waist and is a measure of central obesity; this was measured to the nearest 0.01cm (mean of 3 measurements) using a soft tape measure. Height was measured to the nearest 0.5cm using a stadiometer, and weight was measured to the nearest 0.1kg in light clothing without shoes using standard digital scales. BMI is calculated by weight/height^2 and is a measure of overall obesity.

Analyses

Separate multiple regression analyses were conducted to determine associations between components of the JDCS model and two measures of obesity: waist circumference (Table 3) and BMI (Table 4). In both analyses, control variables: sex, age, household income, working hours and job nature (blue vs. white-collar) were entered at step 1, and components of the JDCS model were entered at step 2. Due to our moderate sample size, to preserve statistical power in our main analyses (Tables 3 and 4), we controlled for sex rather than present results for men and women separately. Supplementary analyses stratified by sex are reported in-text. All analyses were conducted in IBM SPSS Statistics for Windows (Version 20.0).

Seven cases, three male and four female were identified as extreme outliers (standardised residuals ≥3), these cases featured BMIs ranging from 46.27–51.82kg/m^2, and were excluded from all analyses. Cases with missing data for the items in the regression model were also excluded. Data on participant educational attainment is presented in Table 1, however this was not included as a control variable since it was not significant when included in earlier models; instead household income, an alternative measure of socioeconomic status, was included as it was found to account for greater variance in our sample.

Results

Participant Characteristics

A summary of occupational and socioeconomic descriptive variables is provided in Table 1.The sample comprised 450 employees (*n* = 230, 51.1% female) from a South Australian cohort (mean age = 47.66 years). The majority of participants were overweight or obese (mean BMI = 28.32kg/m^2), which is consistent with national prevalence (Australian Bureau of Statistics, 2013). Specifically, 167 (37.1%) participants were categorised as overweight (BMI 25.00–29.99kg/m^2), 154 (34.2%) as obese (BMI ≥30kg/m^2), 126 (28.0%) within the normal range (BMI 18.5–24.99kg/m^2), and 3 (0.7%) underweight (BMI <18.50kg/m^2). Participant occupational data were classified using the Australian and New Zealand Standard Classification of Occupations (ANZSCO) (Australian Bureau of Statistics, 2009). Professionals comprised the largest majority of both male (22.7%) and female (36.5%) participants. More female participants (89.6%) were classified as white-collar workers, compared to males (68.6%), and also reported being part-time employees (47.83%) more often than males (5.0%). The majority of participants (51.6%) reported a household income above $80,001 (Australian dollars) and the distribution was comparable for males and females. The sample was relatively well-educated; while 22.4% did not complete high school, 31.3% of female and 25.0% of male participants reported holding a bachelor's degree or higher.

Table 1 *Summary of Occupation and Socioeconomic Variables*

Variable	Male (%) *n* = 220	Female (%) *n* = 230	Whole sample (%) *N* = 450
Occupational Category (ANZSCO[a] code)			
Uncodable/Inadequately described (0)	3 (1.4%)	0 (0.0%)	3 (0.7%)
Managers (1)	42 (19.1%)	15 (6.5%)	57 (12.7%)
Professionals (2)	50 (22.7%)	84 (36.5%)	134 (29.8%)
Technicians and Trades Workers (3)	36 (16.4%)	7 (3.0%)	43 (9.6%)
Community and Personal Service Workers (4)	7 (3.2%)	31 (13.5%)	38 (8.4%)
Clerical and Administrative Workers (5)	31 (14.1%)	61 (26.5%)	92 (20.4%)
Sales Workers (6)	19 (8.6%)	15 (6.5%)	34 (7.6%)
Machinery Operators and Drivers (7)	24 (10.9%)	5 (2.2%)	29 (6.4%)
Labourers (8)	8 (3.6%)	12 (5.2%)	20 (4.4%)
Job Nature			
Blue-Collar	69 (31.4%)	24 (10.4%)	93 (20.7%)
White-Collar	151 (68.6%)	206 (89.6%)	357 (79.3%)
Employment Type			
Full Time	209 (95.0%)	120 (52.17%)	329 (73.11%)
Part Time	11 (5.0%)	110 (47.83%)	121 (26.89%)
Household Income[b]			
$12,001 - $20,000	0 (0.0%)	2 (0.9%)	2 (0.4%)
$20,001 - $40,000	15 (6.8%)	25 (10.9%)	40 (8.9%)
$40,001 - $60,000	43 (19.5%)	36 (15.7%)	79 (17.6%)
$60,001 - $80,000	45 (20.5%)	52 (22.6%)	97 (21.6%)
$80,001 - $100,000	38 (17.3%)	43 (18.6%)	81 (18.0%)
More than $100,000	79 (35.9%)	72 (31.3%)	151 (33.6%)
Education			
Did Not Complete High School	41 (18.6%)	60 (26.1%)	101 (22.4%)
Completed High School	22 (10.0%)	36 (15.7%)	58 (12.9%)
TAFE[c]/Apprenticeship	25 (11.4%)	17 (7.4%)	42 (9.3%)
Trade Certificate or Diploma	77 (35.0%)	45 (19.6%)	122 (27.1%)
Bachelor Degree or Higher	55 (25.0%)	72 (31.3%)	127 (28.2%)

Note. [a] Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1.
[b] Amount in Australian dollars.[c] Technical and Further Education (vocational education and training).

Table 2 *Summary of Continuous Variables*

Variable	*M*	*SD*	α	Range	
				Potential	Actual
Age (years)	47.66	7.88	_	–	28-63
Waist Circumference (cm)	93.10	14.74	–	–	61.5-134.4
Body Mass Index (kg/m^2)	28.32	5.35	–	–	16.94-44.31
Work Hours (per week)[a]	37.43	11.31	–	–	0-86
Components of the JDCS Model					
Psychological Demands	32.36	5.60	.63 (5 items)	12-48	15-48
Skill Discretion	35.18	5.17	.74 (6 items)	12-48	18-48
Decision Authority	35.37	6.25	.72 (3 items)	12-48	12-48
Coworker Support	9.66	1.28	.85 (3 items)	3-12	6-12
Supervisor Support	9.18	1.62	.80 (3 items)	3-12	3-12

Note. [a] Average hours worked per week in main job over past month.

Predictors of Obesity Measures

Sex, age and household income were significant control predictors for waist circumference. On average, male participants, older participants, and those with a lower household income had a higher waist circumference. Once these effects were controlled for, the two components of job control were the only parts of the JDCS model associated with waist circumference. Specifically, differential directions of association were observed; negative for skill discretion (i.e., more skill discretion, lower waist circumference), and positive for decision authority (i.e., more decision authority, higher waist circumference). With regard to the unstandardised coefficient (*b*) values in Table 3, a 1-unit increase in skill discretion was associated with a 0.50cm (p = .001) decrease in waist circumference. Conversely, a 1-unit increase in decision authority was associated with a 0.28cm (p = .022) increase in waist circumference.

For BMI, household income was the only significant control predictor – where on average, those with a lower household income had a higher BMI. After control variables were entered in step 1, skill discretion was the only part of the JDCS model associated with BMI. With regard to the unstandardised coefficient (*b*) value in Table 4, a 1-unit increase in skill discretion was associated with a .168kg/m^2 (p = .005) decrease in BMI. While the association between decision authority and BMI did not reach significance in this model (p = .075), a positive direction of association was observed, as was seen between decision authority and waist circumference.

Table 3 *Multiple Regression Analyses Predicting Waist Circumference (cm) from Psychosocial Work Factors*

Predictor	*b*	*SE (b)*	β	*t*	Sig. (*p*)
Model 1					
Sex[a]	-5.79	.695	-.393	-8.34	<.001***
Age	.251	.081	.134	3.08	.002**
Household Income[b]	-1.73	.654	-.117	-2.64	.009**
Work Hours	.035	.059	.027	.59	.554
Blue vs. White-Collar[c]	-.090	.825	-.005	-.11	.913
Model 2					
Sex[a]	-5.48	.698	-.372	-7.85	<.001***
Age	.254	.081	.136	3.15	.002**
Household Income[b]	-1.74	.651	-.118	-2.68	.008**
Work Hours	.039	.060	.030	.65	.514
Blue vs. White-Collar[c]	.543	.84	.030	.65	.517
Psychological Demands	-.068	.118	-.026	-.57	.566
Skill Discretion	-.502	.144	-.176	-3.49	.001**
Decision Authority	.282	.122	.120	2.31	.022*
Coworker Support	-.830	.564	-.072	-1.47	.142
Supervisor Support	-.183	.455	.020	-.40	.69

Note. R^2 = .186 for Model 1, p <.001; $R^2\Delta$ = .035 for Model 2, p =.002; Total R^2 = .221, p <.001.
[a] -1 = male, +1 = female,
[b] -1 = up to $80,000. +1 = $80,001+ (median split),
[c] -1 = blue-collar, +1 = white-collar.
*p <.05. **p <.01. ***p <.001.

Table 4 *Multiple Regression Analyses Predicting Body Mass Index (kg/m²) from Psychosocial Work Factors*

Predictor	*b*	*SE (b)*	β	*t*	Sig. (*p*)
Model 1					
Sex[a]	-.064	.276	-.012	-.23	.818
Age	.047	.032	.069	1.45	.147
Household Income[b]	-.587	.260	-.110	-2.25	.025*
Work Hours	.027	.024	.057	1.15	.252
Blue vs. White-Collar[c]	-.024	.328	-.00	-.07	.942
Model 2					
Sex[a]	.042	.279	.008	.151	.880
Age	.047	.032	.069	1.46	.146
Household Income[b]	-.590	.261	-.110	-2.26	.024*
Work Hours	.029	.024	.062	1.22	.225
Blue vs. White-Collar[c]	.191	.335	.029	.57	.569
Psychological Demands	-.030	.047	-.031	-.63	.527
Skill Discretion	-.163	.058	-.158	-2.83	.005**
Decision Authority	.087	.049	.102	1.78	.075[#]
Coworker Support	-.327	.226	-.078	-1.45	.148
Supervisor Support	.008	.182	.002	.04	.965

Note. R^2 = .021 for Model 1, p = .085; $R^2\Delta$ = .029 for Model 2, p =.021; Total R^2 = .051, p = .011.
[a] -1 = male, +1 = female,
[b] -1 = up to $80,000. +1 = $80,001+ (median split),
[c] -1 = blue-collar, +1 = white-collar
*p <.05. **p <.01. ***p <.001. [#]p <.10.

Despite our limited sample size, we conducted additional analyses to explore the possibility of sex differences such as those reported by Joensuu et al. (2014). Using multiple regression models with the same structure as those presented in Tables 3 and 4, results indicated the same differential directions of association between the two job control components and both waist circumference and BMI for both men (n = 220) and women (n = 230). For men: there was a negative association for skill discretion with both waist circumference (b = -.480, p = .018) and BMI (b = -.151, p = .036). Conversely, a positive association was observed for decision authority with both waist circumference (b = .328, p = .051) and BMI (b = .124, p = .038), although the former did not reach significance.

For women: a negative association between skill discretion with both waist circumference (b = -.463, p = .027), and BMI (b = -.148, p = .100) was observed, although the latter was not significant. Conversely, while not significant, a positive direction of association was observed for decision authority with both waist circumference (b = .207, p = .249) and BMI (b = .040, p = .603). When stratified by sex, as observed in the combined analyses, no other parts of the JDCS model (i.e., demands, coworker support or supervisor support) appeared to be associated with waist circumference or BMI.

Discussion

The first aim of this study was to investigate the possibility that separate components of the JDCS model, specifically the two components of job control, may display unique relationships with measures of obesity. This was achieved by not reducing the JDCS components into composite or global scores, making this study the first of its kind to consider differential effects of the two components of job control in relation to obesity. Notably these components, skill discretion and decision authority, appear to have contradictory associations with both waist circumference and BMI, and these differential associations would have been masked if the composite measure of job control (decision latitude) or the global measure of job strain had been used instead. Our results may help to explain why previous research investigating the association between job strain and obesity has produced inconsistent findings (Fransson et al., 2012; Nyberg et al., 2012). Moreover, our results are consistent with evidence that these two components of job control have differential associations with mortality (Joensuu et al., 2012a). The same pattern was observed whereby on average, higher skill discretion appears to be beneficial, while higher decision authority appears to be detrimental.

To explain these findings, it has been suggested that while the benefits of increased decision authority are conceivable when considered in the historical context of growing industrialisation, these benefits are less obvious in contemporary work environments where there is greater global competition (Joensuu et al., 2012b). With regard to a causal mechanism, it is suggested that employees with high decision authority may feel overwhelmed by the number of decisions required of them, or poorly defined choices in their work. Such concepts have previously been referred to as tyrannies of freedom or choice, where excessive choice has been suggested to cause negative emotions due to the related opportunity costs (Schwartz, 2000, 2004). Joensuu et al. (2012a) also suggest stress may result from the perception of too much responsibility being perceived as a burden, challenging a long-held assumption that higher job control can mitigate adverse effects of high job demands (De Jonge, Dollard, et al., 2000).

The perception of too much decision authority may lead to increased stress, resulting in increased food consumption and changes in the way the body processes food, leading to excess fat accumulation. While the psychobiological mechanisms underlying the association between stress and increased eating have been discussed elsewhere (Adam & Epel, 2007; Tomiyama et al., 2012), further research is required to understand the nature of the positive energy balance. Future research may consider the relative contributions of excess energy intake and inadequate physical activity associated with work stress, and how excess decision authority may be implicated.

Personal attributes, such as preference for high or low decision authority is another factor which should be considered. Parker, Jimmieson, and Amiot (2013) suggest that differences in self-determination can moderate the stress-buffering effects of increased job control. Their study suggests high work control may be beneficial for self-determined individuals but stress-exacerbating for non-self-determined individuals (Parker et al., 2013).

The second aim of this study was to compare waist circumference and BMI, to see which displayed the strongest relationships with the variables under investigation. In our analyses, waist circumference appears to be more sensitive compared to the more commonly used BMI. This is indicated by the difference in variance explained in step 2 of Tables 3 and 4 ($R^2\Delta$ = .035 vs. .029). This finding is noteworthy since waist circumference appears to be a better indicator of obesity-related health risks compared to BMI (Janssen et al., 2004). Although the variance explained by components of the JDCS model appears modest for both waist circumference and BMI, this should be considered in context with more acknowledged obesity covariates such as age and socioeconomic status. With regard to the standardised coefficient beta values for predictors of waist circumference (step 2 of Table 3): skill discretion (*beta* = -.176, *p* = .001) and decision authority (*beta* = .120, *p* = .022), are comparable to age (*beta* = .136, *p* = .002) and household income (*beta* = -.118, *p* = .008) in the amount of variance explained. Similarly for BMI (step 2 of Table 4), skill discretion (*beta* = -.158, *p* = .005) is comparable to household income (*beta* = -.110, *p* = .024).

Strengths and Limitations

A key strength of this study was that waist circumference and BMI were measured and recorded objectively in a clinic setting with standardised protocols, while many previous studies have relied upon self-reported data for participant height and weight (Block et al., 2009; Ostry et al., 2006). A further strength was our innovative analysis, assessing the JDCS model components separately in multiple regression models, rather than using composite or global measures.

A core limitation of this study is its cross-sectional design. As with other cross-sectional studies in this field, we cannot rule out the possibility of reverse causality, i.e., an employee's waist circumference/BMI could, through some unknown selection processes, influence their exposure to psychosocial work factors. In addition, the delay between the measurement of waist circumference/BMI and psychosocial work factors highlights the exploratory nature of this work. While we ensured participants were working in the same workplace between the two measurement points, participants may have changed positions within the same workplace during this time; however we do not believe this would be typical or likely to significantly alter the interpretation of our findings. Moreover, while statistical power was limited, the essence of our main finding appeared to be robust in the supplementary analyses stratified by sex. A larger sample would have enabled the exploration of more complex relationships such as those reported by Joensuu et al. (2014), wherein the differential associations between components of job control and mortality varied depending on sex and socioeconomic position.

Conclusions

The evidence presented in this study is not sufficient to recommend changes to workplace policies or practices; however our findings do complement those of Joensuu et al. (2012a, 2014) and should encourage future research into health outcomes associated with work stress to consider the potential for differential effects of the two components of job control. Skill discretion and decision authority should be considered independently, rather than combining them into the single index of job control (decision latitude) or the global measure of job strain. Future research should also include a measure of central obesity, such as waist circumference in addition to the more traditionally used measure of BMI. Finally, future research with a larger sample size may be more sufficiently powered to explore sex differences in relation to the association between obesity and psychosocial work factors.

The high prevalence of obesity and its associated diseases represent significant challenges for societies around the world. The workplace environment is significant since employment is a fundamental part of life for many and potential risk factors in this environment may be modifiable. A better understanding of how components of the JDCS model may be associated with obesity, and perhaps more importantly, the relative contributions of excess energy intake and physical inactivity, will assist in the formulation of better informed strategies to reduce both incidence and prevalence of obesity. Novel findings from the present study challenge the assertion that interventions to reduce work stress may be a low priority in efforts to reduce obesity (Nyberg et al., 2012). Previous research employing overly broad definitions of job strain, specifically concerning the calculation of job control, may be concealing more complex associations and opportunities to improve health outcomes for employees.

CHAPTER 3: PAPER TWO

3.1 Preamble

The first study provided support for an association between some psychosocial work factors within the JDCS model and reduced or elevated obesity measures. Specifically, the novel observation of differential directions of association for the two components of job control – skill discretion and decision authority – where the former appeared to be negatively associated with obesity measures (i.e., more skill discretion, lower obesity measures), while the latter appeared positively associated (i.e., more decision authority, higher obesity measures). A better understanding of why components of the JDCS model may be associated with obesity can be achieved through consideration of the potential mechanisms likely to be involved. The positive energy balance hypothesis is generally accepted as the biological mechanism responsible for most overweight and obesity. Essentially, positive energy balance describes the situation where intake of dietary energy is greater than what is required for bodily processes and physical activity. As such, the positive energy balance hypothesis suggests leisure-time physical activity (LTPA) and habitual diet are likely to be two important health behaviours involved in excess weight gain and maintenance. The present study describes the findings of a systematic review of the existing peer-reviewed literature that reports on the association between favourable or unfavourable psychosocial work factors within the JDC(S) model and LTPA and/or habitual diet. A key inclusion criterion was the stipulation that eligible studies were required to control or adjust for the effects of sex and age in relevant analyses. This was required since both sex and age are associated with differences in daily energy intake requirements and increasing age is often associated with reduced physical activity. Note that the JDC(S) abbreviation is used inclusively to indicate either the Job Demand-Control (JDC) model or the Job Demand-Control-Support (JDCS) model – the latter being the same as the former, with the addition of the 'support' construct.

Associations between work stress, leisure-time physical activity, and diet: A systematic review of studies that use the Job Demand-Control(-Support) model

- MANUSCRIPT UNDER REVIEW FOR PUBLICATION -

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3.2 Statement of Authorship

Title of Paper	Associations between work stress, leisure-time physical activity, and diet: A systematic review of studies that use the Job Demand-Control(-Support) model.
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Principal Author

Name of Principal Author (Candidate)	Christopher G. Bean		
Contribution to the Paper	Responsible for the primary authorship of this paper, and collaborated with co-authors in its conceptualisation and design. Conducted all statistical analyses, and took the lead role in interpreting the results, and writing and revising the manuscript. Served as corresponding author and responsible for manuscript submission, revisions, and responses to journal reviews.		
Overall percentage (%)	80%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Amanda D. Hutchinson		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Acted as second reviewer for the systematic review process. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	10%		
Signature		Date	

Name of Co-Author	Helen R. Winefield		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Charli Sargent		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

3.3 Paper Two

Abstract

The positive energy balance hypothesis suggests leisure-time physical activity (LTPA) and dietary intake are two important, potentially mediating factors, in the development of obesity. Work is a substantial part of life for many, therefore increasing understanding of how favourable or unfavourable psychosocial working conditions (i.e., 'work stress') may be associated with LTPA and diet represents an important area of enquiry. The objective of this systematic review was to identify and describe peer-reviewed research that reports on the association between psychosocial work conditions within the Job Demand-Control(-Support) (JDC[S]) model, LTPA and/or habitual diet. A comprehensive search protocol was applied to eight databases. Following removal of duplicates, potentially relevant records (*n* = 6,863) were screened, with 31 meeting inclusion criteria. There was general support for a negative association between work stress (JDC[S] model) and LTPA; particularly lower job control and lower LTPA, or the inverse. There was some support to suggest an association between work stress (JDC[S] model) and poorer diet, but insufficient studies to make strong conclusions. This review identified the exigent need for more studies in this area to report diet outcomes, specifically total dietary energy intake. Findings generally support consideration of the individual JDC(S) constructs over global measures of job strain.

Keywords: diet; job demands; job control; job strain; leisure-time physical activity; obesity

Introduction

The high prevalence of overweight and obesity is an enduring international concern (Flegal et al., 2012; Moody, 2014; Ng et al., 2014). While the precise causes are not universally agreed (Keith et al., 2006; McAllister et al., 2009), implicated contextual factors include: individual physiology, food production and consumption, individual activity and physical activity environment, individual psychology, and social psychology (Bray, 2004; Butland et al., 2007; Finegood et al., 2010; Kumanyika, 2001). Appreciation of the broad and interactive contextual factors is highly important to help explain *why* obesity happens. Nonetheless, the positive energy balance hypothesis is generally accepted as the biological mechanism (i.e., the *how*) for the development of most overweight and obesity. That is, when energy intake from diet is greater than energy expenditure from daily functioning (e.g., basal metabolism and thermogenesis) and physical activity over a sustained period of time (Faith & Kral, 2006; McArdle, 2007; World Health Organization, 2016a). Dietary patterns may be defined as “the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed” (United States Department of Agriculture, 2014, p. 2). This review focuses on habitual diet, rather than irregular binges, snacking behaviours or specific cravings (Heath et al., 2012; Yau & Potenza, 2013); while these are relevant, a person’s weight is generally influenced (maintained, increased or decreased) through regular patterns of energy intake sustained over time. Physical activity may be defined as “any bodily movement produced by skeletal muscles that requires energy expenditure” (World Health Organization, 2014); notably physical activity is the most important determinant of between-person variation in total energy expenditure (Hu, 2013). Broad categories of physical activity include “occupational” (i.e., performed regularly as part of job), “leisure-time” (e.g., exercise, recreation, or hobbies), “household” (e.g., shopping, home-maintenance), and “transportation” (e.g., cycling as means of transport) (Ainsworth et al., 2000). This review focuses on leisure-time physical activity (LTPA), since work-related or occupational physical activity may confound perceptions of work stress. Furthermore, work-related activity may be an inherent characteristic of some jobs and therefore less easily modifiable than LTPA (Martins & Lopes, 2013).

Since paid employment is a fundamental part of life for many, extending understanding of how psychosocial work factors may be implicated in energy balance regulation comprises a narrow yet potentially far-reaching area of enquiry. While some studies suggest increased work stress is associated with increased incidence of overweight and obesity (Block et al., 2009; Brunner et al., 2007), others do not (Kivimäki, Singh-Manoux, Nyberg, Jokela, & Virtanen, 2015). Furthermore, the mechanisms underlying these potential associations are less clearly understood since the role of suspected mediating behaviours (e.g., diet and LTPA) has traditionally received less attention than the outcomes (e.g., body mass index; BMI) themselves (Lallukka et al., 2008). It has been proposed that adverse health behaviours may occur in response to environmental challenges, such as poor psychosocial working conditions conducive to work stress (Bhui, 2002; Siegrist & Rödel, 2006), and the positive energy balance hypothesis suggests chronically stressed employees gain weight by either: (i) excessive dietary intake, (ii) not maintaining sufficient physical activity, or (iii) a combination of these behaviours. While outside the scope of this review, other contributing factors likely include physiological processes associated with chronic stress, which may interact with behavioural responses to promote excess fat accumulation (Adam & Epel, 2007; Dallman, 2010; Dallman et al., 2003; Pecoraro et al., 2004; Tomiyama et al., 2011).

There are a number of ways to conceptualise stress related to work factors, including length of work hours, (Härmä, 2006; Van der Hulst, 2003), type of hours worked (e.g., shiftwork) (Harrington, 2001; Srivastava, 2010), work-life balance (Kalliath & Brough, 2008), and work-related daily hassles (Steptoe et al., 1998). However much research has focused on internal organisational factors, particularly job design, which refers to the specification of employee activities, such as tasks required and how these are structured and scheduled (Daniels et al., 2014; Dollard et al., 2014; Humphrey et al., 2007). For reasons discussed further in the methods section, this review includes only studies that use the Job Demand-Control(-Support) (JDC[S]) model, also known as the job strain model (Johnson & Hall, 1988; Karasek, 1979; Karasek & Theorell, 1990), which is the most commonly tested model of work stress (Eller et al., 2009; Nyberg et al., 2012). This model generally suggests there is an increased risk for work stress when there is a mismatch between psychological job demands and job control (two job control subscales: skill discretion and decision authority). The idea of including social support (two job social support subscales: coworker support, supervisor support) was added later (i.e., JDCS), but it is not always included, so the model is sometimes referred to as the Job Demand-Control model (i.e., JDC) or similar.

There is notable discrepancy between studies in the treatment and analysis of the JDC(S) model variables. While most initially combine the control and support subscales into their respective composites, some then elect to consider the model constructs (i.e., demands, control, support) independently, while others calculate a global measure of job strain. The quadrant approach is the most common method for calculating presence of job strain, whereby the demand and control scales are split at the sample-specific median and job strain is indicated by the combination of above median demands and below median control (Courvoisier & Perneger, 2010). Iso-strain is a less common variant of job strain and is indicated by the addition of below median social support at work. Studies commonly categorise employees into four job strain groups: low strain (low demands, high control), active (high demands, high control), passive (low demands, low control), and high strain (high demands, low control). While most research has focused on the deleterious effects of high strain jobs, passive jobs have also been shown to be associated with poor health outcomes (Gimeno et al., 2009). More recently, there has been greater consideration given to the utility of the individual JDC(S) constructs, and even more finely, the subscales of job control: skill discretion and decision authority (Bean, Winefield, Sargent, & Hutchinson, 2015; De Jonge, Reuvers, et al., 2000; Joensuu et al., 2012a; Mansell & Brough, 2005). A recent meta-analysis featuring eight studies found no consistent association between job strain and risk of weight gain, leading the authors to suggest job strain may not be an important factor for obesity prevention (Kivimäki et al., 2015). However in response it was suggested that future research should consider possible influences of the individual components of job strain (i.e., demands, control) (Mathieu & Tremblay, 2015).

Previous research on the association between work stress and health behaviours is characterized by mixed findings; suggested reasons include small sample sizes, measurement or classification issues, as well as uncertainty about generalisability between geographic regions, owing to the possibility of cultural and climatic differences potentially influencing variables of interest (Choi, Ko, & Ostergren, 2015; Hellerstedt & Jeffery, 1997; Houdmont et al., 2015; LaMontagne, 2012; Siegrist & Rödel, 2006; Smith & LaMontagne, 2015).

The Individual Participant Data (IPD)-Work Consortium have produced papers considering the potential influence of psychosocial work factors on obesity and related health behaviours, using extensive individual-level data from multiple published and unpublished studies (Fransson et al., 2012; Nyberg et al., 2012). An IPD-Work meta-analysis including up to 170,000 employees provided robust support for the association between unfavourable psychosocial work characteristics, specifically high strain jobs or passive jobs, and greater leisure-time physical inactivity (Fransson et al., 2012). It was suggested that high strain jobs may result in fatigue, thereby increasing the likelihood of sedentary behaviour; while the unchallenging nature of passive jobs may lead to reduced self-efficacy, predisposing employees to a more passive lifestyle (Fransson et al., 2012; LaMontagne, 2012). While most research frames and supports the notion that stress has a negative influence on physical activity (i.e., behavioural inhibition), it should be noted that the relationship between physical activity and stress sometimes appears reciprocal, and a subset of employees may use physical activity as a means of mitigating stress (i.e., behavioural activation) (Stults-Kolehmainen & Sinha, 2014).

Different types of stress appear to have different influences on food consumption (O'Connor et al., 2011). Acute and physically threatening stressors are commonly associated with a decrease in eating (e.g., fight or flight response), whereas more chronic, psychosocial, ego-threatening or work-related stressors are generally associated with increases in eating (O'Connor et al., 2011). Contrarily there also appears to be a proportion of people who do not overeat, or eat less, when stressed (Dallman, 2010); it has been suggested that eating style (i.e., restrained vs. unrestrained) may influence this response (O'Connor et al., 2008). The tendency of a subset of people to react differently to stress (e.g., maintain/increase physical activity, and/or eat less/no change in diet) compared with more common deleterious responses (e.g., reduce physical activity, and/or increase diet intake) may help explain the results of another IPD-Work meta-analysis, which suggested a ‘U’-shaped cross-sectional association between job strain and body mass index (BMI). This indicated that job strain was associated with both underweight and obesity (Nyberg et al., 2012). Based on the relatively modest associations in this study, it was suggested that interventions to reduce job strain would likely be ineffective for reducing obesity at the population level (Nyberg et al., 2012). It should be noted that the procedures used to combine the IPD-Work cohorts, specifically the approach used to classify job strain, have been queried and it has been suggested the methodology may have resulted in an underestimation of the association between job strain and health outcomes (Choi et al., 2015).

It is important to consider why one IPD-Work meta-analysis indicated robust associations between job strain and physical inactivity (Fransson et al., 2012), while another found only modest associations between job strain and obesity (Nyberg et al., 2012). Discussion of proximal (i.e., close to source) and distal (i.e., further away) factors can be observed on both sides of the possible associations between work stress and health-related outcomes (Wahrendorf & Siegrist, 2014). With regards to health behaviours, it has been suggested that the long distance between job strain and disease outcomes explains why we should expect to see a weaker association than in the study of more proximal factors (e.g., lifestyle-related health behaviours) (Theorell, 2014). For example, BMI is sometimes used as a proxy for low physical activity and unhealthy diet – however weight is a more distal outcome, owing to the time lag between health behaviour and weight gain (Hutchinson & Wilson, 2012; LaMontagne, 2012). Instead, it has been suggested that more proximal and likely mediating variables, such as habitual diet and LTPA are likely to be more sensitive indicators of the potential long-term impact of work stress on weight-related outcomes (Hutchinson & Wilson, 2012).

A previous review which considered the relationship between stress at work and eating concluded there was some support for an association between stress and unhealthy food choices but that the relationship between work stress and eating remains poorly understood and under-researched (Stewart-Knox, 2014). Furthermore, the measures of stress used by the studies included in this previous review were not all work-specific, such as the Perceived Stress Scale – which may include sources of stress unrelated to employment. A previous integrative review considering work environment factors associated with physical activity among white-collar workers included studies published up to November 2011 and concluded there was weak or equivocal evidence for the association between job strain and physical activity (Lin, McCullagh, Kao, & Larson, 2014). This previous review included measures of total physical activity (i.e., including work-related or during work-time) as well as leisure-time physical activity (LTPA). This is noteworthy since the former may confound perceptions of work stress, and work-related activity may be less easily modifiable than LTPA.

Important theoretical and methodological issues identified with previous research in this area form the rationale for this review. Firstly there are inconsistencies in the approaches used for conceptualising work stress in the context of the JDC(S) model, and uncertainty about which approaches may be most useful (e.g., global job strain measure or strain groups vs. individual constructs). Secondly, there is increasing acknowledgment for the utility of observing more proximal indicators (e.g., LTPA and diet) over more distal indicators (e.g., BMI), for better understanding the potential long-term effects of work stress on obesity prevalence. Finally, previous reviews in this area have tended to focus on either physical activity or diet, but not both simultaneously. Further methodological issues with previous reviews involve inclusion of studies that did not use work-specific measures of stress, or studies that included work-related or occupational physical activity. In light of these matters, clarification through a systematic review of relevant published literature is warranted. As such, the specific aims of this review are to:

(a) identify peer-reviewed original journal articles that report on the association between favourable or unfavourable psychosocial work factors (i.e., work stress) (within the JDC[S] model) and LTPA and/or habitual diet;

(b) detail the methods used in these studies and highlight common or divergent approaches (i.e., conceptualisation of JDC(S) variables, LTPA and diet measurement tools, analyses used);

(c) provide a summary of previous findings and make recommendations for future research.

Method

Search Protocol and Procedure

Evidence-based systematic review guidelines were consulted in the development of the review methods (Meline, 2006; National Health and Medical Research Council [NHMRC], 1999; Petticrew & Roberts, 2006), and the PRISMA statement was applied to summarise the search procedure (Moher, Liberati, Tetzlaff, & Altman, 2009). A comprehensive search protocol, incorporating a combination of subject headings (e.g., MeSH and EMTREE) and free text search terms (e.g., title, abstract, keywords), was developed in collaboration with an experienced research librarian and customised for respective databases' requirements. Dependent on the search functions of each database, search terms were grouped into separate sets for subject headings and free text search terms specific to: (i) work stress (e.g., "job demand control support, job stress, psychosocial work, workplace stress"), and (ii) energy balance health behaviours (e.g., "diet, energy balance, exercise, health behaviour*, kilojoule*, lifestyle*, physical activity"). These sets were then combined to identify relevant papers.

Eight databases were selected based on their comprehensive nature (e.g., PubMed and Scopus) or specific relevance to the subject area (e.g., Business Source Complete). The full list of databases, all searched on June 8, 2016, is presented in the PRISMA flowchart (Figure 1). The development of the search protocol (Appendix 1; available from corresponding author) was an iterative process that involved pre-testing many different combinations of subject headings, search terms, and synonyms, to achieve the highest level of coverage.

Consistent with a critical evaluation approach (Meline, 2006; Slavin, 1986), quality appraisal of the included studies was incorporated into the eligibility criteria, listed in Table 1. To meet inclusion for the review, papers needed to be published in a peer-reviewed journal, as verified by the Ulrichsweb Global Serials Directory (Serials Solutions, 2016). In addition to this, the current review considered research published since 1990 and up to the latest search date June 8, 2016, consistent with previous reviews (LaMontagne, Keegel, Louie, Ostry, & Landsbergis, 2007; Ruotsalainen, Serra, Marine, & Verbeek, 2008; Theorell et al., 2015), and noted intensification of research in this area after 1990.

When the initial criteria were applied to the full set of papers (n = 6,863), 184 papers were deemed eligible, however this was considered too large to meaningfully synthesise the results. The Job Demand-Control(-Support) (JDC[S]) model was the single most prevalent model applied by the eligible papers (Figure 1); and the Job Content Questionnaire (JCQ) (Karasek et al., 1998) is the recommended instrument for measuring the JDC(S) dimensions. It was also observed that the most comprehensive studies had used statistical techniques to adjust or control for the lifestyle-relevant demographic variables of sex and age, while others had only used bivariate analysis methods (often when LTPA or diet were not the main variables of interest). Therefore, the included papers were limited to studies that used the JDC(S) model, and the JCQ or a tool explicitly derived from it; and respective statistical analyses needed to control or adjust for the effects of sex and age.

Increasing age is commonly associated with reduced physical activity, changes in diet and increased weight (Chodzko-Zajko et al., 2009; Tchernof & Després, 2013). As such, dietary energy intake requirements and recommendations vary by age, sex, and activity levels (NHMRC, 2006). On average men are larger and thereby require greater dietary intake to maintain homeostasis compared to women; energy requirements also reduce with age (NHMRC, 2006). Furthermore, the subjective experiences of work stress may differ by sex, or men and women may differ in the types of jobs they occupy and the respective psychosocial working conditions (Evans & Steptoe, 2002). The review was limited to studies accounting for these differences in order to identify high quality papers with comparable methods which could be synthesised meaningfully.

In order to assess the effectiveness and reliability of the inclusion/exclusion criteria, a second reviewer (ADH) used the inclusion criteria to independently review a subset of papers (*n* = 79; 16.9% of the papers retrieved for full-text analysis). This subset had been earmarked as meeting part of the additional criteria (i.e., used JDC[S] model) but had not yet been screened to see if they simultaneously controlled or adjusted for the effects of at least sex and age in the relevant analysis. Working independently, the second reviewer initially allocated 34 papers to be included in the review, largely agreeing with the results of the primary reviewer (92.4% initial agreement for combined inclusion/exclusion). Both reviewers met to resolve discrepancies, resulting in final agreement for the inclusion of 31 studies. The two reviewers extracted and checked data on study origin and design, sample characteristics, and relevant measures.

Table 1

List of Inclusion Criteria, detailing both preliminary and additional criteria applied

Inclusion Criteria	
Preliminary Criteria	Additional Criteria
• Journal article • Published in a peer-reviewed journal[a] • Published since 1990 • English language • Participants: human adults (e.g., age 18+) • Includes a quantitative measure of work stress • Includes a quantitative measure of leisure-time physical activity and/or habitual diet. • Statistical methods to describe the relationship between: the measure of work stress and the measure of leisure-time physical activity; and/or the measure of habitual diet • Contains original data (i.e., not a review/meta-analysis, or duplicate publication)	• Uses the Job Demand-Control(-Support) model[b] • Uses the Job Content Questionnaire (JCQ), or a tool that is explicitly derived or translated from this tool • Statistical analyses must control or adjust for effects of both sex and age[a]

Note. [a]Incorporates Quality Assessment Criteria. [b]Must cite associated reference, e.g Karasek (1979, 1985); Karasek and Theorell (1990) (JDC) or Johnson and Hall (1988) (JDCS).

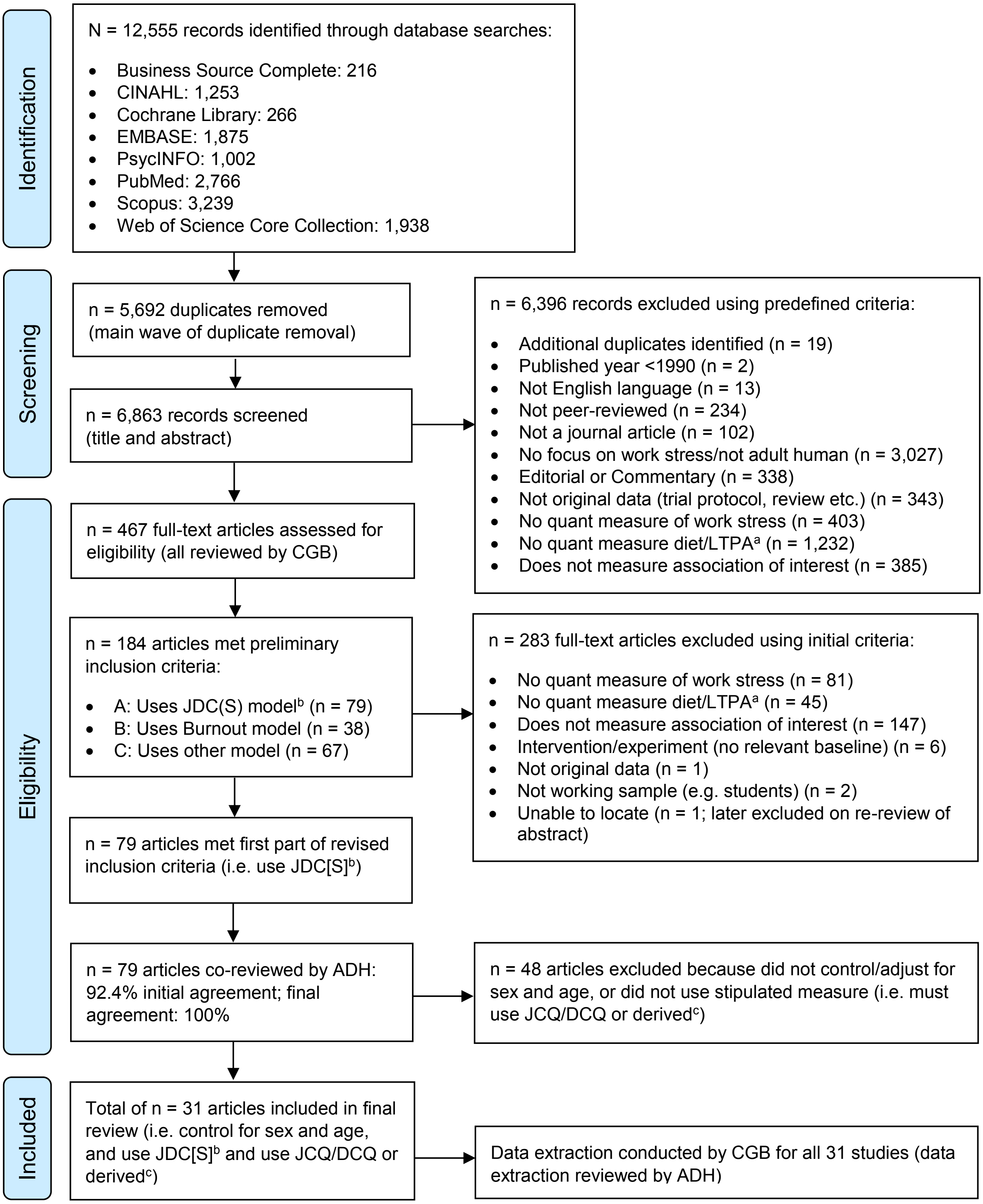

Figure 1. Summary of systematic search procedure and included studies according to the PRISMA statement (Moher et al., 2009). *Note*. Records sorted by most salient criterion feature. All databases searched June 8, 2016. [a]LTPA = Leisure-time Physical Activity, [b]JDC(S) = Job Demand-Control(-Support) model and cites associated reference, e.g., Karasek et al., 1979, 1985, Karasek and Theorell 1990 (JDC) or Johnson and Hall 1988 (JDCS), [c]Must use Job Content Questionnaire (JCQ)/Demand-Control Questionnaire (DCQ), or JCQ/DCQ derived instrument.

Results

Origin, Sample Sizes, Study Design and Year Published

A summary of the included studies is presented in Table 2, detailing respective measurement tools and definitions used for the variables of interest, as well as relevant results. Studies are listed in alphabetical order and numbered [#] in order of presentation in table for ease of reference in-text.

Most studies comprised a single origin sample, however one included cohorts from the UK, Finland, and Japan (#22). The study samples were geographically and culturally diverse: the most common origin was Finland (n = 6), followed by Japan and the USA (n = 5 each), the UK (n = 4; all from the Whitehall II Study), Sweden and Canada (n = 3 each), Brazil (n = 2), and Denmark, Italy, Mexico, Netherlands, Taiwan (n = 1 each). To assist with homogeneity of results, in the case of studies that presented multiple models adjusting for various variables outside the scope of this review, the least adjusted model that controlled for sex and age was selected. Recorded study design and sample size were based on the number of participants providing data for variables of interest for this review; as such, these may be different to those reported for the whole sample in the respective studies.

Most studies were classified as cross-sectional (n = 24), while the remainder were longitudinal or prospective (n = 7). There was considerable variety in sample size: the smallest with 202 participants (#24), to the largest with 46,573 (#19); the median was 3,411 participants (#27). Four studies had less than 1,000 participants, while five had over 10,000. Larger sample sizes tended to be associated with a higher frequency of reporting statistically significant (p<.05) findings: four studies below the median sample size reported no relevant significant findings (mean number of significant results reported below the median: 1.73; mode: 2), while all studies above the median reported at least one significant result (mean number of significant results reported above the median: 3.0; mode: 2). The earliest study meeting inclusion criteria was published in 1997 (#15). More than half of the relevant studies were published in the last 10 years (*n* = 20). Distribution by published year is as follows: 1995-1999 (*n* = 3), 2000-2004 (*n* = 5), 2005-2009 (*n* = 12), 2010-2014 (*n* = 5), 2015 - mid 2016 (*n* = 6). The latter suggests an intensification of interest in this area.

Work Stress Measurement and Operationalisation

To meet inclusion criteria, studies were required to measure work stress using the Job Content Questionnaire (JCQ) or items derived from it (e.g., shortened list and/or translated questions). The JCQ was the most commonly cited tool for providing items to measure the JDC(S) constructs, followed by the Demand-Control Questionnaire (DCQ), which itself is derived from the JCQ (Landsbergis, Theorell, Schwartz, Greiner, & Krause, 2000). Studies varied in the number of items used for each construct, as detailed in Table 2.

Just over half of the studies reported analyses with the core individual JDC constructs: job demands (*n* = 17) and job control (*n* = 19), while a smaller number also included social support at work (*n* = 8). Some studies identified the number of items specific to the job control subscales (skill discretion and decision authority); however these subscales were consistently combined into a composite measure of job control for analysis. Another popular method (*n* = 16) involved using the quadrant approach to create four job strain groups (low strain, active, passive, high strain) by dichotomising scores for demands and control at the median and pairing alternate combinations of high and low scores.

LTPA and Diet Measurement and Operationalisation

Of the 31 studies included, 29 reported an applicable measure of LTPA, nine reported a measure of habitual diet, and of these only seven simultaneously reported on LTPA and diet. One other study simultaneously reported diet and physical activity, but the measure of

LTPA was combined with work time physical activity, so it was only included for diet in this review (#29). All measures were self-report and there was significant variation in the amount of detail collected. Although sometimes unclear, most studies used a positive definition for LTPA (e.g., amount or intensity of activity), while approximately one third discussed physical inactivity or sedentary behaviour (e.g., lack of LTPA). Less than half of the included studies reported using standardised or previously validated tools for measuring or calculating physical activity (e.g., IPAQ-short, MET indexes). Around one third of studies relied on a single-item questionnaire, often with a multi-level categorical response (e.g., "Do you exercise?" Response options: "occasionally or never", "daily", "two to three times per week"). Notably the majority of studies did not report the relevant measurement period (e.g., LTPA over the past 4 weeks vs. past year); of those that did, one study specified "at present time" (#24), two specified over the past 4 weeks or month (#3, 7), two over the previous 3 months (#26, 27), one over the past 6 months (#4), and two over the previous 12 months (#13, 23). The most common approach (n = 25) for operationalising LTPA was dichotomising participants using two ordinal categories (e.g., "no LTPA" or "insufficient LTPA" vs. "active" or "sufficient"); however as detailed in Table 2, the methods for classification varied considerably. The most authoritative classification approach was seen in studies where the operationalisation corresponded to cited relevant guidelines, such as the WHO recommendations: "at least 150 min a week of moderate exercise, or at least 75 min of vigorous exercise, or an equivalent combination of the two" (World Health Organization, 2016b).

Of the nine studies that reported on diet, three of these used only one or two self-report questions related to frequency of fruit and vegetable consumption (#6, 8, 13), while five of the studies reported using a food frequency questionnaire (FFQ) – with the number of items ranging from 18 to 178 (#15, 17, 23, 28, 29). The single most common approach for operationalising diet was frequency of fruit and vegetable consumption (*n* = 4) (#6, 8, 13, 29), followed by determination of "healthy" vs. "unhealthy" or similar dietary patterns (*n* = 3) (#22, 23, 28). One study reported a continuous measure of energy intake (kcal) from high-fat foods (#15), while only one study reported a continuous measure of total dietary energy intake (kcal), as well as macronutrients such as dietary fat (g) (#17).

Analyses

To meet inclusion criteria, studies were required to adjust or control for the influence of sex and age. A summary of the analyses used is provided in Table 2; the majority of studies (*n* = 20) provided odds ratios (OR) with 95% confidence intervals. The single most commonly reported statistical tool was logistic regression analysis.

Summary of Findings

Of the 29 studies that reported LTPA, 25 provided some support for an association between components of the JDC(S) model indicative of work stress and reduced LTPA. Of the nine studies that reported diet, six provided some support for an association between some components of the JDC(S) model indicative of work stress and poorer diet.

Job Control

For the individual constructs of the JDC(S) model, the greatest support was observed for the importance of job control: nine studies provided unisex support for an association between lower job control and less LTPA (#2, 8, 10, 14, 19, 20, 21, 27, 31); while five studies provided unisex support for an association between higher job control and greater LTPA (#3, 9, 11, 15, 26). Furthermore, one study provided support for an association between lower job control and less LTPA in men only (#4); and two studies provided support for an association between higher job control and greater LTPA in men only (#16, 31). One study provided unisex support for an association between lower job control and lower consumption of vegetables (#28).

Job Demands

There was less support for the importance of job demands: four studies provided unisex support for an association between higher job demands and lower LTPA (#7, 8, 21, 31). Two studies provided support for an association between higher jobs demands and lower LTPA for women only (#4, 20); and one study provided support for an association between lower job demands and greater LTPA for women only (#31). One study provided support for an association between higher job demands and higher consumption of calories (kcal) from high fat food in men only (#15).

Social Support

One study provided unisex support for an association between higher coworker support and greater LTPA, as well as higher supervisor support and greater LTPA (#11). Another study provided support for an association between higher social support (combined coworker and supervisor support) and greater LTPA for men only (#16). One study provided unisex support for an association between higher social support (combined coworker and supervisor support) and greater total dietary energy intake of calories (kcal) (#17).

Job Strain Groups

With regards to the four job strain groups, the greatest support was observed for deleterious outcomes associated with high strain and passive jobs, with mixed findings for active jobs and limited support for beneficial associations with low strain jobs. Six studies provided unisex support for an association between high strain jobs (when calculated as one of four job strain groups) and less LTPA (#1, 8, 14, 19, 20, 25). Furthermore, three studies provided support for this association in men only (#4, 22: UK cohort, 30), while one provided support for this association in women only (#22: Finnish cohort). Five studies provided unisex support for an association between passive jobs and less LTPA (#7, 14, 19, 20, 25). Furthermore, five studies provided support for this association in men only (#4, 12, 15, 22: UK cohort, 30), while one provided support for this association in women only (#22: Finnish cohort). One study provided support an association between passive jobs and an "unhealthy" dietary pattern in men only (#22).

Two studies provided unisex support for an association between active jobs and less LTPA (#20, 25), while one provided support for this association in men only (#19). Conversely, one study provided unisex support for a beneficial association between active jobs and LTPA (#9), while one provided support for this association in men only (#5), and another for women only (#15). One study provided statistically significant ($p<.05$) support for the association between active jobs and "healthy" diet in women only (#23). One study provided unisex support for an association between low strain jobs and greater LTPA (#9), while one study provided support for this association in men only (#5), and another for women only (#23). Furthermore, one study provided support for an association between low strain jobs and lower consumption of calories (kcal) from high fat food in men only (#15). Another provided support for an association between low strain jobs and "healthy" diet in women only (#23).

When job strain was calculated alone (i.e., not calculated as one of four job strain groups), three studies provided unisex support for an association between presence of job strain (i.e., high strain) and lower LTPA (#11, 21, 31), with one of these studies also supporting an association between lower job strain and higher LTPA (#31). Conversely, one study provided unisex support for an association between presence of job strain and higher LTPA, but only in racial/ethnic minorities (i.e., "non-white") (#3). One study provided unisex support for an association between presence of job strain and lower vegetable consumption (#28), while another found an association between presence of job strain and increased consumption of dietary fat (g) in men only (#17). For iso-strain (i.e., high job strain with low social support), one study provided unisex support for an association between presence of iso-strain and lower LTPA, as well as lower fruit and vegetable consumption (#6).

Table 2

Summary of Included Studies (N = 31)

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[1] Ali and Lindstrom (2006), Sweden. *N* = 5,180, 56% male, ages 18-64 years. Includes 13.5% unemployed. Cross-sectional design. <u>Named data source:</u> The 2000 Public Health Survey in Scania.	1. job strain: 4 groups (low strain ["relaxed"], active, passive, high strain ["job strain"]). <u>Tool and definition:</u> JCQ[c] derived – 11 items (5 items demands, 6 items control). Scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> Low LTPA. <u>LTPA tool and definition:</u> Self-report single-item with 4-alternative response about hours of LTPA/week. LTPA dichotomized into active and sedentary.	OR (95% CI) of low LTPA according to psychosocial work conditions. Analyses stratified by sex and adjusted for age. "Low strain" as reference. <u>Job strain</u> **Men:** Active 1.33 (0.97-1.82), Passive 1.05 (0.75-1.47), High strain 1.49 (1.06-2.08), Unemployed 1.62 (1.12-2.34). **Women:** Active 1.03 (0.66-1.61), Passive 1.33 (0.87-1.61), High strain 1.63 (1.07-2.47), Unemployed 1.81 (1.16-2.81).	Both high strain and unemployment associated with higher odds of low LTPA compared to low strain. Authors note this difference becomes non-significant following further adjustment, in particular adjustment for education.
[2] Allard et al. (2011), Denmark. *N* = 2,805 (crude *N* = 3,146, 22.0% male, ages 20-67 years). Prospective design (LTPA analyses cross-sectional). <u>Named data source:</u> Psychological RISk factors in the work environment and biological MEchanisms in the development of stress (PRISME) Study.	1. job demands, 2. job control, 3. social support. <u>Tool and definition:</u> Copenhagen Psychosocial Questionnaire/JCQ[c] derived – 14/16 items (4 items job demands, 8 items job control [4 items skill discretion, 4 items decision authority], 2/4 items social support [unclear if 1 or 2 each for coworker and supervisor support]). Mean scores computed for each scale. Measured at baseline (2007).	<u>LTPA:</u> Physical inactivity at follow-up. <u>LTPA tool and definition:</u> Self-report single-item about hours of LTPA/week. Measured at baseline (2007) and follow-up (2009). Responses dichotomised into being inactive at follow-up vs. being active at follow-up.	OR (95% CI) from logistic regression to assess risk of being physically inactive at follow-up predicted by higher job demands, lower job control, or lower social support at baseline. OR indicates risk related to change from lowest to highest score value (or opposite). All analyses adjusted for sex, age, education, income, leadership, shiftwork, life events, neuroticism, extraversion, and loneliness. Job demands, job control, and social support also adjusted for each other. <u>Job demands (higher)</u> 1.38 (0.93-2.05). <u>Job control (lower)</u> 1.95 (1.04-3.66). <u>Social support (lower)</u> 1.06 (0.74-1.52).	In analyses adjusted for sex, age, and various other covariates, lower job control was associated with increased risk of physical inactivity at follow-up. In crude analyses, higher job demands and lower social support were significant risk factors for being physically inactive at follow-up, but these were not significant in the adjusted analyses.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[3] Bennett et al. (2006), USA. *N* = 1,442, 66.0% male, *M* age 43.2 years (*SD* = 11.7). Asian/Pacific Islander (7.1%), Black (5.5%), Hispanic (13.8%), White (74.2%). Cross-sectional design. <u>Named data source:</u> Harvard Cancer Prevention Program Project: Healthy Directions Study.	1. job demands, 2. job control, job strain (no vs. yes). <u>Tool and definition:</u> JCQ[c] derived – 5 items (2 items demands, 3 items control [2 items skill discretion, 1 item decision authority]). Job control calculated using a weighted sum of decision authority and skill discretion. Participants assigned to the job strain category if their psychological demand score was greater than the national median and job control was below the national median.	<u>LTPA:</u> Mean LTPA hours/week. <u>LTPA tool and definition:</u> Self-report semi-quantitative activity questionnaire, previously validated in the target population. Definition based on variety of LTPA over past 4 weeks. Responses coded into hours per week of activity.	1. Slope estimate (*SE*) from regression for LTPA associated with job strain, job demands, and job control. All analyses adjusted for sex and age. <u>Job demands</u> Slope estimate 0.09, *SE* 0.08, *p* = .25. <u>Job control</u> Slope estimate 0.29, *SE* 0.11, *p* = .01. <u>Job strain</u> (no vs. yes) Slope estimate 0.68 (0.27), *p* = .01. 2. Mean LTPA hours/week, SE (CI) from multivariable regression (interaction effects). All analyses adjusted for sex, age (slope), managerial status, education, and heavy occupational physical activity (slope). Analyses stratified by race/ethnicity, Tukey–Kramer adjusted *p* = .03. <u>Job strain (no)</u> **Asian:** 3.78, 0.61 (2.58-4.98). **Black:** 4.45, 0.70 (3.08-5.82), **Hispanic:** 5.99, 0.47 (5.07-6.91), **White:** 6.04, 0.26 (5.33-6.55) <u>Job strain (yes)</u> **Asian:** 4.01, 0.84 (2.36-5.66), **Black:** 6.00, 0.92 (4.20-7.80), **Hispanic:** 6.52, 0.68 (5.19-7.85), **White:** 5.01, 0.36 (4.30-5.72).	In sex and age adjusted analyses, job strain and job control were significantly associated with higher LTPA. Further analyses suggested race/ethnicity modified this association for job strain. Whites reporting job strain had ~1 hr less LTPA per week, compared to Whites who did not report job strain. Racial/ethnic minorities reporting job strain collectively reported higher weekly LTPA than their counterparts not reporting job strain. Authors suggest a number of explanations for their surprising findings, including possibility of measurement error.
[4] Brisson et al. (2000), Canada. *N* = 6,995, 50.5% male, ages 18-64 years. Cross-sectional design. <u>Named data source:</u> None cited.	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 18 items (9 items demands, 9 items control). For the first two definitions, control and demands scores were divided into quartiles. For the "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> Sedentary behaviour. <u>LTPA tool and definition:</u> Self-report questionnaire. Sedentary behaviour defined as exercising less than once per week during past 6 months. One exercise session defined as rigorous physical activity during leisure-time, lasting at least 20 minutes.	OR (95% CI) of sedentary behaviour for quartiles (Q1-Q4) of job control and job demands. Followed by OR (95% CI) of sedentary behaviour for job strain categories. All analyses stratified by sex and adjusted for age, education, physical activity at work, social support at work and outside of work, and hostility and cynicism. Q4 (highest) as reference for job control, Q1 (lowest) a reference for job demands. "Low strain" as reference for job strain. <u>Job demands</u> **Men:** Q2 0.9 (0.8-1.2), Q3 0.8 (0.7-1.0), 1.0 (0.8-1.3). **Women:** Q2 1.0 (0.8-1.3), Q3 1.3 (1.1-1.6), Q4 1.1 (0.9-1.4). <u>Job control</u> **Men:** Q1 1.3 (1.0-1.17), Q2 1.1 (0.9-1.3), Q3 1.1 (0.9-1.3). **Women:** Q1 1.0 (0.8-1.3), Q2 1.1 (0.9-1.3), Q3 1.0 (.08-1.2). <u>Job strain</u> **Men:** Active 1.1 (0.9-1.4), Passive 1.3 (1.0-1.5), High strain 1.2 (1.0-1.6). **Women:** Active 1.1 (0.9-1.5), Passive 1.0 (0.8-1.3), High strain 1.1 (0.9-1.5).	For men, prevalence of sedentary behaviour was higher in the lowest quartile of job control as well as in the passive and high strain groups. For women prevalence of sedentary behaviour was only elevated in the third quartile of job demands. Authors note these results only provide partial support for an association between psychosocial work factors and the prevalence of sedentary behaviour.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[5] Cesana et al. (2003), Italy. *N* = 2,669 (2,809-140 missing), 64.33% (64.04%) male, ages 25-54 years. Pooled cross-sectional design. Named data source: World Health Organization-MONItoring cardiovascular disease (WHO-MONICA) (Brianza).	1. job strain: 4 groups (low strain, active, passive, high strain). Tool and definition: JCQ[c] derived – 13 items (5 items demands, 6 items control, 2 items social support - latter not included in this study). For the "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	LTPA: Regular LTPA. LTPA tool and definition: Self-report previously validated questionnaire. Regular LTPA corresponds to engaging in sports at least twice per week, or in recreational activities (e.g., walking, cycling), for one hour at least three times per week.	Distribution (%) and X^2 of prevalence of regular LTPA for job strain categories. Analyses stratified by sex and adjusted for age. *Note: X^2 is an omnibus test, no follow-up analyses to specify where differences exist.* Job strain **Men:** Low strain 21.41%, Active 22.08%, Passive 16.82%, High strain 12.68%, X^2 15.939 (p=.001)*. **Women:** Low strain 9.46%, Active 13.48%, Passive 6.53%, High strain 7.29%, X^2 7.317 (p=.062).	Prevalence of regular LTPA was higher for men in active and low strain groups. Same pattern observed for women but not differences between groups was not significant.
[6] Chandola et al. (2008), UK. *N* = 4,352 (fruit/vegetable), *N* = 4,357 (physical activity). Sub-sample of Whitehall II cohort *N* = 10,308, 67% male, ages 35-55 (relevant analyses based on participants under 50 at phase 2). Cross-sectional analysis of cohort study. Named data source: Whitehall II Study.	1. iso-strain (job strain and social isolation at work): A cumulative measure (range 0–2) was created by summing reports of iso-strain at phases 1 (1985-88) and 2 (1989-90). Participants without iso-strain data at either phase were assigned a missing value. Tool and definition: JCQ[c] derived – included items for job demands, control, and social support; specific number of items not reported. "Job strain" defined as being above or below the median score for job demands and job control. "Iso-strain" defined as experiencing job strain and being socially isolated at work.	LTPA: Absence of physical activity. LTPA tool and definition: Self-report frequency of moderate physical activities per week. For logistic regression analyses, physical activity was coded into binary variable of no physical activity vs. some activity. Measured only at phase 3 (1991-93). Diet: Less than monthly fruit or vegetable consumption. Diet tool and definition: Self-report frequency of fruit or vegetable consumption. Measured only at phase 3 (1991-93).	OR (95% CI) of no physical activity and less than monthly fruit/vegetable consumption according to cumulative iso-strain. Analyses adjusted for sex, age, and employment grade. No report of iso-strain as reference. Bonferroni correction reported. No physical activity One iso-strain report: 1.07 (0.74-1.55). Two iso-stain reports: 1.33 (1.00-1.78) Less than monthly fruit/vegetable consumption One iso-strain report: 1.10 (0.43-2.84) Two iso-strain reports: 2.12 (1.07-4.18)	In sex, age, and employment grade adjusted analyses, repeated reports of iso-strain (work stress) were associated with less physical activity and eating less fruit and vegetables.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[7] Chin, Nam, and Lee (2016), USA. *N* = 394, 9.39% male, ages 23-81 years, *M* age 48.4 (*SD* = 12.1) years. Cross-sectional design. <u>Named data source:</u> None cited (sample comprised nurses actively licensed with California Board of Registered Nursing).	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 14 items (5 items demands, 9 items control [6 items skill discretion, 3 items decision authority]). For "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> 1. aerobic LTPA, 2. muscle-strengthening LTPA. <u>LTPA tool and definition:</u> Self-report questionnaire from the Behavioural Risk Factor Surveillance System (Centers for Disease Control and Prevention, 2013). Aerobic LTPA measured using 2 questions about LTPA/week over past month. Total aerobic LTPA minutes/week calculated by multiplying the frequency of physical activity per week by number of minutes. Regular aerobic LTPA defined as engaging in ≥ 150 minutes/week. Muscle-strengthening LTPA measured by question about muscle-strengthening exercises over past month. Regular muscle-strengthening LTPA defined as performing these activities ≥ 2 days/week.	OR (95% CI) from multivariable logistic regression to assess associations of job demands, job control, and job strain with regular aerobic LTPA (≥ 150 minutes/week) and regular muscle-strengthening LTPA (≥ 2 days/week). All analyses adjusted for sex, age, race/ethnicity, educational background, and musculoskeletal pain. *$p<.05$. <u>Job demands (median split)</u> **Aerobic LTPA:** Low demands 1.00 (reference), High demands 1.63* (1.06-2.51). **Muscle-strengthening LTPA:** Low demands 1.00 (reference), High demands 1.24 (0.81-1.90). <u>Job control (median split)</u> **Aerobic LTPA:** Low control 1.00 (reference), High control 1.23 (0.81-1.89). **Muscle-strengthening LTPA:** Low control 1.00 (reference), High control 1.35 (0.88-2.07). <u>Job strain</u> **Aerobic LTPA:** Low strain 0.74 (0.41-1.36), Active job 1.01 (0.54-1.86), Passive job 0.49* (0.26-0.93), High strain 1.00 (reference). **Muscle-strengthening LTPA:** Low strain 1.06 (0.58-1.96), Active job 1.01 (0.54-1.89), Passive job 0.61 (0.33-1.13), High strain 1.00 (reference).	In analyses adjusted for sex, age, and other covariates, participants with high job demands or passive jobs were less likely to engage in regular aerobic LTPA. No other JDC components or job strain models associated with aerobic LTPA and no significant associations with muscle-strengthening LTPA.
[8] Chou, Tsai, Li, and Hu (2016), Taiwan. *N* = 1,329, 17.16% male, ages 21-64 years (*M* age 38 years). Cross-sectional design. <u>Named data source:</u> Sin-Lau Hospital-Health Promotion Survey (SLH-HPS).	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 16 items (Chinese version) (7 items demands, 9 items control). For "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> Physical inactivity. <u>LTPA tool and definition:</u> Self-report questionnaire assessed total time engaged in moderate or strenuous exercise per week. Responses categorised into thee levels: poor (none; i.e., physical inactivity), intermediate (1-149min/week moderate intensity) and ideal (≥ 150 min/week moderate intensity). <u>Diet:</u> Fruit and vegetable consumption (poor, intermediate, ideal). <u>Diet tool and definition:</u> Self-report measure of fruit and vegetable consumption. Responses categorised into thee levels: poor (none), intermediate (≥ 5 fruit or vegetables/day, 1-4 days in a week,) and ideal (≥ 5 fruit or vegetables/day, ≥ 5 days/week).	1. Multiple logistic regression coefficients (*SE*) indicating associations of physical inactivity and unhealthy diet with job demands, job control, and job strain. Analyses adjusted for sex, age, education and profession. *$p<.05$. <u>Job demands (median split: high vs. low)</u> **Physical inactivity:** 0.401* (0.129). **Unhealthy diet:** 0.012 (0.199) <u>Job control (median split: low vs. high)</u> **Physical inactivity:** 0.262* (0.121). **Unhealthy diet:** 0.300 (0.192) <u>Job strain (high strain vs. others)</u> **Physical inactivity:** 0.506* (0.165). **Unhealthy diet:** 0.277 (0.229) 2. OR (95% CI) for physical inactivity in association with job strain. Analyses adjusted for sex and, age. *$p<.05$. <u>Job strain</u> Low strain 1 (reference), Active 1.4* (1.00-2.03), Passive 1.2 (0.93-1.67), High strain 1.9* (1.38-2.81).	In analyses adjusted for sex, age, education and profession, high job demands, low job control, and high strain jobs were associated with physical inactivity. There appear to be no associations between these psychosocial work factors and unhealthy diet. In further analyses adjusted for sex and age, compared with low strain, both active and high strain jobs were associated with higher likelihood of physical inactivity.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[9] Choi et al. (2010a), USA. *N* = 2,019, 49.6% male, ages 32-69 years. Cross-sectional design. Named data source: National Survey of Midlife Development in the United States (MIDUS) II Study.	1. job demands, 2. job control, 3. supervisor support, 4. coworker support, 5a. job strain: 4 groups (low strain, active, passive, high strain), 5b. job strain: 5 groups (low strain, active, middle, passive, high strain). Tool and definition: JCQ[c] derived – 8 items (3 items demands, 5 items control [2 items skill discretion, 3 items decision authority]). Two methods used to calculate job strain groups: a) traditional "4-group definition" using the medians of job demands and control; b) "5-group definition" using quartiles of job demands and control (i.e., 16 cells), with the outer 12 cells used to form the 4 groups, avoiding potential misclassification around the medians.	LTPA: Active LTPA. LTPA tool and definition: Self-report 2 single-item questions (vigorous and moderate LTPA) with 6-frequency based response. Active LTPA defined as presence of either vigorous (at least 3 days/week) or moderate LTPA (at least 5 days/week).	OR (95% CI) of active LTPA according to psychosocial work conditions. Analyses adjusted for sex, age, supervisor and coworker support, hours of work per week at major job, any other paid work, physical effort at work, marital status, race, education, annual household income. Job demands (quartiles) Lowest 1.00 (reference), 2nd Lowest 0.85 (0.64-1.13), 2nd Highest 0.89 (0.69-1.14), Highest 0.99 (0.72-1.28). Job control (quartiles) Lowest 1.00 (reference), 2nd Lowest 1.14 (0.87-1.13), 2nd Highest 1.20 (0.90-1.60), Highest 1.55 (1.16-2.08). Supervisor support Low 0.91 (0.73-1.12), No immediate supervisor 1.03 (0.73-1.45). Coworker support Low 0.99 (0.81-1.21), No coworkers 0.92 (0.61-1.37). Job strain (4 groups) Passive job 1.00 (reference), High strain 0.95 (0.73-1.25), Low strain 1.18 (0.89-1.57), Active job 1.22 (0.93-1.60). Job strain (5 groups) Passive job 1.00 (reference), High strain 1.06 (0.77-1.47), Middle 1.09 (0.81-1.45), Low strain 1.50 (1.08-2.09), Active job 1.43 (1.04-1.97).	In analyses adjusted for sex, age, and other covariates, high job control was associated with active LTPA. Low strain jobs (high control, low demands) and Active jobs (high control, high demands) both increased odds for active LTPA, compared to Passive jobs (low control, low demands). In further analyses stratified by sex and education, the highest level of job control was associated with active LTPA for all groups except men with low education (see original paper for additional analyses).
[10] Dich, Head, and Rod (2016), UK. *N* = 2,697 for LTPA (Study sub-sample *N* = 5419, 71% male, ages 39-62 years, average 49 years). Longitudinal design. Named data source: Whitehall II Study.	1. job demands, 2. job control, 3. social support. Measured at baseline (1991-94). Tool and definition: JCQ[c] derived – 25 items (4 items demands, 15 items control, 6 items social support). Items scored as continuous scales, low and high values defined as 1 SD below and above the mean, respectively.	LTPA: Reduced LTPA below recommended level (i.e., ≥150 min/week of moderate exercise, or ≥75 min/week of vigorous exercise, or an equivalent combination of the two) between baseline and follow-up. LTPA tool and definition: Self-report: different questionnaires used at baseline and follow-up. At baseline (1991-94), mild, moderate and vigorous LTPA assessed using questions about average number of hours a week engaged in moderate and vigorous physical activity. At follow-up (1997-99), LTPA hours/week computed based on 20 questions about frequency and duration of various leisure activities. Each activity assigned a metabolic equivalent (MET), and categorised as moderate (3 to 6 MET) or vigorous (≥ 6 MET) LTPA. Adherence to recommended LTPA dichotomised (yes vs. no) as to whether participants reduced LTPA below guidelines during follow-up period.	OR (95% CI) from logistic regression to assess effects of job demands, job control, and social support on whether participants reduced LTPA below recommended amount at follow-up. 53% of all participants met the LTPA recommendations at baseline (1991-94); of those, 32% reduced LTPA to below the recommended level by follow-up (1997-99). Analyses adjusted for sex, age, and marital status. Job demands Low demands 1.00 (0.91-1.11), Average demands (reference), High demands 1.00 (0.90-1.10). Job control Low control 1.24 (1.12-1.39), Average control (reference), High control 0.80 (0.72-0.90). Social support Low support 0.98 (0.89-1.07), Average support (reference), High support 1.02 (0.93-1.12).	In analyses adjusted for sex, age and marital status, low job control was associated with a higher likelihood of reducing LTPA below the recommended amount at follow-up. Job demands or social support at work did not appear related to changes in LTPA during the follow-up period.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[11] Garcia-Rojas, Choi, and Krause (2015), Mexico. *N* = 2,330, 67.6% male, 46.6% aged ≤ 35 years, 48.1% aged 36-55 years, 5.2% aged ≥ 56 years. Cross-sectional design. Named data source: Mexican Institute of Social Security (IMSS) and Companies' Collaboration Model to Promote Workers' Healthy Behaviors	1. job demands, 2. job control, 3. social support (coworker, supervisor, and combined), 4. job strain (high strain vs. no high strain; high strain vs. low strain), 5. iso-strain. Tool and definition: JCQ[c] derived – 22 relevant items (Spanish version) (5 items demands, 9 items control [6 items skill discretion, 3 items decision authority], 8 items social support [4 items coworker support, 4 items supervisor support]). "Job strain ratio" defined as job demands score x2, divided by job control. "High job strain" categorical defined as combination of high job demands (>sample median) and low job control (<sample median). "Iso-strain" continuous defined as job demands score, minus job control and total social support. "Iso-strain" categorical defined as combination of high job strain and low social support (<sample median).	LTPA: LTPA (yes vs. no). LTPA tool and definition: Self-report single-item. Responses dichotomised into "yes" or "no".	Standardized OR (95% CI) from logistic regression for LTPA (yes vs. no) associated with psychosocial work factors. All analyses adjusted for sex, age physical workload, smoking, alcohol, education, income, marital status, worksite, and seniority. **p*<.05. Job demands 0.89* (0.80-0.99). Job control 1.11* (1.01-1.24). Social support Coworker support 1.15* (1.04-1.27), Supervisor support 1.15* (1.03-1.27), Total support 1.17* (1.06-1.30). Job strain Job strain ratio 0.86* (0.77-0.95), High job strain (categorical, ref. category: no high job strain) 0.80 (0.62-1.03), High job strain (categorical, ref. category: low strain) 0.81 (0.60-1.09). Iso-strain Iso-strain (continuous) 0.84* (0.76-0.94), Iso-strain (categorical) 0.75 (0.55-1.03).	In analyses adjusted for sex, age and other covariates, job demands were negatively associated with LTPA, while job control and social support were positively associated. Both job strain (ratio) and iso-strain (continuous) were negatively associated with LTPA. .
[12] Gimeno et al. (2009), UK. *N* = 4,291, 100% male, *M* age 43.6 (*SD* = 5.8) years. Longitudinal design (cumulative exposure). Named data source: Whitehall II Study.	1. passive jobs (one of the 4 job strain groups, passive jobs are those with low demands and low control). Cumulative exposure over three phases (1: 1985-88, 2: 1989-90, 3: 1992-93). Tool and definition: JCQ[c] derived – 19 items (4 items demands, 15 items control). Participants classified as having passive job if reported below sex-specific median score for demands and control.	LTPA: At least recommended LTPA level (i.e., ≥30 minutes a day of at least moderate intensity on five or more days of the week") vs. below recommended LTPA level. LTPA tool and definition: Self-report 2 item questionnaire about the average number of hours per week engaged in moderate and vigorous LTPA. Assessed at phases 1 (1985-88) and 2 (1989-90). Diet: None meeting review criteria (poor diet – relevant analyses stratified by sex but does not control for age).	In their analyses, authors found no evidence of a relationship between passive jobs and low LTPA in women, so they present multivariate regression models for men only. PR (95% CI) of association between cumulative exposure to passive jobs over three phases (1, 2 and 3) and low LTPA at phase 3 in men. Analyses adjusted for age, ethnicity, marital status, and employment grade. Passive job None 1.00 (reference), 1 phase 0.98 (0.88-1.11), 2 phases 1.09 (0.95-1.25), 3 phases 1.24 (1.08-1.42). *p* = 0.003 for linear trend.	In analyses adjusted for age and other covariates, cumulative exposure to passive jobs is associated with low LTPA in men.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[13] Goston, Caiaffa, Andrade, and Vlahov (2013), Brazil. N = 893, 30.9% male, M age 40.2 (SD = 11.1) years. Cross-sectional design. <u>Named data source:</u> Move-se Hemominas Study (part of Saúde em Beagá Study).	1. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> DCQ[d] derived – 11 items (Portuguese translation; 5 items demands, 6 items control [4 items skill discretion, 2 items decision authority]). Scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> LTPA (yes vs. no). <u>LTPA tool and definition:</u> Self-report single item about practice of any physical activity in last 12 months. Responses dichotomised into "yes" or "no". <u>Diet:</u> Regular fruit and vegetable consumption. <u>Diet tool and definition:</u> Self-report 2 items (1 for fruit, 1 for vegetable). A single item constructed using cut-off of consumption on 5 or more days/week.	PR (95% CI) of health behaviours by job strain groups. Analyses adjusted for sex, age, marital status, education (years), income, occupation, weekly working hours, adopt positions that cause muscle pain in or outside at work, not breaks at work, shift work, overtime work. "Low strain" as reference. <u>LTPA Physical activity (yes vs. no)</u> High strain 0.99 (0.85-1.17), Active 0.89 (0.76-1.04), Passive 0.90 (0.77-1.05). <u>Regular fruit/vegetable consumption (5 or more days/week)</u> High strain 1.06 (0.91-1.26), Active 1.07 (0.76-1.04), Passive 0.95 (0.81-1.13).	In analyses adjusted for sex, age and other covariates, this study did not support an association between job strain categories and LTPA or regular fruit/vegetable consumption. Authors note in unadjusted analyses, passive jobs appear negatively associated with LTPA (see original manuscript). Authors also note LTPA measure was not ideal due to dichotomous nature and other limitations.
[14] Griep et al. (2015), Brazil. N = 11,779, 47.75% male, M age 49.2 years. Cross-sectional design. <u>Named data source:</u> Brazilian Longitudinal Study of Adult Health (ELSA-Brasil).	1. job demands, 2. job control, 3. social support, 4. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> DCQ[d] derived – 17 items (Brazilian version) (5 items demands, 6 items control, 6 items social support). Continuous scores for job demands, job control and social support summed. For "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> LTPA duration. <u>LTPA tool and definition:</u> Self-report questionnaire: International Physical Activity Questionnaire (IPAQ-short): assessed frequency of engaging in moderate or vigorous physical activity for ≥10 minutes in free time, on any given day. Time spent in LTPA computed by multiplying number of days on which physical activity was undertaken by duration in minutes. LTPA classified into 3 levels of duration: none, <150 minutes/week, and ≥ 150 minutes/week.	OR (95% CI) from multinomial logistic regression for LTPA in relation to job demands, job control, job social support, and job strain. All analyses stratified by sex and adjusted for age and marital status. LTPA reference ≥150min/week. *p<.05, **p<.01, ***p<.001. <u>Job demands</u> **Men**: LTPA none 0.98 (0.96-1.00), <150min/week 1.03* (1.00-1.05). **Women**: LTPA none 0.97* (0.95-0.99), <150min/week 1.00 (0.98-1.03). <u>Job control</u> **Men**: LTPA none 0.90*** (0.88-0.91), <150min/week 0.96*** (0.94-0.98). **Women**: LTPA none 0.87*** (0.85-0.89), <150min/week 0.96** (0.93-0.98). <u>Social support</u> **Men**: LTPA none 1.01 (0.99-1.03), <150min/week 0.99 (0.97-1.01). **Women**: LTPA none 1.00 (0.98-1.01), <150min/week 0.99 (0.97-1.01). <u>Job strain (strain reference: low strain)</u> **Men**: Active | LTPA none 0.94 (0.78-1.12), Active | <150min/week 1.18 (0.97-1.44), Passive | LTPA none 1.74*** (1.51-2.02), Passive | LTPA <150min/week 1.28** (1.07-1.51), High strain | LTPA none 1.83*** (1.51-2.23), High strain | <150min/week 1.61*** (1.29-2.01). **Women**: Active | LTPA none 0.98 (0.83-1.17), Active | <150min/week 0.94 (0.77-1.16), Passive | LTPA none 2.04*** (1.75-2.39), Passive | LTPA <150min/week 1.14 (0.94-1.37), High strain | LTPA none 2.00*** (1.67-2.38), High strain | <150min/week 1.18 (0.95-1.46).	In analyses stratified by sex and adjusted for age and marital status, men in high strain and passive jobs had a greater likelihood of not engaging in LTPA (none) or less than recommended levels (<150min/week) compared to men in low strain jobs. Women in high strain and passive jobs were more likely to be categorised has having no LTPA. Low job control was associated with lower LTPA (either none or <150min/week) in both men and women. Associations between job demands and LTPA appeared weak and did not hold after additional adjustment for education. Similarly, social support did not appear to be associated with LTPA in the relevant analyses.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[15] Hellerstedt and Jeffery (1997), USA. *N* = 3,843, 53.7% male, men *M* age 39.0 (*SD* = 0.2) years, women *M* age 37.7 (*SD* = 0.2) years. Cross-sectional design. Named data source: Healthy Worker Project.	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). Tool and definition: JCQ[c] derived – 13 items (5 items demands, 8 items control). For the first two definitions, control and demands scores were divided into quartiles. For the "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	LTPA: Exercise sessions/week. LTPA tool and definition: Self-report previously validated 12-item questionnaire. Diet: Calories from high-fat foods/day. Diet tool and definition: Self-report 18-item food frequency questionnaire derived from the National Health and Nutrition Examination Survey II data.	Mixed models: Mean (*SE*) risk factors by quartiles of job demand, control (analyses 1 & 2), or strain categories (analyses 3). All analyses stratified by sex and adjusted for age, marital status, education (years), white race, job classification, presence of vigorous job, salary, hours worked/week, presence of hazardous work, and time with company. Q1 (Low) – Q4 (High). †Mean different ($p < .05$) than quartile 1 (analyses 1 & 2)/high strain (analyses 3), ‡Mean different ($p < .05$) than quartile 2 (analyses1 & 2)/low strain (analyses 3). §Mean different ($p < .05$) than quartile 3 (analyses 1 & 2)/active (analyses 3). #Mean different ($p < .05$) than quartile 4 (analyses 1 & 2)/passive (analyses 3). Job demands (quartiles) **Men:** Exercise sessions/week: Q1 9.2 (0.2), Q2 9.3 (0.3), Q3 9.5 (0.2), Q4 9.5 (0.3). Calories high-fat foods/day: Q1 649[#] (14), Q2 663 (16), Q3 681 (16), 710[†] (18). **Women:** Exercise sessions/week: Q1 8.2 (0.2), Q2 8.2 (0.2), Q3 8.7 (0.2), Q4 8.7 (0.2). Calories high-fat foods/day: Q1 523 (13), Q2 516 (13), Q3 528 (13), 519 (13). Job control (quartiles) **Men:** Exercise sessions/week: Q1 8.7[§,#] (0.3), Q2 9.4 (0.2), Q3 9.6[†] (0.2), Q4 9.6[†] (0.2). Calories high-fat foods/day: Q1 658 (20), Q2 690 (15), Q3 667 (16), 672 (15). **Women:** Exercise sessions/week: Q1 8.1[§,#] (0.2), Q2 8.5 (0.2), Q3 8.7[†] (0.3), Q4 8.8[†] (0.3). Calories high-fat foods/day: Q1 523 (11), Q2 524 (12), Q3 511 (14), 526 (16). Job strain **Men:** Exercise sessions/week: High strain 9.6[#] (0.3), Low strain 9.6[#] (0.2), Active 9.5 (0.2), Passive 8.8[†,‡] (0.2). Calories high-fat foods/day: High strain 694[‡] (19), Low strain 645[†,§] (16), Active 692[‡] (16), Passive 667 (16). **Women:** Exercise sessions/week: High strain 8.3[§] (0.2), Low strain 8.0[§] (0.3), Active 9.2[†,‡,#] (0.3), Passive 8.3[§] (0.2). . Calories high-fat foods/day: High strain 523 (12), Low strain 506 (17), Active 524 (14), Passive 525 (11).	In analyses stratified by sex, and adjusted for age and other covariates, job demands were positively associated with high-fat food intake in men only. Job control was positively associated with LTPA in both men and women. Men in passive jobs reported less LTPA than all other men. Women in active jobs reported more LTPA than all other women. Men in low strain jobs reported fewer calories from high-fat foods than men in high-strain and active jobs, while calories from high-fat foods did not vary significantly between job strain categories for women.
[16] Jonsson, Rosengren, Dotevall, Lappas, and Wilhelmsen (1999), Sweden. *N* = 1,338, 49.2% male, ages 25-64 years. Cross-sectional design. Named data source: World Health Organization-MONItoring cardiovascular disease (WHO-MONICA) (Göteborg).	1. job demands, 2. job control, 3. social support. Tool and definition: JCQ[c] derived – 27 items (12 items demands [5 psychological demands], 9 items control, 6 items social support).	LTPA: LTPA grade. LTPA tool and definition: Self-report single-item questionnaire, responses coded 1-4; 1 = sedentary leisure-time activity, 4 = regular (strenuous) leisure-time activity. Grades 3 and 4 combined due to very few participants in grade 4.	Mean scores for job control, job demands, and social support by levels of LTPA. ANOVA used to test differences among means. All analyses stratified by sex and adjusted for age (covariate). Job demands **Men:** Sedentary LTPA: 29.4, Moderately active: 29.6, Regular exercise: 29.8, (NS). **Women:** Sedentary LTPA: 29.8, Moderately active: 30.1, Regular exercise: 30.1, (NS). Job control **Men:** Sedentary LTPA: 27.3, Moderately active: 28.4, Regular exercise: 28.6, ($p = .01$). **Women:** Sedentary LTPA: 26.7, Moderately active: 27.0, Regular exercise: 27.7, (NS). Social support **Men:** Sedentary LTPA: 15.8, Moderately active: 16.6, Regular exercise: 16.6, ($p = .02$). **Women:** Sedentary LTPA: 16.5, Moderately active: 16.9, Regular exercise: 16.8, (NS).	In analyses stratified by sex and adjusted for age, job control was higher among men who reported engaging in greater LTPA, and social support was also higher among those who engaged in greater LTPA There were no significant differences in LTPA by psychosocial work factors for women.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[17] Kawakami et al. (2006), Japan. *N* = 18,148, 84.28% male, men *M* age 40.8 (*SD* = 8.8) years, women *M* age 36.3 (*SD* = 10.5) years. Cross-sectional design. Named data source: Japan Work Stress and Health Cohort (JSTRESS) Study.	1. job strain (sex-specific quartiles of job strain ratio), 2. social support (sex-specific quartiles). Tool and definition: JCQ[c] derived (Japanese version) – included items for job demands, control, and social support; specific number of items not reported. Job strain defined as a ratio of job demands to job control, multiplied by 2. Social support score was created by adding the scale scores of supervisor support and coworker support.	Diet: Average daily intake of total energy (kcal), dietary fat (g) (protein, carbohydrate, and fibre also provided in original paper). Diet tool and definition: Self-report 31-item previously validated dietary history questionnaire. Consisted of questions about the average frequency of consumption and a gender-specific average portion of 31 food items during the past year.	Mean (95% CI) for average daily intakes of total energy (kcal) and dietary fat (g) by quartiles of job strain and social support. Q1 (Low) – Q4 (High). All analyses stratified by sex and adjusted for age. Statistical differences among the quartiles of job strain and worksite support were tested using ANCOVA). *P* for linear trend. Job strain (sex-specific quartiles) **Men:** Total energy (kcal): Q1 2243 (2226-2261), Q2 2242 (2224-2260), Q3 2238 (2220-2256), Q4 2244 (2225-2264), (trend p= .774). Dietary fat (g): Q1 56.6 (56.3-56.8), Q2 57.1 (56.9-57.4), Q3 57.2 (57.0-57.5), Q4 57.6 (57.4-57.9), (trend p<.001). **Women:** Total energy (kcal): Q1 1980 (1941-2020), Q2 2040 (1999-2081), Q3 2003 (1965-2041), Q4 2009 (1961-2051), (trend p= .678). Dietary fat (g): Q1 61.8 (61.3-62.4), Q2 61.9 (61.4-62.5), Q3 62.0 (61.5-62.5), Q4 61.6 (61.1-62.2), (trend p= .953). Social support (sex-specific quartiles) **Men:** Total energy (kcal): Q1 2219 (2197-2240), Q2 2232 (2216-2249), Q3 2225 (2205-2246), Q4 2270 (2255-2286), (trend p<.001). Dietary fat (g): Q1 57.2 (56.9-57.6), Q2 57.0 (56.8-57.3), Q3 57.1 (56.8-57.3), Q4 57.2 (57.0-57.4), (trend p= .689). **Women:** Total energy (kcal): Q1 1988 (1947-2029), Q2 1974 (1929-2020), Q3 1990 (1955-2027), Q4 2066 (2026-2106), (trend p= .001). Dietary fat (g): Q1 61.8 (61.2-62.3), Q2 62.2 (61.6-62.9), Q3 61.8 (61.4-62.3), Q4 61.7 (61.2-62.2), (trend p= .730).	In analyses stratified by sex and adjusted for age, job strain was positively associated with daily intake of dietary fat in men. Workplace social support was positively associated with average daily intake of total energy for both men and women. Authors note these differences were generally small.
[18] Kobayashi, Hirose, Tada, Tsutsumi, and Kawakami (2005), Japan. *N* = 1401, 0% male, ages 35-63 years. Cross-sectional design. Named data source: None cited.	1. job strain: job demands/job control ratio (low, medium, high), 2. supervisor support (social support), 3. coworker support (social support). Tool and definition: JCQ[c] derived (Japanese version) – 22 items (5 items demands, 9 items control [6 items skill discretion, 3 items decision authority], 8 items support [4 items supervisor support, 4 items coworker support]). Job strain calculated using quotient of job demands to job control. Job strain tertiles: low (.28-.51), medium (.51-61), and high (.61-1.62. Supervisor and coworker support also grouped into tertiles using sum of respective scales.	LTPA: Lack of exercise (less than once weekly). LTPA tool and definition: Self-report single item. Participants dichotomised into “more than once weekly” or less (defined as lack of exercise).	Prevalence (%) and X^2 of lack of exercise (less than once weekly) for levels of job strain, supervisor support, and coworker support. Analyses on all female participants and adjusted for age. *Note: X^2 is an omnibus test, no follow-up analyses to specify where differences exist.* Job strain (Job demands/Job control ratio) Low 77.9%, Medium 72.8%, High 75.8%, X^2 not reported (NS). Supervisor support Low 76.5%, Medium 76.1%, High 72.9%, X^2 not reported (NS). Coworker support Low 75.6%, Medium 71.4%, High 79.3%, X^2 5.6 (p<.10).	In age-adjusted analyses of an all-female sample, there were no significant differences in LTPA by psychosocial work factors. Although not statistically significant, participants who reported low coworker support tended to exercise less frequently.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[19] Kouvonen et al. (2005), Finland. *N* = 46,573, 24.1% male, ages 17-64 years. Cross-sectional design. <u>Named data source:</u> 10-town Study and Hospital Personnel Study.	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 11 items (2 items demands, 9 items control [7 items skill discretion, 2 items decision authority]). Job control and job demand scales divided into tertiles (low, intermediate, high). For the "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> Metabolic equivalent task (MET) hours/week. <u>LTPA tool and definition:</u> Self-report MET index: assessed average amount of time per week spent in LTPA corresponding to the activity intensity of walking, vigorous walking, jogging, and running. Time spent on each activity in hours per week multiplied by its typical energy expenditure, expressed in metabolic equivalent tasks (METs).	Mean scores (*SE*) of MET-hours/week between the categories of job control, job demands, job strain. Separate models using ANOVA. Significance of difference between means calculated using hypothetically least adverse group as reference. All analyses stratified by sex and adjusted for age. *p<.05, **p<.01, ***p<.001. <u>Job demands</u> **Men:** Low 36.59 (0.67), Intermediate 36.87 (0.56), High 34.95 (0.68). **Women:** Low 31.77 (0.29), Intermediate 31.27 (0.23), High 31.34 (0.24). <u>Job control</u> **Men:** Low 33.27*** (0.65), Intermediate 36.65* (0.60), High 38.62 (0.63). **Women:** Low 30.04*** (0.25), Intermediate 31.50*** (0.24), High 32.77 (0.25). <u>Job strain</u> **Men:** Low strain 39.73 (0.70), Active 36.19*** (0.67), Passive 33.85*** (0.72), High strain 34.71*** (0.82). **Women:** Low strain 32.62 (0.29), Active 32.18 (0.26), Passive 30.35*** (0.31), High strain 30.31*** (0.28).	In analyses stratified by sex and adjusted for age, LTPA was significantly lower for both men and women with low job control. LTPA was also significantly lower for both men and women in passive and high strain jobs, as well as men in active jobs. No significant relationship between job demands and LTPA for men or women. Results suggest low job control, either alone, on in combination with high demands (high strain) or low demands (passive jobs), was associated with lower LTPA. Direction of relationships were in the same direction for men and women.
[20] Kouvonen et al. (2007), Finland. *N* = 42,212, 19.32% male, ages 17-63 years. Cross-sectional design. <u>Named data source:</u> Finnish Public Sector Study (10-town Study and Hospital Personnel Study).	1. job demands, 2. job control, 3. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 11 items (2 items demands, 9 items control). Job control and job demand scales divided into tertiles (low, intermediate, high). For the "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	<u>LTPA:</u> Physical inactivity. <u>LTPA tool and definition:</u> Self-report MET index: assessed amount of time per week spent in LTPA corresponding to the activity intensity of walking, vigorous walking, jogging, and running. Time spent on each activity in hours per week multiplied by its typical energy expenditure, expressed in metabolic equivalent tasks (METs). Participants with LTPA <2 MET-hours/day were classified as physically inactive.	OR (95% CI) of physical inactivity (LTPA) according to psychosocial work conditions. Binary logistic regression analyses. All analyses stratified by sex and adjusted for age, basic education, marital status, and type of job contract. "Low strain" as reference for job strain. <u>Job demands</u> **Men:** not reported. **Women:** High 1.11 (1.04-1.18). <u>Job control</u> **Men:** Low 1.36 (1.19-1.55). **Women:** Low 1.23 (1.15-1.31). <u>Job strain</u> **Men:** Active 1.20 (1.04-1.37), Passive 1.39 (1.21-1.60), High strain 1.39 (1.20-1.62). **Women:** Active 1.09 (1.01-1.17), Passive 1.19 (1.11-1.29), High strain 1.26 (1.17-1.36).	In analyses stratified by sex and adjusted for age, physical inactivity was significantly higher for both men and women with low job control. High job demands were associated with physical inactivity in women. Compared to low strain jobs, active, passive, and high strain jobs were all associated with greater likelihood of physical inactivity in both men and women.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[21] Kouvonen et al. (2013), Finland. *N* = 13,976, 18% male, *M* age 44.0 (*SD* = 7.2) years. Prospective design. Named data source: Finnish Public Sector Study (10-town Study and Hospital Personnel Study).	1. job demands, 2. job control, 3. job strain. Tool and definition: JCQ[c] derived – 12 items (3 items demands, 9 items control). Job strain defined by subtracting the mean score of job demands from mean score of job control. Job demands control, and strain scores dichotomised at median for within subject analyses. Repeated exposure to working conditions measured over Time 1 (2000-02) and Time 2 (2004).	LTPA: Insufficient physical activity. LTPA tool and definition: Self-report MET index (measured at Time 3: 2008): participants reported average amount of time per week spent in LTPA corresponding to the activity intensity of walking, vigorous walking, jogging, and running. Time spent on each activity in hours per week multiplied by its typical energy expenditure, expressed in metabolic equivalent tasks (METs). Respondents reporting <14 MET- hours/week classified as insufficiently active.	OR (95% CI) of insufficient physical activity (LTPA) according to psychosocial work conditions. Logistic regression analyses. All analyses adjusted for sex, age, marital status, socio-economic status, employer type, and weekly working hours. Data from online table. Job demands High job demands: none (reference), 1 phase 1.06 (0.97-1.16), 2 phases 1.03 (0.93-1.14). Job control Low job control: none (reference), 1 phase 1.06 (0.96-1.18), 2 phases 1.26 (1.14-1.39). Job strain High strain: none (reference), 1 phase 1.13 (1.03-1.24), 2 phases 1.23 (1.11-1.36).	In analyses adjusted for sex, age and other socio-demographics, repeated exposure to low job control or high job demands was associated with increased likelihood of insufficient LTPA, compared to those who did not report these work stresses. Exposure to high job strain at either 1 or 2 phases was associated with insufficient LTPA, compared to those who did not report these work stresses.
[22] Lallukka et al. (2008), UK, Finland, Japan. UK cohort *N* = 2,917, 73.19% male (LTPA), *N* = 2,907, 73.27% male (diet). Finnish cohort *N* = 4,946, 17.33% male (LTPA), *N* = 5,749, 17.83% male (diet). Japanese cohort N = 1,087, 72.22% male (LTPA). All cohorts Ages 45-60 years. Cross-sectional design. Named data sources: UK: Whitehall II Study; Finland: Helsinki Health Study (HSS); Japan: Civil Servants Study.	1. job strain (low strain, active, passive, high strain). Tool and definition: JCQ[c] derived – 12 items (4 items demands, 8 items control). For the "job strain" definition, scores for demands and control each dichotomised at the median (calculated separately for each cohort and sex) to form 4 groups.	LTPA: Physical inactivity. LTPA tool and definition: All data sources used self-report measures of amount and intensity of LTPA. For the UK cohort, physical activity was calculated from responses to questions about mild, moderate, and vigorous LTPA. "Physically inactive" category comprised ≤ 1hour of LTPA/week. For Finnish and Japanese cohorts, responses to questions about mild, moderate, and vigorous physical activities were also summed and dichotomized to indicate physical inactivity. The lowest quintile of the distribution of the sum was used as a cut-off point reflecting a similar proportion of physically inactive employees as in UK cohort. Diet: Unhealthy food habits. Diet tool and definition: Self-report questionnaire. Healthy food habits defined as consuming fruit and vegetables ≥2 per day, and wholegrain bread and low-fat milk as typical choices in place of white bread and whole milk. Participants without these "healthy" food habits classified as having "unhealthy" food habits. Not measured in Japanese cohort.	OR (95% CI) from logistic regression to assess associations between psychosocial working conditions and physical inactivity and unhealthy food habits. All analyses stratified by sex and study cohort, and adjusted for age. "Low strain" as reference for job strain. **UK cohort** LTPA (inactivity): **Men:** Active 1.16 (0.83-1.63), Passive 1.82 (1.34-2.48), High strain 1.97 (1.36-2.83). **Women:** Active 0.88 (0.47-1.65), Passive 1.49 (0.85-2.61), High strain 0.77 (0.32-1.85). Unhealthy food habits: **Men:** Active 1.08 (0.75-1.55), Passive 1.67 (1.20-2.33), High strain 1.09 (0.70-1.69). **Women:** Active 0.78 (0.43-1.40), Passive 0.96 (0.55-1.67), High strain 0.80 (0.36-1.75). **Finnish cohort** LTPA (inactivity): **Men:** Active 1.12 (0.69-1.82), Passive 1.22 (0.75-1.97), High strain 1.48 (0.92-2.39). **Women:** Active 0.99 (0.79-1.24), Passive 1.29 (1.05-1.58), High strain 1.25 (1.00-1.56). Unhealthy food habits: **Men:** Active 1.30 (0.86-1.96), Passive 1.08 (0.71-1.65), High strain 0.78 (0.49-1.24). **Women:** Active 1.01 (0.76-1.34), Passive 1.22 (0.94-1.59), High strain 1.22 (0.92-1.62). **Japanese cohort** LTPA (inactivity): **Men:** Active 1.08 (0.68-1.72), Passive 1.43 (0.91-2.24), High strain 1.25 (0.74-2.09). **Women:** Active 1.84 (0.81-4.19), Passive 1.05 (0.46-2.42), High strain 1.19 (0.40-3.54).	In analyses stratified by sex and study cohort, and adjusted for age, results were inconsistent across sex and cohort. For UK men, both passive and high strain jobs were associated with greater physical inactivity than men in low strain jobs. For the Finnish cohort, passive and high strain jobs only associated with physical inactivity in women, but not men; and neither men nor women from Japanese cohort. For UK men, passive jobs associated with unhealthy food habits; whereas for Finnish cohort, unhealthy food habits did not appear associated with job strain for either sex. Authors suggest dissimilarities in social context and working environment among the three countries may partly explain the results.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[23] Lallukka et al. (2004), Finland. *N* = 6,243, 20.05% male, ages 40-60 years. Cross-sectional design. Named data source: Helsinki Health Study (HSS)	1. job strain (low strain, active, passive, high strain). Tool and definition: JCQ[c] derived – 19 items – included items for job demands and control; specific number of items not reported Job demands and control scales summed, scores dichotomised and cross-tabulated to form the 4 job strain groups.	LTPA: LTPA over past 12 months. LTPA tool and definition: Self-report MET index: average amount of time/week spent on LTPA corresponding to activity intensity of walking, vigorous walking, jogging, and running. Time spent on each activity in hours per week multiplied by its typical energy expenditure, expressed in metabolic equivalent tasks (METs). LTPA MET index expressed as summary score of MET-hours/week. >30 MET- hours/week classified as physically active (corresponds to recommended levels). Diet: Healthy diet. Diet tool and definition: Self-report 22-item food frequency inventory: consumption of each item in past 4 weeks. Healthy diet index formed from six items 1. fresh vegetables daily, 2. fruit or berries daily, 3. rye bread (whole grain) daily, 4. fish at least twice a week, 5. using vegetable-based margarine on bread, 6. usually using oil in cooking. If ≥ 5 of these habits met, participant diet classified as healthy.	OR (95% CI) from logistic regression to assess associations between psychosocial working conditions and physical activity and healthy diet. All analyses stratified by sex and adjusted for age. "High strain" as reference for job strain. LTPA (active) **Men:** Passive 0.97 (0.64-1.45), Low strain 1.25 (0.84-1.84), Active 1.24 (0.83-1.85). **Women:** Passive 0.92 (0.75-1.12), Low strain 1.26 (1.04-1.52), Active 1.09 (0.89-1.32). Diet (healthy diet) **Men:** Passive 0.75 (0.45-1.24), Low strain 0.81 (0.50-1.32), Active 1.12 (0.69-1.82). **Women:** Passive 0.86 (0.69-1.07), Low strain 1.41 (1.15-1.73), Active 1.46 (1.18-1.80).	In analyses stratified by sex and adjusted for age, women with low strain jobs were significantly more likely to report recommended levels of LTPA compared to those in high strain jobs. Women in both low strain and active jobs were also significantly more likely to report a healthy diet compared to those in high strain jobs. Job strain did not appear significantly associated with LTPA or healthy diet in men. Authors suggest the low proportion of male participants may have prevented similar associations reaching statistical significance for men.
[24] Landsbergis et al. (1998), USA. *N* = 202, 100% male, ages 30-60 years. Cross-sectional design. Named data source: None cited.	1. job demands, 2. job control, 3. job strain (yes vs. no). Tool and definition: JCQ[c] derived – 14 items (5 items demands, 9 items control [6 items skill discretion, 3 items decision authority]). Job demands and job control scales were each scaled to have a range of 12-48. For the "job strain" definition, scores for demands and control each dichotomised at the median. High strain defined as combination of above median demands and below media control.	LTPA: Sedentary behaviour. LTPA tool and definition: Self-report 3 items about regularity, frequency/week, and duration of LTPA. Product dichotomised into <2 hours/week vs. ≥ 2 hours/week. (Job-related physical exertion measured separately).	Standardised OR (95% CI) from logistic regression to assess association between sedentary behaviour and job demands and job control – standardised OR is the estimated OR for persons who differ by one standard deviation in the independent variable. OR (95% CI) from logistic regression to assess association between sedentary behaviour and job strain. All analyses adjusted for age, education, race, marital status, and number of children at home. Job demands 0.8 (0.5-1.2). Job control 1.0 (0.7-1.6). Job strain (High strain vs. others) 1.3 (0.4-4.0).	In age adjusted analyses of an all male sample, there were no significant differences in LTPA by psychosocial work factors. Authors suggest sample size may have been inadequate to detect modest effects.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[25] Oshio, Tsutsumi, and Inoue (2016), Japan. *N* = 9,871, 76.9% male, *M* age 40.3 years (*SD* = 10.4) at baseline. Wave 1 (2010-11), waves 2-4 conducted ~1 year after each other. Panel data design incorporates both cross-sectional (pooled cross-sectional) and longitudinal (fixed-effects) analyses. Named data source: Japanese Study of Health, Occupation, and Psychosocial factors related Equality (J-HOPE).	1. job strain: 4 groups (low strain, active, passive, high strain). Tool and definition: JCQ[c] derived – 14 items (Japanese version) (5 items demands, 9 items control). For "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups.	LTPA: Leisure-time physical inactivity: 1. dichotomous (no LTPA vs. >none), 2. categorical 4-point-score. LTPA tool and definition: Self-report single item with 4-point scale response: none, low (i.e., mild exercise without breathlessness or heart palpitations) ≥ 1/week, intense (i.e., heavy exercise with breathlessness, heart palpitations, or seating ≥ 20 minutes) 1-2/week, and intense physical activity ≥ 3/week. Binary variable: "1" = none LTPA, "0" = >none LTPA. Categorical variable: "4" = none LTPA to "1" = intense LTPA ≥ 3/week.	1. OR (95% CI) estimated association between job strain and physical inactivity (binary: "1" = none LTPA, "0" = >none) from pooled and fixed-effects binary logistic regression. All analyses adjusted for sex, age, educational attainment, hours worked, income, job types, and waves. (*N* = number of observations/number of individuals). **p*<.05, ***p*<.01, ****p*<.001. Job strain **Pooled cross-sectional** (*N* = 31,025/9,871): Low strain 1.00 (reference), Active job 1.12*** (1.05-1.20), Passive job 1.20*** (1.11-1.28), High strain 1.33*** (1.24-1.43). **Fixed-effects** (*N* = 10,135/3,047): Low strain 1.00 (reference), Active job 1.17* (1.02-1.34), Passive job 1.09 (0.93-1.28), High strain 1.22* (1.03-1.43). 2. OR (95% CI) estimated association between job strain and physical inactivity (4-point categorical: "4" = none LTPA to "1" = intense LTPA ≥3/week) from pooled and fixed-effects ordered logistic regression. All analyses adjusted for sex, age, educational attainment, hours worked, income, job types, and waves. **p*<.05, ***p*<.01, ****p*<.001. Job strain **Pooled cross-sectional** (*N* = 31,025/9,871): Low strain 1.00 (reference), Active job 1.13*** (1.06-1.21), Passive job 1.20*** (1.12-1.28), High strain 1.35*** (1.26-1.45). **Fixed-effects** (*N* = 18,459/4,178): Low strain 1.00 (reference), Active job 1.19** (1.06-1.35), Passive job 1.13 (0.98-1.30), High strain 1.28*** (1.11-1.49).	In analyses adjusted for sex, age, and other covariates, fixed effects models showed those with high strain jobs or active jobs were more likely to be physical inactive, compared to those with low strain jobs. This pattern was also seen in pooled cross-sectional models, which also suggest passive jobs were associated with greater likelihood of physical inactivity, compared to those with low strain jobs. Authors conclude that job stress, specifically high job strain, is modestly associated with leisure-time physical inactivity.
[26] Smith, Frank, Bondy, and Mustard (2008), Canada. *N* = 2,097, 55.94% male, ages 25-60 years. Longitudinal design. Named data source: Canadian National Population Health Survey (NPHS).	1. job control. Tool and definition: JCQ[c] derived – 5 items (all job control). Scores summed (higher scores indicate greater job control). Change in job control assessed using difference score between time 2 and time 1 estimates (higher scores indicate increase in job control) Measured at baseline (1994-95) and follow-up (2000).	LTPA: Energy expenditure from LTPA, expressed as kcal/kg per day (log Mean). LTPA tool and definition: Self-report questionnaire incorporating time, duration, and frequency of LTPA in previous 3 months. Measured at baseline (1994) and follow-up (2000).	Unstandardised regression coefficients (*b*) for job control and changes in job control on LTPA. Analyses adjusted for baseline: sex, age, self-rated health, body mass index, education, hypertension, heart disease, back pain, and baseline LTPA. Job control *b* = 0.030, *t*-Stat = 6.15, *p*< .001. Change in job control (higher score indicates increased job control) *b* = 0.028, *t*-Stat = 5.50, *p*< .001.	In analyses adjusted for sex, age and other covariates, higher levels of baseline job control, as well as an increase in job control at follow-up, were associated with higher levels of LTPA. Baseline LTPA had no effect on changes in job control at follow-up, while baseline job control did have an effect on LTPA at follow-up – supporting a causal relationship between changes in job control and LTPA, and not vice versa.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[27] Smith, Frank, Mustard, and Bondy (2008), Canada. *N* = 3,411, 56.35% male, ages 25-60 years. Longitudinal design (prospective). Named data source: Canadian National Population Health Survey (NPHS).	1. job control. Tool and definition: JCQ[c] derived – 5 items (all job control). Scores summed (higher scores indicate less job control) and divided into quartiles. Measured at baseline (1994-95).	LTPA: Energy expenditure from LTPA, expressed as kcal/kg per day (log Mean). LTPA tool and definition: Self-report questionnaire incorporating time, duration, and frequency of LTPA in previous 3 months. Measured at baseline (1994) and follow-up (1996).	Standardised regression coefficients (*b*) for low job control (1994) on LTPA (1996). Analyses adjusted for baseline: sex, age, self-rated health, body mass index, self-reported hypertension, heart disease, back pain, education and baseline (1994) LTPA. *b* = -0.065, *t*-Stat = -3.284, *p* = .001. Subsequent analyses considered relationship between baseline (1994-5) quartile of job control and levels of physical inactivity (zero energy expenditure from LTPA) in 1996. Percentage of participants who were physically inactive in 1996 by quartiles of job control. Analyses adjusted for baseline: sex, age, self-rated health, family stress, personal stress, environmental stress, household income, financial stress, hypertension, body mass index, back pain, heart disease and baseline LTPA. 1st quartile (high job control): 53.6%, 2nd quartile: 57.6%, 3rd quartile: 58.6%, 4th quartile: 64.8%.	In analyses adjusted for sex, age and other covariates, low job control was associated with lower LTPA. Further analyses suggests a graded effect between level of job control and leisure-time physical inactivity, whereby lower levels of job control were associated with higher levels of physical inactivity.
[28] Tsutsumi et al. (2003), Japan. *N* = 6,759, 47.94% male, ages 30-65 years. Cross-sectional. Named data source: Jichi Medical School (JMS) Cohort Study.	1. job demands, 2. job control, 3. job strain. Tool and definition: JCQ[c] derived – 11 items (Japanese version) (5 items demands, 6 items control [4 items skill discretion, 2 items decision authority]). Job strain defined as the ratio of demands to job control. Participants grouped into tertiles (low, intermediate, high), defined separately for men and women, according to distribution of scores in total working population.	LTPA: High LTPA. LTPA tool and definition: Self-report physical activity index calculated by totalling hours at each level of activity and multiplying by a weight based on the oxygen consumption required for that activity. Physical activity index scores divided into tertiles (low, intermediate, high), for men and women separately. Top tertile defined as a high LTPA group. Diet: Dietary pattern. Diet tool and definition: Self-report 30-item food frequency questionnaire. Participants grouped into one of three linear strata of food frequency pattern (vegetable, meat, or western) based on factor analyses.	OR (95% CI) from logistic regression to assess associations between psychosocial work factors and health behaviours. All analyses adjusted for sex, age, marital status, and education and employment status. LTPA analyses also adjusted for working hours. **p*<.05, ***p*<.01, ****p*<.001. Job demands (tertiles) **High LTPA:** Low demands (reference), Intermediate 0.89 (0.74-1.08), High demands 0.91 (0.76-1.09). **Vegetable diet pattern:** Low demands (reference), Intermediate 0.99 (0.86-1.14), High demands 0.96 (0.84-1.10). **Meat diet pattern:** Low demands (reference), Intermediate 1.08 (0.94-1.24), High demands 1.13 (0.99-1.29). **Western diet pattern:** Low demands (reference), Intermediate 1.00 (0.86-1.15), High demands 0.98 (0.86-1.13). Job control (tertiles) **High LTPA:** High control (reference), Intermediate 0.97 (0.81-1.17), Low control 0.94 (0.79-1.13). **Vegetable diet pattern:** High control (reference), Intermediate 0.77*** (0.68-0.89), Low control 0.69*** (0.60-0.79). **Meat diet pattern:** High control (reference), Intermediate 0.96 (0.84-1.10), Low control 0.96 (0.84-1.10). **Western diet pattern:** High control (reference), Intermediate 1.03 (0.90-1.18), Low control 0.98 (0.85-1.12). Job strain (tertiles of ratio) **High LTPA:** Low strain (reference), Intermediate 0.94 (0.78-1.14), High strain 1.01 (0.84-1.21). **Vegetable diet pattern:** Low strain (reference), Intermediate 0.89 (0.78-1.02), High strain 0.76*** (0.66-0.87). **Meat diet pattern:** Low strain (reference), Intermediate 1.11 (0.97-1.27), High strain 1.11 (0.97-1.27). **Western diet pattern:** Low strain (reference), Intermediate 1.10 (0.96-1.27), High strain 1.05 (0.91-1.20).	In analyses adjusted for sex, age and other covariates, low job control and high strain were associated with lower consumption of vegetables. There were no other statistically significant associations between psychosocial work factors and diet patterns or high LTPA.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[29] Van Loon, Tijhuis, Surtees, and Ormel (2000), Netherlands *N* = 3,009, 50.62% male, ages 20-65 years. Cross-sectional design. <u>Named data source:</u> Monitoring Project on Chronic Disease Risk Factors (MORGEN-project).	1. job strain: 4 groups (low strain, active, passive, high strain), 2. iso-strain: 8 groups (high and low social support variants of low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – 23 items (Dutch translation) (4 items job demands, 14 items job control [6 items skill discretion, 8 items decision authority], 5 items social support). For "job strain" definition, scores for demands and control each dichotomised at the median to form 4 groups. For "iso-strain" definition, social support was dichotomised at the median and overlayed on the 4 job strain groups to crease 8 exposure groups.	<u>LTPA:</u> None meeting review criteria (LTPA combined with work-time physical activity in 1996). <u>Diet:</u> 1. fruit intake servings/day, 2. vegetable intake servings/day. <u>Diet tool and definition:</u> Self-report 178-item food frequency questionnaire assessed habitual consumption during previous year. Number of servings per day dichotomised at median for each measure, for men and women separately.	OR (95% CI) from logistic regression to assess association between 1. job strain, 2. iso-strain, and fruit intake and vegetable intake (servings/day below vs. above median). All analyses stratified by sex and adjusted for age and highest level of education. <u>Job strain</u> **<u>Men | Fruit intake:</u>** High strain (reference), Low strain 1.04 (0.76-1.41), Active 1.04 (0.77-1.39), Passive 1.07 (0.80-1.43). **<u>Vegetable intake:</u>** High strain (reference), Low strain 1.17 (0.86-1.59), Active 1.14 (0.85-1.52), Passive 1.11 (0.84-1.48). **<u>Women | Fruit intake:</u>** High strain (reference), Low strain 1.21 (0.90-1.63), Active 1.01 (0.73-1.40), Passive 1.04 (0.78-1.39). **<u>Vegetable intake:</u>** High strain (reference), Low strain 0.98 (0.73-1.32), Active 0.85 (0.62-1.17), Passive 1.30 (0.97-1.74). <u>Iso-strain (Low support)</u> **<u>Men | Fruit intake:</u>** High strain (reference for 2a and 2b), Low strain 1.27 (0.82-1.97), Active 1.14 (0.77-1.70), Passive 1.35 (0.92-2.00). **<u>Vegetable intake:</u>** High strain (reference for 2a and 2b), Low strain 1.14 (0.74-1.76), Active 1.26 (0.85-1.86), Passive 1.21 (0.82-1.79). **<u>Women | Fruit intake:</u>** High strain (reference for 2a and 2b), Low strain 1.16 (0.75-1.81), Active 1.04 (0.66-1.65), Passive 1.23 (0.81-1.86). **<u>Vegetable intake:</u>** High strain (reference for 2a and 2b), Low strain 0.90 (0.58-1.41), Active 0.77 (0.49-1.22), Passive 0.92 (0.61-1.40). <u>Iso-strain (High support)</u> **<u>Men | Fruit intake:</u>** High strain 1.24 (0.77-1.98), Low strain 1.04 (0.70-1.55), Active 1.11 (0.75-1.65), Passive 1.02 (0.69-1.49). **<u>Vegetable intake:</u>** High strain 1.14 (0.71-1.81), Low strain 1.29 (0.87-1.92), Active 1.13 (0.76-1.68), Passive 1.14 (0.78-1.66). **<u>Women | Fruit intake:</u>** High strain 1.12 (0.70-1.79), Low strain 1.34 (0.91-1.98), Active 1.08 (0.70-1.67), Passive 1.00 (0.68-1.49). **<u>Vegetable intake:</u>** High strain 0.80 (0.50-1.27), Low strain 0.88 (0.59-1.29), Active 0.76 (0.49-1.17), Passive 1.41 (0.95-2.09).	In analyses stratified by sex and adjusted for age and education there were no statistically significant associations between job strain or iso-strain and intake of fruit or vegetables. In other analyses that did not adjust for age, for women there appeared to be a positive association between vegetable intake and job control and a negative association between job demands and vegetable intake. *Note: data also presented on individual scales of job demands, job control, and social support, but these analyses did not adjust for age.*
[30] Wemme and Rosvall (2005), Sweden. *N* = 4,451, 56.55% male, men *M* age 41.99 (*SD* = 0.19) years, women *M* age 42.15 (*SD* = 0.2) years (ages reported for larger sub sample). Cross-sectional design. <u>Named data source:</u> The Scania Health Survey 2000.	1. job strain: 4 groups (low strain, active, passive, high strain). <u>Tool and definition:</u> JCQ[c] derived – included items for demands and control; specific number of items not reported. Preparation of variables or definition of job strain not reported.	<u>LTPA:</u> Low LTPA. <u>LTPA tool and definition:</u> Self-report single item with 4-point scale response: low, moderate, regular, and vigorous. Low LTPA group defined as <30 minutes of moderate LTPA every day of the week.	OR (95% CI) from logistic regression for low LTPA in relation to job strain. All analyses stratified by sex and adjusted for age. **Men:** Low strain (reference), Active 1.0 (0.7-1.3), Passive 1.3 (1.0-1.7), High strain 1.5 (1.1-2.0). **Women:** Low strain (reference), Active 0.7 (0.5-1.1), Passive 0.8 (0.5-1.1), High strain 1.2 (0.8-1.6).	In analyses stratified by sex and adjusted for age, psychosocial work factors were not strongly related to low LTPA. There were no statistically significant associations between job strain and low LTPA for women, while men exposed to passive or high strain jobs were more likely to report low LTPA.

[#] Reference, Country, Sample[a] and Design	Work Stress Measures, Tool and Definition	LTPA[b] and/or Diet Measures, Tool and Definition	Relevant Results	Summary
[31] Yang et al. (2010), Finland. N = 861, 47.15% male, ages 24-39 years (in 2001). Longitudinal design (prospective). *Sub-sample of a larger series of cohort surveys: relevant data from LTPA measured in 1992 and 2001.* Named data source: Cardiovascular Risk in Young Finns Study.	1. job demands, 2. job control, 3. job strain: (a. standardized z-scores, b. high vs. low). Measured at follow-up (2001). Tool and definition: JCQ[c] derived – 12 items (3 items demands [from tool similar to JCQ], 9 items control [JCQ derived]). Job strain definitions: a. continuous strain variable (linear term) calculated by subtracting job control from job demands, converted to standardized z-scores. b. tertile-based strain; highest two tertiles in demands combined with lowest two tertiles in control to form high strain category. Lowest two tertiles in demands combined with highest two tertiles in control to form low strain category. All other combinations defined as intermediate. Coded as ordinal variable (1-3, higher values indicating higher strain.	LTPA: 1. LTPA (low, moderate, high) at follow-up (2001), 2. change in LTPA since LTPA baseline (1992). LTPA tool and definition: Self-report previously validated questionnaire (1992 and 2001), included intensity, frequency and duration of physical activity. LTPA defined as continuous exercise ≥ 30min/session. Responses divided highly active (tertile 3) [moderate or vigorous physical activity at least twice a week], moderately active (tertile 2) [moderate physical activity once a week], and inactive (tertile 1) [physical activity less than once/week or none]. Participants coded into 2 categories for both phases: 1 = moderately and highly active group, 0 = inactive group. Participants categorized into 4 groups: persistently active (score 1 in both 1992 and 2001, increasingly active (0 in 1992, 1 in 2001), decreasingly active (1 in 1992, 0 in 2001), and persistently inactive (0 both phases). Change score in LTPA (ΔLTPA) calculated by subtracting baseline LTPA from follow-up LTPA.	1. Means (SD) of job demands, job control, and job strain (linear term) by levels of LTPA (2001) from UNIANOVA. Original manuscript also presents this data for baseline LTPA (1991) and ΔLTPA. Analyses stratified by sex and adjusted for age. Significantly different from "low" category: *p<.05, **p<.01, ***p<.001. Job demands **Men**: Low LTPA 0.10 (0.09), Moderate LTPA -0.06 (0.08), High LTPA -0.11 (0.09). **Women:** Low LTPA 0.19 (0.10), Moderate LTPA 0.03 (0.06), High LTPA -0.28*** (0.11). Job control **Men**: Low LTPA -0.20 (0.09), Moderate LTPA -0.07 (0.08), High LTPA 0.19** (0.09). **Women:** Low LTPA -0.07 (0.10), Moderate LTPA 0.08 (0.06), High LTPA 0.02 (0.11). Job strain **Men**: Low LTPA 0.23 (0.09), Moderate LTPA 0.01 (0.08), High LTPA -0.23*** (0.09). **Women:** Low LTPA 0.20 (0.10), Moderate LTPA -0.04 (0.06), High LTPA -0.20*** (0.11). 2. OR (95% CI) for tertiles of job demand, job control, and job strain by ΔLTPA over 9-year period. Analyses adjusted for baseline sex, age, education, occupational status and smoking. Significantly different from "persistently active" category: *p<.05, **p<.01, ***p<.001. Job demands (high vs. low) Persistently active 1 (reference), Increasingly active 0.8 (0.43-1.64), Decreasingly active 1.4 (0.80-2.31), Persistently inactive 2.7*** (1.59-4.59). Job control (low vs. high) Persistently active 1 (reference), Increasingly active 1.9 (0.89-3.52), Decreasingly active 2.2** (1.25-3.88), Persistently inactive 1.8* (1.08-3.15). Job strain (high vs. low) Persistently active 1 (reference), Increasingly active 1.7 (0.78-3.76), Decreasingly active 2.4** (1.29-4.40), Persistently inactive 4.0*** (1.17-7.39).	In analyses stratified by sex and adjusted for age, men with high LTPA had significantly higher job control scores, while women with high LTPA had significantly lower job demand scores. Both men and women with high LTPA had significantly lower job strain scores. In other analyses adjusted for sex, age, and other covariates, persistently inactive (1992 and 2001) participants were more likely to report high job strain, high job demands, and low job control compared to persistently active ones. Participants reporting decreased LTPA were also more likely to report high job strain and low job control compared to the persistently active group. Authors suggest participation in regular LTPA may help young adults cope with job strain.

Note. [a]Sample size (N) refers to highest N of relevant analyses. [b]LTPA = Leisure-Time Physical Activity. [c]JCQ = Job Content Questionnaire. [d]DCQ = (Swedish) Demand Control Questionnaire.

Discussion

Part of the rationale for this review was the noted inconsistencies in the approaches used for conceptualising work stress in the context of the JDC(S) model (e.g., global job strain measure or strain groups vs. individual constructs), and uncertainty about which approaches may be most useful. In this review, the most consistent unisex support was found for a relationship between lower job control and lower LTPA, and higher job control and higher LTPA. There was considerably less support for the adverse impacts of high job demands or low social support. In terms of the job strain groups, the most consistent support was found for passive and high strain groups – both of which are defined by the presence of low control, and either low or high demands respectively. Therefore it may be that the presence of low job control is the real driver in the apparent association, between passive and high strain jobs and lower LTPA, which was observed in this review and a previous IPD-Work meta-analysis (Fransson et al., 2012). Furthermore, concerns have previously been raised about the inconsistencies in the calculation of job strain and the strain groups, and the ramifications for the validity of this global (i.e., combining constructs) measurement/classification approach (Choi et al., 2015; Smith & LaMontagne, 2015). These concerns, combined with the observations of this review, support the idea that focusing on the individual constructs of the JDC(S) model may be the most effective approach. The presence of job strain (i.e., the combination of high demands and low control) is not the only outcome of the JDC(S) model that can indicate unfavourable psychosocial working conditions (i.e., 'work stress'). The evidence in this review suggests paying closer attention to the individual constructs of the JDC(S) model, particularly low job control, as indicators of work stress, may present opportunities for understanding more nuanced mechanisms for how psychosocial work factors may be implicated in employee health.

Where previous reviews have focused on either physical activity or diet, one of the innovative features of this review was the inclusion of both. In doing so, this review has highlighted the shortage of studies which report on diet and the comparatively greater number that report on LTPA. In agreement with Stewart-Knox (2014), there were an insufficient number of studies to make strong conclusions about potential associations between work stress (within the JDC[S] model) and diet. Therefore, based on the evidence presented, it is unfeasible to decipher the relative potential contributions of insufficient LTPA vs. excessive dietary intake, which according to the positive-energy balance hypothesis, may partially mediate potential associations between work stress and overweight or obesity. Findings of this review are somewhat consistent with previous reviews. While Lin et al. (2014) concluded there was weak evidence for an association between job strain and physical activity, based on the evidence presented in this review there appears to be considerable support for an association between other conceptualisations of work stress within the JDC(S) model, particularly for low job control, and reduced LTPA.

A previous meta-analysis of intervention studies suggests the workplace may be an effective health promotion setting, capable of facilitating modest improvement in employee physical activity and diet health behaviours (Hutchinson & Wilson, 2012). Interestingly, Hutchinson and Wilson (2012) suggested interventions which focused on one health behaviour were more effective than those that attempted to improve multiple health behaviours; this underscores the importance of identifying whether work stress is typically more associated with adverse LTPA or diet behaviours. Most studies included in the present study provided unisex support for the associations between components of the JDC(S) model and energy balance-related behaviours, nonetheless a small number suggest sex-specific support for certain relationships. Observation of sex-specific associations were generally exceptions to the majority and too scant to provide recommendations for tailoring sex-specific interventions, however future intervention studies should consider assessing their effectiveness for men and women separately. It has previously been suggested that associations between psychosocial work factors and LTPA may not generalize well between geographic regions, owing to the possibility of cultural and climatic differences potentially influencing variables of interest (Houdmont et al., 2015). Nonetheless, the general agreement in findings from the diverse samples of the studies included in this systematic review suggests findings may be reasonably generalizable, at least within the JDC(S) model.

While it is sensible to expect LTPA and habitual diet to be correlated with obesity given the generally accepted positive energy balance hypothesis, it is important to reiterate that obesity has a multifactorial aetiology and should not, in and of itself, be considered simply a matter of lifestyle (Choi, Dobson, Ko, & Landsbergis, 2014). Nonetheless, the generally high level of support observed in this review for an association between unfavourable psychosocial work factors within the JDC(S) model (i.e., 'work stress') and reduced LTPA, supports the idea that considering more proximal factors can be useful in seeking to understand the potential influence of these work factors on more distal potential disease outcomes such as obesity (Theorell, 2014).

This review has focused on the JDC(S) model, but other conceptualisations or dimensions of 'work stress', such as burnout, also appear relevant for a holistic understanding of how psychosocial work factors may be associated with energy balance-related behaviours (Alexandrova-Karamanova et al., 2016). Other relevant factors may be more general characteristics of the workplace environment, such as the belief that the business values employee health, and social learning through observing colleagues engaging in healthy behaviours or selection into workgroups (Quist, Christensen, Carneiro, Hansen, & Bjorner, 2014; Tabak, Hipp, Marx, & Brownson, 2015). While excluded from the scope of this review, physical activity at work is likely another important factor in energy balance regulation: previous research suggests sedentary work is a risk factor for obesity, especially in male employees and those working long hours (Choi et al., 2010b).

Recommendations for Future Research

While some papers included in this review reported the separate number of measurement items for the two subscales of job control: skill discretion and decision authority, these subscales were consistently combined into the composite measure of job control for analyses. It has been suggested that research should consider analysing these subscales separately (De Jonge, Reuvers, et al., 2000; Mansell & Brough, 2005). Two previous studies reporting the association between mortality and job control suggested these constructs may hold differential associations with health outcomes (Joensuu et al., 2012a; Joensuu et al., 2014). For reasons discussed elsewhere, in the contemporary context, higher skill discretion may be more likely to be beneficial for employee health, while higher decision authority may be more likely to be detrimental (Joensuu et al., 2012b). Both of these studies presented separate bivariate associations between the two job control subscales and LTPA, which was included as a covariate in follow-up analyses, however these bivariate analyses did not control or adjust for sex or age, so did not meet inclusion criteria for this review. Nonetheless, the first study suggested higher levels of skill discretion were reported by those with more regular LTPA, while no significant differences were seen for decision authority (Joensuu et al., 2012a). Conversely, the second study suggested lower levels of LTPA were observed in participants reported higher levels of decision authority, but also higher levels of skill discretion (Joensuu et al., 2014). Higher levels of both subscales were also reported for those not classified as obese (Joensuu et al., 2014); however it is important to reiterate that these covariates were not the main focus of these studies and bivariate analyses did not control or adjust for the effects of sex or age. More recently, one study that did control for the effects of sex and age suggested higher levels of skill discretion were associated with smaller waist circumference – while higher levels of decision authority were associated with larger waist circumference (a potential distal outcome of low LTPA) (Bean et al., 2015). Future research considering the potential for the two job control subscales to hold differential associations with LTPA and diet (more proximal outcomes), with analyses controlling for sex and age is recommended.

There was considerable variability noted in the methods used to measure LTPA. To encourage consistency and comparability, operationalisation of these variables should be related to relevant guidelines that outline recommended levels of LTPA – such as the those provided by the World Health Organization (2016b). In order to assess the degree of adherence to these guidelines, and to promote measurement validity, future research using self-report measures of LTPA should capture information about the type, duration, frequency, and intensity of the activities performed (Hu, 2013). Relevant reporting period (e.g., LTPA over past month or past 3 months) should also be stated. With the increasing availability and affordability of activity trackers, future research may also benefit from including an objective measure of physical activity paired with time-use diaries or work schedules to categorise LTPA and work-related physical activity (Appelboom et al., 2014; Diaz et al., 2015).

This review only identified one study that reported total dietary energy intake (kcal) in relation to work stress (JDC[S] model), which adjusted for age and stratified by sex (#17). Most studies that reported on diet only described fruit and vegetable consumption or broad dietary patterns, which provides limited information about the potential association between work stress and diet, and the role diet may play in mediating the potential association between work stress and obesity. More research, specifically including measurement of total dietary energy intake (kcal or kJ), would be especially useful and compatible with the positive energy balance hypothesis. Ideally, future research should include such a measure, as well as a credentialed operationalisation of LTPA, and employ statistical methods to control for sex and age in reported analyses.

Strengths and Limitations

This review comprised a systematic approach to the identification of relevant studies using a comprehensive search protocol, informed by relevant guidelines and the support of an experienced research librarian. Studies were classified for inclusion using an objective and reasoned set of inclusion criteria; the effectiveness of these criteria was supported by the high level of inter-rater agreement between the first and second authors who worked independently to classify relevant studies. The inclusive search protocol cast a wide net to identify a diverse and representative set of published studies, which combined with the specific inclusion criteria, facilitated an effective qualitative synthesis of previous findings and recommendations for future research. This approach was especially suitable for addressing the aims of this review since the variables of interest (LTPA and diet) were often included as variables secondary to the main focus of many of the included studies. Nonetheless, this may also be considered a limitation since the broad nature of the included studies and diversity in methodology meant a quantitative synthesis of results in the form of a meta-analysis was impractical.

Conclusions

This systematic review has identified peer-reviewed original journal articles that report on the association between favourable or unfavourable psychosocial work factors (i.e., work stress) within the JDC(S) model, detailed the methods used in these studies, provided a summary of previous findings and made recommendations for future research. There was general support for a negative association between work stress (specified in this review as unfavourable psychosocial working conditions in the JDC[S] model) and LTPA; particularly for lower job control and lower LTPA, or the inverse. There was limited support for an association between unfavourable psychosocial working conditions and poorer diet; however there were not sufficient studies to make strong conclusions. Methods used in the included studies have been detailed and discussed in relation to reported findings, facilitating recommendations for future research. Most notably these include the need for more studies to report diet outcomes, specifically total dietary energy intake (kcal or kJ). Other salient recommendations include encouragement for the consideration of the individual JDC(S) constructs instead of global measures of job strain. Future research may also consider the potential for differential associations of the job control subscales: skill discretion and decision authority, as this matter has generally been overlooked by previous research in this area.

3.4 Appendix A: Systematic Review Search Protocol

PubMed: 08 June 2016 **Title: Work stress and energy balance health behaviours**		
	Search terms	**Items found**
Work stress		
1.	burnout, professional[mh] OR workplace/psychology[mh] OR employment/psychology[mh] OR workload[mh] OR (stress, psychological[mh] and (workplace[tiab] OR occupational environment[tiab] OR job demand*[tiab] OR work related[tiab]))	33033
2.	burnout[tiab] OR decision authority[tiab] OR decision latitude[tiab] OR demand resource*[tiab] OR demand-induced strain compensation[tiab] OR effort reward*[tiab] OR employee stress*[tiab] OR employment stress*[tiab] OR iso strain[tiab] OR isostrain[tiab] OR job autonomy[tiab] OR job characteristics[tiab] OR job content questionnaire*[tiab] OR job control[tiab] OR job demand control support[tiab] OR job demand control[tiab] OR job demand*[tiab] OR job strain*[tiab] OR job stress*[tiab] OR job support[tiab] OR occupational stress*[tiab] OR organisational culture[tiab] OR organizational culture[tiab] OR psychosocial safety climate[tiab] OR psychosocial work*[tiab] OR role ambiguity[tiab] OR skill discretion[tiab] OR work demand*[tiab] OR work related stress*[tiab] OR work strain[tiab] OR workplace stress*[tiab]	15995
3.	#1 OR #2	41492
Energy Balance Health Behaviours		
4.	diet[mh:noexp] OR dietary fats[mh:noexp] OR dietary records[mh] OR eating[mh] OR energy intake[mh] OR exercise[mh] OR fast foods[mh] OR food and beverages[mh] OR food habits[mh:noexp] OR health behavior[mh:noexp] OR hyperphagia[mh] OR life style[mh:noexp] OR meals[mh] OR nutrition surveys[mh] OR nutritive value[mh] OR overnutrition[mh:noexp] OR portion size[mh] OR sedentary lifestyle[mh] OR serving size[mh] OR snacks[mh]	880829
5.	beverage*[tiab] caloric[tiab] OR calorie*[tiab] OR diet[tiab] OR dietary behavior*[tiab] OR dietary behaviour*[tiab] OR dietary fat*[tiab] OR dietary[tiab] OR eat*[tiab] OR energy balance[tiab] OR energy balance-related[tiab] OR energy imbalance[tiab] OR energy intake[tiab] OR exercise[tiab] OR fast food*[tiab] OR food frequency questionnaire*[tiab] OR food habit*[tiab] OR food*[tiab] OR health behaviour*[tiab] OR health behavior*[tiab] OR health related behaviour*[tiab] OR health related behavior*[tiab] OR hyperphagia[tiab] OR kilocalorie*[tiab] OR kilojoule*[tiab] OR life style*[tiab] OR lifestyle*[tiab] OR macro nutrient*[tiab] OR macronutrient*[tiab] OR meal[tiab] OR meals[tiab] OR nutrition*[tiab] OR over eating[tiab] OR overeating[tiab] OR physical activity[tiab] OR physical inactivity[tiab] OR physically active[tiab] OR physically inactive[tiab] OR portion size*[tiab] OR sedentary[tiab] OR serving size*[tiab] OR snack*[tiab] OR obesogenic behavior*[tiab] OR obesogenic behaviour*[tiab] OR fruit*[tiab] OR vegetable*[tiab]	1198797
6.	#4 OR #5	1624166
Combined sets		
7.	**3 AND 6**	3115
Limits		
8.	**7 AND Filters: Publication date from 1990/01/01**	2838
9.	**8 AND Filters: English**	2766

PsycINFO via Ovid SP: 08 June 2016 **Title: Work stress and energy balance health behaviours**		
	Search terms	**Items found**
Work stress		
1.	(Job Characteristics or Occupational Stress or Work Load).sh.	24058
2.	("burnout" or "decision authority" or "decision latitude" or "demand resource*" or "demand-induced strain compensation" or "effort reward*" or "employee stress*" or "employment stress*" or "iso strain" or "isostrain" or "job autonomy" or "job characteristics" or "job content questionnaire*" or "job control" or "job demand control support" or "job demand control" or "job demand*" or "job strain*" or "job stress*" or "job support" or "occupational stress*" or "organisational culture" or "organizational culture" or "psychosocial safety climate" or "psychosocial work*" or "role ambiguity" or "skill discretion" or "work demand*" or "work related stress*" or "work strain" or "workplace stress*").ti. or ("burnout" or "decision authority" or "decision latitude" or "demand resource*" or "demand-induced strain compensation" or "effort reward*" or "employee stress*" or "employment stress*" or "iso strain" or "isostrain" or "job autonomy" or "job characteristics" or "job content questionnaire*" or "job control" or "job demand control support" or "job demand control" or "job demand*" or "job strain*" or "job stress*" or "job support" or "occupational stress*" or "organisational culture" or "organizational culture" or "psychosocial safety climate" or "psychosocial work*" or "role ambiguity" or "skill discretion" or "work demand*" or "work related stress*" or "work strain" or "workplace stress*").ab.	22940
3.	#1 OR #2	34074
Energy Balance Health Behaviours		
4.	(Diets or Eating Behavior or Energy expenditure or Exercise or Food Intake or Food or Health Behavior or Lifestyle or Nutrition or Physical Activity).sh.	94449
5.	("beverage*" or "caloric" or "calorie*" or "diet" or "dietary behavior*" or "dietary behaviour*" or "dietary fat*" or "dietary" or "eat*" or "energy balance" or "energy balance-related" or "energy imbalance" or "energy intake" or "exercise" or "fast food*" or "food frequency questionnaire*" or "food habit*" or "food*" or "health behavior*" or "health behaviour*" or "health related behavior*" or "health related behavior*" or "hyperphagia" or "kilocalorie*" or "kilojoule*" or "life style*" or "lifestyle*" or "macro nutrient*" or "macronutrient*" or "meal" or "meals" or "nutrition*" or "over eating" or "overeating" or "physical activity" or "physical inactivity" or "physically active" or "physically inactive" or "portion size*" or "sedentary" or "serving size*" or "snack*" or "obesogenic behavior*" or "obesogenic behaviour*" or "fruit*" or "vegetable*").ti. or ("beverage*" or "caloric" or "calorie*" or "diet" or "dietary behavior*" or "dietary behaviour*" or "dietary fat*" or "dietary" or "eat*" or "energy balance" or "energy balance-related" or "energy imbalance" or "energy intake" or "exercise" or "fast food*" or "food frequency questionnaire*" or "food habit*" or "food*" or "health behavior*" or "health behaviour*" or "health related behavior*" or "health related behavior*" or "hyperphagia" or "kilocalorie*" or "kilojoule*" or "life style*" or "lifestyle*" or "macro nutrient*" or "macronutrient*" or "meal" or "meals" or "nutrition*" or "over eating" or "overeating" or "physical activity" or "physical inactivity" or "physically active" or "physically inactive" or "portion size*" or "sedentary" or "serving size*" or "snack*" or "obesogenic behavior*" or "obesogenic behaviour*" or "fruit*" or "vegetable*").ab.	216038
6.	#4 OR #5	233992
Combined sets		
7.	**3 AND 6**	1640
Limits		
8.	**7 AND Filters: Publication date from 1990/01/01**	1398
9.	**8 AND Filters: English**	1319
10.	**9 AND Filters: Peer reviewed journal**	1002

The search result, usually found at the end of the documentation, forms the list of abstracts

.sh = Subject Headings (also known as "descriptors" or "index terms") from the American Psychological Association's Thesaurus of Psychological Index Terms
.ti = Title
.ab = Abstract
* = Truncation
" " = Quotation marks; searches for an exact phrase

Web of Science Core Collection: 08 June 2016 Title: Work stress and energy balance health behaviours		
	Search terms	**Items found**
Work stress		
1.	TS=("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*")	33775
Energy Balance Health Behaviours		
2.	TS= ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "health related behavior*" OR "health related behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR fruit* OR vegetable*)	1923774
Combined sets		
3.	**#1 AND #2**	2033
Limits		
4.	**3 AND Filters: Publication date from 1990/01/01**	2023
5.	**4 AND Filters: English**	1938

The search result, usually found at the end of the documentation, forms the list of abstracts

TS = Topic; includes words in the title, abstract, author keywords and WOS keywords.
* = Truncation
“ “ = Quotation marks; searches for an exact phrase
Note: Web of Science does not use a controlled vocabulary (e.g. MeSH).

Scopus: 08 June 2016 Title: Work stress and energy balance health behaviours		
	Search terms	**Items found**
Work stress		
1.	TITLE-ABS-KEY ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*")	62356
Energy Balance Health Behaviours		
2.	TITLE-ABS-KEY ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "health related behavior*" OR "health related behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR “meals” OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*")	2981708
Combined sets		
3.	**#1 AND #2**	3687
Limits		
4.	**3 AND Filters: Publication date from 1990/01/01**	3678
5.	**4 AND Filters: English**	3384
6.	**5 AND Filters: Source Type: Journals**	3239

The search result, usually found at the end of the documentation, forms the list of abstracts

TITLE-ABS-KEY = field includes words in the title, abstract, keywords.
* = Truncation
“ “ = Quotation marks; searches for an exact phrase
Note: Scopus does not use a controlled vocabulary (e.g. MeSH).

Business Source Complete via EBSCO (Boolean/Phrase search mode): 08 June 2016 Title: Work stress and energy balance health behaviours		
	Search terms	**Items found**
Work stress		
1.	SU (JOB stress OR BURNOUT (Psychology) OR EMPLOYEES -- Workload OR OCCUPATIONS OR WORK design OR JOB descriptions OR work -- psychological aspects)	31607
2.	TI ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*") OR AB ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*") OR KW ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*")	14205
3.	#1 OR #2	41006
Energy Balance Health Behaviours		
4.	SU (HEALTH behaviour OR LIFESTYLES OR LEISURE OR DIET OR PHYSICAL fitness OR EXERCISE OR Eating OR food habits OR NUTRITION OR FOOD -- Caloric content OR Meals OR Food consumption OR nutrition surveys OR Physical Activity OR sedentary lifestyle* OR snack)	61603
5.	TI ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*") OR AB ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*") OR KW ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*")	111602

6.	#4 OR #5	157065
Combined sets		
7.	**#3 AND #6**	489
Limits		
8.	**7 AND Filters: Publication date from 1990/01/01**	447
9.	**8 AND Filters: English**	444
	9 AND Filters: Scholarly (Peer Reviewed) Journals	216

The search result, usually found at the end of the documentation, forms the list of abstracts

SU = Subject terms
TI = Title
AB = Abstract
KW = Keyword
* = Truncation
“ “ = Quotation marks; searches for an exact phrase

CINAHL via EBSCO (Boolean/Phrase search mode): 08 June 2016 **Title: Work stress and energy balance health behaviours**		
	Search terms	**Items found**
Work stress		
1.	MH (burnout, professional OR job characteristics OR job description OR stress, occupational OR work environment/pf OR workload)	27590
2.	TI ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*") OR AB ("burnout" OR "decision authority" OR "decision latitude" OR "demand resource*" OR "demand-induced strain compensation" OR "effort reward*" OR "employee stress*" OR "employment stress*" OR "iso strain" OR "isostrain" OR "job autonomy" OR "job characteristics" OR "job content questionnaire*" OR "job control" OR "job demand control support" OR "job demand control" OR "job demand*" OR "job strain*" OR "job stress*" OR "job support" OR "occupational stress*" OR "organisational culture" OR "organizational culture" OR "psychosocial safety climate" OR "psychosocial work*" OR "role ambiguity" OR "skill discretion" OR "work demand*" OR "work related stress*" OR "work strain" OR "workplace stress*")	7942
3.	#1 OR #2	30558
Energy Balance Health Behaviours		
4.	MH (diet OR dietary fats OR eating behavior OR eating OR energy intake OR exercise OR food and beverages OR food habits OR health behavior OR hyperphagia OR leisure activities OR life style OR life style, sedentary OR meals OR nutrition OR nutritive value OR portion size OR physical activity OR physical fitness OR snacks)	131667
5.	TI ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*") OR AB ("beverage*" OR "caloric" OR "calorie*" OR "diet" OR "dietary behavior*" OR "dietary behaviour*" OR "dietary fat*" OR "dietary" OR "eat*" OR "energy balance" OR "energy balance-related" OR "energy imbalance" OR "energy intake" OR "exercise" OR "fast food*" OR "food frequency questionnaire*" OR "food habit*" OR "food*" OR "health behavior*" OR "health behaviour*" OR "hyperphagia" OR "kilocalorie*" OR "kilojoule*" OR "life style*" OR "lifestyle*" OR "macro nutrient*" OR "macronutrient*" OR "meal" OR "meals" OR "nutrition*" OR "over eating" OR "overeating" OR "physical activity" OR "physical inactivity" OR "physically active" OR "physically inactive" OR "portion size*" OR "sedentary" OR "serving size*" OR "snack*" OR "obesogenic behavior*" OR "obesogenic behaviour*" OR "fruit*" OR "vegetable*")	195983
6.	#4 OR #5	255791
Combined sets		
7.	**#6 AND #3**	1517
Limits		
8.	**7 AND Filters: Publication date from 1990/01/01**	1492
9.	**8 AND Filters: English**	1425
10.	**9 AND Filters: Peer Reviewed**	1253

The search result, usually found at the end of the documentation, forms the list of abstracts

MH = MeSH (Medical Subject Headings) is the NLM controlled vocabulary thesaurus used for indexing articles for CINAHL, includes other terms listed below this term in the MeSH hierarchy
/pf = psychosocial factors subheading
Note: CINAHL includes some MeSH not used by PubMed.

TI = Title
AB = Abstract
* = Truncation
“ “ = Quotation marks; searches for an exact phrase

Cochrane Library: 08 June 2016 **Title: Work stress and energy balance health behaviours**		
	Search terms	**Items found**
Work stress		
1.	MeSH descriptor: [Burnout, Professional] explode all trees OR MeSH descriptor: [Workload] explode all trees OR MeSH descriptor: [Job Description] explode all trees OR ((MeSH descriptor: [Stress, Psychological] explode all trees AND (workplace OR occupational environment OR job demand* OR work related:ti,ab,kw (Word variations have been searched))))	703
2.	"burnout" or "decision authority" or "decision latitude" or "demand resource*" or "demand-induced strain compensation" or "effort reward*" or "employee stress*" or "employment stress*" or "iso strain" or "isostrain" or "job autonomy" or "job characteristics" or "job content questionnaire*" or "job control" or "job demand control support" or "job demand control" or "job demand*" or "job strain*" or "job stress*" or "job support" or "occupational stress*" or "organisational culture" or "organizational culture" or "psychosocial safety climate" or "psychosocial work*" or "role ambiguity" or "skill discretion" or "work demand*" or "work related stress*" or "work strain" or "workplace stress*":ti,ab,kw (Word variations have been searched)	781
3.	#1 OR #2	1238
Energy Balance Health Behaviours		
4.	MeSH descriptor: [Diet] explode all trees OR MeSH descriptor: [Dietary Fats] this term only OR MeSH descriptor: [Eating] explode all trees OR MeSH descriptor: [Energy Intake] explode all trees OR MeSH descriptor: [Exercise] explode all trees OR MeSH descriptor: [Fast Foods] explode all trees OR MeSH descriptor: [Food and Beverages] explode all trees OR MeSH descriptor: [Food Habits] explode all trees OR MeSH descriptor: [Food] explode all trees OR MeSH descriptor: [Health Behavior] this term only OR MeSH descriptor: [Hyperphagia] explode all trees OR MeSH descriptor: [Life Style] explode all trees OR MeSH descriptor: [Meals] explode all trees OR MeSH descriptor: [Nutrition Surveys] explode all trees OR MeSH descriptor: [Nutritive Value] explode all trees OR MeSH descriptor: [Overnutrition] this term only OR MeSH descriptor: [Portion Size] explode all trees OR MeSH descriptor: [Serving Size] explode all trees OR MeSH descriptor: [Sedentary Lifestyle] explode all trees OR MeSH descriptor: [Snacks] explode all	48398
5.	"beverage*" or "caloric" or "calorie*" or "diet" or "dietary behavior*" or "dietary behaviour*" or "dietary fat*" or "dietary" or "eat*" or "energy balance" or "energy balance-related" or "energy imbalance" or "energy intake" or "exercise" or "fast food*" or "food frequency questionnaire*" or "food habit*" or "food*" or "health behavior*" or "health behaviour*" or "hyperphagia" or "kilocalorie*" or "kilojoule*" or "life style*" or "lifestyle*" or "macro nutrient*" or "macronutrient*" or "meal" or "meals" or "nutrition*" or "over eating" or "overeating" or "physical activity" or "physical inactivity" or "physically active" or "physically inactive" or "portion size*" or "sedentary" or "serving size*" or "snack*" or "obesogenic behavior*" or "obesogenic behaviour*" or "fruit*" or "vegetable*":ti,ab,kw (Word variations have been searched)	136756
6.	#4 OR #5	142342
Combined sets		
7.	**#3 AND #6**	266
8.	***Cochrane Reviews***	*64*
9.	***Cochrane Other Reviews***	*10*
10.	***Cochrane Trials***	*181*
11.	***Cochrane Methods Studies***	*1*
12.	***Cochrane Technology Assessments***	*0*
13.	***Cochrane Economic Evaluations***	*8*
14.	***Cochrane Groups***	*2*

The search result, usually found at the end of the documentation, forms the list of abstracts

MeSH descriptor = MeSH (Medical Subject Headings) is the NLM controlled vocabulary thesaurus used for indexing articles for PubMed, includes other terms listed below this term in the MeSH hierarchy
ti = Title
ab = Abstract
kw = Keyword
* = Truncation
“ “ = Quotation marks; searches for an exact phrase

Embase: 08 June 2016 **Title: Work stress and energy balance health behaviours**		
	Search terms	**Items found**
Work stress		
1.	'burnout'/exp OR 'job characteristics'/exp OR 'job stress'/exp	15610
2.	'burnout':ab,ti OR 'decision authority':ab,ti OR 'decision latitude':ab,ti OR 'demand resource':ab,ti OR 'demand resources':ab,ti OR 'demand-induced strain compensation':ab,ti OR 'effort reward':ab,ti OR 'employee stress':ab,ti OR 'employee stressors':ab,ti OR 'employment stress':ab,ti OR 'iso strain':ab,ti OR 'isostrain':ab,ti OR 'job autonomy':ab,ti OR 'job characteristics':ab,ti OR 'job content questionnaire':ab,ti OR 'job content questionnaires':ab,ti OR 'job control':ab,ti OR 'job demand control support':ab,ti OR 'job demand control':ab,ti OR 'job demand':ab,ti OR 'job demands':ab,ti OR 'job strain':ab,ti OR 'job strains':ab,ti OR 'job stress':ab,ti OR 'job stressors':ab,ti OR 'job support':ab,ti OR 'occupational stress':ab,ti OR 'occupational stressors':ab,ti OR 'organisational culture':ab,ti OR 'organizational culture':ab,ti OR 'psychosocial safety climate':ab,ti OR 'psychosocial work':ab,ti OR 'psychosocial working':ab,ti OR 'role ambiguity':ab,ti OR 'skill discretion':ab,ti OR 'work demand':ab,ti OR 'work demands':ab,ti OR 'work related stress':ab,ti OR 'work related stressor':ab,ti OR 'work related stressors':ab,ti OR 'work strain':ab,ti OR 'workplace stress':ab,ti	18351
3.	#1 OR #2	25492
Energy Balance Health Behaviours		
4.	'caloric intake'/exp OR 'diet'/exp OR 'dietary intake'/exp OR 'eating'/exp OR 'exercise'/exp OR 'fast food'/exp OR 'fat intake'/exp OR 'food'/exp OR 'lifestyle'/exp OR 'overnutrition'/syn OR 'portion size'/syn OR 'sedentary lifestyle'/syn OR 'food intake'/exp OR 'health behavior'/de OR 'hyperphagia'/exp OR 'meal'/exp OR 'nutrition'/exp OR 'nutritional value'/exp	2292996
5.	'beverage':ab,ti OR 'beverages':ab,ti OR 'caloric':ab,ti OR 'calorie':ab,ti OR 'calories':ab,ti OR 'diet':ab,ti OR 'dietary behavior':ab,ti OR 'dietary behaviors':ab,ti OR 'dietary behaviour':ab,ti OR 'dietary behaviours':ab,ti OR 'dietary fat':ab,ti OR 'dietary fats':ab,ti OR 'dietary':ab,ti OR 'eat':ab,ti OR 'eating':ab,ti OR 'energy balance':ab,ti OR 'energy balance-related':ab,ti OR 'energy imbalance':ab,ti OR 'energy intake':ab,ti OR 'exercise':ab,ti OR 'fast food':ab,ti OR 'fast foods':ab,ti OR 'food frequency questionnaire':ab,ti OR 'food frequency questionnaires':ab,ti OR 'food habit':ab,ti OR 'food habits':ab,ti OR 'food':ab,ti OR 'foods':ab,ti OR 'health behavior':ab,ti OR 'health behviors':ab,ti OR 'health behaviour':ab,ti OR 'health behaviours':ab,ti OR 'hyperphagia':ab,ti OR 'kilocalorie':ab,ti OR 'kilocalories':ab,ti OR 'kilojoule':ab,ti OR 'kilojoules':ab,ti OR 'life style':ab,ti OR 'life styles':ab,ti OR 'lifestyle':ab,ti OR 'lifestyles':ab,ti OR 'macro nutrient':ab,ti OR 'macro nutrients':ab,ti OR 'macronutrient':ab,ti OR 'macronutrients':ab,ti OR 'meal':ab,ti OR 'meals':ab,ti OR 'nutrition':ab,ti OR 'nutritional':ab,ti OR 'over eating':ab,ti OR 'overeating':ab,ti OR 'physical activity':ab,ti OR 'physical inactivity':ab,ti OR 'physically active':ab,ti OR 'physically inactive':ab,ti OR 'portion size':ab,ti OR 'portion sizes':ab,ti OR 'sedentary':ab,ti OR 'serving size':ab,ti OR 'serving sizes':ab,ti OR 'snack':ab,ti OR 'snacks':ab,ti OR 'obesogenic behavior':ab,ti OR 'obesogenic behaviors':ab,ti OR 'obesogenic behaviour':ab,ti OR 'obesogenic behaviours':ab,ti OR 'fruit':ab,ti OR 'fruits':ab,ti OR 'vegetable':ab,ti OR 'vegetables':ab,ti	1470226
6.	#4 OR #5	2775595
Combined sets		
7.	**#3 AND #6**	3012
Limits		
8.	**7 AND Filters: Publication date from 1990/01/01, i.e. [1-1-1990]/sd**	2928
9.	**8 AND Filters: English, i.e. [english]/lim**	2704
10	**9 AND Filters: ([article]/lim OR [article in press]/lim OR [erratum]/lim)**	1875

The search result, usually found at the end of the documentation, forms the list of abstracts

Emtree = hierarchically structured, controlled vocabulary - the equivalent of MeSH
/exp = Explosion (Emtree index term)
/syn = Emtree and synonyms search
/de = to search for words or phrases anywhere in an Emtree heading; .ti = title .ab = abstract
Note: Embase does not support truncation for phrases enclosed in quotation marks. Although “erratum” type included, 0 records of this type. (Auto mapping turned off)

3.5 Appendix B: Systematic Review Data Extraction Tables

Note. See Chapter 3, Table 2 for corresponding reference [#] number.

Variable	Count [Reference #]
Study design (for relevant analysis)	
Cross-sectional	[1] [2] [3] [4] [5] [6] [7] [8] [9] [11] [13] [14] [15] [16] [17] [18] [19] [20] [22] [23] [24] [28] [29] [30]
Longitudinal	[10] [12] [25] [26]
Prospective (longitudinal)	[21] [27] [31]

Variable	Count [Reference #]
Work stress conceptualisation approach	
Job strain (continuous: calculated by subtracting control from demands, converted to standardized Z-score)	[31]
Job strain (dichotomised: yes/no [combined median splits])	[3] [24]
Job strain (dichotomised: yes/no [job strain ratio])	[11]
Job strain (dichotomised: yes/no [*Ms* of Cont- Dem] med. spl.)	[21]
Job strain (low, average, high [+/- 1 SD])	
Job strain (global score; tertiles of job strain ratio/"quotient")	[18] [28]
Job strain (tertiles; highest two tertiles of demands combined with highest two tertiles of control to form high strain. Lowest two tertiles of demands combined with highest two tertiles of control to form low strain. All other combinations defined as intermediate).	[31]
Job strain (global score; quartiles of job strain ratio)	[17]
Iso-strain (continuous)	None
Iso-strain (dichotomised: yes/no [combined median splits])	[6] [11]
Iso-strain (job strain groups [combined median splits] stratified by high/low support)	[29]
Job strain (all 4 groups) (quadrant approach [combined median splits])	[1] [4] [5] [7] [8] [9] [13] [14] [15] [19] [20] [22] [23] [25] [29] [30]
Passive job individual	[12]
Job strain (5 groups) (4 groups + "middle" group)	[9]
Job demands individual (continuous)	[2] [3] [11] [14] [16] [24] [31]
Job demands individual (median split)	[7] [8] [21] [31]
Job demands individual (tertiles; low, avg, high [+/- 1 SD])	[10]
Job demands individual (tertiles)	[19] [20] [28]
Job demands individual (quartiles)	[4] [9] [15]
Job control individual (continuous)	[2] [3] [11] [14] [16] [24] [26] [27] [31]
Job control individual (median split)	[7] [8] [21] [31]
Job control indiv. (tertiles; low, avg, high [+/- 1 SD])	[10]
Job control individual (tertiles)	[19] [20] [28]
Job control individual (quartiles)	[4] [9] [15]
(Job control) Skill discretion individual	None
(Job control) Decision authority individual	None
Job social support individual (continuous)	[2] [11] [14] [16]
Job social support individual (median split)	None (see 29: stratified by median split)
Job social support indiv. (tertiles; low, avg, high [+/- 1 SD])	[10]
Job social support individual (quartiles)	[17]
Coworker support individual	[9: low vs. high] [11: continuous] [18: tertiles]
Supervisor support individual	[9: low vs. high] [11: continuous] [18: tertiles]

Variable	Count [Reference #]
LTPA measurement features (based on information reported in article)	
LTPA Survey design (all self-report questionnaires)	
Specified type (e.g. aerobic vs. muscle-strengthening, sport vs. recreation)	[5] [7]
Duration (continuous: minutes)	[7] [8] [14] [26] [27]
Duration (continuous: hours)	[3] [19] [20] [21] [22] [23] [28] [31]
Duration (categorical/ordinal)	[4] [24: 10min increments]
Frequency (i.e. sessions/wk)	[4] [6] [7] [9] [12] [14] [15] [18] [24] [26] [27] [31]
Intensity/activity (e.g. moderate/intense/strenuous)	[8] [9] [10] [12] [14] [16] [19] [20] [21] [22] [23] [28] [31]
Single item (multi-level cetegorical response)	[1] [2] [11] [16] [18] [30]
Single item (dichotomous response)	[13] [25: 4 levels, combine intensity, frequency, duration]
Standardized/preiously validated intrument/physical activity index (e.g. IPAQ; MET index)	[5] [7] [8] [10] [12] [14] [15] [19] [20] [21] [23] [28] [31]
LTPA Conceptualisation	
Continuous LTPA h/wk (mean)	[3]
Continuous MET-h/wk (mean)	[19]
Continuous LTPA energy expenditure kCal/kg per day (log Mean)	[26] [27]
Continuous exercise sessions/wk (mean)	[15]
2 ordinal categories (no LTPA; vs. ≥1x 20m/wk rigerous LTPA session)	[4]
2 ordinal categories (no LTPA; vs. >none in last 12 months)	[13]
2 ordinal categories (“lack of exercise” <1x session/wk; vs. others)	[18]
2 ordinal categories (“inactive” ≤4h/wk low-intensity or <2h/wk intense LTPA; vs. “active” >4h/wk low-intensity or ≥2h/wk intense LTPA)	[2]
2 ordinal categories (occasionally or never [no LTPA]; vs. 2 or 3 sessions/week or daily [yes LTPA]	[11]
2 ordinal categories (low <1x 30m/wk of “moderate” LTPA; vs. others)	[30]
2 ordinal categories (low <2h/wk LTPA; vs. ≥2h/wk LTPA)	[24]
2 ordinal categories (“sufficient” ≥30m/day ≥5days/wk; vs. below recommended)	[12]
2 ordinal categories (“sufficient” ≥150m/wk of moderate or ≥75m/wk vigorous, or equivalent combination; vs. below reccomended)	[10]
2 ordinal categories (“sufficient” ≥150m/wk of aerobic; vs. below recommended)	[7]
2 ordinal categories (“sufficient” ≥2 days/wk of muscle-strengthening; vs. below recommended)	[7]
2 ordinal categories (“active” ≥5 x sessions/wk of moderate LTPA or ≥3 sessions/wk of vigorous LTPA; vs. others)	[9]
2 ordinal categories (“active” LTPA >30 MET-h/wk; vs. others)	[23]
2 ordinal categories (“regular” LTPA [top 10th percentile for LTPA index]; vs. others)	[5]
2 ordinal categories (“inactive” LTPA [no LTPA reported]; vs. others)	[6] [25: definition 1]
2 ordinal categories (“inactive”<14 MET-h/wk LTPA; vs. others)	[21]
2 ordinal categories (“inactive”<2 MET-h/day LTPA; vs. others)	[20]
2 ordinal categories (“inactive”≤1h/wk LTPA; vs. others)	[22]
2 ordinal categories (“inactive” lowest quintile of LTPA; vs. others)	[22: different sources]
2 ordinal categories (“sedentarty” LTPA; > “sedendary” LTPA)	[1]
2 ordinal categories (from tertiles: low, intermediate, high) – high group compared to others	[28]
3 ordinal categories (low ≤1x ≥30m/wk; moderate 1x ≥30m/wk; high ≥2x ≥30m/wk)	[31]
3 ordinal categories frequency (none; “some” 1-149m/wk; “sufficient” ≥150m/wk)	[8] [14]
3 ordinal categories (none, some, sufficient)	
3 ordinal categories (4 participant interpreted grades: 1 (sedentary) to 4 (regular strenuous LTPA) [grades 3 and 4 combined]	[16]
4 ordinal categories (high inactivity = no LTPA; lowest inactvity = intense LTPA = ≥3x 20min/wk)	[25: definition 2]

Variable	Count [Reference #]
LTPA measurement features	
LTPA vs. LTP-Inactivity	
Framed as physical activity	[1] [3] [5] [6] [7] [9] [11] [12] [13] [15] [16] [19] [23] [26] [27] [28] [30] [31] (6, 11, 12, 30: but operationalised as inactivity)
Framed as physical **in**activity	[2] [8] [10] [14] [20] [21] [22] [25]
Framed as sedentary behaviour (physical **in**activity)	[4] [18] [24]
Relevant LTPA time period	
Not reported	[1] [2] [5] [6] [8] [9] [10] [11] [12] [14] [15] [16] [18] [19] [20] [21] [22] [25] [28] [30] [31]
At “present time”	[24]
Past 4 weeks/month	[3] [7]
Over previous 3 months	[26] [27]
Over previous 6 months	[4]
Over previous 12 months	[13] [23]

Variable	Count [Reference #]
Diet measurement features (based on information reported in article)	
Diet Survey design (all self-report questionnaires)	
Unclear	[22]
1-2 self-report questions (e.g. 1. fruit, 2. vegetable)	[6] [8] [13]
18 item food-frequency questionnaire (FFQ)	[15]
22 item food-frequency questionnaire (FFQ)	[23]
30 item food-frequency questionnaire (FFQ)	[28]
31 item food-frequency questionnaire (FFQ)	[17]
178 item food-frequency questionnaire (FFQ)	[29]
Diet Conceptualisation	
Fruit and vegetable consumption (frequency)	[6] [8] [13] [22: plus bread & milk choices] [23] [29]
“Healthy” vs. “unhealthy” diet	[22] [23]
Diet pattern: vegetable; meat; Western	[28]
Calories from fat (kcal/kJ)	[15]
Total energy intake (kcal/kJ)	[17]
Micronututrients (g) [inc grams of dietary fat]	[17]
Relevant diet time period	
Not reported	[6] [8] [13] [15] [22] [28]
Past 4 weeks/month	[23]
Over previous 3 months	
Over previous 6 months	
Over previous 12 months	[17] [29]

Most Salient Findings from each Paper in Systematic Review

JDCS Variables	Unisex vs. Sex-Specific Evidence	LTPA Adverse Indication	LTPA Beneficial Indication	No Sig (p<.05) LTPA Indication	Diet Adverse Indication	Diet Beneficial Indication	No Sig (p<.05) Diet Indication
Job strain (present /higher)	**Unisex**	[11] [21] [31]	[3] (3: non-whites only)	[28] (all JDC)	[28] (vegetables)		[29] (fruit/veg)
	Men only			[24] (all JDC)	[17] (diet fat)		
	Women only			[18] (all JDCS)			
Job strain (absent /lower)	**Unisex**		[31]				
	Men only						
	Women only						
Iso-strain (presence)	**Unisex**	[6]			[6] (fruit/veg)		[29] (fruit/veg)
	Men only						
	Women only						
Higher job **demands** (individual)	**Unisex**	[7] [8] [21] [31]					[8] (fruit/veg)
	Men only				[15] (kcal fat)		
	Women only	[4] [20]					
Lower job **demands** (individual)	**Unisex**						
	Men only						
	Women only		[31]				
Higher job **control** (individual)	**Unisex**		[3] [9] [11] [15] [26]				
	Men only		[16] [31]				
	Women only						
Lower job **control** (individual)	**Unisex**	[2] [8] [10] [14] [19] [20] [21] [27] [31]			[28] (vegetables)		[8] (fruit/veg)
	Men only	[4]					
	Women only						
Higher job **support** (individual)	**Unisex**						
	Men only		[16]				
	Women only						
Lower job **support** (individual)	**Unisex**				[17] (kcal)		
	Men only						
	Women only						
Higher job ***coworker support*** (individual)	**Unisex**		[11]				
	Men only						
	Women only			[18]			
Lower job ***coworker support*** (individual)	**Unisex**						
	Men only						
	Women only						
Higher job ***supervis. support*** (individual)	**Unisex**		[11]				
	Men only						
	Women only			[18]			
Lower job ***supervis. support*** (individual)	**Unisex**						
	Men only						
	Women only						
Low strain (job strain group)	**Unisex**		[9]				
	Men only		[5]			[15] (kcal fat)	
	Women only		[23]			[23] (“healthy”)	
Active job (job strain group)	**Unisex**	[20] [25]	[9]				
	Men only	[19]	[5]				
	Women only		[15]			[23] (“healthy”)	
Passive job (job strain group)	**Unisex**	[7] [14] [19] [20] [25]					
	Men only	[4] [12] [15] [22: UK] [30]			[22: UK] (“unhealthy”)		
	Women only	[22: Finnish]					
High strain (job strain group)	**Unisex**	[1] [8] [14] [19] [20] [25]		[13]			[8] [13] (fruit/veg)
	Men only	[4] [22: UK] [30]					
	Women only	[22: Finnish]					[15] (kcal fat)

CHAPTER 4. PAPER THREE

4.1 Preamble

The second study provided a comprehensive summary of the methodology and findings of previously published literature examining the potential associations between psychosocial work factors within the Job Demand-Control(-Support) (JDC[S]) model and two important energy balance-related behaviours: leisure-time physical activity (LTPA) and habitual diet. This review found the most support for a negative association between various conceptualisations of work stress within the JDC(S) model and LTPA. There was particularly strong support to suggest lower levels of job control were associated with lower LTPA. Only a small number of studies reported dietary outcomes; while there was some support to suggest an association between unfavourable psychosocial work factors and poor diet, the small quantity of studies prevented the drawing of strong conclusions with regards to diet. As such, the review identified the important need for more studies to report diet outcomes, and it was suggested that reporting of dietary energy intake would be especially useful, since this would be compatible with the perspective of the positive energy balance hypothesis. Collectively, the findings of the review generally endorsed the utility of considering the broad JDC(S) constructs individually, rather than global measures of job strain. Despite the particular salience regarding the importance of job control in the findings, no studies meeting the review criteria had considered the potential for its two components – skill discretion and decision authority – to hold differential associations with either LTPA or diet. This observation, paired with the novel observations of study one – where these subscales appeared to hold differential associations with measures of obesity – formed the rationale for the following study, along with a number of other recommendations identified. As such, the following study uses a methodology that is similar to study one, however now the variables of interest are LTPA and dietary energy intake (kJ/day).

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

- MANUSCRIPT UNDER REVIEW FOR PUBLICATION -

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4.2 Statement of Authorship

Title of Paper	Unique associations of the Job Demand-Control-Support model subscales with leisure-time physical activity and dietary energy intake.
Publication Status	☐ Published ☐ Accepted for Publication ☑ Submitted for Publication ☐ Unpublished and Unsubmitted w ork w ritten in manuscript style
Publication Details	Bean, C. G., Winefield, H. R., Hutchinson, A. D., Sargent, C., & Shi, Z. (2016). Unique associations of the Job Demand-Control-Support model subscales with leisure-time physical activity and dietary energy intake. *Manuscript submitted for publication, University of Adelaide, Australia*.

Principal Author

Name of Principal Author (Candidate)	Christopher G. Bean		
Contribution to the Paper	Responsible for the primary authorship of this paper, and collaborated with co-authors in its conceptualisation and design. Conducted all statistical analyses, and took the lead role in interpreting the results, and writing and revising the manuscript. Served as corresponding author and responsible for manuscript submission, revisions, and responses to journal reviews.		
Overall percentage (%)	80%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Helen R. Winefield		
Contribution to the Paper	Supervised the research that led to this publication, facilitated access to the dataset used for analyses, and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Amanda D. Hutchinson		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Charli Sargent		
Contribution to the Paper	Supervised the research that led to this publication and engaged in ongoing collaboration with the primary author. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

Name of Co-Author	Zumin Shi		
Contribution to the Paper	Facilitated access to dietary data. Provided feedback on manuscript drafts, making suggestions on methodology, presentation of material, and editorial input.		
Overall percentage (%)	5%		
Signature		Date	

4.3 Paper Three

Abstract

Emerging evidence suggests that evaluating associations between health outcomes and components of the Job Demand-Control-Support (JDCS) model at the subscale level may reveal unique associations, otherwise concealed when JDCS constructs are reduced to composite or global scores. Leisure-time physical activity (LTPA) and dietary energy intake are two important health behaviours, which at too low or high levels respectively, can induce a positive energy balance associated with overweight and obesity. This study explores potential associations between subscales of the JDCS model and both 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 multinomial logistic regression analyses adjusted for sex, age, and sociodemographic variables, higher levels of skill discretion were associated with a more than two-fold increased likelihood for attaining sufficient activity, in two LTPA definitions: definition 1 (OR = 2.19; 95% CI = 1.00-4.79) and definition 2 (OR = 2.45; 95% CI = 1.10-5.47). Higher levels of decision authority were associated with a less than half likelihood (OR = 0.43; 95% CI = 0.20-0.93) for being in the highest tertile of daily energy intake (kJ/day). Above median scores for coworker support were associated with a more than two-fold increased likelihood (OR = 2.20; 95% CI = 1.15-4.23) for being in the highest tertile of daily energy intake (kJ/day). These findings support individual consideration of the JDCS subscales, since this practice may reveal novel associations with health outcomes – presenting new opportunities to improve employee health and wellbeing.

Keywords: energy intake; diet; job demand-control-support model; leisure-time physical activity; obesity

Introduction

High prevalence of overweight and obesity is a global phenomenon, and Australia has some of the highest recorded levels (Flegal et al., 2012; Ng et al., 2014). National health survey data, collected between 2014-15, indicates 63.4% of Australian adults (aged ≥18 years) are overweight (body mass index; BMI 25.00 - 29.99) or obese (BMI ≥30); comprised of 35.5% overweight and 27.9% obese respectively (Australian Bureau of Statistics, 2015a). The concern is especially salient for Australian men – of whom 70.8% are overweight or obese, compared to 56.3% of Australian women (Australian Bureau of Statistics, 2015a).

There are a number of theories relating to the interactive biopsychosocial factors implicated in the development and maintenance of overweight and obesity (Bray, 2004; Butland et al., 2007; Finegood et al., 2010; Keith et al., 2006; Kumanyika, 2001; McAllister et al., 2009). The energy balance hypothesis, specifically positive energy balance, continues to be generally accepted as the biological mechanism that accounts for most overweight and obesity (World Health Organization, 2016a). This concept describes the relationship between a person's total dietary energy intake (i.e., foods and beverages consumed) and total energy expenditure from daily functioning (e.g., basal metabolism and thermogenesis) and physical activity (Faith & Kral, 2006; McArdle, 2007; World Health Organization, 2016a). A positive energy balance, leading to excess weight gain and maintenance, occurs when energy intake is greater than energy expenditure over a sustained period of time; the nature of the positive energy balance may be related to either excess energy intake (e.g., consuming too much), or insufficient expenditure (e.g., moving too little), or a combination of these behaviours (World Health Organization, 2016a). Physical activity is the most important determinant of between-person variance in total energy expenditure (Hu, 2013). The nature of physical activity may be broadly classified into categories such as occupational (e.g., related to a person's job) and leisure-time (e.g., exercise or recreation) (Ainsworth et al., 2000).

Leisure-time physical activity (LTPA) is a useful construct since recognised guidelines outlining sufficiency have been published, and it may also be more easily modifiable than other types such as occupational physical activity, which may be limited by job nature or other constraints (Martins & Lopes, 2013). The World Health Organization (2016b) recommends ≥150 minutes (or ≥75 minutes vigorous intensity, or equivalent combination) of LTPA per week for adults. Similarly, the National Physical Activity Guidelines for Australian adults (Australian Institute of Health and Welfare, 2003) recommend the same amount, with the added stipulation that this is spread over at least five sessions. Previous research suggests both insufficient LTPA (Montgomerie, Chittleborough, & Taylor, 2014) and excess dietary energy intake (Swinburn et al., 2009) are associated with increased risk of overweight and obesity. However, the relative importance of insufficient LTPA vs. excess dietary intake, thought to underpin the high prevalence of overweight and obesity, remains inconclusive (Millward, 2013; Prentice & Jebb, 1995, 2004; Swinburn, 2013; Swinburn, Caterson, Seidell, & James, 2004).

The positive energy balance hypothesis is useful to explain *how* people generally gain and maintain excess weight, but it does little to explain *why* individuals may engage in the implicated maladaptive health behaviours of insufficient physical activity and/or excess dietary energy intake. There have been a number of attempts to contextualise these health behaviours and the comprehensive models produced (e.g., the UK Government Obesity Foresight report) effectively demonstrate the multifarious nature of potential aetiological pathways for overweight and obesity (Butland et al., 2007). While it is important to recognise that a myriad of complex, putative causal factors exist within the ecological context, researchers can still contribute to increased understanding of the phenomenon through consideration of more distinct 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 (Gordon & Schnall, 2009; Karasek & Theorell, 1990; Winefield, 2013). 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 years (Daniels et al., 2014; Macik-Frey et al., 2007; Maslach et al., 2001; Van der Doef & Maes, 1999).

The most widely tested model of work stress is the Job Demand-Control (JDC) model, or in its extended form the Job Demand-Control-Support (JDCS) model (Eller et al., 2009; Karasek, 1979; Nyberg et al., 2012). The JDC model features two core components: 'job demands' and 'job control' (Karasek, 1979). Job demands are primarily related to expending psychological effort related to workload, organisational constraints on task completion, and conflicting demands (Karasek et al., 1998). 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 quantity of decisions entailed in their work (De Araújo & Karasek, 2008; Karasek et al., 1998). 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. However, lack of demands may be associated with unstimulating work, which may also be harmful (Gimeno et al., 2009). The addition of social support (two subscales: 'coworker support' and 'supervisor support') provides a third broad dimension to the model (i.e., JDCS) (Johnson and Hall, 1988), and is a recognised extension (Brough & Pears, 2004; Karasek & Theorell, 1990). In the work context, support refers to levels of helpful social interaction available on the job, received from coworkers and/or supervisors (Karasek & Theorell, 1990). Higher levels of social support are proposed to work in a similar way to higher levels of job control, which is to increase efficacy and help mitigate the effects of high job demands.

Despite the common use of the JDC(S) model, there is considerable inconsistency between studies in the treatment and analysis of the JDC(S) model variables. A potential reflection of these differing approaches, mixed findings are common in previous research pertaining to the potential associations between health behaviours and work stress (Hellerstedt & Jeffery, 1997; LaMontagne, 2012; Siegrist & Rödel, 2006; Smith & LaMontagne, 2015). Most researchers combine skill discretion and decision authority, and coworker and supervisor support, into the respective job control and 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' (e.g., sometimes a quotient or ratio of job demands to control, other times by subtracting job control from demands), or four categorical job strain groups (i.e., low strain, passive, active, and high strain) (Courvoisier & Perneger, 2010). While, the homonymous job strain and job strain groups are traditionally the most prevalent operationalisations of the JDC(S) model, there is increasing consideration for the value of assessing the individual JDCS constructs separately.

More specific than the individual JDCS components, there may be additional value in consideration of the subscales of the two divisible constructs: support (i.e., coworker and supervisor support), and particularly job control (i.e., skill discretion and decision authority) (Bean et al., 2015; De Jonge, Reuvers, et al., 2000; Joensuu et al., 2012a; Mansell & Brough, 2005). 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 (Joensuu et al., 2012b). In a previous study of the present sample, sex and age adjusted analyses suggested higher levels of skill discretion were associated with reduced indicators of obesity (i.e., smaller BMI and waist circumference), while higher levels of decision authority were associated with increased indicators of obesity (i.e., larger waist circumference) (Bean et al., 2015). These findings suggest considering the JDCS model constructs at the subscale level may be worthwhile and improve understanding by identifying more subtle relationships between psychosocial work factors and health outcomes.

In addition to matters related to the treatment of the JDC(S) variables, it has been suggested that the vast spatiotemporal distance between work stress and many disease outcomes (i.e., distal outcomes), could infer weaker associations than those that may be observed in the study of more proximal factors – such as lifestyle-related health behaviours, which may foreshadow disease outcomes (Lallukka et al., 2008; Theorell, 2014). For example, elevated BMI is often used to indicate overweight or obesity, or as a proxy for low physical activity and unhealthy diet. However, weight gain and consequent increases in BMI occur over time – as such, overweight or obesity status as indicated by elevated BMI, is a distal outcome, since there is a time lag between implicated health behaviours and weight gain (Hutchinson & Wilson, 2012; LaMontagne, 2012). An alternative and more intricate approach may be to consider more proximal, and theoretically mediating variables, such as LTPA and habitual diet, which are likely to be more immediate or sensitive indicators of the potential long-term influences of work stress on overweight or obesity (Hutchinson & Wilson, 2012).

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. (2012a) 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. (2014) 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 these 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 (Artazcoz, Borrell, Cortès, Escribà-Agüir, & Cascant, 2007; Evans & Steptoe, 2002). Furthermore, increasing age is often associated with reduced physical activity, as well as changes in diet and increased weight (Chodzko-Zajko et al., 2009; Tchernof & Després, 2013). 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 (NHMRC, 2006). 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 (Choi et al., 2010a).

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/day) for both men and women (i.e., higher support, higher dietary energy intake) (Kawakami et al., 2006). The latter is surprising since higher levels of stress are generally thought to increase dietary intake (Adam & Epel, 2007), while higher levels of support are generally thought to alleviate work stress.

There is an exigent need for more research in relation to work stress and diet; in particular, studies that include measurement of total dietary energy intake would be especially useful and compatible with the perspective of the positive energy balance hypothesis (Bean, Hutchinson, Winefield, & Sargent, 2016; Stewart-Knox, 2014). Furthermore, including a credentialed operationalisation of LTPA would allow exploration of potential associations between psychosocial work factors and both energy intake and expenditure (Bean et al., 2016; Bean et al., 2015). Finally, it is important that such studies 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/day).

Method

Sample and Procedure

The present study employed a cross-sectional design using a sub-sample drawn 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. Diet 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 years (*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 years. Many participants reported considerably longer service than this minimum; the mean time with current workplace was 16.10 years (min = 4, max = 46, *SD* = 9.48).

Sampling and data collection processes related to the NWAHS involved random selection from the northern and western suburbs of Adelaide, South Australia, using the Electronic White Pages telephone directory, as detailed previously (Grant et al., 2006; Grant et al., 2009). 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 years, 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 (Australian Institute of Health and Welfare, 2003) to capture data on type, intensity, frequency, and duration of LTPA over the past week. Questions enquired about low intensity (e.g., walking continuously for at least 10 minutes), 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 (Brown, Burton, Marshall, & Miller, 2008; Brown, Trost, Bauman, Mummery, & Owen, 2004).

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 (Australian Institute of Health and Welfare, 2003). For the first definition, 'sufficient activity' was defined as ≥150 minutes (or ≥75 minutes 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 (2016b). 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 (Australian Institute of Health and Welfare, 2003). Distribution between LTPA groups for each definition is provided in Table 1.

Daily energy intake (kJ/day) from diet. A self-completed food frequency questionnaire, the Dietary Questionnaire for Epidemiological Studies (DQES v2) (Giles & Ireland, 1996), was mailed to participants to collect data on habitual diet relating to the previous 12 months. Returned DQES v2 forms were forwarded to Cancer Council Victoria for processing and analyses using the Australian Nutrient Data Table (NUTTAB 95) (National Food Authority, 1995). The 80-item DQES v2 comprises a 74-item food list with 10 frequency response options ranging from *never* to *3 or more times per day*, as well as a section covering intake of six types of alcoholic beverages with 10 frequency response options ranging from *never* to *every day*. The DQES v2 covers four food type categories: (i) cereal foods, sweets and snacks, (ii) dairy products, fish and milk, (iii) fruit, and (iv) vegetables. 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) (Giles & Ireland, 1996).

The DQES v2 was developed specifically for measuring dietary intake in Australian adults (Giles & Ireland, 1996), and has demonstrated validity (Hodge, Patterson, Brown, Ireland, & Giles, 2000; Xinying, Noakes, & Keogh, 2004), despite limitations characteristic of all food frequency questionnaires (Willett, 2013). For the present study, the dietary variable of interest is the estimated daily energy intake from diet, expressed as total kilojoules per day (kJ/day), including energy from fibre and alcoholic beverages. Distribution between sex-specific tertiles of kJ/day are provided in Table 1, while properties of the continuous kJ/day variable are provided in Table 2.

Psychosocial work factors. A follow-up CATI included items from the Job Content Questionnaire (JCQ) (Karasek et al., 1998) 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 (Courvoisier & Perneger, 2010; Karasek et al., 1998), with established reliability and validity (De Araújo & Karasek, 2008; Karasek et al., 1998). The present study utilised a 35-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 (Karasek, 1985). Psychometric properties of the resulting JDCS subscales used in analyses, including internal reliability estimates, are provided in Table 2.

Anthropometric measurements. Participant height, weight, and waist circumference were measured by clinic staff using standardised protocols and were recorded as continuous variables (see Table 2). Waist circumference and BMI (weight/height^2) were the variables of interest in a previous study (Bean et al., 2015), and are provided here to illustrate the representativeness of the sample.

Analyses

Continuous daily energy intake (kJ/day) 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 (NHMRC, 2006). 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/day) 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 + [1.5xIQR]) were determined as values ≥15,170kJ/day, and lower outliers (≤Q1 - [1.5xIQR) were determined as values ≤3,034kJ/day. For women, upper outliers (≥Q3 + [1.5xIQR]) were determined as values ≥13,411kJ/day, and lower outliers (≤Q1 - [1.5xIQR) were determined as ≤2,680kJ/day. 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/day) 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/day, 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-text. 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 years) employees. Consistent with national prevalence (Australian Bureau of Statistics, 2015a), and indicative of the representativeness of the sample, the majority of participants (both men and women) were overweight or obese (mean BMI = 28.32kg/m^2). Employees were classified as either blue or white-collar using the Australian and New Zealand Standard Classification of Occupations (ANZSCO) (Australian Bureau of Statistics, 2009). 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 hours) compared to women (mean = 33.81 hours), 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: Whole Sample

Levels of LTPA were comparable between men and women for both LTPA definition 1 ('sufficient activity' defined as ≥150 minutes per week of LTPA) and definition 2 ('sufficient activity' defined as ≥150 minutes per week, over ≥5 sessions) (see 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 than twice as 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 almost four times 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 almost three times as likely in LTPA 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 an approximately three times 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 a similar greater likelihood in LTPA 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 (years) 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 LTPA definition 2 (OR = 0.96; 95% CI = 0.92-0.99). This equates to about a 4% reduction in likelihood of being in the ‘sufficient activity’ group (compared to ‘no activity’ group) for each year increase in age. Employees with higher age (years) 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). This equates to about a 5% reduction for likelihood of being in the ‘activity but not sufficient’ group (compared to ‘no activity’ group) for each year increase in age. The addition of sex and age in Model 2, amplified the ORs for the associations between skill discretion and LTPA observed in crude analyses (see Model 2 in 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 (see 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 = .015; and definition 2, χ^2 (26, N = 433) = 40.99, p = .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).

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 (years) 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 LTPA definition 2 (OR = 0.92; 95% CI = 0.87-0.98). Male employees with higher age (years) 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 LTPA 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 LTPA 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 LTPA 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 LTPA 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 LTPA 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 = .003; and definition 2, χ^2 (24, N = 213) = 46.74, p = .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 (hours per week) 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 = .460; or definition 2, χ^2 (24, N = 220) = 23.13, p = .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/day) from Diet: Whole Sample

Men reported higher daily energy intake on average compared to women (see Table 2). The creation of sex-specific tertiles (low, middle, high kJ/day) 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/day 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/day’ 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/day) 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/day) from diet. Employees reporting scores in the highest tertile of decision authority (compared to the lowest tertile) had an approximately 65% reduced likelihood (OR = 0.35; 95% CI = 0.16-0.73) of being in the ‘high kJ/day’ tertile (compared to ‘low kJ/day’ tertile). A positive association was observed between coworker support and daily energy intake (kJ/day) from diet. Employees reporting above median scores for coworker support were more than twice as likely (OR = 2.25; 95% CI = 1.19-4.25) to be in the ‘high kJ/day’ tertile (compared to ‘low kJ/day’ tertile).

In sex and age adjusted analyses (Model 2; Table 5), considering that the kJ/day tertiles were sex-specific, neither sex nor age appeared to be directly associated with daily energy intake (kJ/day) 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/day) from diet and decision authority, and coworker support (see 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 (hours per week), 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/day) from diet, and the associations previously noted in Models 1 and 2 (Table 5) remained significant in this final model (see 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 than twice as likely (OR = 2.17; 95% CI = 1.28-3.67) to be in the 'high kJ/day' tertile (compared to 'low kJ/day' tertile). Model 3 (Table 5) also suggested a potentially curvilinear association between skill discretion and daily energy intake (kJ/day) 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/day' tertile (compared to 'low kJ/day' tertile). The final model for daily energy intake (kJ/day) from diet was statistically significant, χ^2 (26, N = 409) = 44.92, p = .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/day) from diet.

Additional analyses were conducted to explore the possibility of sex differences in the associations with daily energy intake (kJ/day) 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/day) from diet, for men (n = 205) and women (n = 204).

Daily Energy Intake (kJ/day) 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/day’ tertile (compared to ‘low kJ/day’ 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/day’ tertile (compared to ‘low kJ/day’ tertile). However, the model fit for male-specific analyses was not significant for daily energy intake (kJ/day) from diet, χ^2 (24, N = 205) = 22.97, p = .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/day) from Diet: Female-Specific Analyses

For women, none of the associations with daily energy intake (kJ/day) from diet observed in unisex analyses remained statistically significant (p <.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/day’ tertile (compared to ‘low kJ/day’ tertile). Furthermore, a negative association was observed between daily energy intake (kJ/day) from diet and work hours (hours per week), 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/day’ tertile (compared to ‘low kJ/day’ tertile). This indicates an approximately 3% reduction for likelihood of being in the ‘high kJ/day’ tertile (compared to ‘low kJ/day’ tertile) for each additional hour worked per week for female employees. The model fit for female-specific analyses was significant for daily energy intake (kJ/day) from diet, χ^2 (24, N = 204) = 41.77, p = .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/day) from diet for women.

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/day) [Tertiles[a]]				
Low [T1: Men ≤8097, Women ≤7080]	136 (33.3%)	68 (33.2%)	68 (33.3%)	
Middle [T2: Men 8098-9901, Women 7081-8618]	137 (33.5%)	69 (33.7%)	68 (33.3%)	
High [T3: Men ≥9902, Women ≥8619]	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 [≥150min/week]	219 (50.6%)	109 (51.2%)	110 (50.0%)	.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 [≥150min/week, ≥5 sessions]	176 (40.6%)	81 (38.0%)	95 (43.2%)	.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%)	<.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%)	.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%)	.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%)	.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%)	.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%)	<.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%)	.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%)	<.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%)	<.001***

Note. 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 2x2 table. **p* <.05. ***p* <.01. ****p* ≤.001.

Table 2 *Summary of Continuous Variables*

	Whole Sample (N = 433)				Male (n = 213)		Female (n = 220)		Sex Differences[b]
		Range							
Variable	*M (SD)*	Potential	Actual	α	*M (SD)*	Range	*M (SD)*	Range	Sig. *(p)*
Daily Energy Intake (kJ/day)	8,475 (2,275)	–	3,098-15,005	–	9,006 (2,361)	3,516-15,005	7,942 (2,056)	3,098-13,235	<.001***
Age (years)	47.69 (7.97)	–	28-63	–	46.92 (8.42)	28-62	48.44 (7.45)	29-63	.046*
Work Hours (per week)[a]	37.41 (11.40)	–	0-86	–	41.13 (7.70)	0-65	33.81 (13.14)	0-86	<.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	<.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	.729
Psychological Demands	32.37 (5.60)	12-48	15-48	.64 (5 items)	31.50 (5.16)	15-48	33.21 (5.89)	17-48	.001***
Skill Discretion	35.20 (5.17)	12-48	18-48	.74 (6 items)	34.89 (5.12)	18-48	35.49 (5.22)	22-48	.229
Decision Authority	35.38 (6.27)	12-48	12-48	.71 (3 items)	35.89 (6.30)	12-48	34.89 (6.21)	12-48	.098
Coworker Support	9.68 (1.29)	3-12	6-12	.85 (3 items)	9.59 (1.15)	7-12	9.77 (1.40)	6-12	.152
Supervisor Support	9.18 (1.62)	3-12	3-12	.80 (3 items)	9.09 (1.50)	3-12	9.27 (1.72)	3-12	.237

Note. [a] Average hours worked per week in main job over past month. [b] Difference between means for men and women. **p* <.05. ***p* <.01. ****p* ≤.001.

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 (≥150min/week)	Activity But Not Sufficient	Sufficient Activity (≥150min/week)	Activity But Not Sufficient	Sufficient Activity (≥150min/week)
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 (years)			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 week)					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]

Note. Reference category: No Activity. *p <.05. **p <.01. ***p ≤.001.

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 (≥150min/week, over ≥5 sessions)	Activity But Not Sufficient	Sufficient Activity (≥150min/week, over ≥5 sessions)	Activity But Not Sufficient	Sufficient Activity (≥150min/week, 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 (years)			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 week)					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]

Note. Reference category: No Activity. **p* <.05. ***p* <.01. ****p* ≤.001.

Table 5 *Crude and Adjusted Odds Ratios [95% Confidence Intervals] for the Association between Sex-Specific Tertiles of Daily Energy Intake (kJ/day) from Diet and Psychosocial Work Factors (N = 409)*

Variable	Model 1		Model 2		Model 3	
	Middle kJ/day (Tertile 2)	High kJ/day (Tertile 3)	Middle kJ/day (Tertile 2)	High kJ/day (Tertile 3)	Middle kJ/day (Tertile 2)	High kJ/day (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 (years)			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 week)					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]

Note. Reference category: Low kJ/day (Tertile 1). **p* <.05. ***p* <.01. ****p* ≤.001.

Discussion

This study comprised a finer, subscale level consideration of the JDCS model in relation to two proximal health behaviours, LTPA and dietary energy intake (kJ/day), 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 that 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/day). 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 broad 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 (Kivimäki et al., 2015; Nyberg et al., 2012).

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 indicators of obesity (i.e., higher levels of skill discretion, smaller BMI and waist circumference) (Bean et al., 2015). 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/day). Instead, results of the present study suggest high levels of decision authority are strongly associated with dietary energy intake (kJ/day). 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 and age, as well as after controlling for additional sociodemographic variables of 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 (Joensuu et al., 2012b). 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) (Bean et al., 2015). 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/day) 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/day' tertile). This association persisted after controlling for the effects of sex and age, as well as after controlling for additional sociodemographic variables of 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 (André-Petersson, Engström, Hedblad, Janzon, & Rosvall, 2007; De Bacquer et al., 2005; Eller et al., 2009), a similar finding was reported by Kawakami et al. (2006), 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. (2006) 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, since stratifying our sample by sex effectively halved the respective sample sizes.

Observations in the present study validate the importance of controlling for the effects of sex and age in investigations of this nature. Age was associated with increased risk of lower LTPA, with each year increase in age associated with an approximately 5% and 4% reduced likelihood of being in the 'activity but not sufficient' or 'sufficient activity' groups, respectively (compared to 'no activity' group) for both LTPA definitions used. While this may seem like a relatively small difference, a 10-year age gap between employees would equate on average to an approximately 50% and 40% reduced likelihood of being in the 'activity but not sufficient' or 'sufficient activity' groups, respectively (compared to 'no activity' group). 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/day) in the present sample. With regards to sex differences, additional sex-stratified analyses reported in-text 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 (Artazcoz et al., 2007; Evans & Steptoe, 2002). There was some indication of this in the present study, wherein women were more likely to report higher psychological demands in their work, 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, as this allowed exploration of potential associations between psychosocial work factors and both energy intake and expenditure (Bean et al., 2016; Bean et al., 2015). 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 and age, as well as 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. Furthermore, since both LTPA and dietary energy intake are complex behaviours that are difficult to measure, it is important to acknowledge the potential for measurement error, and how this may be reduced in future studies. While the use of previously validated measures of LTPA is a strength of the present study, all such self-report instruments are susceptible to reporting bias. To reduce the potential for measurement error in future studies, self-reported outcomes may be verified with more objective data recorded using electronic activity trackers (e.g. pedometer data) (Appelboom et al., 2014; Diaz et al., 2015).

The dietary energy intake (kJ/day) values for participants in the present study suggest under-reporting of dietary intake may have occurred. Men reported higher daily energy intake (mean = 9,006kJ/day) compared to women (mean = 7,942kJ/day) (see 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/day) and women (8,700kJ/day) of typical height with a healthy BMI (22.0 kg/m^2) and mostly sedentary activity levels (ABS, 2012; NHMRC, 2006). Such under-reporting is common when using food frequency questionnaires (Willett, 2013), and overweight or obese persons may be more likely to under-report (Heitmann & Lissner, 1995). 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. While under-reporting of energy intake may partly account for the lower than expected kJ/day values, another explanation may be a limitation of the food frequency questionnaire used in the present study, as the DQES v2 does not measure soft drink consumption. This is a key limitation, since a common response to elevated stress is increased consumption of highly palatable (e.g., sweet) foods and beverages (Adam & Epel, 2007), such as sugary soft drinks (also known as 'soda' or 'sugar-sweetened beverages', e.g., cola). Soft drink consumption is popular in Australia, with national health survey data, collected between 2011-12, indicating around one-third of Australian adults (aged ≥19 years) consumed sugar sweetened beverages in the previous day (Australian Bureau of Statistics, 2015b). Men and younger adults are also more likely to consume higher quantities of soft drinks (Pollard et al., 2016). To facilitate a more comprehensive exploration of the associations between psychosocial work factors and dietary energy intake, future research would benefit from using a food frequency questionnaire that does include measurement of soft drink consumption, such as the updated DQES V3.2 (Cancer Council Victoria, 2016).

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/day), 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) (Mozaffarian, Hao, Rimm, Willett, & Hu, 2011). 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 (Mozaffarian et al., 2011). 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 unique associations with two important health behaviours: LTPA and dietary energy intake (kJ/day), 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) (Bean et al., 2015), suggests interventions to increase skill discretion may result in increased LTPA (proximal factor), and in time reduced 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 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/day) 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. Somewhat surprisingly, coworker support was positively associated with dietary energy intake (kJ/day) (i.e., higher levels of coworker support, increased likelihood of being in high kJ/day 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 (Kawakami et al., 2006).

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 suggested relationships between JDCS model components, LTPA and dietary energy intake (kJ/day) 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 larger sample size may be more sufficiently 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 subscales enables the evaluation of more intricate relationships and could uncover uncharted opportunities to improve employee health and wellbeing.

CHAPTER 5: CONCLUSION

5.1 Overview

The distinct aims stated in the individual sections of this thesis were ultimately interfolded. The overall aim was to provide a clearer understanding of how the psychosocial work environment may be associated with overweight and obesity. The introductory chapter served to describe the nature of overweight and obesity, and the importance of increasing our understanding of this phenomenon so that the high prevalence of these conditions may be reduced. The specific distinctions between overweight and obesity were noted in Section 1.2.1, but it was also noted that this distinction is somewhat arbitrary since: (a) there is no steep delineation between health and disease at a definite point, and (b) many overweight individuals transition to obesity over time. For this reason, the term 'obesity' is sometimes used more generally to describe various degrees of excess fat accumulation. In study one, the majority of participants were overweight or obese, so instead of using these categories to assign group membership for a categorical variable, analyses were conducted using two continuous measures of obesity (i.e., waist circumference in cm, and body mass index in kg/m^2). The introductory chapter also provided an in-depth consideration of the aetiology of obesity, starting with the basic science of energy balance and energy balance-related behaviours (e.g., diet and physical activity). It was highlighted that while the positive energy balance hypothesis is generally accepted as the biological mechanism for the development and maintenance of most overweight and obesity (i.e., the 'how'), a major limitation of this explanation is that it cannot answer 'why' people engage in the associated maladaptive health behaviours of excess energy intake (i.e., consuming too much), and/or not attaining sufficient physical activity.

Concepts from health psychology and the biopsychosocial model were enlisted in this thesis to assist the contextualisation of energy balance-related behaviours. Furthermore, the focus was tapered to the importance and duality of stress, how stress is conceptualised biologically and psychosocially, and specifically the nature of stress in the workplace. Common approaches to the study of work stress, including psychosocial work factors and notable models of work stress, were then presented. The introductory chapter closed by piecing together gaps in the literature and how these could be explored, leading to the specific aims of the studies that form the main body of this thesis.

Throughout this thesis, particular attention has been given to the most commonly used model of work stress: the Job Demand-Control (JDC) model, or its extended form: the Job Demand-Control-Support (JDCS) model (Johnson & Hall, 1988; Karasek, 1979). In forming the rationale for the original studies that comprise the body of this thesis, it was noted that previous research using this model had produced mixed findings in relation to potential associations with overweight and obesity. One potential explanation for this was the inconsistencies apparent in the different operationalisations of the model components. Generally speaking, much previous research had reduced the model to a broad global score (e.g., 'job strain' present: yes/no), indicated by a combination of high demands (e.g., >median) and low control (e.g., <median), or four job strain groups based on alternate high/low (e.g., >median, <median) combinations of the demand and control scores respectively. Less frequently, the social support component of the model was included, wherein below median workplace support combined with job strain is sometimes used to indicate 'iso-strain' (i.e., socially isolated workers, with high demands and low control). In creating these categories, the sample median is generally used as the cut-point by respective studies, however there is no standardised amount of the broad model components (i.e., 'demands', 'control', and 'support') that is recognised as high or low, so definitions often vary between studies.

Some previous research has considered the potential for the individual broad components (e.g., high demands or low control) to be individually associated with health outcomes, however the potential for subscales of the divisible constructs to hold unique associations with outcomes had received very little attention. Within the JDCS model, 'job demands' generally refer to psychological demands, and this component does not have any subscales. On the other hand, the broad 'job control' and 'support' components each have two subscales: 'skill discretion' and 'decision authority', and 'coworker support' and 'supervisor support', respectively. While the support subscales simply demarcate social support received from coworkers or supervisors, the two job control subscales represent two theoretically distinct concepts. Skill discretion describes the level of skill and creativity required on the job and the flexibility an employee has in deciding what skills to use, whereas decision authority describes the organisationally mediated potential for employees to make decisions about their work, or simply the quantity of decisions entailed in their work (De Araújo & Karasek, 2008; Karasek et al., 1998).

Despite the common practice of combining the two job control subscales into the broad job control construct, a small number of researchers have voiced concerns about this methodology, such as its potential to confound the measurement of job control with the measurement of job complexity (Mansell & Brough, 2005). While higher levels of job control have traditionally been perceived as a broad panacea for high job demands, a small number of previous studies indicate that the two job control subscales may be differentially associated with health outcomes. Joensuu et al. (2012a) found that the two components of job control displayed differential associations with mortality, finding employees with high levels of skill discretion experienced lower all-cause mortality, while high levels of decision authority were associated with elevated risks of all-cause, cardiovascular, and alcohol-related mortality. Joensuu et al. (2012b) suggested that while the benefits of increased decision authority are conceivable when considered in the historical context of growing industrialisation, these benefits are less obvious in the contemporary work environments that feature greater global competition. Joensuu et al. (2012a) also suggested that stress may result from the perception of too much responsibility associated with too high levels of decision authority; in other words, too much decision authority may be perceived as a burden – challenging a long-held assumption that increased job control can mitigate the potentially adverse effects of high job demands (De Jonge, Dollard, et al., 2000). Earlier work by De Jonge, Reuvers, et al. (2000) also suggested differential effects for the two components of job control, but unlike Joensuu et al. (2012a), their results suggest decision authority was negatively associated with psychosomatic health complaints and sickness absence, whereas skill discretion was not a significant predictor. De Jonge, Reuvers, et al. (2000) noted that skill discretion and decision authority exerted opposite effects on these outcome variables, suggesting that the two components should be analysed separately.

At the time of publication, no previous research had considered the potential for the two subscales of job control to hold differential associations with measures of overweight and obesity. As such, the main aim of the first study reported here was to explore potential associations between components of the JDCS model at the subscale level, especially skill discretion and decision authority, with measures of obesity. Furthermore, it was noted that body mass index (BMI; a measure of overall obesity) had been used almost exclusively to indicate overweight or obesity in previous research, despite evidence that waist circumference (a measure of central obesity) may be more sensitive and represent a better indicator of health risks. As such, the second aim of study one was to test the associations using both waist circumference and BMI, thereby providing a comparison of these measures to see which displayed the strongest relationships with the JDCS components. A review of these findings is provided in Section 5.2.1.

Around the same time as the publication of study one, Töres Theorell (2014) described the importance of proximal and distal outcomes in the study of associations between psychosocial work factors and health outcomes. He suggested that the vast spatiotemporal distance between work factors and disease outcomes (i.e., distal outcomes), may produce weaker associations than those that may be observed in the study of more proximal factors – that is, more immediate indicators such as lifestyle-related health behaviours, which may foreshadow disease outcomes. These suggestions informed the rationale for studies two and three in the present thesis. Firstly, study two comprised a systematic review of peer-reviewed literature that had used the JDC(S) model to explore associations between favourable or unfavourable psychosocial work factors (i.e., work stress) and leisure-time physical activity (LTPA) and/or habitual diet. This facilitated a comprehensive assessment of the methods used in previous studies and provided the opportunity to highlight common and divergent approaches (i.e., conceptualisations of JDC(S) variables, LTPA and diet, measurement tools, analyses used). The summary of methodologies and previous findings outlined in study two, and reviewed in Section 5.2.2, were used to generate recommendations for future research. These ideas were followed-up in study three.

In study one it was observed that the two subscales of job control – skill discretion and decision authority, appeared to hold differential associations with measures of obesity. Following this, the systematic review in study two revealed that no previous studies, which controlled for the effects of sex and age, had considered the potential for the two subscales of job control to hold unique associations with either LTPA or habitual diet. This observation, along with other limitations of previous research outlined in study two, were used to inform the conceptualisation of study three. Consequently, study three is the first of its kind to consider the unique associations of the JDCS subscales with LTPA and dietary energy intake, with analyses that control for the effects of sex and age. A review of these findings is provided in Section 5.2.3.

This final chapter reviews the findings of each study in the order presented (Section 5.2), and considers their collective implications – both for theory and practice (Section 5.3). Furthermore, the limitations of the original studies are discussed (Section 5.4) and recommendations for future research are outlined (Section 5.5). Finally, a section of final comments bring this thesis to a close (Section 5.6).

5.2 Review of Thesis Findings

5.2.1 Differential Associations of Job Control Components with both Waist Circumference and Body Mass Index

It was hypothesised that considering the associations between measures of obesity and components of the JDCS model at the subscale level (i.e., considering skill discretion and decision authority separately) may provide new insights into the potential associations between psychosocial work factors and overweight and obesity. This approach proved fruitful. In analyses that controlled for sex, age, household income, work hours and job nature (blue vs. white-collar), the two components of job control were the only parts of the JDCS model to hold significant associations with measures of obesity. Notably, the associations between skill discretion and waist circumference, and skill discretion and BMI were negative. Conversely, the association between decision authority and waist circumference was positive. The findings of study one add weight to the idea that skill discretion and decision authority should be treated separately. In addition to this main finding, psychosocial work factors displayed stronger associations and explained greater variance in waist circumference compared with BMI. Possible reasons for this, including potential psychobiological interactions, are further discussed in Chapter 2.

To preserve statistical power, the main analyses controlled for sex rather than present separate analyses for men and women. Nonetheless, supplementary sex-stratified analyses were reported in-text. These analyses suggested stronger associations for men compared to women, despite an approximately even number of men (n = 220) and women (n = 230) in the sample. One explanation may be that men were more likely to work full-time (95%) compared to women (52%) in the present sample, and as such, men reported greater working hours (men: M = 41.1 hours/week, SD = 7.7, vs. women: M = 33.8 hours/week, SD = 13.1). As a result, the importance of psychosocial work factors may be amplified for men due to their greater temporal exposure (i.e., men spending more time at work, therefore greater exposure to the psychosocial work factors and greater potential influence – positive or negative). Future research with a larger sample may be more sufficiently powered to further explore potential sex differences.

5.2.2 Associations Between Work Stress, Leisure-Time Physical Activity, and Diet: A Systematic Review of Studies that use the Job Demand-Control(-Support) Model.

Following the novel observations in study one it was important to consider the behaviours that could underpin these associations. The positive energy balance hypothesis suggests leisure-time physical activity (LTPA) and dietary intake are two important, potentially mediating behaviours, in the development and maintenance of overweight and obesity. Study two comprised a systematic review of peer-reviewed literature published since 1990, which considers associations between work stress, LTPA, and diet using the JDC(S) model. A comprehensive search protocol was developed in collaboration with an experienced research librarian and applied to eight databases. Following removal of duplicates, potentially relevant records (n = 6,863) were screened by hand using explicit inclusion/exclusion criteria, with 31 studies found to meet criteria. There was strong inter-rater reliability between the primary and secondary reviewer, suggesting this list of inclusion/exclusion criteria was objective and effective. One important inclusion criterion was the stipulation that studies needed to have controlled or adjusted for the effects of sex and age in their relevant analyses. This was important because the 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 work factors (Artazcoz et al., 2007; Evans & Steptoe, 2002). Furthermore, increased age is associated with increased weight, reduced physical activity and changes in dietary energy requirements (Chodzko-Zajko et al., 2009; Tchernof & Després, 2013).

The systematic review revealed general support for a negative association between unfavourable psychosocial work factors and LTPA. The greatest support was observed for the importance of job control: nine studies provided unisex support for an association between lower job control and less LTPA; while five provided unisex support for an association between high job control and greater LTPA. Where previous reviews have focused on either physical activity or diet, one of the innovative features of this review was the inclusion of studies that reported either or both. In doing so, this review highlighted the shortage of studies that report diet outcomes and the comparatively greater number that report on LTPA.

There was some support to suggest an association between work stress (JDC[S] model) and poorer diet, but insufficient studies to draw strong conclusions. Findings generally supported consideration of the individual JDC(S) constructs over global measures of job strain. However, this review identified that no previous studies, that controlled or adjusted for the effects of sex and age, had considered the potential for the two components of job control (skill discretion and decision authority), to display unique associations with LTPA or diet. This observation, combined with the novel associations observed in study one, helped to inform the rationale for study three.

5.2.3 Unique Associations of the Job Demand-Control-Support Model Subscales with Leisure-Time Physical Activity and Dietary Energy Intake

Study three was conceptualised in a way that followed-up the findings of study one, and adhered to the recommendations for future research as outlined in study two. The outcomes of interest comprised a measure of total energy intake from diet (kJ/day), alongside two credentialed operationalisations of LTPA, thereby facilitating the exploration of potential associations between psychosocial work factors and both energy intake and expenditure. Furthermore, an important strength of study three was the use of multivariate statistics that controlled for the effects of sex and age, as well as other sociodemographic variables in the final models.

As is study one, the consideration for potentially unique associations between subscales of the JDCS model with the variables of interest proved worthwhile. In study one it was observed that skill discretion was negatively associated with indicators of obesity (i.e., higher levels of skill discretion, smaller BMI and waist circumference). The findings of study three identified a potential mechanism underpinning this association, since skill discretion was positively associated with LTPA (i.e., higher levels of skill discretion, greater likelihood of attaining sufficient LTPA). However, skill discretion was not generally associated with dietary energy intake. Not all results were as expected; based on the observation in study one that higher levels of decision authority were associated with larger waist circumference, it was anticipated that decision authority would may be negatively associated with LTPA and/or positively associated with dietary energy intake. Nonetheless, decision authority was not associated with LTPA, and surprisingly negatively associated with dietary energy intake (i.e., higher levels of decision authority, less dietary energy intake). Another surprising finding was that coworker support was positively associated with dietary energy intake (i.e., higher levels of coworker support, greater dietary energy intake). This was surprising because higher levels of support at work (coworker and/or supervisor support) are thought to be stress reducing (Karasek & Theorell, 1990), however most people eat more when they experience higher levels of stress, compared to when they are not stressed (Adam & Epel, 2007). Some potential theoretical implications of these unexpected observations are discussed in Section 5.3.1.

As in study one, to preserve statistical power the main analyses in study three controlled for sex, rather than present separate analyses for men and women. Nonetheless, supplementary sex-stratified analyses were reported in-text. As in study one, these sex-specific analyses suggested generally stronger associations for men compared to women, despite approximately even numbers of men (n = 213 for LTPA, n = 205 for diet) and women (n = 220 for LTPA, n = 204 for diet) in the sample. As for study one, a potential explanation may be that in this sample men were more likely to work full-time (94%) compared to women (52%), and therefore reported greater working hours. As such, the benefit or harm associated with certain psychosocial work factors may be amplified or reduced depending on temporal exposure. Nonetheless, an additional finding from this study suggests the relationships between sex, psychosocial work factors, and work hours may be more complex than this. Female employees who worked longer hours had a reduced likelihood of being in the ‘high kJ/day’ tertile (compared to ‘low kJ/day’ tertile). This association suggests a 3% reduction in likelihood for each additional hour worked per week, but only for female employees.

5.3 Implications

The main implications specific to each study are discussed in their respective manuscripts. This section reflects on the potential implications of the collective findings. First and foremost, replication of the novel findings presented in studies one and three should be attempted. These works in particular present the first efforts to consider the potential for unique associations between obesity and energy balance-related behaviours with subscales of the JDCS model. As these studies are the first of their kind, it is imperative for future research to test if the findings can be reliably reproduced. The findings of study one have already been noted by other researchers (Li, 2015), suggesting future research may be conducted to see if the results can be replicated in other samples.

5.3.1 Theoretical Implications for Research

The novel findings of study one suggest there may be an incomplete understanding in the literature about how psychosocial work factors within the JDCS model may be associated with overweight and obesity. Previous inconclusive findings, using the composite measure of job control or global measure of job strain, have led some to suggest improving psychosocial working conditions may not be a priority in efforts to reduce obesity at the population level (Kivimäki et al., 2015; Nyberg et al., 2012). However, the novel findings reported in this thesis should renew interest and further exploration that could lead to a better understanding of potentially more nuanced relationships. Specifically, the findings of study one suggest combining the theoretically distinct components of skill discretion and decision authority may conceal their differential associations with measures of obesity (and possibly other outcomes), thereby potentially masking their individual importance. Findings also reinforce the importance of these job control subscales since there were no other associations observed between measures of obesity and the other JDCS components (i.e., job demands, coworker or supervisor support). The findings of study one also imply the superiority of waist circumference as a measure of obesity, since it was shown to be more sensitive to psychosocial work factors (i.e., greater variance explained), compared to the more commonly used measure of BMI.

Study two also presents a number of potential implications derived from the synthesis of previous research. In the systematic review, the most consistent support was found for a relationship between lower job control and lower LTPA, and higher job control and higher LTPA. Notably, there was considerably less support for the adverse impacts of high job demands or low social support. Furthermore, with regards to the job strain groups, the most consistent support was found for passive and high strain groups – both of which are defined by the presence of low control, and either low or high demands respectively. As such, this may suggest that the presence of low job control is the real driver in the apparent association, between passive and high strain jobs and lower LTPA, which was observed in this review and a previous meta-analysis (Fransson et al., 2012). In other words, study two points to the particular importance of job control, while studies one and three point more specifically to the importance of the two job control subscales.

Study two also identified the exigent need for more studies in this area to report dietary outcomes, particularly total dietary energy intake, which was only reported in one previous study. Study three contributed to meeting the research needs identified in study two; however more research is needed to strengthen the knowledge base – particularly with regard to dietary outcomes. Furthermore, the findings of study three reinforced the utility of considering components of the JDCS model at the subscale level, as well as the particular importance of skill discretion, since its association with LTPA was particularly strong and the most consistent of all variables of interest. Unexpected patterns of association between decision authority and dietary energy intake, and coworker support and dietary intake, point to the need for more studies to contribute to a more comprehensive understanding of the potential relationships between these variables. Future research may wish to draw on some concepts outlined in the Vitamin Model (Warr, 1987, 2007), which suggests some job characteristics, such as opportunity for control (similar to decision authority) and interpersonal contact (similar to coworker support), may be considered to have additional decrement. In other words, some job characteristics, such as decision authority and coworker support may follow a curvilinear pattern, where *either* too little *or* too much may be conducive to increased experiences of work stress and/or maladaptive health behaviours.

5.3.2 Potential Practical Implications for Job Design and Intervention

While conscious efforts to restrict dietary energy intake and increase physical activity are the current cornerstones for obesity treatment, these prescriptions assume such individual lifestyle changes are a generally accessible and valid option (Bray, 2004). The persistent high prevalence of overweight and obesity suggest this approach has so far proved largely ineffective. An alternative viewpoint is the ‘fluoride hypothesis for obesity’, which suggests changes can be made in the environment to reduce obesity, in a similar way as fluoridation of water supplies reduced the incidence of dental disease (Bray, 2004). In other words, ‘fluoride-like’ strategies could work to produce meaningful improvements at a community or societal level, without the personal effort associated with conscious changes in individual lifestyle. More generally, these strategies may include reduced portion sizes for packaged foods, and building design that encourages physical activity (e.g., provision of easily accessible stairs in office buildings) (Gortmaker et al.; Nicoll & Zimring, 2009). In the context of the present research, the suggestion is that adjustments to psychosocial work factors (e.g., job redesign to increase beneficial features, or policies to mitigate potentially harmful workplace or task-level job characteristics) could contribute to an environment that better facilitates more healthful behaviours (e.g., increased physical activity, reduced dietary energy intake) automatically, without requiring conscious effort from individuals to be ‘more healthy’.

Since paid employment comprises a large part of life for many people, ‘fluoride-like’ changes to workplace or job-level characteristics, could have far-reaching consequences for health and wellbeing. The findings presented in studies one and three are best considered exploratory in nature and in need of replication. Notable limitations include their cross-sectional deign – this and other limitations are discussed further in Section 5.4. While these findings alone are generally insufficient to make strong recommendations for specific changes, such as to policy or job redesign, they do point to the importance of re-evaluating long-held assumptions about the broad benevolence of high job control. The following section describes the potential practical implications for job redesign interventions if our findings are taken on their face value.

Firstly, the findings of study one suggest increasing levels of skill discretion and/or reducing levels of decision authority may result in a reduction in overweight and obesity. A potential mechanism for this was identified in study three, where higher levels of skill discretion were associated with a more than doubled likelihood for attaining sufficient LTPA. Furthermore, based on the results of study three, 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 suggested stronger associations between skill discretion and LTPA, compared to unisex analyses. Skill discretion may be increased by providing employees with the opportunity to learn new task-related knowledge and develop new skills. Furthermore, task-level activities on the job may be redesigned so that they are less repetitive, task variety may be increased, or job-related activities could be restructured to facilitate more creativity at the task-level (Karasek & Theorell, 1990). The moderate sample sizes in studies one and three suggest they may not have been adequately powered to sufficiently explore sex differences. Nonetheless, the observation of some sex-specific associations – particularly in study three, suggest intervention studies may be most effective if tailored for men and women separately, or at least consider assessing effectiveness for men and women separately.

Since higher levels of decision authority were positively associated with measures of obesity in study one (i.e., higher decision authority, larger waist circumference), it was expected that decision authority would be positively associated with dietary energy intake and/or negatively associated with LTPA. However, in study three higher levels of decision authority appeared to be associated with reduced dietary energy intake, while not associated with LTPA. As such, the findings of study three suggest increasing levels of decision authority may lead to a reduction in dietary energy intake, which would be associated with reduced overweight and obesity over time. Since this finding contradicts the positive association with measures of obesity observed in study one, further research is required to ascertain the most likely nature of these associations. It should be noted that in study one the outcomes of waist circumference and BMI were measured objectively by trained clinic staff, whereas in study three the food frequency questionnaires were completed by participants themselves. As discussed elsewhere, underreporting of dietary intake may have occurred, suggesting the positive association with measures of obesity observed in study one may be more accurate that the negative association with dietary energy intake observed in study three.

5.4 Limitations

Limitations specific to studies one and three are discussed first since they share a number of the same concerns. Cross-sectional designs, such as those employed in studies one and three are common in this field; however the authority of their findings is inhibited. Since the variables of interest were only measured at one time point we cannot rule out the possibility of reverse causality. In the case of study one, an employee’s weight status could, through some unknown selection processes, influence their exposure to psychosocial work factors. For example, prejudice towards overweight or obese persons may limit their opportunities and increase the likelihood that they find themselves in jobs of poorer psychosocial quality. Similarly with study three, an employee's ability (or lack thereof) to participate in LTPA, and/or the extent of their dietary energy intake could otherwise influence their exposure to, or their interpretation of psychosocial work factors.

Another limitation common to studies one and three is the delay between the measurement of the outcome variables of interest (i.e., waist circumference, BMI, LTPA, and diet) and employees' psychosocial work factors. Outcome variables were measured between 2008 and 2010, while psychosocial work factors were measured in 2011. To mitigate this problem, eligible participants were required to be working at the same workplace throughout both measurement points. Nonetheless, this was not a perfect solution since some participants may have changed positions within the same workplace, or the psychosocial nature of their work may have changed in the interim. Despite this limitation, we believe the psychosocial conditions represented in the JDCS model would be relatively stable within the same workplaces over the timeframe in question. While future research should be mindful of such potential problems and plan to avoid them, we do not believe this limitation is likely to significantly alter the interpretation of our findings.

The outcomes of interest in studies one and three are observable phenomena (i.e., not latent). As such, practical interpretation of the statistical output was an important consideration when selecting the most appropriate statistical techniques to apply. For example in study one, unstandardized coefficients can be easily interpreted using the original measurement units of the outcome variable (e.g., cm for waist circumference). Nonetheless, other statistical techniques such as structural equation modelling may have provided additional insights for further theoretical development of the JDCS model.

Since studies one ($N = 450$) and three ($N = 433$) utilised the same sample drawn from pre-existing data, a final limitation common to both is their moderate sample size. Despite the limited statistical power associated with our moderate sample size, the essence of our main findings (differential associations of skill discretion and decision authority with obesity measures) appeared robust in sex-stratified analyses for study one. Potential sex differences appeared more likely in study three, where sex-stratified analyses suggest the influence of the JDCS subscales were stronger for men compared to women. The model fit for male-specific analyses predicting LTPA was significant and suggested the positive influence of skill discretion was stronger for men, compared to unisex analyses. Meanwhile the model fit for female-specific analyses predicting LTPA was not significant. In the unisex analyses, there was a negative association between dietary energy intake and decision authority. The model fit for male-specific analyses predicting dietary energy intake was not significant, while for female-specific analyses it was. However, none of the JDCS components were significantly associated with dietary intake for women. A larger sample would have enabled a more powerful and comprehensive exploration of more complex relationships, such as the potential for associations with the JDCS subscales to vary depending on sex and socioeconomic factors.

A further limitation specific to study three was the apparent underreporting of dietary intake. Nonetheless, this limitation appears common in all studies that use similar food frequency measurement tools (Willett, 2013). A limitation of study three that could be more easily remedied is the focus on quantity of dietary energy intake (i.e., kJ/day), and not considering quality of dietary intake (e.g., macronutrient composition). This is notable since previous research suggests dietary quality (i.e., types of foods consumed) may influence dietary energy intake, since some foods are more satiating than others (Mozaffarian et al., 2011).

It is also important to recognise the limitations related to the systematic review that comprised study two. Firstly, the broad nature of the included studies and the diversity in their methodology meant that more rigorous quantitative synthesis in the form of a meta-analysis was impractical. Another limitation of the review was that it focused exclusively on one form of physical activity, leisure-time physical activity (LTPA), and ignored other types such as work-related physical activity. This decision was made for practical reasons, to enable more meaningful comparison between included studies, as well as theoretical reasons such as the potential for confounding between psychosocial work factors and work-related physical exertion. Furthermore, work-related physical activity may be an inherent characteristic of some jobs and not others, as such it may be less easily modifiable than LTPA (Martins & Lopes, 2013). Nonetheless, physical activity at work is likely another important factor in energy balance regulation. Previous research suggests jobs that involve mostly sedentary work are a risk factor for obesity – particularly for men and employees who work long hours (Choi et al., 2010b).

Another limitation of study two, which can be generalised to the thesis as a whole, is the heavy focus on the JDCS model. While this model is the most prominent in the field, it is not necessarily the best, and there are other conceptualisations of work stress and psychosocial work factors that are also valuable. For example, other conceptualisations such as ‘burnout’, also appear relevant for a holistic understanding of how psychosocial work factors may be associated with energy balance-related behaviours (Alexandrova-Karamanova et al., 2016). There is also likely to be additional value in the consideration of more general characteristics of the workplace environment, such as the belief that employers value the health of their employees, as well as social learning and the establishment of social norms that may occur through the observation of colleagues engaging in healthy behaviours (Quist et al., 2014; Tabak et al., 2015).

As noted in Chapter 1, George Engel (1980, p.537) – a key proponent of the biopsychosocial model – stated “in scientific work the investigator is generally obliged to select one system level on which to concentrate, or at least at which to begin, [their] efforts…

[yet] the systems-oriented scientist will be aware that the task is always a dual and complementary one" (i.e., to work at one level while at the same time appreciating the greater context). This perspective seems particularly pertinent to the study of causes and maintenance of overweight and obesity. The reach of the original studies presented in this thesis is expressly limited to the potential roles of psychosocial work factors and their association with obesity and associated energy balance-related behaviours. While the results of these studies suggest that certain psychosocial work factors are important pieces of the ecological determinants of overweight and obesity, there are certainly other pieces to the puzzle. The aetiological pathways leading to the development and maintenance of overweight and obesity are likely unique for each person and may resemble the obesity system map produced by the UK Foresight Programme (detailed in this thesis, Section 1.6.3). In other words, there is more to obesity than just an individual's psychosocial work factors – indeed there are many people who are overweight or obese and not employed and not seeking employment. As such, while the workplace and psychosocial work factors appear to be a meaningful and practical domain for research to better understand some of the potential drivers of overweight and obesity, it is important to remember these factors are only one piece in a complex aetiological puzzle.

5.5 Future Research Directions

Based on the findings of this thesis, a core recommendation is for future research to consider the potential for subscales of the JDCS model, particularly skill discretion and decision authority, to hold unique associations with outcome variables. The results of the studies presented in this thesis suggest that skill discretion and decision authority may play important and differential roles in the development of obesity and energy balance-related behaviours. Future research could be conducted to reveal if our findings can be replicated in relation to these outcomes in other samples – both in Australia and internationally, as well as other related outcomes, such as cardiovascular disease and diabetes. Future research may wish to consider disease outcomes themselves (i.e., distal outcomes, such as disease diagnoses). Alternatively, the findings presented in this thesis suggest more proximal outcomes such as elevated blood glucose levels suggestive of pre-diabetes, may be more readily observable, particularly for studies with limited statistical power. Future research intending to test the replicability of our findings would need to use an analytical approach such as those employed in studies one and three, which does not combine the JDCS subscales into composite scores or global scores.

For the measurement of overweight and obesity in future studies, we recommend researchers include a measure of central obesity such as waist circumference in addition to the more commonly used measure of BMI. The reasons for this are twofold. Firstly, excess waist circumference is more likely to represent increased health risk since it indicates excess fat accumulation proximal to internal organs, whereas BMI is more prone to miscategorising fat free mass (e.g., muscle mass). Secondly, the results of study one suggest psychosocial work factors explained more variance in waist circumference (i.e., a more sensitive measure) compared to BMI. As noted in study one, the psychobiological chronic stress network – through a number of behavioural and physiological mechanisms – implicates abdominal obesity, which is indicated by elevated waist circumference, more so than overall obesity (e.g., elevated BMI) (Dallman et al., 2005; Tomiyama et al., 2011).

The positive energy balance hypothesis is the foremost biological mechanism used to explain most overweight and obesity. As explored in studies two and three, there appears to be value in considering energy balance-related behaviours, namely physical activity and diet, to provide a better understanding of how psychosocial work factors may be associated with overweight and obesity. These behaviours have been labelled proximal factors (i.e., closer to the source), which may make them more immediate indicators of the effects of work stress, while the outcomes of overweight and obesity have been labelled distal factors (i.e., further away from the source) since these outcome take more time to materialise. Nonetheless, the potential roles of health behaviours (e.g., LTPA and diet) suspected to mediate and foreshadow disease outcomes (e.g., elevated BMI), have generally received less attention than the disease outcomes themselves (Lallukka et al., 2008; Theorell, 2014).

The systematic review that comprised study two identified a number of limitations and recommendations for future research in the field that has considered the association between psychosocial work factors (using the JDCS model) and two prominent energy balance-related behaviours: LTPA and diet. Firstly, there were considerable inconsistencies in the methods used to measure LTPA. Therefore, we recommend future research should use more consistent operationalisations of LTPA, using credentialed measures that are based on recognised guidelines such as those outlined by the World Health Organization (2016b). In addition, future research may also benefit from considering more objective measures of physical activity, such as employing electronic activity trackers, which are increasingly accessible (Appelboom et al., 2014; Diaz et al., 2015).

Study two also identified that only a small number of studies have considered the associations between psychosocial work factors (using the JDCS model) and diet outcomes. Of the 31 studies meeting inclusion criteria for the review, 29 reported an applicable measure of LTPA, while only nine reported a measure of diet. Furthermore, only seven studies concurrently reported LTPA and diet outcomes. The shortage of studies reporting diet outcomes mean that it is impractical to infer the relative contributions of insufficient physical activity or excess dietary energy intake, suspected to underpin potential associations between work stress and obesity. The majority of studies that reported on diet only measured fruit and vegetable consumption or broad dietary patterns. Such approaches provide limited information about the potential association between work stress and diet, and the role diet may play in mediating the potential association between work stress and obesity. A key recommendation for future research is to consider reporting dietary outcomes, specifically including measurement of total dietary energy intake (kcal or kJ) would be especially useful since this is most compatible with the positive energy balance hypothesis. This recommendation is made with the acknowledgement that there are methodological challenges associated with this type of measurement and these challenges may present a barrier to their adoption. Nonetheless, since there is such little evidence currently available, the collection and publication of these data is an important endeavour that could contribute significantly to understanding of the potential associations between work stress and dietary energy intake. Preferably, future research considering the associations between work stress, obesity, and energy balance-related behaviours, would report both a measure of dietary energy intake alongside a credentialed operationalisation of LTPA.

Study three is one example of a study that followed the recommendations outlined above. While we believe this is a good start, more studies are needed to contribute to a comprehensive understanding of the relationships between these variables. Furthermore as indicated in study three, the difficulties associated with the accurate measurement of dietary energy intake, such as underreporting, suggest future studies may benefit from the consideration of dietary quality (e.g., macronutrient composition) alongside the quantity of total dietary intake (e.g., kJ/day). While quantity of dietary intake (i.e., how much is consumed) appears prone to underreporting, dietary quantity appears to be related to dietary quality (i.e., what is consumed) (Mozaffarian et al., 2011). As such, consideration of both dietary quantity and quality may provide a more accurate description of diet, thereby facilitating a potentially more valid assessment of potential associations with psychosocial work factors. In such analyses, it is suggested that researchers may elect to assess the predictive values of both dietary quantity and quality, or use an approach such as latent class analysis to derive a dietary intake score (Harrington, Dahly, Fitzgerald, Gilthorpe, & Perry, 2014).

In study one, age was positively associated with waist circumference, while in study three age was negatively associated with LTPA. This suggests increasing age is associated with elevated waist circumference and reduced participation in LTPA. Furthermore, in study three, the positive association between skill discretion and LTPA was stronger in male-specific analyses, compared to unisex analyses, and was not observed in female-specific analyses. As such, these findings indicate the importance of controlling for the effects of sex and age in future studies looking to explore the associations between psychosocial work factors, obesity, and energy balance-related behaviours. Future research with a larger sample size would be more sufficiently powered to explore sex differences in relation to the associations between psychosocial work factors and obesity.

As noted in Section 5.3, the novel findings presented in studies one and three require replication before they can be considered more authoritative. Since there is already a large body of research that has employed the JDCS model, there is the potential to reanalyse data from previous studies, using a fresh approach to analyses that considers the JDCS constructs at the subscale level. In providing recommendations for the conceptualisation of new research it is important to consider choice of study design. Studies one and three were cross-sectional in nature, and this type of design was used in 24 of the 31 studies included in the systematic review described in study two. A significant limitation of cross-sectional designs is that they are unable to infer causality. In other words, these studies may suggest there is an association between the variables under investigation, but they cannot claim that the predictor variables (e.g., psychosocial work factors) cause a change in the outcome variables (e.g., waist circumference, BMI, LTPA, or diet), since reverse causality or extraneous influences cannot be ruled out. As such, we suggest future research should utilise a longitudinal or prospective design, wherein individuals are followed over time and variables of interest are measured more than once, since these types of design are generally accepted as better suited to inferring causality (Wunsch, Russo, & Mouchart, 2010).

A noted limitation of this thesis is the relatively narrow focus on the potential role of psychosocial work factors, and specifically subscales of the JDCS model, in relation to obesity and energy balance-related behaviours. Future research may wish to embrace a broader perspective using an ecological approach. For example, research that is sufficiently powered with large samples, may wish to consider how psychosocial work factors may interact with factors at other ecological levels, such as family situation, as well as national and international economic conditions. In this vein, updates to the Job Content Questionnaire (JCQ) should be noted. The JCQ (Karasek, 1985) instrument was specifically developed to capture the JDCS model variables and it is the most commonly used instrument for this purpose. After more than 30 years, it is receiving a significant update to reflect changing work environments and researcher needs. While details of the JCQ 2.0 (JCQ Center, 2016; Karasek, 2015) are still emerging, it appears that in addition to core JDCS items, it will also include items related to external/macro level conditions and multi-level theory. This suggests the JCQ 2.0 will be more conducive to a holistic approach that is more consistent with multilevel perspectives, such as that outlined in Engel's (1980) biopsychosocial model of health.

5.6 Final Comments

The series of studies presented in this thesis provide new insights into how psychosocial work factors may be associated with overweight and obesity, and energy balance-related behaviours. The results suggest that the most widely used model of work stress, the JDCS model, may be commonly operationalised in a way that could obscure more subtle associations between its subscales and health outcomes. Specifically, while the two subscales of job control, skill discretion and decision authority, are noted as theoretically distinct constructs, they are almost always combined to form the composite measure of job control. The JDCS model suggests that work stress typically occurs when job demands are too high, commensurate to levels of job control. The suggestion being that increased levels of job control may mitigate the stress of high demands. In this equation, no discrimination is made between skill discretion and decision authority. Emerging evidence, including two studies presented in this thesis, suggest that the two subscales of job control may have differential associations with certain health outcomes, including obesity and energy balance-related behaviours. These findings add weight to the suggestion, presented in Section 1.8.4b, that increasing job control may not necessarily be a broad-brush panacea.

The results of this thesis suggest skill discretion is most likely beneficial, as higher levels were associated with reduced measures of obesity (i.e., reduced waist circumference and BMI), as well as increased leisure-time physical activity. The potential influence of decision authority appears to be more ambiguous. Higher levels of decision authority were associated with increased measures of obesity (i.e., increased waist circumference), but surprisingly were also associated with reduced dietary energy intake.

Further research is required to see if these novel findings can be replicated in other samples. Preferably, future research would employ a longitudinal design so that potential findings may be more authoritative. Furthermore, a larger sample would also provide the opportunity for a more comprehensive exploration of potential sex differences. Such differences were hinted throughout the studies presented in this thesis, and especially in study three where the influence of psychosocial work factors appeared somewhat stronger for men compared to women. Overall, the findings of this thesis indicate that psychosocial work factors should be taken into account for planning health promotion efforts to reduce the incidence and prevalence of overweight and obesity.

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APPENDIX A

Paper One Reprint

NOTE:

This publication has been removed as per errata. See Chapter 2: Paper one for the unpublished version of the publication.

Bean, C. G., Winefield, H. R., Sargent, C., & Hutchinson, A. D. (2015). Differential associations of job control components with both waist circumference and body mass index. Social Science & Medicine, 143, 1-8.

The published publication is included in the print copy of the thesis held in the University of Adelaide Archives.

It is also available online to authorised users at:
http://dx.doi.org/10.1016/j.socscimed.2015.08.034