DISSERTATION

# Work, Stress and Health

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# Abbreviations

**GAS** general adaptation syndrome . . . 11
**HPA** hypothalamic-pituitary-adrenal . . . 13
**GRRs** generalized resistance resources . . . 18
**SOC** sense of coherence . . . 19
**COR** conservation of resources . . . 26
**JD-C** job demands-control . . . 29
**JD-C-S** job demands-control-support . . . 30
**ERI** effort-reward imbalance . . . 31
**JD-R** job demands-resources . . . 32
**CHD** coronary heart disease . . . 39
**MSP** musculoskeletal problems . . . 40
**SAM** sympathetic-adrenal-medullary . . . 42
**IBD** inflammatory bowel diseases . . . 43
**ENS** enteric nervous system . . . 43
**SES** socio-economic status . . . 47
**AWCI** Austrian Work Climate Index . . . 60
**IFES** Institute for Empirical Social Studies . . . 60
**AEHM** Austrian Employee Health Monitor . . . 60
**SS** somatic symptoms . . . 61
**JD** job demands . . . 63
**JR** job resources . . . 64
**MAR** missing at random . . . 65
**CFA** confirmatory factor analysis . . . 66

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# Zusammenfassung

Die gesundheitsgefährdende Wirkung eines stressreichen Arbeitsumfeldes wurde vielfach aufgezeigt, wobei die zugrunde liegenden Mechanismen noch nicht eindeutig geklärt sind. Etablierte Stresstheorien gehen davon aus, dass gesundheitliche Probleme aufgrund eines Zusammenspiels von sowohl positiven als auch negativen Faktoren des Arbeitsumfeldes vorhergesagt werden können. Das vorliegende Projekt hat zum Ziel, diese Prozesse näher zu beleuchten und insbesondere den Einfluss der Arbeitsbelastung sowie unterschiedlicher Dimensionen von Ressourcen auf die Gesundheit erwerbstätiger Personen zu erfassen. Dieser Forschungsgegenstand wird aus drei unterschiedlichen Perspektiven betrachtet. Erstens wird untersucht, inwieweit personen- und arbeitsbezogene Ressourcen den negativen Einfluss der Arbeitsbelastung auf die Gesundheit abschwächen können. Zweitens wird ein alternatives Stressmodell getestet, welches die Entwicklung von Gesundheitsproblemen aufgrund der wahrgenommenen Arbeitsbelastung sowie der vorhandenen Ressourcen zu erklären versucht. Drittens werden die Auswirkungen unterschiedlicher Konstellationen von Arbeitsbelastungen auf die Gesundheit untersucht.

In der vorliegenden Dissertation werden Sekundärdaten aus einer Querschnittsumfrage unter Österreichischen ArbeitnehmerInnen ($N = 17.941$) analysiert. Die verwendeten Skalen werden in einem ersten Schritt mit Hilfe der Konfirmatorischen Faktorenanalyse auf ihre psychometrische Eignung überprüft. Zur Beantwortung der Forschungsfragen werden die multiple lineare Regressionsanalyse, die Strukturgleichungsmodellierung und die latente Klassenanalyse eingesetzt.

In der Regressionsanalyse zeigt sich ein Zusammenhang zwischen übermäßiger Arbeitsbelastung und schlechter psychischer und körperlicher Gesundheit. Ein Mehr an personen- und arbeitsbezogenen Ressourcen ist hingegen mit einem positiven Gesundheitszustand assoziiert. Jedoch gibt es nur schwache Hinweise für einen möglichen protektiven Effekt der Ressourcen im Zusammenhang zwischen Arbeitsbelastung und

Gesundheit. Die Strukturgleichungsmodellierung zeigt eine gute Passung des vorgeschlagenen Stressmodells mit den Daten. Dabei wurde gefunden, dass die unterschiedlichen Facetten der personen- und arbeitsbezogenen Ressourcen als Domänen eines zugrunde liegenden Ressourcenfaktors angesehen werden können. Dieser Ressourcenfaktor erlaubt eine bessere Vorhersage des Gesundheitszustandes als die einzelnen Ressourcendimensionen alleine. Außerdem kann die Annahme bestätigt werden, dass der Zusammenhang zwischen der Arbeitsbelastung und der körperlichen Gesundheit indirekt durch die psychische Symptomatik vermittelt wird. In der latenten Klassenanalyse werden schlussendlich Gruppierungen von Personen ermittelt, welche jeweils ein typologisches Antwortmuster hinsichtlich der wahrgenommen Belastungen am Arbeitsplatz (entspricht den Arbeitsbelastungsprofilen) sowie der Anfälligkeit für die Ausbildung unterschiedlichster Gesundheitsprobleme (entspricht den Symptomclustern) aufweisen. Die Arbeitsbelastungsprofile zeigen einen signifikanten Zusammenhang zu den Symptomclustern, wobei die Stärke des Zusammenhangs von der Art der Belastung abhängig ist.

Die Ergebnisse bestärken die Annahme, dass übermäßige Arbeitsbelastungen nachteilig für die Gesundheit sein können. Besonders die Belastung durch mehrere Stressoren unterschiedlichen Typs (z.B. physisch, psychosozial und organisatorisch) scheint gesundheitsgefährdend zu sein. Umgekehrt stellen sich eine gute körperliche Fitness, ein globales Vertrauen in die eigenen Fähigkeiten, ein unterstützender Freundeskreis und ein ressourcenreiches Arbeitsumfeld als gesundheitsförderliche Faktoren heraus. Die Ergebnisse lassen schließen, dass die betriebliche Gesundheitsförderung an drei Ebenen ansetzen kann: (1) der Vermeidung übermäßiger Arbeitsbelastungen, (2) der Verminderung arbeitsbedingter psychischer Spannungen und (3) der Stärkung von Ressourcen zur Stressbewältigung.

# Abstract

There is extensive evidence that demonstrates the adverse effects of a stressful working environment on both mental and somatic health, yet to date the underlying mechanisms have not been clarified in detail. Prominent work-related stress theories suggest that work-related health problems can be predicted by the combined effects of both positive and negative aspects of the working environment. This thesis aims to shed new light on these processes in order to better understand the role of both job demands and different dimensions of resources in explaining workplace health. This main objective is tackled from three different perspectives: first of all, it is examined whether different dimensions of person- and job-related resources buffer the negative impact of job demands on health. Second, an alternative stress model explaining the pathways between job demands, person and job-related resources, and mental and somatic health is established and tested. Third, this thesis explores the differential effects of different constellations of job demands on health.

This thesis analyses secondary data provided by a cross-sectional survey of a sample of Austrian employees ($N$ = 17,941). In a preliminary step, confirmatory factor analysis is conducted to examine the psychometric properties of the used scales. Next, moderated linear regression analysis, structural equation modelling, and latent class cluster analysis are performed to investigate the research questions.

The results of the moderated regression analysis reveal extensive job demands to be associated with poor mental and somatic health, whereas a rich pool of person- and job-related resources is accompanied by a good state of health. However, the buffering effects of the different resource dimensions in the relationship between job demands and health are very weak and the practical implications are negligible. Structural equation modelling further demonstrates that the proposed stress model is fully able to explain the relationships between job demands, resources, and health. More specifically, it was found that different dimensions of person- and job-related resources can be considered

as domains of an underlying resources factor, which allows an even better prediction of mental and somatic health than the single resource dimensions separately. Moreover, the findings confirm the assumption that job demands exert their negative effects on somatic health via an indirect pathway through mental strain. In the latent class analysis, different subgroups of employees are revealed, each of which demonstrates a typological response pattern in terms of both the perceived burden due to job demands (representing the job demand profiles) and the vulnerability of exhibiting signs of poor health (representing the symptom clusters). The job demand profiles are found to be significantly related to the symptom clusters, although the strength of association varies depending on the nature of the job demands that an employee experiences.

In conclusion, the results converge in supporting the assumption that extensive job demands adversely affect mental and somatic health. Synchronous exposure to several demands of different nature (e.g. physical, psychosocial, and organizational) was found to be most critical with regard to the seriousness of reported health problems. However, good physical fitness, a global confidence in one's own capabilities, a supporting circle of friends, and a resourceful working environment seem to have a beneficial health effect. The findings suggest that workplace health interventions may take action on three levels: (1) the prevention of overwhelming job demands; (2) the prevention of work-related mental strain; and (3) the increase of resources to better cope with stress.

# CHAPTER 1

# Introduction

VIRTUALLY no other concept in the biological and social sciences has received as much attention as that of *stress*. This is probably due to the fact that the phenomenon of stress is ubiquitous in our modern society. Every kind of person knows what it feels like to be *under stress*. Stress has been observed in a variety of situations and in different populations: in children at kindergarten (Hatzinger et al., 2008; Hatzinger et al., 2007) and children at school (S. L. Brown, Teufel, Birch, & Kancherla, 2006); in university students (Bayram & Bilgel, 2008; Cotton, Dollard, & de Jonge, 2002); in workers of various professions (Eurofound & EU-OSHA, 2014; Leka & Jain, 2010; Nixon, Mazzola, Bauer, Krueger, & Spector, 2011); and even in respect of leisure time activities (Cropley & Purvis, 2003; Sonnentag, 2012) and in family life (Edwards & Rothbard, 1999). One can hardly imagine any domain of everyday life in which stress does not play an important role.

Especially work-related stress has been intensively investigated in recent decades and work-related stress has also become a major public health issue. According to the European Working Conditions Survey 2014 (Eurofound & EU-OSHA, 2014), about one quarter of European employees experienced stress for all or most of their working time and state that their jobs affect their health negatively. For the vast majority of human beings, work is a necessity and a duty in order to survive in today's society. Work can be a source of financial security, status, and well-being. Work gives meaning to people's lives, offers the opportunity to express one's own creativity, or can promote personal growth and self-realization. Work, however, can also be associated with extensive work-related demands, including heavy workloads, long working hours, time pressures,

and interpersonal conflicts. Work and exposure to detrimental job demands therefore constitute a serious risk factor for mental and somatic health (Lundberg & Cooper, 2011).

Work thus represents a meaningful aspect of life on the one hand, and a health-threatening burden on the other hand. This dualism of work is also evident in an article written by Levi (1990) entitled 'Occupational stress. Spice of life or kiss of death?' (see also Lundberg & Cooper, 2011, p. 1). Levi has argued that work-stress-related health problems are of human origin, and human beings also have the power to prevent such work-related health problems. In reality, workplaces are first and foremost designed to maximize financial profits and to minimize financial costs. The needs of a working person therefore only come second. Although this article was published nearly 30 years ago, Levi's conclusions are still valid in today's working world. Levi even used the term 'self-killing' when he argued that human beings permit deleterious working conditions to persist until health has been irreversibly damaged, even though he also remarked that human behaviour is heavily conditioned by politics and social structures in and beyond the workplace.

An extreme example of work stress is *overwork death* or *karoshi*, a Japanese term that describes the phenomenon of people literally working themselves to death. *Karoshi* usually refers to death or permanent disability from serious diseases – such as cerebrovascular diseases, ischemic heart diseases, or psychiatric issues – caused by overwork (Iwasaki, Takahashi, & Nakata, 2006). Especially in the Eastern Asian region, *karoshi* still represents a growing public health issue (see e.g. Cheng, Park, Kim, & Kawakami, 2012), even though the government and companies have been making an effort to reduce the burden due to work. A number of cases have already been documented where workers died from stroke, heart attack, or suicide, caused by extensively long working hours (for example, more than 100 hours a week; see http://www.ilo.org/safework/info/publications/WCMS_211571/lang--en/index.htm [retrieved October 10, 2017]).

In contrast to the above-mentioned metaphor of the *kiss of death*, the beneficial aspects of a job (for example, control over work processes, career and job opportunities, and income) may turn a potentially adverse working environment into the *spice of life*. Work may thus only have negative consequences in situations where job demands exceed job resources. Moreover, people's individual characteristics also have be taken into account. People who have sufficient resources at their disposal may see a potentially demanding situation as a manageable challenge, whereas people who lack sufficient resources may see the same situation as inevitable and stressful, due to the belief that they are not able to meet the external and internal requirements (Lazarus & Folkman, 1984). Whereas the latter case (i.e. demands exceeding resources) can have

negative consequences for health and well-being, the former case (i.e. resources suffice to face demands) may also have positive effects on health, well-being, and life/job satisfaction (Bandura, 1977; Lazarus & Folkman, 1984). It is thus essential to take both negative and positive aspects of a job (and a person) into account, in order to obtain a comprehensive view of the stress phenomenon.

## 1.1 The nature of work

To put this thesis into context, this section will discuss the most important organizational and demographic changes that have taken place in the world of work in recent decades. An important question is whether these changes have increased or diminished occupational demands and the related health risks for working persons. To answer these and other important questions, the *European Agency for Safety and Health at Work* 'set up a risk observatory' (EU-OSHA, 2007, p. 4) comprised of an expert survey and an analysis of the scientific literature. This 'expert forecast on emerging psychosocial risks related to occupational safety and health' has revealed a number of new or previously unknown occupational risks, and the effects of these risks on workers' health are getting more serious. Although this risk observatory was published approximately 10 years ago, most of the findings are still valid today. Moreover, the risk observatory not only highlights the changes in occupational and economic concerns, but also constitutes a good representation of the nature of work today. The following issues were emphasized by the experts (see EU-OSHA, 2007).

First, the survey findings pointed out negative consequences for workers' health due to new forms of employment contracts and the resulting job insecurity. According to the experts, the globalisation of labour markets has increased competition between companies at both national and international levels. Consequently, companies are urged to cut costs in order to remain competitive. This includes strategies such as the reduction of the number of workplaces, lean manufacturing, and just-in-time production. On-call, part-time, or temporary contracts are used to meet these organizational requirements. The trend towards precarious employment contracts and the growing threat of imminent job loss decreases workers' job satisfaction and organizational commitment, and also affects physical and mental health negatively (De Witte, Pienaar, & De Cuyper, 2016; Sverke, Hellgren, & Näswall, 2002).

The second risk revealed was considered to be partly a consequence of the aforementioned risk: workplace reduction and the new contracting practices result in work intensification. Fewer people are supposed to get the same amount of – or even more – work done; this situation leads to increased workload, and increased work or time pressure, or results in overtime or long working hours in order to get the job done

on time. All of these demands were demonstrated to be consistently related to ill health (Nixon et al., 2011).

The third risk concerns emotional demands. Although high emotional demands at work is a risk factor that is not new, it was nevertheless found to be a growing concern. Employees working in health care or the service sector were found to be particularly affected by high emotional demands, including bullying or violence at the workplace. Extensive emotional demands have been illustrated to be amongst the most powerful stressors with regard to their effects on both physical and mental health (Nixon et al., 2011; Schaufeli & Bakker, 2004).

The fourth risk relates to poor work-life balance. According to the experts, increasing numbers of workers fail to achieve a decent balance between their work and their personal lives. Changes in work organization were considered as the main reason for this phenomenon. Workers are required to be increasingly flexible (e.g. regarding working hours), and constantly accessible. In many occupational fields, modern communication technologies permit work anywhere, at any time, and on any device (e.g. on smartphones and tablets). This all results in work without boundaries, where work aspects increasingly spill over into personal life and leisure time (Lundberg & Cooper, 2011, p. 29). Furthermore, work intensification and increasing psychosocial demands impede switching off from work during personal life. Consequently, problems associated with the job are present even during leisure time and may thereby result in insufficient recovery. Work without boundaries thus impedes the recovery process, which, in turn, may intensify the link between work stress and health (Geurts & Sonnentag, 2006).

Finally, the experts pointed out an emerging risk due to the ageing workforce. The European Commission (2015) estimated the life expectancy of European men and women to reach 84.8 years and 89.1 years, respectively, by the year 2060. For the same projection period, the proportion of people aged 65 or over in relation to those aged 15–64 is expected to increase from 27.8 % to 50.1 %. In recognition of the ageing population, people are increasingly required to work longer years in order to accommodate these demographic changes and the related burden on future economic, budgetary, and societal resources (Börsch-Supan, Härtl, & Ludwig, 2014; European Commission, 2015). The older working population was also considered to be particularly vulnerable to poor working conditions and to be more at risk to becoming unemployed than younger workers (EU-OSHA, 2007). Experts thus recommended paying special attention to the ageing workforce and highlighted the necessity of specific interventions to reduce work-related stress for older workers in particular.

All of these risks seemed to be further intensified by the economic crisis with its peak in 2009. In a recent systematic review, this economic crisis was found to be associated

with staff reduction, increased workload, and increasing unemployment (Mucci, Giorgi, Roncaioli, Fiz Perez, & Arcangeli, 2016). Moreover, the authors demonstrated that these changes were related to an increasing rate of health problems. At the time of writing this thesis, the economic crisis is still ongoing in a number of countries, while others have already recovered (i.e. Austria).

#### Concluding remarks

There is extensive evidence that demonstrates the negative effects of a stressful working environment on both mental and physical health (Nixon et al., 2011). Against the backdrop of considerable changes in the world of work in recent decades, the work-stress-related burden even seems to be on the rise (EU-OSHA, 2007). Apart from the health effects, work-related stress is also associated with an economic burden, caused by aspects such as increased absenteeism, a reduction in performance and work productivity, a higher number of stress-induced accidents at work, and increased treatment costs of stress-related illnesses. In 2000, the European Commission estimated the societal costs of work-stress-related consequences to amount to approximately 20 billion euros per year (European Commission, 2000). In a more recent publication, the costs of work-stress-related diseases and occupational accidents were estimated to range between 2.6 % and 3.8 % of the European Union's gross domestic product (European Commission, 2013). Thus, this issue is of great topical importance not only for research, but also for public health policies aiming to reduce the financial and health-related burden of work-stress-related factors. However, occupational health research should not only focus on the negative aspects of a job (i.e. the job stressors), but also reveal beneficial factors (i.e. person- and job-related resources) that help to attenuate the negative impact of detrimental work factors on health.

## 1.2 Aims and objectives

The main objective of this thesis project is to investigate the effects different kinds of stressors at work have on both mental and physical health, and to examine the role of both the positive aspects of a job and the beneficial personal characteristics of individuals in the relationship between work-related stressors and health. These research issues are tackled from three different angles: in the first part, the buffering role of the mental, physical, and social resources of a person as well as positive job-related factors in the relationship between work-related stressors and health are examined. In the second part, a heuristic stress model explaining potential relationships between job demands, person- and job-related resources, and health is established and tested. In the third instance, this thesis aims to reveal both work-related stress profiles and health

typologies, in order to explore the differential health effects of different constellations of stress at work.

# CHAPTER 2

# Terminology and outline

## 2.1 A note on the terminology

As is discussed in more detail in section 3.1.4, there is great ambiguity in the terminology of stress-related concepts. For the sake of clarity in reading, the following terminology is used throughout this thesis (unless otherwise stated in the specific stress theories): *stimulus*, *stressor*, and *demand* are used synonymously, and are defined as 'any agent, event, or situation – internal or external – that elicits a response from an organism' ('stimulus, n.'; VandenBos, 2015, pp. 1032–1033). Stimulus, stressor, and demand have a neutral connotation: they can elicit either desirable or undesirable responses from the individual. The reaction of the individual in response to that stimulus/stressor/demand is labelled as a *stress response*. Stress responses include physiological reactions (such as the secretion of adrenaline), behavioural reactions (such as fight or flight responses; see Cannon, 1927), and mental/emotional reactions (i.e. mental or emotional strain/tension, such as emotional exhaustion, irritation, and depression). These stress responses are considered to depend on the situational context, the available resources, or appraisal processes. The entire (dynamic, transactional) process – involving stressors, stress responses, and other related factors – is represented by the term *stress*.

## 2.2 Outline of the thesis

The thesis is divided into two main parts: a theoretical part and an empirical part. The theoretical part constitutes the theoretical framework of this thesis project. Eminent

stress theories are discussed, previous research findings are reviewed and summarized, and open research questions are highlighted. In the empirical part, the research questions are tackled from three different angles. The methods and materials are described, the statistical data analysis is presented, and the findings are reported and discussed in detail.

### 2.2.1 Theoretical part

The structure of the theoretical part of this thesis is as follows. The following chapter begins with an overview of eminent stress concepts which are considered to be most important for this research project. This includes a short historical overview of the evolution of the stress concept from a biological perspective, and a review of biologically oriented concepts and theories, namely the concept of *homeostasis*, the *general adaptation syndrome* theory, and the *allostatic load* theory.

In the second section of this chapter, the focus shifts to psychologically and sociologically oriented theories of stress. These theories consider stress to result from a dynamic process, involving reciprocal interactions between individual, social, and environmental factors (Mark & Smith, 2008). This second section discusses *salutogenic* views of the stress phenomenon, the *transactional model of stress and coping*, and the *conservation of resources* theory. Since several work-related stress concepts build on the basic assumptions of these theories, a short discussion of their main ideas is essential for the understanding of the research questions of this thesis.

Next, the three leading work-related stress models (see Schaufeli & Taris, 2014) are presented and discussed, namely the *job demands-control(-support)* model, the *effort-reward imbalance* model, and the *job demands-resources* model. These models are specific to the work context and assume that work-related stress responses can be predicted by a combination of both positive and negative aspects of the working environment.

The third section of the theoretical part is about manifestations of work-stress-related health problems. Previous research findings are summarized that reveal work-related stressors to be strongly associated with health issues such as cardiovascular diseases, musculoskeletal problems, immune dysfunction, gastrointestinal problems, and psychiatric disorders.

Next, an overview is presented of interventions aiming to improve workplace health and well-being at both the individual and the contextual levels. Since this thesis focuses on work-related stress, special emphasis is placed on strategies to prevent workplace stress and its negative consequences. Primary, secondary, and tertiary stress prevention strategies are discussed.

Finally, in the last part of the theoretical review, previous research findings are summarized and open research questions discussed. Consequently, three specific research objectives are defined.

### 2.2.2 Empirical part

The empirical part of this thesis includes the materials and methods section, the results section, and the discussion section. In the materials and methods section, the research design, data, measures, and statistical methods are described in detail. The results section presents the findings with regard to sample characteristics, missing data and imputation, psychometric analysis, and hypothesis testing. In order to account for the three specific research objectives, the findings in terms of hypothesis testing are divided into three parts: results from moderated regression analysis, results from structural equation modelling, and results from latent class cluster analysis. These findings are individually discussed in the discussion section, and the particular findings are also considered as a whole in the general discussion subsection. The latter includes a discussion of both the strengths and weaknesses of this entire thesis project, as well as the practical implications with regard to prevention strategies aiming to promote employees' health.

# CHAPTER 3

# Theoretical framework

## 3.1 The evolution of the concept of stress and recent developments

### 3.1.1 Homeostasis

Historically, stress research is considered to originate from the studies by Claude Bernard (Goldstein & Kopin, 2007), who argued that living organisms constantly try to keep their internal environment (the so-called *milieu intérieur*) on a constant level, even when the external environment changes (Bernard, 1878). The key argument of Bernard's theory is that physical threats to the organism evoke physiological reactions to face these threats. Even though Bernard did not use the term *stress*, his ideas about the bodily responses to specific demands from the environment are considered as the foundation of the concept of stress (Lovallo, 2015, p. 31).

Building on these achievements, Walter Cannon (1929) coined the term *homeostasis*, defined as the 'coordinated physiological reactions which maintain most of the steady states in the body' (p. 400). According to Cannon, the organism is an open system related to its surroundings through receptors and organs. Changes in the environment thus also affect the organism and evoke reactions in the system which may cause internal disturbances. These disturbances usually remain within specific limits; automatic physiological adjustments prevent great oscillations and the internal states remain within an optimal range. For example, when the organism detects an increase of the core body temperature due to hot climate, the thermo-regulatory system activates the

sweat glands and diverts blood flow to normalize the core body temperature. A number of physiological variables are regulated by such compensatory responses.

Although Cannon was first and foremost a physiologist and his primary interests lay in the investigation of physiological reactions, he also recognized that psychologically meaningful factors are among the most powerful stimuli with regard to physiological adaptation. Fear, rage, pain, and hunger and their related emotional disturbances were seen to be strongly associated with bodily changes such as alterations in digestion, adrenal secretion, or an increase in blood sugar (Cannon, 1927). Although the research by Bernard and Cannon contributed greatly to the evolution and development of the concept of stress, the pioneering work of Hans Selye in particular popularized the stress concept most (Goldstein & Kopin, 2007; Lovallo, 2015, p. 32). His basic ideas are described in the following paragraphs.

### 3.1.2 Selye and the general adaptation syndrome

In line with Bernard and Cannon, Selye (1973) considered stress as a physiological response to any threat to the organism. However, unlike Bernard and Cannon, he differentiated between two distinct physiological responses: first, each specific demand to the organism is followed by a specific and unique response. When doing sports, for instance, there is an increased demand upon the musculature and the heart is required to beat more rapidly and strongly. This reaction is specific to the demand.

Second, irrespective of the nature of the demand, any challenges placed upon the organism are also thought to cause a consistent pattern of nonspecific responses. For example, in his experiments Selye (1936) found that rats exhibited a typical syndrome after exposure to stressful situations. This syndrome involved consistent bodily adaptations such as changes in the size of glands and organs, disappearance of fat tissue, or a fall in body temperature. These unspecific responses were found to be independent of the actual stressor (e.g. cold, surgical injury, excessive muscular exercise) and were considered as the essence of stress.

Hence, each challenge placed upon the organism was thought to evoke a specific response that deals with the particular demand on the one hand, and an unspecific and basic response on the other hand. As the nonspecific responses in particular were found to cause considerable damages to the organism, Selye focused his research on this typical syndrome, which he termed the *general adaptation syndrome (GAS)* (Selye, 1936, 1950).

The GAS consists of three stages (Selye, 1936): in the initial stage, the *alarm reaction*, the organism responds to an acute stimulus by evoking an orchestrated set of physiological reactions in order to meet the increased demands upon the body. In

the second stage, the stage of *resistance*, the organism initiates the necessary bodily changes to maintain the compensatory mechanisms against the stressor and to bring the organism back into balance, until the stressful situation is overcome or the organism is no longer able to sustain the compensatory actions. The latter point is critical for the third stage, namely the stage of *exhaustion*. The failure to compensate in this third stage can harm the body considerably or even result in death (which was actually the case with Selye's laboratory animals).

Accordingly, although physiological stress reactions have protective effects on the organism in the short term, physical damage results when the exposure to extensive demands persists over a longer period of time and when compensatory processes fail. Selye (1950) thus considered stress, in a biological sense, as 'the interaction between damage and defence, just as in physics tension or pressure represents the interplay between a force and the resistance offered to it' (p. 1384). Generally speaking, stress represents a dynamic process which involves the demands placed upon the organism on the one hand, and the (physiological resistance) resources available to deal with the demanding situation on the other hand. This idea is critical for this thesis and is discussed in more detail in section 3.2.

### 3.1.3 Allostasis and allostatic load

#### From homeostasis to allostasis

Building on these preceding theories and concepts, the most influential theory in recent years has been *allostastic load theory* (McEwen, 1998; McEwen & Stellar, 1993). This theory focuses on the effects of chronic and repeated demands on the organism, and explains the underlying physiological mechanisms of the stress-health link. Allostatic load theory is based on the concept of *allostasis* (Sterling & Eyer, 1988), maintaining that the 'internal milieu varies to meet perceived and anticipated demand' (p. 646). In essence, allostasis means that physiological stability can be maintained predominantly through change (McEwen, 2000a). In other words, to maintain stability a number of physiological mechanisms (e.g. neural, cardiovascular, autonomic, immune or metabolic) are forced to evoke allostatic variations in the body. These variations help the body to mobilize its forces and to meet the requirements of the environment.

Although Sterling and Eyer (1988) proposed that the allostatic system largely overrides the homeostatic system, they did not intend to conceptually replace homeostasis with allostasis, but rather argued for a coexistence of these two systems. One crucial difference to homeostatic systems is that allostatic systems are not required to remain within narrow limits, but rather have much broader boundaries in order to adapt appropriately to internal and external demands. For example, Sterling and Eyer

(1988) found arterial blood pressure to vary considerably during a period of 24 hours, depending on the behavioural states and environmental circumstances. They argued that the idea of a constant state is a fiction for most physiological processes. Rather, 'to maintain stability an organism must vary all the parameters of its internal milieu and match them appropriately to environmental demands' (Sterling & Eyer, 1988, p. 636).

A second difference to homeostasis is that allostasis emphasizes physiological parameters to vary also according to anticipated demands. Thus, the organism can make the necessary adjustments also in advance, in order to meet not only current but also predicted needs. This means that allostasis theory considers not only physiological sources of stressors, but also psychological sources.

### Allostatic (over)load

In general, allostastic mechanisms are thought to protect the organism from short-term threats, but can harm the body if threats prolong for an extended period of time or if sufficient recovery fails. In the former case, a certain demand evokes adequate physiological responses in the organism (e.g. activation of the sympathetic nervous system or the hypothalamic-pituitary-adrenal [HPA] axis), which are then sustained for an appropriate period of time and afterwards shut down for complete recovery. In this case, the systems are turned off when the stressful situation is over and no harm to the organism should be expected.

However, if the allostatic mechanism remains activated or elevated over an extended period of time, and therefore complete recovery fails, the organism and the involved systems may be negatively affected. These damages and costs resulting from allostatic adaptations to repeated or chronic demands were labelled *allostatic load* or *allostatic overload* (McEwen, 1998).

More specifically, McEwen (1998) described four different situations in which allostatic load may occur and may thereby have negative consequences for health: (1) frequent demands permanently induce allostatic responses and thereby lead to wear and tear of the affected systems; (2) habituation to repeated demands of the same type fails; (3) recovery is lacking due to the inability to turn off allostatic reactions after stress exposure; and (4) an inadequate response of a particular system evokes responses of other systems which are supposed to compensate for the failure of the affected system.

The fundamental idea of allostatic load theory thus implies that even though the allostatic mechanisms protect the body from internal and external threats, the wear and tear due to chronic over- or underactivity of the regulatory processes results in damage to the affected systems (McEwen, 1998; McEwen & Stellar, 1993). Hence, if an

individual faces extensive demands over an extended period of time or if an individual's allostatic reactions are inefficient, the compensatory systems may be depleted and in turn negatively affected. Seeman, McEwen, Rowe, and Singer (2001), for example, found individuals with higher levels of physiological activity (i.e. indicating higher levels of allostatic load) at baseline to reveal an elevated mortality risk and a higher decline in cognitive and physical health seven years later, in comparison to those with lower physiological activity levels at baseline. Thus, the exposure to extensive demands over an extended period of time and the resulting allostatic load may play a significant role in developing critical diseases.

Unlike other biological theories of stress, the concept of allostatic load also considers the stress response to be mediated by individual and group differences in aspects such as genetic disposition, the general state of physical health, behavioural factors and lifestyle, and social and psychological resources (McEwen, 1998, 2000a, 2008). This also implies that specific factors and resources may have the potential to alter allostatic responses and to prevent damage from allostatic (over)load.

### 3.1.4 Defining stress

Although *stress* has become an important concept in everyday life and language, there is still great ambiguity about the meaning of this term. Even in scientific terms, there is not the one and only generally accepted definition of stress. A general lack of precision in the definition of technical terms is quite common in the scientific world. Further prominent examples of this phenomenon are the rather vague and ambiguous definitions with regard to intelligence, creativity, and happiness. Every person has an idea about the meaning of these terms and concepts, but concrete and precise definitions are rarely observed.

Butler (1993) has argued that there are at least three ways of defining stress (see also Hobfoll, 1989): (1) stimulus-based, (2) response-based, and (3) process-oriented. To put it differently, stress may either represent an event that threatens the organism (e.g. an electric shock, sleep deprivation, high demands at work); may be considered as the reaction of the organism in response to that event (e.g. physiological arousal, negative affect, mental strain); or may be defined as a dynamic process in which internal and external factors interact with each other.

**Stimulus-based** Stimulus-based definitions focus on external sources of stress (Butler, 1993). In the *Oxford English Dictionary* ('stress, n', 2017) for example, stress is defined as 'force or pressure exercised on a person'. Stress therefore relates to force or pressure; the more pressure exerted on a person, the higher the burden experienced. A stimulus-

based conceptualization of stress was also provided by Wheaton (1999). He outlined different kinds of stressors and placed these stressors on a stress continuum. At one end of the continuum are discrete stressors (key characteristics: acute and time-limited), and at the other end are continuous stressors (key characteristics: slow and subtle onset of the event, open-ended and recurring). Sudden traumas and life change events were placed near the discrete end of the continuum. Chronic stressors and non-events (something anticipated that did not occur) were placed near the continuous end. Daily hassles were placed in the middle of these two poles. Wheaton concluded that different kinds of stressors have differential effects on health, with chronic stressors and childhood traumas having the greatest impact. This theory thus focuses on the stimulus, and maintains that the stress response is determined by the type of stimulus.

**Response-based** Response-based definitions focus on the reactions of the organism to potentially threatening stimuli. According to Bernard (1878) and Cannon (1927, 1929), stress results from a disturbance of the internal milieu and the level of stress can therefore be measured in terms of changes in physiological variables (see also Lazarus & Folkman, 1984, p. 2). Thus, stress can be considered as a deviation from homeostasis and reflects the bodily responses to internal and external threats. In this regard, Cannon also introduced the concept of so-called 'fight or flight' responses which describe acute physiological stress responses that occur in response to a potentially harmful situation. The concepts of Bernard (1878) and Cannon (1927, 1929) thus clearly focus on an organism's responses to an event.

In a similar vein, Selye's (1936, 1950, 1973) main interest was to examine the bodily responses to any threat to the organism. He pointed out that although the challenges that individuals face in diverse situations are completely different, in each of these situations the organism responds in a stereotyped manner to cope with the increased demands upon the body. However, Selye (1973, p. 692) clearly differentiated between the cause and the effect, and he labelled the stimuli that evoke the reactions in the body as *stressors* and the 'nonspecific response of the body to any demand made upon it' as *stress*. Selye's definitions are still popular in today's scientific language. For example, in the *APA Dictionary of Psychology* stress is defined as 'the physiological and psychological response to internal and external stressors' ('stress, n'; VandenBos, 2015, p. 1036).

**Process-oriented** Both the stimulus- and the response-based conceptualizations of stress have been criticized because of two main reasons (see e.g. Antonovsky, 1979; Hobfoll, 1989; Lazarus & Folkman, 1984): first, the notion of a unidirectional cause-and-effect relationship is too simplistic and does not reflect the complex, dynamic, and

reciprocal interactions between the stressor and the response to that stressor. Second, the idea that responses to stressors are uniform among human beings (see e.g. Selye, 1950) is a fiction. Individual differences in biological (e.g. genetics), psychological (e.g. dispositional beliefs), and social (e.g. social support) factors can strongly influence responses to stressors (McEwen, 1998, 2000a, 2008).

Process-oriented conceptualizations of stress are more complex than plain stimulus-response relationships. One of these definitions stems from McEwen (2000b): stress is defined as an 'event or events that are interpreted as threatening to an individual and which elicit physiological and behavioral responses' (p. 173). Consequently, stress has been associated with both the stimulus and the reaction to that stimulus. Moreover, this definition includes a cognitive component, namely the evaluation and interpretation of a stimulus as either threatening or not threatening. This implies that the level of stress responses depends on the interaction between internal (e.g. appraisals) and external (e.g. physical stressors) factors.

However, it should be noted that McEwen (2000b) also suggested replacing or at least supplementing the term 'stress' by 'allostatic load', due to the imprecise and ambiguous definitions of stress. Nevertheless, although McEwen is primarily a neuroendocrinologist, allostatic load theory does not restrict itself to the biological perspective, but rather considers the allostatic (stress) response to be strongly influenced by psychological, social, and environmental factors. Allostatic load theory can thus be considered a process-oriented and dynamic stress model.

The process-oriented perspective has much in common with most of the psychologically and sociologically oriented approaches, in which stress is considered a dynamic process resulting from interactions of the individual with its environment. Factors such as psychological or social resources, perceptions, appraisals, and coping strategies also play a significant role in these theories (Mark & Smith, 2008). In the following section, an overview of prominent psychologically and sociologically oriented theories is given. These theories and models are most important with regard to work-related stress research and are critical for the understanding of the main research questions of this thesis.

## 3.2 Theories and models of (work-related) stress

### 3.2.1 Salutogenesis and generalized resistance resources

Although the *salutogenesis* concept is not a 'classic' work-related stress theory, the fundamental ideas of this concept are reflected in a number of both traditional and modern theories aiming to explain the (work-)stress-health link. The revolutionary idea

of salutogenesis was to focus on factors that maintain health, rather than on factors that cause disease. One prominent example in this context stem from the sociologist Aaron Antonovsky and his colleagues. About 25 years after World War II, Antonovsky, Maoz, Dowty, and Wijsenbeek (1971) examined adaptations and maladaptations of female survivors of the Nazi concentration camps. Not surprisingly, Antonovsky et al. found that the camp survivors were more poorly adapted than the control group, i.e. the camp survivors exhibited more menopausal symptoms, lower levels of well-being, poorer physical and emotional health, and less role satisfaction. More importantly, however, he also found that a considerable portion of camp survivors were well adapted. Despite having lived through the most terrible experience, quite a large group of camp survivors displayed a good physical and mental health status, had raised families, and were well integrated into society (Antonovsky, 1979). Antonovsky et al. (1971, p. 191) posed the fundamental question: 'What has enabled some women, subjected to the most destructive experience conceivable, to lead well-adapted lives?'

In his book *Health, Stress, and Coping*, Antonovsky (1979) gave some answers to this question. First of all, Antonovsky's revolutionary ideas and fundamental concepts need to be discussed. Most importantly, Antonovsky (1979, 1987b) had shifted the focus from disease to health, or to put it a different way, from *pathogenesis* to *salutogenesis*. While the pathogenic approach focuses on disease or illnesses, the salutogenic approach considers everything that could be important in defining an individual's health status. The salutogenic approach emphasizes factors that maintain human health, rather than focusing on factors that cause illness or health problems. Moreover, unlike the traditional approach of dichotomizing health status into presence or absence of disease, the salutogenic model defines health on a multidimensional health-illness continuum (also *health ease/dis-ease continuum*, or *breakdown*; Antonovsky, 1972). The main purpose of the salutogenesis concept is to identify factors that pushes a person 'toward this end or toward that end of the continuum' (Antonovsky, 1979, p. 37). Antonovsky (1979, p. 56) stated: 'To ask about ease and dis-ease is to ask about generalized factors that are relevant to all diseases.'

This salutogenic perspective is the principle behind Antonovsky's (1979, 1987b) understanding of the *stress* phenomenon. He defined a stressor as 'a demand made by the internal and external environment of an organism that upsets its homeostasis' (Antonovsky, 1979, p. 71). A stressor is thought to place a load on the organism, and Antonovsky (1979) called an organism's response to that stressor *tension*. Tension per se is not necessarily noxious or pathogenic, and can even be related to a positive psychological and physiological state. If tension is successfully overcome, no negative consequences are expected. However, if tension is not resolved and the load on the organism remains high, *stress* results. Antonovsky (1979, p. 3) thus defined stress as

'strain that remains when the tension is not successfully overcome'. This process of dealing with the tension has been called *tension management*. Hence, only if tension management is inefficient, does tension have negative consequences for the organism. In other words, lack of the ability to manage the tension translates tension into stress. This might cause harm to the organism, or, in salutogenic terms, might push the individual in the undesired direction on the health ease/dis-ease continuum.

The salutogenic perspective of the stress phenomenon does not focus on the stimulus or the potential stressor, but rather aims to identify factors that prevent tension from being transformed into a state of stress (Antonovsky, 1979). The reason for largely disregarding the stressful event itself is that analysing the stressor does not explain individual differences in stress responses or movements on the health ease/dis-ease continuum. The critical question is: why do two people who were exposed to an identical stressor exhibit completely different responses to that stressor? Or, in other words, why does one person deal successfully with the demanding situation, while the other person feels overburdened by this situation? Returning to the example above, why do some Nazi camp survivors lead well-adapted lives and others do not?

Antonovsky (1972, 1979) saw the answer in *generalized resistance resources (GRRs)*. The GRRs are the multidimensional (physical, cognitive, interpersonal-relational, etc.) characteristics of an individual, a group, a (sub)culture, or a society that are useful in avoiding or combating any kind of stressor (Antonovsky, 1979, p. 103). The GRRs are important factors in tension management and thereby prevent stressors from having negative consequences for health and well-being. Although Antonovsky did not deny the importance of *specific* resistance resources in particular situations, he considered these specific resources to be too often subject to chance and luck. The GRRs, by contrast, can be applied to meet *any* demands in *any* situation. Given that people live in an ever-changing environment and that the demands to which they are exposed can be extremely variegated and unpredictable, Antonovsky considered generalized resources to be the key factor in helping to understand how individuals adapt to demanding situations.

The definition of GRRs is quite broad and leaves scope for interpretation. This makes an operationalization of this concept difficult. Antonovsky thus asked what is common to all GRRs and found that GRRs give meaning to the countless number of challenges people face in everyday life. In other words, GRRs help to develop 'a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that one's internal and external environments are predictable and that there is a high probability that things will work out as well as can reasonably be expected' (Antonovsky, 1979, p. 119). This global orientation is thought to help the individual to successfully manage the tension, and this concept is

therefore considered to be a crucial variable in explaining movements on the health ease/dis-ease continuum. Antonovsky (1972, 1979) defined this central concept as a *sense of coherence (SOC)*.

The SOC comprises three dimensions (Antonovsky, 1987b): (1) comprehensibility, (2) manageability, and (3) meaningfulness. Whether or not an individual successfully adapts to a particular situation depends on the belief that the events happening in one's life are structured, predictable, and explainable (comprehensibility); that the available resources suffice to efficiently cope with the demands (manageability); and that the events are challenging, and worthy of investment (meaningfulness) (Antonovsky, 1987b). The SOC is a basic element in the personality structure, and it includes perceptual, cognitive, and affective components (Antonovsky, 1979). Under 'normal' circumstances, the SOC is considered to be relatively stable, with only minor ups and downs throughout one's life. However, this does not mean that radical changes in one's own life cannot modify one's SOC to a considerable degree.

### Resources and resilience

Antonovsky's salutogenesis theory is strongly related to the concept of *resilience*. Resilience refers to the adequacy of an individual's resources with regard to a demanding situation and thus represents an individual's ability to efficiently cope with internal and external demands (Antonovsky, 1979; Kobasa, 1979; Lazarus, 1999; Lazarus & Folkman, 1984). People who are resilient are expected to have adequate resources at their disposal in order to cope with a variety of demanding situations. By contrast, people who display low resilience lack adequate resources and are thus less able to efficiently manage potentially stressful situations. The latter case thus represents an increased vulnerability or susceptibility with regard to the development of mental and/or physical health problems in response to chronic exposure to stressors.

In line with Antonovsky's stress concept, resources constitute the main factor that helps to distinguish between resilient and less resilient (or vulnerable) people. Resources are usually defined as a multidimensional construct, including not only psychological factors such as cognitive abilities or optimism, but also biological factors such as energy or physical functioning, as well as social factors such as social skills or social support (Antonovsky, 1979; Kobasa, Maddi, & Puccetti, 1982; Kobasa & Puccetti, 1983; Lazarus, 1999; Murphy & Moriarty, 1976). In other words, resources can be considered as the physical, psychological, and social 'equipment' of a person with regard to resilience against any kind of potentially stressful situations (Lazarus & Folkman, 1984; Murphy & Moriarty, 1976). The main reason for increased vulnerability is seen as a deficiency in such physical, psychological, and social resources, and, in turn, in coping abilities.

For example, a well-functioning immune system is supposed to protect the organism against a variety of pathogens and thereby represents a defence system in order to prevent the development of serious infections in the body. A strong immune system can be seen as a crucial physical resource that protects the organism against external and internal threats. However, in particular circumstances – such as in immunodeficiency – the immune system's ability might be impaired and an organism might be particularly vulnerable to illness.[1] In essence, a well-functioning system represents an individual's ability to demonstrate resilience even in highly demanding situations, whereas an impaired system represents a potential vulnerability in terms of protecting the organism against threats. In a similar vein, high levels of psychological and social resources increase resilience against internal and external demands, whereas a lack of these resources represents a potential vulnerability. In the following paragraphs, empirical evidence for the health-promoting effects of psychological, physical, and social resources is presented.

### Empirical evidence

**Psychological resources** Not only the SOC, but also other related psychological constructs have been found to play an important role in stress processes. These psychological resources involve concepts such as hardiness (Kobasa, 1979), self-efficacy (Bandura, 1977, 1982), locus of control (Rotter, 1966), and optimism (Scheier & Carver, 1985). What they all have in common is that an individual's dispositional beliefs about how the world works and about one's own capacity to take control of life are expected to alter responses to potential stressors.

McSherry and Holm (1994) investigated psychological and physiological parameters in response to a stressful situation and found subjects with low (vs. high) levels of SOC to exhibit more arousal (perceived stress, anxiety, anger) and less efficient coping strategies. As regards the physiological responses (i.e. pulse rate), the authors found that high SOC subjects adapted more efficiently to the stressful situation than low SOC subjects. A similar result was found by Kobasa et al. (1982). In their pioneering work, they demonstrated that personality-based hardiness buffers the negative impact of stressful events on illness. Moreover, they revealed an interaction between personality-based hardiness and physical exercise in predicting illness. The authors concluded that people high in both personality-based hardiness and physical fitness exhibited better health status when they encountered stressors than people that registered high in either hardiness or physical fitness.

[1] It appears necessary to mention that in the opposite case, namely in autoimmune disease, a hyperactive immune system mistakenly attacks normal body tissue and can thereby also cause serious health problems.

As regards the psychological resource of self-efficacy, Bandura, Taylor, Williams, Mefford, and Barchas (1985) found that high (vs. low) perceived coping self-efficacy was associated with a less pronounced physiological stress response (i.e. lower levels of plasma epinephrine and norepinephrine) to a phobic object. In another study, it has been demonstrated that both psychological and physiological stress responses changed as a function of locus of control and the level of perceived control (Bollini, Walker, Hamann, & Kestler, 2004). Jobin, Wrosch, and Scheier (2014) also illustrated that dispositional optimism buffered the negative impact of perceived stress on the physiological stress responses (i.e. diurnal cortisol levels).

Further convincing evidence for the buffering effect of psychological resources has been provided by Taylor et al. (2008). The researchers found a psychological resources composite variable (comprising dimensions such as optimism, mastery, and self-esteem) to attenuate the cortisol response to a stress challenge task. Further analyses revealed that the relationship between psychological resources and stress reactivity was mediated by amygdala activity during threat regulation. The authors interpretation of this finding was that people registering high in psychological resources evaluate a potential stressor as less threatening than people registering low in psychological resources, probably due to the belief of being better able to efficiently cope with the challenging situation (see also section 3.2.2 for further discussions on cognitive appraisal in the stress process; Lazarus & Folkman, 1984).

**Physical resources** There is also convincing evidence for the protective effects of physical resources with regard to stress responses. A meta-analytic review of 34 studies revealed that the aerobic fitness of individuals was related to decreased reactivity (e.g. heart rate, electrodermal activity, perceived stress level) to a stressful or challenging situation (e.g. solving arithmetic problems, holding a limb in ice water; Crews & Landers, 1987). In another study, it has been demonstrated that physical fitness (operationalized as aerobic capacity based on a physical fitness exercise) moderated the effect of life stress (self-report questionnaire) on health (number of visits each participant made to the health facility; J. D. Brown, 1991). J. D. Brown found that higher levels of life stress were strongly related to a higher number of visits to a health facility among subjects who exhibited a relatively low level of physical fitness. By contrast, life stress had no or only little effect on health among subjects who exhibited good physical fitness.

More recent study results support these findings. For example, a study based on survey data tested the moderating effect of physical fitness in the relationship between both social and physiological stressors and health (depression, physical symptoms). The researchers concluded that physical fitness attenuated the adverse effects of the stressors on both depression and physical symptoms (Ensel & Lin, 2004).

Based on a meta-analysis conducted by Jackson and Dishman (2006), it has been concluded that the key factor in this context is recovery. Although the authors failed to reveal the hypothesized buffering effect of physical fitness (i.e. cardiorespiratory capacity) on physiological stress response (e.g. heart rate, blood pressure), they found another health protective effect of physical fitness. People who exhibited higher levels in cardiorespiratory fitness demonstrated better recovery from laboratory stressors than people low in cardiorespiratory fitness.

In a recent review, Silverman and Deuster (2014) revealed further health protective effects of physical resources in the stress process and concluded that the underlying mechanisms are multifaceted and quite complex: physical fitness was demonstrated to optimize physiological and neuroendocrine stress reactivity; physical fitness was found to diminish inflammatory processes; and physical fitness was revealed to promote neuroplasticity as well as growth factor expression. These biological mechanisms are supposed to optimize stress responsiveness and to improve the interplay between the response and recovery systems of the body. Together, this facilitates adaptation to and recovery from the stressful situation, and, in turn, protects the organism from developing health problems and diseases. Moreover, the authors concluded that physical fitness is one of the best indicators of resilience, as well as of long-term health status.

**Social resources** Research also has a long tradition of investigating the protective effects of social resources in the stress-health link. In this respect, indicators of social support in particular have received a great deal of attention. In an early review, Cohen and Wills (1985) found accumulated evidence for the buffering hypothesis of social support. That is, social support (i.e. interpersonal relationships, integration in social networks) mitigated the adverse effects of life stressors (e.g. undesirable life events, economic strain) on depression symptoms.

Another meta-analysis confirmed these results. Viswesvaran, Sanchez, and Fisher (1999) revealed a threefold effect of social support: first, higher levels of social support (e.g. support by co-workers/supervisors, support by friends/family) were related to lower levels of perceived stress-related symptoms (e.g. self-reported health, burnout). Second, social support exhibited a negative relationship to the level of perceived stressors (e.g. work overload, role conflict). Third, social support moderated the relationship between stressors and health.

A further comprehensive review concerning the role of social support in health-related physiological mechanisms again highlighted the protective effects of this social resource (Uchino, Cacioppo, & Kiecolt-Glaser, 1996). The researchers found social support to have beneficial effects on the cardiovascular, endocrine, and immune systems. In line with the reviews described above, this study also revealed evidence for the

buffering effects of social support in the relationship between stressors and health-related outcomes.

### 3.2.2 The transactional model of stress and coping

Like Antonovsky's stress concept, the *transactional model of stress and coping* (also known as the *cognitive-relational theory of stress*) is not a 'classic' work-related stress theory. Nevertheless, the basic ideas of this theory provide a comprehensive framework that explains the transaction between a (working) person and the (working) environment. In Lazarus and Folkman's (1984) transactional model, stress has been defined as 'a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being' (p. 19). This model emphasizes the *relational meaning* that an individual constructs from the transaction between evaluations of the social and physical environment and personal beliefs about the self, the world, or available resources (Lazarus, 2000).

The key factor in the stress process is seen in cognitive appraisals. According to Lazarus and Folkman (1984, p. 24), 'a cognitive appraisal reflects the unique and changing relationship taking place between a person with certain distinctive characteristics (values, commitments, styles of perceiving and thinking) and an environment whose characteristics must be predicted and interpreted'. Through cognitive appraisals an individual evaluates the relevance of what is happening and how this event affects his or her well-being. Since these evaluations are thought to substantially shape the physiological, emotional, and behavioural responses of a person, cognitive appraisal processes play the primary role in this theory.

Two basic component processes of cognitive appraisal have been defined (Lazarus & Folkman, 1984): *primary* and *secondary* appraisal. Lazarus and Folkman have somewhat regretted their initial definition of terminology and considered the distinction between *primary* and *secondary* to be misleading. One reason for this is that these terms may erroneously suggest that 'primary' is more important than 'secondary', and that the primary process precedes the secondary process. However, as will be discussed in more detail below, neither of these meanings conform to the main assumptions of their stress theory. Since the terms *primary appraisal* and *secondary appraisal* have quickly found a place in the scientific literature, Lazarus and Folkman (and others) have stuck with this terminology.

### Appraisal

**Primary appraisal** In the *primary appraisal* process a person evaluates whether there is anything at stake for her or his well-being. A fundamental question that a person might ask during primary appraisal is: 'Do I have a goal at stake, or are any of my core values engaged or threatened? And if there is a stake, what might the outcome be?' (Lazarus, 1999, p. 76). In this regard, three kinds of situations have been distinguished: (1) *irrelevant*, (2) *benign-positive*, and (3) *stressful* situations. First, a situation is appraised as irrelevant, when an encounter has no significance for a person's well-being or, in other words, there is nothing to lose or to gain in the person-environment transaction. In such instances, no particular actions or adaptational processes need to be carried out. Second, a situation is appraised as benign-positive if an encounter itself fosters well-being or if the outcome of such an encounter is expected to do so. Benign-positive appraisals are associated with a positive emotional state, including pleasure, happiness, joy, or fun.

Third, a stressful situation can be further divided into: *harm/loss*, *threat*, or *challenge* (Lazarus & Folkman, 1984). Harm/loss concerns a negative event that has already taken place. This includes not only damage to the physical body (e.g. injuries or illnesses), but also damage to the self (e.g. loss of self-esteem) or loss of a beloved person, a valued object or social standing (Jerusalem & Schwarzer, 1992). By contrast, threat is associated with negative events that have not yet occurred, but are expected to occur. For instance, this might be the case when a person perceives being in danger and anticipates future detrimental outcomes. Threat is therefore associated with negative emotions, especially fear and anxiety. Harm/loss and threat are interrelated, because a negative event that has already taken place also entails negative consequences for well-being in the future. However, the distinction is important, because the appraisal of threat permits planning for the potentially threatening event and to think of anticipatory coping strategies to master the faced situation. Harm/loss, by contrast, occurs abruptly and no actions can be carried out in advance.

The third kind of appraisal in a stressful situation refers to challenge. In challenging situations, people expect great potential for gain, and they seek to prove themselves in order to achieve personal growth and mastery. Challenge is associated with physical and psychological activity, involvement, and engagement (Jerusalem & Schwarzer, 1992). Consequently, challenging situations are thought to result in pleasurable emotions such as enthusiasm, joy, eagerness, and excitement (Lazarus, 1999). Challenge thus has much in common with Selye's (1975) concept of *eustress*. Whereas *distress* refers to the negative stress effects, eustress is thought to be positive for health and well-being.

The process of primary appraisal is also affected by an individual's underlying

beliefs about the world (Park & Folkman, 1997). People's understanding about how the world works influences the meaning that is attributed to an event (i.e. whether a stressful event is appraised as either threatening or challenging). Park and Folkman mention the example of religious beliefs: people who strongly believe in God and trust that God has a divine plan for everyone might experience a potentially stressful event more as a challenge rather than a threat. Consequently, the significance of a potential stressor has to be seen in the context of a person's global beliefs and underlying assumptions.

**Secondary appraisal** Primary appraisal processes are constantly accompanied by secondary appraisal processes, particularly in situations where people perceive harm/ loss, threat, or challenge (Jerusalem & Schwarzer, 1992; Lazarus, 1999; Lazarus & Folkman, 1984). Secondary appraisal refers to 'a complex evaluative process that takes into account which coping options are available, the likelihood that a given coping option will accomplish what it is supposed to, and the likelihood that one can apply a particular strategy or set of strategies effectively' (Lazarus & Folkman, 1984, p. 35). In other words, people are thought to evaluate a stressful event in terms of what must be done to handle the situation and whether they have sufficient resources at their disposal to do so. During this process, people evaluate their own capacity to manage a potentially dangerous or threatening situation and weigh their coping options. The more confidence people have in their capacities, powers, abilities, or resources, the more likely they will perceive a stressful situation as challenging rather than threatening and the fewer unwanted stress reactions are to be expected (Lazarus, 1999; Lazarus & Folkman, 1984).

Beliefs about one's own capabilities can be considered as relatively stable personality traits (Lazarus, 1999). One concept which has received much attention in this context is that of *self-efficacy* (Bandura, 1977, 1982), in particular *general self-efficacy* (Jerusalem & Schwarzer, 1992). General self-efficacy is defined as a 'global confidence in one's coping ability across a wide range of demanding or novel situations' (Schwarzer, Bäßler, Kwiatek, Schröder, & Zhang, 1997, p. 71), and is therefore considered to be an important resource in the appraisal process. People high in self-efficacy are more likely to interpret a danger or obstacle as a challenging situation, rather than a threatening situation. By contrast, people low in self-efficacy are more likely to be threatened and stressed, due to the belief of not being able to effectively manage the demanding situation.

**Reappraisal** As already mentioned above, there is not necessarily an explicit time order for primary and secondary appraisal processes. It is also possible for secondary appraisal to precede primary appraisal, or for primary and secondary appraisal to occur

at the same time (Jerusalem & Schwarzer, 1992). Given that primary appraisal refers to evaluations of the *demands* and secondary appraisal concerns evaluations of one's own *resources*, Jerusalem and Schwarzer even suggested replacing the terms 'primary appraisal' and 'secondary appraisal' with *demand appraisal* and *resource appraisal*, respectively. This would avoid confusion in terms of the time order of appraisal processes.

Nevertheless, primary and secondary appraisal processes seem to function in a reciprocal relationship. In other words, primary and secondary appraisals mutually influence each other. For example, appraisals of one's own resources and coping options (i.e. secondary appraisal) can change the way a particular demand is appraised (i.e. primary appraisal). People may now appraise an initially irrelevant demand as threatening, after realizing that the available resources no longer suffice. Lazarus and Folkman (1984) designated this reciprocal relationship as *reappraisal*. In essence, reappraisal describes an appraisal process that follows an earlier appraisal, or, in other words, a reappraisal refers to an altered appraisal due to new insights from the environment or due to new information from a person's own responses. Primary appraisal, secondary appraisal, and reappraisal are highly interrelated and it seems to be difficult to arrive at a clear delineation of these concepts, in both theoretical and empirical terms. Some researchers (e.g. Hobfoll, 1989) even went further and argued that this approach is tautological, circular, and can therefore never be empirically tested. As an alternative, the conservation of resources theory has been proposed. This theory is described in the following section.

### 3.2.3 The conservation of resources theory

In 1989, Steven E. Hobfoll published an article entitled 'Conservation of resources: A new attempt at conceptualizing stress' (Hobfoll, 1989). This title already implies that this theory aims to provide an alternative to the hitherto dominant stress theories. Hobfoll criticized traditional conceptualizations and definitions of stress as ambiguous, overly complex, and not practically applicable. The *conservation of resources (COR)* theory is supposed to provide a clear, parsimonious, and comprehensive framework that permits direct testing of stress-related phenomena, thereby offering new directions for studying stress.

The title also implies that this theory emphasizes resources, while stressors only come second. The key argument in COR theory is that people have an innate and learned drive to 'retain, protect, and build resources and that what is threatening to them is the potential or actual loss of these valued resources' (Hobfoll, 1989, p. 513; see also Gorgievski and Hobfoll, 2008; Hobfoll, 2001). Hobfoll (1989) even argued that what is essential for an understanding of the stress phenomenon is the predominant role of resources. Resources are defined as those 'objects, personal characteristics, conditions,

or energies that are valued in their own right, or that are valued because they act as conduits to the achievement or protection of valued resources' (Hobfoll, 2001, p. 339). In COR theory, resources are not only thought to have instrumental value to people, but also symbolic value. This means that resources are also important for personal identity, i.e. they help individuals define who they are (Hobfoll, 1989). Resources were categorized into objects (e.g. home, car); personal characteristics (e.g. self-esteem, self-efficacy); contextual conditions (e.g. employment, marriage); and energies (e.g. time, money).

In essence, COR theory maintains that (psychological) stress responses are the reaction of an individual's own resources being actually lost or threatened to be lost, or result when recovery or replacement of resources following a significant investment fails (Hobfoll, 1989, 2001). Examples of loss (or envisaged loss) of resources include loss of important social relationships (e.g. due to death of a family member), loss of financial security (e.g. due to unemployment), or loss of physical capability (e.g. due to illness). Although loss of resources is per se stressful, people usually try to recover from this loss in order to reduce the stressful state. The most effective strategy is thought to be resource replacement. Following job loss, for example, the most direct way to recover would be to quickly find a new job. The stressful state remains until the resource pool has been fully recovered.

Moreover, when not currently confronted with a stressful situation, people are assumed to develop resource surpluses. These surpluses are supposed to protect against future resource losses and are therefore considered an important resilience factor. By contrast, individuals who lack the ability to enrich their resources are particularly vulnerable to future resource investments. For example, people who accumulate money (i.e. enrich their financial resources) during productive times are better prepared for the hard times ahead. A rich pool of resources is thus expected to go along with greater levels of well-being, due to the belief that future resource investments do not threaten the individual's resource capacity.

In contrast to the transactional model of stress and coping, appraisal processes are only of minor importance in COR theory. Rather than focusing on individual differences in appraisal processes, COR theory expects appraisals to be held jointly by people who share a group or culture. The subjective interpretations of stressors and resources by individuals are thus less important than objectively measurable factors (Hobfoll, 2010).

A further assumption of COR theory is that resources do not exist in isolation, but rather develop and act in concert (Hobfoll, 1989, 2001). Thus, resources are thought to exist in so-called *resource caravans* (Hobfoll, 2012). This also means that resources are mutually dependent and that they interact with each other (Hobfoll, Johnson, Ennis, & Jackson, 2003). Two side effects of these resource caravans have been described: *loss*

*spirals* and *gain spirals* (Hobfoll, 1989, 2001). Loss spirals build on the assumption that people invest resources in order to protect against or recover from resource loss. Ongoing loss of resources, however, increasingly depletes the resource pool. An example is the development of burnout: ongoing loss of resources exhausts an individual's resource reserves and, in turn, impairs her/his ability to cope with the situation (Buchwald & Hobfoll, 2004). However, it is also thought that resources develop in aggregate, and tend to generate other resources. In other words, resources facilitate gain and enrichment of other resources, which likely generates gain spirals. For example, high social support likely triggers positive emotions, which, in turn, enhances optimism and self-efficacy. In essence, people low in resources are expected to be particularly vulnerable to current and future loss, whereas people high in resources are assumed to be resilient against any threats to both the resource capacity and coping ability.

A recent review found considerable growth in research on COR theory over the past few years, particularly in the context of work (Halbesleben, Neveu, Paustian-Underdahl, & Westman, 2014). This review found reasonable support for the main assumptions of COR theory, yet a number of unanswered questions still remain. For example, Zeidner, Ben-Zur, and Reshef-Weil (2011) experimentally induced a vicarious life threat, and found this manipulation to result in loss of psychological resources, and in increased levels of threat perceptions and negative affect. In another study, it has been observed that job-related resources (e.g. autonomy, social support, locus of control) were positively related to active coping strategies (e.g. working harder, seeking advice), and negatively related to emotional exhaustion (Ito & Brotheridge, 2003). Moreover, it has been found that resource gain (social support, mastery) by means of a stress reduction intervention was related to reduced levels of psychological strain (Freedy & Hobfoll, 1994).

As regards support for the gain/loss spirals, Llorens, Schaufeli, Bakker, and Salanova (2007) revealed in a longitudinal study the reciprocal causal relationships between task resources, self-efficacy beliefs, and well-being. More specifically, task resources (i.e. time control and method control) increased self-efficacy beliefs, which, in turn, reinforced engagement. Moreover, engagement increased future self-efficacy beliefs, which, in turn, fostered task resources. In a similar vein, Schaufeli, Bakker, and Van Rhenen (2009) observed that job resources (e.g. social support, autonomy, performance feedback) and engagement enhanced each other reciprocally. Conclusive evidence for loss spirals has been provided by Demerouti, Bakker, and Bulters (2004). In a three-wave study, they found baseline work pressure as well as baseline emotional exhaustion to predict future work-home inter-role conflict, and baseline work-home inter-role conflict was found to predict future work pressure as well as future emotional exhaustion. This means

that loss of resources in one domain (e.g. due to work pressure or inter-role conflict) increases vulnerability to additional losses in other resource domains.

### 3.2.4 The job demands-control(-support) model

One of the leading and most influential work-related stress models in occupational health research (see De Lange, Taris, Kompier, Houtman, & Bongers, 2003; Mark & Smith, 2008) is Karasek's (1979; see also Karasek and Theorell, 1990) *job demands-control (JD-C) model*, also known as the *job strain model*. According to this model, two aspects in particular are supposed to be critical with regard to whether or not work is experienced as stressful: the level of job demands and the level of job control.

Job demands refer to work-related stressors, particularly psychosocial stressors such as high workload, time pressure, or conflicts. Job control or decision latitude in turn describes the 'range of decision-making freedom (discretion) available to the worker facing those demands' (Karasek, 1979, p. 287). The combination of high job demands and low job control, in particular, is seen to be characteristic of high-strain jobs. This job constellation is thought to result in mental strain reactions (such as depression, exhaustion, or nervousness) and in physical health problems. Karasek (1979) suggested avoiding the term *stress* in connection with his JD-C model, because his model does not measure stress directly. Instead, he used the term *job strain* to describe a stressful working constellation due to high job demands and low job control. His job strain model postulates that a sufficient level of job control and decision latitude is essential to release or transform stress-induced tension into the energy of action. Lack of job control thus impedes diverse actions being undertaken and the unreleased tension may manifest itself mentally as strain, which is considered as the main stress response.

More specifically, the model differentiates four types of job constellations that result from the joint effects of job demands and job control. First, as already mentioned, when job demands are high and decision latitude is low, high job strain is assumed. By contrast, the model predicts low strain as a result of high job control while job demands are low. The third situation unfolds if job demands and job control are simultaneously low. In this case, the model hypothesizes a *passive* job, in which a lack of overall activity (e.g. problem-solving activity) is expected. Fourth, at the opposite extreme, the combination of high job demands and high job control results in an *active* job that is hypothesized to be associated with the development of new learning behaviour, problem-solving strategies, or coping pattern development (Karasek et al., 1998). Karasek (1979) confirmed his main hypotheses by illustrating, on the one hand, that workers in high-strain jobs were more likely to report exhaustion, depression, nervousness, anxiety, sleep disturbances, and job dissatisfaction. On the other hand,

low-strain jobs (the combination of low demands and high control) were found to be associated with lower than the average number of health problems.

In the late eighties, Johnson and colleagues (Johnson & Hall, 1988; Johnson, Hall, & Theorell, 1989) proposed extending Karasek's JD-C model with a social dimension, namely work-related social support. This extended model has been called the *job demands-control-support (JD-C-S) model*. This model highlights the moderating role of social support in the relationship between job strain and health problems. A lack of social support combined with high job strain is considered to further increase the likelihood of developing work-related health problems. Johnson and Hall (1988) and Johnson et al. (1989) confirmed the assumptions of their JD-C-S model by demonstrating that workers with high demands, low control, and low social support were twice as likely to report cardiovascular disease than a comparison group with low demands, high control, and high social support.

A large number of studies has tested the main hypotheses of both the JD-C and the JD-C-S models (for extensive reviews see e.g. De Lange et al., 2003; der Doef & Maes, 1998, 1999; Häusser, Mojzisch, Niesel, & Schulz-Hardt, 2010). Der Doef and Maes (1999), for example, found 28 out of 41 studies and 9 out of 19 studies to support the strain hypothesis in terms of the JD-C and the JD-C-S models, respectively. These supportive studies indicate that the combination of high job demands and low job control (as well as low social support) is associated with poor general psychological well-being.

However, the evidence for a moderating or 'buffering' effect of job control and social support was rather weak. Only a few studies found job control as well as social support to attenuate the negative impact of job demands on general or job-related psychological well-being or burnout (der Doef & Maes, 1999). Moreover, the findings supporting the models were predominantly derived from cross-sectional designs, whereas almost none of the longitudinal studies yielded support for the main hypotheses of the JD-C and JD-C-S models. Similar results were found in a review of De Lange et al. (2003), in which only high-quality studies based on longitudinal designs were included. Although evidence highlighted the lagged causal effects of a detrimental working environment (i.e. by examining the job demands dimension and the job control dimension separately) on self-rated health and well-being, only modest support was found for the strain hypothesis. That is, the review failed to reveal that high job demands with low job control (and low social support) combined result in poor physical and psychological health over time.

The JD-C and JD-C-S models have often been criticised due to two main reasons (see e.g. Mark & Smith, 2008). First, although the original JD-C model has been extended by a social support dimension, it restricts itself to only two specific resources

(i.e. job control and social support), while other beneficial factors with regard to the working environment are neglected. For example, positive factors in terms of rewards (e.g. payment, education opportunities), performance feedback, or job security are not reflected in the model, even though these work-related resources were previously found to play an important role in work-related stress processes (e.g. Demerouti, Bakker, Nachreiner, & Schaufeli, 2001).

Second, the model cannot explain individual differences in the vulnerability to strain in persons with similar levels of job demands, job control, and social support. This criticism gave rise to the inclusion of further variables in the model. For example, Schaubroeck and Merritt (1997) revealed self-efficacy as a moderating variable in the JD-C model, such that high control attenuated the negative impact of job demands on blood pressure only for workers with high job self-efficacy. Similarly, Meier, Semmer, Elfering, and Jacobshagen (2008) found a three-way interaction between person-related resources (i.e. locus of control and self-efficacy), job control, and job demands with regard to affective strain and musculoskeletal pain. They demonstrated that job control buffered the detrimental effects of job demands only for those with high levels of both locus of control and self-efficacy.

### 3.2.5 The effort-reward imbalance model

In a second prominent model, namely the *effort-reward imbalance (ERI)* model (Siegrist, 1996), the focus of analysis shifted from control to reward. The key concept in this model is reciprocity, which means that an important prerequisite of social life is exchange. Especially work is seen as a critical part of the *socially organized exchange process* in which workers' efforts are supposed to be compensated by the society in terms of adequate rewards. Lack of reciprocity results if an individual has the feeling that the efforts made are rewarded inappropriately, and this state is assumed to be associated with physical and psychological strain reactions.

Two sources of efforts were defined in the ERI model: extrinsic and intrinsic efforts (Siegrist, 1996). While extrinsic efforts are associated with factors directly related to the working environment (e.g. working in a demanding job, under high work pressure, or with many obligations), intrinsic efforts concern personal coping strategies in particular (e.g. efforts to achieve control over demanding tasks). Societal rewards in turn concern the satisfaction of basic needs: (1) to ensure status control (e.g. by providing job stability, or by offering promotion prospects); (2) to guarantee financial security (e.g. by achieving a fair pay scale); and (3) to satisfy the need for esteem and approval at work (e.g. by recognizing an individual's hard work and achievements).

If an individual experiences the high efforts made at work to be rewarded inap-

propriately, both psychological (e.g. anger or depression) and physiological responses of the autonomic nervous system may result. Consequently, these stress responses are also thought to cause serious health problems (Siegrist, 1996). In fact, Siegrist found that single measures of effort and reward were good predictors of cardiovascular disease. Moreover, he demonstrated that the aggregate measure of ERI (i.e. a score that reflected the level of perceived imbalance between efforts and rewards) was even more powerful in predicting this health outcome.

There is much further support for the main assumptions of the ERI model. For example, De Jonge, Bosma, Peter, and Siegrist (2000) illustrated that employees with both high efforts and low rewards had increased risks of emotional strain responses (i.e. emotional exhaustion), of (psycho-)somatic health issues, and of job dissatisfaction. In a review, van Vegchel, de Jonge, Bosma, and Schaufeli (2005) revealed that all of the studies testing the ERI model supported the hypothesis that the combination of high efforts and low rewards manifests itself in physical health problems, and in cardiovascular diseases in particular. Furthermore, they found many studies to confirm the assumption that psychological and job-related well-being is negatively influenced by a mismatch of (high) efforts and (low) rewards.

### 3.2.6 The job demands-resources model

A further well-known model which is supposed to integrate previous theories is the *job demands-resources (JD-R) model* (Demerouti et al., 2001). In recent years, this model has gained great popularity among researchers and is currently considered one of the leading models in the context of occupational health research, along with the JD-C and the ERI models (Schaufeli & Taris, 2014). Schaufeli and Taris (2014) have mentioned two main reasons for its popularity: first of all, in line with the JD-C and the ERI models, the JD-R model assumes that workers' somatic and mental health is affected by a combination of both positive and negative aspects of the working environment. However, the JD-R model does not restrict itself to specific beneficial or adverse factors (e.g. job control as only resource in the JD-C model). Instead, the JD-R model recognizes *any* demands and *any* resources to affect health, and thus is much more flexible and can be applied to a broader range of work settings.

A second explanation for its popularity is that there is actually not only one JD-R model on which all previous research is based. Rather, the model permits a heuristic way of thinking, and thereby offers explanations for the associations between different job characteristics and health, well-being, motivation, and job satisfaction. This fact, however, has also been recognized as a potential shortcoming: due to its wide applicability, usefulness, and flexibility, the model is often applied in a somewhat casual and loose way (Schaufeli & Taris, 2014). Nevertheless, the positive features of

this model presumably contributed to the JD-R's achievements in stress research and practice.

### The early job demands-resources model

From a historical perspective, the model was first published by Demerouti et al. (2001), who aimed to explain the causal pathways of burnout. The authors considered two main factors: job demands and job resources. While job demands relate to 'those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort and are therefore associated with certain physiological and/or psychological costs' (Bakker, Demerouti, De Boer, & Schaufeli, 2003, p. 344), job resources were defined as all beneficial aspects of the job that do any of the following: (a) mitigate job demands and the related costs (physiological and/or psychological); (b) are functional in achieving work objectives; and (c) facilitate personal growth and development (Bakker, Demerouti, De Boer, & Schaufeli, 2003; Demerouti et al., 2001).

### Dual processes of the job demands-resources model

The original JD-R model considered two processes to be critical for the development of burnout symptoms (Demerouti et al., 2001). The first process – referred to as the energetic or health-impairment process – was justified by Hockey's (1997) state regulation model of compensatory control. This model states that human beings strive to maintain performance levels in order to achieve pre-set goals. Exposure to high job demands, however, requires an investment of mental effort such as narrowing of attention or redefinition of task requirements. Even though this investment involves mental energy loss, the effects on the organism are minor when the level of energy utilized corresponds with the individual's energy budget. However, where demands exceed an individual's capacities, it is likely that efforts are further increased to a level beyond an individual's reserve limits. Such a compensatory strategy to deal with extensive demands might have unwanted side effects in terms of mental strain reactions – defined as negative mood states or feelings of mental impairment (i.e. core components of burnout: exhaustion or cynicism; Bakker, Demerouti, De Boer, & Schaufeli, 2003; Hockey, 1997) – or physiological stress responses such as sympathetic nervous system activation.

The second premise of the early JD-R model is that high levels of job resources are related to motivational aspects such as high work engagement, lower cynicism, and strong performance (Demerouti & Bakker, 2011). The motivational role of job resources can be both intrinsic and extrinsic in nature: while the intrinsic role refers to cognitive

aspects and behaviour patterns that are beneficial for personal growth or development, resources (i.e. social and organizational resources) play an extrinsic role if they facilitate the achievement of work objectives (Demerouti & Bakker, 2011; Demerouti et al., 2001). Lack of job resources therefore impedes the reaching of work goals or the development of the person to his or her full potential, thereby leading to withdrawal behaviour, reduced motivation, and disengagement. These mechanisms have been referred to as the motivational process of the JD-R model.

### The interaction between job demands and job resources

Next to these two processes, the JD-R model proposes that job resources attenuate the negative effects of job demands on mental strain. This buffer hypothesis follows from the definition of job resources, which are supposed to reduce job demands and the related costs. The moderating role of job resources is consistent with the main assumptions of the JD-C and the ERI models. However, while these models maintain that high job control and adequate rewards, in particular, diminish the negative effects of a demanding working environment, the JD-R model considers *any* combination of demands and resources to be critical in predicting health and well-being (Demerouti & Bakker, 2011). The significance and meaning of specific types of demands and resources with regard to stress responses are assumed to depend upon the particular working context.

Research by Bakker, Demerouti, and Euwema (2005) partly confirmed the buffer hypothesis by demonstrating that approximately 56 % of the tested interactions (i.e. 18 out of 32 interactions) between specific job demands (e.g. work overload, emotional demands) and specific job resources (e.g. autonomy, social support) explained a considerable proportion of the variance in two core aspects of burnout, namely exhaustion and cynicism. In a more recent study, Q. Hu, Schaufeli, and Taris (2011) found empirical support for both the energetic and the motivational processes, but rather weak evidence for additional buffering effects.

### The revised version of the job demands-resources model

Only three years after the first publication of the JD-R model, Schaufeli and Bakker (2004) presented and tested a revised version of this model. As can be seen in Figure 3.1, this model assumes mental strain (reflected by burnout symptoms) and work engagement (defined as a positive and fulfilling state of mind in terms of work-related vigour, dedication, and absorption; Schaufeli & Bakker, 2004; Schaufeli & Taris, 2014) to mediate the relationship between job demands and health problems, and the relationship between job resources and performance or organizational commitment, respectively.

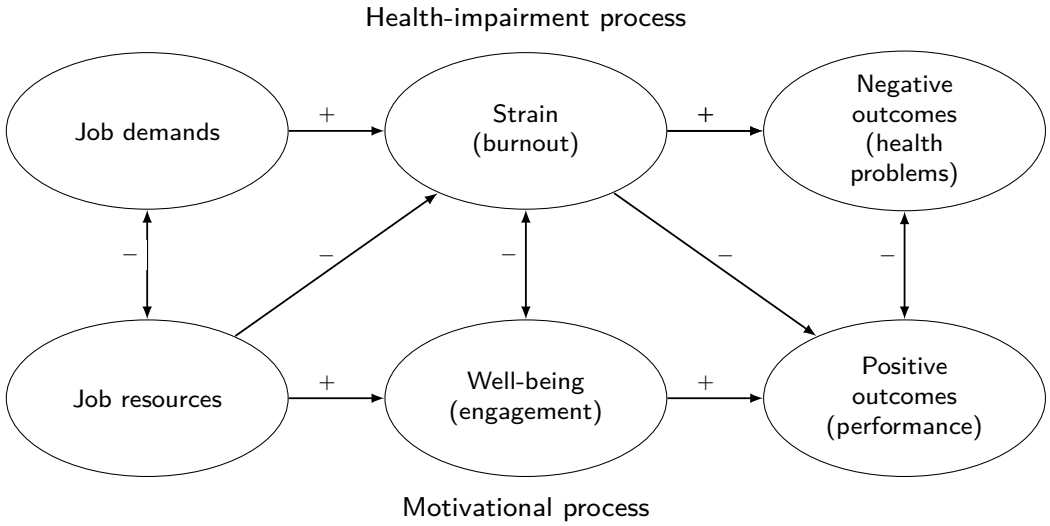


**Figure 3.1:** The revised version of the job demands-resources model. Reproduced without adaptation from 'A critical review of the job demands-resources model: implications for improving work and health,' by W. B. Schaufeli, and T. W. Taris, 2014, In G. F. Bauer, and O. Hämmig (Eds.), *Bridging occupational, organizational and public health: a transdisciplinary approach* (p. 43–68), Dordrecht: Springer Netherlands, p. 46, with permission from Springer Science+Business Media Dordrecht (see chapter C of the appendix). Copyright 2014 by Springer Science+Business Media Dordrecht. See text for further explanations.

The energetic process was thus extended by assuming that extensive job demands lead to mental strain in a first step, and result in health problems in a second step. This is in line with previous research on burnout and stress (e.g. McEwen, 1998; Melamed, Shirom, Toker, Berliner, & Shapira, 2006), which demonstrated excessive (job) demands and the related strain reactions to be associated with adverse long-term effects on the organism (e.g. cardiovascular diseases, psychosomatic symptoms, or psychiatric disorders).

As for the motivational process, the revised version of the JD-R model proposes that high job resources stimulate work engagement, and work-related well-being. The effect of job resources on engagement and well-being can be explained by both the extrinsic and intrinsic aspects of job resources: job resources facilitate the achievement of work-related goals on the one hand (reflecting the extrinsic aspect of job resources), and ensure the satisfaction of personal human needs such as the need for personal growth and development on the other hand (reflecting the intrinsic aspect of job resources). Moreover, work engagement is expected to mediate the relationship between job resources and organizational outcomes such as commitment and performance. In other words, high levels of job resources are thought to increase work-related well-being, that in turn enhances commitment and performance. Beside the positive effects of job resources on engagement and well-being, high levels of job resources are also assumed

to decrease mental strain. In turn, lower levels of mental strain are expected to have positive effects on organizational outcomes (i.e. performance and commitment).

There is convincing evidence for the validity of the revised JD-R model across different countries, cultures, and occupational groups. Cross-sectional evidence confirming the main assumptions of this model were found among Dutch employees of a call centre (Bakker, Demerouti, & Schaufeli, 2003), an insurance company, a pension fund company, an occupational health and safety service, and a home-care institution (Schaufeli & Bakker, 2004); among Finnish teachers (Hakanen, Bakker, & Schaufeli, 2006); among volunteer staff of an Australian ambulance service (Lewig, Xanthopoulou, Bakker, Dollard, & Metzer, 2007); among Austrian white- and blue-collar workers (Korunka, Kubicek, Schaufeli, & Hoonakker, 2009); and among Chinese blue-collar workers and health professionals (Q. Hu et al., 2011).

Moreover, confirming longitudinal evidence for both the energetic and motivational process of the JD-R model has been provided by Hakanen, Schaufeli, and Ahola (2008). In a follow-up study over a three-year period, they demonstrated that job demands predicted burnout status three years later, and, in turn, they revealed that burnout had a significant impact on future levels of depression (reflecting the energetic process). As regards the motivational process, job resources affected work engagement over time, which, in turn, predicted future organizational commitment. Moreover, there was no evidence for reversed causation, i.e. neither work engagement nor burnout predicted job demands or job resources, and neither depression nor organizational commitment predicted burnout or work engagement. These findings clearly support the claims about the causally mediated processes assumed in the revised JD-R model.

### The integration of person-related resources in the job demands-resources model

Both the early and the revised versions of the JD-R model focused on valuable factors directly related to the work environment (i.e. job resources), whereas the beneficial person-related characteristics of individuals were often disregarded. Given that prominent psychological stress theories (e.g. Lazarus & Folkman, 1984, see section 3.2.2) assume human behaviour and experience to be affected by an interaction between personal and environmental aspects, recent research has also come to integrate personal or person-related resources in the JD-R model. Person-related resources are usually defined as aspects of the self associated with resilience and hardiness (see also section 3.2.1 for further explanations on the concept of resilience), and refer to the ability to deal with one's environment in a successful manner (Hobfoll et al., 2003; Schaufeli & Taris, 2014). Examples of person-related resources which have subsequently been included in the JD-R model are self-esteem, self-efficacy, and optimism (Airila et al., 2014; Xanthopoulou, Bakker, Demerouti, & Schaufeli, 2009a, 2009b). To date,

study results concerning the role of person-related resources in the JD-R model are inconclusive and seem to vary depending on which types of person-related resources were studied. Schaufeli and Taris (2014) reviewed findings concerning the integration of person-related resources in the JD-R model and revealed five different approaches:

1. *The direct effect on mental strain and engagement.* Given that person-related resources are expected to have health-promoting effects and to be positive for development and well-being, they are supposed to be negatively related to mental strain and positively related to work engagement. Indeed, in a longitudinal study among Spanish teachers, it has been found that person-related resources – in terms of mental and emotional competences – predicted future levels of burnout and work engagement (Lorente, Salanova, Martínez, & Schaufeli, 2008).
2. *The moderating role of person-related resources.* By definition, person-related resources should have the potential to buffer the negative impact of extensive job demands on stress responses, and to reinforce the positive effects of job resources on work engagement. These assumptions were supported by demonstrating that the adverse effects of job demands (i.e. workload and interpersonal conflict) on mental strain (i.e. emotional exhaustion) were more pronounced among employees who lacked person-related resources (i.e. with a strong prevention focus oriented towards safety and security; Brenninkmeijer, Demerouti, Blanc, & van Emmerik, 2010), and by demonstrating that the person-related resource of high intrinsic work motivation increased the beneficial effects of job resources (i.e. job autonomy) on work engagement (den Broeck, Ruysseveldt, Smulders, & Witte, 2011).
3. *The mediating role of person-related resources.* Recent research also provided contradictory evidence with regard to the moderating effects of person-related resources. Instead of supporting the hypothesized buffering role of person-related resources in the relationship between job demands and emotional exhaustion, Xanthopoulou, Bakker, Demerouti, and Schaufeli (2007) found person-related resources to mediate the link between job resources and exhaustion. In other words, high job resources predicted higher levels of person-related resources, which, in turn, were found to result in lower levels of exhaustion. This finding can be justified by a resource-oriented stress concept (see subsection 3.2.3 for detailed explanations on the *conservation of resources theory*; Hobfoll, 1989), which states that specific kinds of resources (e.g. job resources) tend to foster other resources (e.g. person-related resources), and resources in general are considered a critical factor with regard to resilience and well-being. Supporting this reasoning, den Broeck, Vansteenkiste, Witte, and Lens (2008) found that the satisfaction of basic psychological needs (i.e. autonomy, belongingness, and competence) fully

explained the relationship between job resources and exhaustion, and partially accounted for the link between job resources and work engagement (i.e. vigour).

Job resources were thus seen as a hypothetical antecedent of person-related resources insofar as a resourceful working environment promotes the accumulation of person-related resources. For example, working in a highly controllable environment (i.e. in a job with high job resources) may result in higher levels of self-efficacy or self-esteem (i.e. person-related resources). However, Xanthopoulou et al. (2007) also argued for a potential reversed direction and found job resources to be an antecedent of person-related resources. Individuals high in person-related resources may thus be more capable of creating a resourceful work environment than those low in person-related resources. Finally, in a longitudinal study it has been demonstrated that job resources and person-related resources are mutually related to each other (Xanthopoulou et al., 2009a). More specifically, person-related resources and job resources affected each other over time and this link therefore reflected a dynamic relationship acting in cycles (see also Kohn & Schooler, 1982).

4. *The impact of person-related resources on the perception of work characteristics.* Lazarus and Folkman (1984) have pointed out that an individual's perceptions and evaluations of the environment depend on his/her available resources. Individuals high in person-related resources, compared to those low in person-related resources, may perceive their jobs as less burdensome due to the belief of being capable of adequately meeting these challenges (see also subsection 3.2.2). Judge, Bono, and Locke (2000) also argued that individuals high in person-related resources predominantly seek out information in their work environment that result in positive evaluations of their jobs, whereas individuals low in person-related resources focus more on unfavourable aspects of the work environment. Indeed, they found core self-evaluations – a construct comprising self-esteem, self-efficacy, low neuroticism, and locus of control – to impact how individuals perceive the characteristics of their jobs, which, in turn, influenced job satisfaction. Person-related resources may thus shape the way individuals perceive their working environment, and this determines whether or not a working environment causes stress and strain responses.

5. *Person-related resources as confounding or third variables.* Given that person-related resources influence the appraisal of the work environment and directly affect health and well-being, there is reason to believe that these person-related resources play a confounding role in the relationship between work characteristics and psychological and physical health. In a study by Bakker et al. (2010) this reasoning was only partly supported. After controlling for neuroticism and extroversion (i.e. indirect indicators of person-related resources), the relationship

between job resources and organisational commitment as well as between job demands and health problems, respectively, still remained strong. Furthermore, the indirect effects of neuroticism and extroversion on health problems and organisational commitment (via job demands and job resources, respectively) were very weak and explained only a small portion of the covariance.

To sum up, person-related resources play a crucial role in the JD-R model. However, diverging research designs have led to a number of different findings, while the conclusions of these findings should not be considered as mutually exclusive. Instead, the role of person-related resources in the JD-R model may be multifaceted and the mechanisms involved may also interact with each other.

## 3.3 Work-stress-related health problems

The negative health consequences of chronic work-related stress exposure are manifold. Adverse outcomes include cardiovascular diseases, musculoskeletal problems, immune dysfunctions, and mental and affective disorders. In the following paragraphs, empirical evidence and possible explanatory approaches are summarized and discussed.

### 3.3.1 Cardiovascular diseases

Quite a few reviews and meta-analyses about the link between work-related stress and cardiovascular diseases have been published to date. Kivimäki et al. (2006) conducted a systematic review and meta-analysis of 14 prospective studies and estimated the relative risk of coronary heart disease (CHD) in association with a stressful working environment (as measured by the JD-C model, the ERI model, and the organizational injustice model). The researchers observed the following (adjusted) risk ratios: 1.16 for a combination of high job demands and low job control, 2.05 to 2.51 for an ERI, and 1.47 for organisational injustice. Together, the authors estimated work stress to be associated with an approximately 50 % excess risk of CHD, i.e. persons who work in a stressful environment have a 1.5 times increased risk to suffer from CHD compared to those who do not work in a stressful environment.

Another extensive meta-analysis (Kivimäki et al., 2012) investigating the relationship between job strain (high job demands/low job control) and the incidence of CHD (myocardial infarction or coronary death) revealed consistent results, yet the effect estimate was relatively low. This study analysed individual data of about 200,000 workers and found the (adjusted) hazard ratio for job strain vs. no job strain to range between 1.16 (unpublished data) and 1.43 (published data).

A further systematic review confirmed these results (Backé, Seidler, Latza, Ross-

nagel, & Schumann, 2012). This review revealed an association between work-related stress and cardiovascular morbidity and mortality in 13 out of 20 cohorts, with the strength of association depending on the work stress model used.

A recently published study including 96 articles in total investigated the relationship between ischaemic heart disease and single as well as composite measures of work-related factors (Theorell et al., 2016). The researchers found relatively strong evidence for the effects of job strain (high job demands/low job control) as well as low job control, and moderate evidence for the effects of iso-strain (job strain plus low social support), as well as single measures such as high job pressure, low social support, and long working hours.

To summarize, there is extensive evidence that highlights the impact of a stressful working environment on the development of CHD, yet the effect estimates are rather heterogeneous and depend on the stress model employed. A number of underlying physiological mechanisms have been identified as moderators and mediators that link work-related stress to CHD. These mechanisms involve metabolic and neuroendocrine processes, inflammation processes, or immune functioning (Chandola et al., 2008; Lundberg & Cooper, 2011; Melamed et al., 2006; Steptoe & Kivimäki, 2012). Moreover, changes in behaviour and lifestyle may also play a significant role in this regard. For example, Chandola et al. (2008) found approximately 32 % of the effect of an adverse working environment (as measured by the JD-C model) on coronary heart disease to be attributable to both health behaviours (low physical activity, poor diet) and metabolic syndrome.

### 3.3.2 Musculoskeletal problems

The relationship between work-related stress and musculoskeletal problems (MSP) is also a well-documented phenomenon. In 1993, Bongers, de Winter, Kompier, and Hildebrandt published a review on the association between psychosocial factors at work and MSP (i.e. back pain, neck or shoulder pain). The reviewed studies suggested that monotonous work, high work load, time pressure, low job control, and lack of social support are all positively related to problems in the back, neck, and shoulder regions. Moreover, the authors observed that these symptoms are often associated with typical stress responses – such as tension, anxiety, or fatigue – and argued that perceived stress mediates the relationship between psychosocial factors at work and MSP.

A more recent systematic review and meta-analysis examined the causal impact of a psychosocially demanding work environment on MSP, based on prospective longitudinal research (Lang, Ochsmann, Kraus, & Lang, 2012). Different categories of psychosocial work stressors (e.g. monotonous work, job insecurity) were consistently found to

contribute to MSP (lower back pain in particular), although most psychosocial stressors had a small to moderate impact on the development of MSP (pooled odds ratios ranged between 1.15 and 1.66).

In a similar study, Hauke, Flintrop, Brun, and Rugulies (2011) reviewed and meta-analysed 54 longitudinal studies about the effects of a psychosocially demanding working environment on MSP in three specific body regions (neck/shoulder, upper extremities, lower back). Taken together, 31 studies found at least one significant positive relationship between psychosocial job demands and MSP. Moreover, the effect sizes varied as a function of stressor type and body region. For example, low social support, high demands, and low control revealed the largest effect for the lower back and the smallest effect for the neck/shoulder region. By contrast, high job strain had the largest effect for the neck/shoulder region and the smallest effect for the upper extremities.

Several explanatory models have been proposed in order to explain work-related MSP (see e.g. Lovallo, 2015, pp. 87-88). According to a bio-psychological approach proposed by Melin and Lundberg (1997), both psychosocial and physical stressors at work (separately and in combination) trigger hormonal stress responses and thereby increase muscle tension. For example, Laursen, Jensen, Garde, and Jørgensen (2002) examined the effects of mental demands during computer work on muscular activity in the forearm, shoulder, and neck muscles. The researchers found that a mentally demanding task increased static muscular activity in all of the recorded regions. Lundberg et al. (2002) also demonstrated that psychosocially demanding situations were related to a similar motor unit activity as physical activity, indicating that psychosocial demands keep muscle fibres active, even during physical inactivity. This means that an ongoing psychosocially demanding situation prevents relaxation of muscles and thereby likely contributes to the onset of MSP. Increased muscle tension, as well as lacking the ability to unwind after work, were thus considered important factors that help to explain chronic work-related MSP (Melin & Lundberg, 1997).

Schleifer, Ley, and Spalding (2002) proposed a specific *hyperventilation theory* of work-related stress and MSP. According to this theory, psychosocial stress induces hyperventilation (or overbreathing), which, in turn, reduces arterial carbon dioxide levels. This results in a chain of physiological reactions that adversely affect musculoskeletal health, in terms of increased muscle tension, muscle spasm, muscle ischemia, hypoxia, and greater sensitivity to stress hormones (e.g. catecholamines). All of these reactions likely contribute to the onset of MSP.

### 3.3.3 Immune dysfunction

Segerstrom and Miller (2004) meta-analysed studies on the association between general measures of psychosocial stressors and immune functioning. They found that chronic stressors (e.g. dementia care-giving, unemployment) revealed a negative relationship with several functional measures of the immune system, and they concluded that chronic stressors suppress both cellular and humoral immunity.

In a systematic review, Nakata (2012) analysed and summarized 56 studies on the association between work-related stressors and several immune parameters. The researcher found a relatively robust relationship between an adverse working environment (e.g. high job demands, low control, high job strain, ERI) and immune functioning (impaired natural killer and T cell activity, CD4+/CD8+ ratio, increased inflammatory markers). Nevertheless, Nakata argued that these findings were mainly based on cross-sectional or case-control study designs. In consideration of this fact, claims about cause and effect are questionable and more prospective longitudinal studies are needed.

Two recent reviews (Eddy, Heckenberg, Wertheim, Kent, & Wright, 2016; Siegrist & Li, 2017) largely confirmed these conclusions. These reviews summarized previous findings on the association between ERI and indicators of immune function. In general, higher levels of ERI were consistently found to be related to altered functions of immune markers (e.g. mucosal immunity, leukocytes) and inflammatory markers (e.g. tumour necrosis factor A, C-reactive protein). Again, the authors recommended caution about drawing cause and effect inferences, due to the fact that the conclusions were almost exclusively based on cross-sectional studies and that the few longitudinal studies on this topic revealed inconsistent results.

The growing field of psychoneuroimmunology provides some explanations for the effects of (work-related) stressors on immune functioning. However, the mechanisms that underlie this relationship are complex and not yet fully understood. In essence, stressors are thought to modulate the interaction of three systems, namely the central nervous system, the endocrine system, and the immune system. According to Glaser and Kiecolt-Glaser (2005), stressors trigger activation of the HPA axis and the sympathetic-adrenal-medullary (SAM) axis. This activation provokes the release of pituitary and adrenal hormones (so-called stress hormones; e.g. catecholamines, adreno-corticotropic hormone, cortisol). Each of these hormones can considerably affect immune functioning through either direct (i.e. binding to its receptors at the surface of the cell) or indirect pathways (i.e. secondary effects on immune responses such as modulation of cytokine production). As a result, chronic exposure to extensive stressors increases susceptibility to infections or cancer, impairs wound healing processes, and has pro-inflammatory effects (Dhabhar, 2014; Glaser & Kiecolt-Glaser, 2005).

### 3.3.4 Gastrointestinal problems

The findings concerning the link between work-related stress and gastrointestinal diseases are less clear. A recent study reviewed and meta-analysed individual participant data of 95,000 men and women with regard to the relationship between job strain (as measured by the JD-C model) and inflammatory bowel diseases (IBD) (Crohn's disease and ulcerative colitis). Results suggested that job strain did not increase the risk for developing IBD (Heikkilä et al., 2014). Despite the study's large sample size, it remains questionable whether there was sufficient statistical power to detect potential relationships. Inflammatory bowel diseases are very rare and the meta-analysis included just over 100 cases of Crohn's disease and 400 cases of ulcerative colitis. Other study results somewhat contradict these findings. These studies indicated that both life and work stressors are very common in patients suffering from IBD (Pellissier, Dantzer, Canini, Mathieu, & Bonaz, 2010; Singh et al., 2011).

Further evidence for an association between stress and gastrointestinal problems comes from a prospective, longitudinal study in soldiers. Li et al. (2013) examined the effects of psychologically and physically demanding combat training on gastrointestinal symptoms. Results suggested that prolonged combat training provoked higher levels of perceived stress, higher anxiety and depression ratings, elevated immune activation (pro-inflammatory cytokine concentration) and intestinal permeability, and more gastrointestinal symptoms (e.g. abdominal pain, diarrhoea, and/or constipation), compared with the rest period. Moreover, the researchers observed that gastrointestinal symptoms developed in 70 % of soldiers during combat training. These symptoms also persisted in 30 % of soldiers into the rest period 12 days later.

In another study, occupational stressors (covering domains such as physical environment, safety, and organizational structure) were found to be related to ulcer-like symptoms such as stomach pain/discomfort, or poor appetite (Chen, Wong, & Yu, 2009). The authors also observed that coping behaviour moderated the effect of occupational stressors on ulcer-like symptoms: persons who exhibited a more adaptive coping strategy (vs. a less adaptive coping strategy) were less likely to present with ulcer-like symptoms in response to occupational stressors.

Explanatory approaches suggest that stress modulates the nervous, endocrine, and immune systems and thereby increases susceptibility to gastrointestinal problems. In this regard, the cascade of physiological responses to stressors also involves the enteric nervous system (ENS). The ENS is bidirectionally connected to the neural networks of the brain, forming the so-called brain-gut axis. Chronic or excessive exposure to stressful situations can modify these neural networks (i.e. by increasing corticotropin-releasing factor synthesis, increasing catecholamine activity, and decreasing the sensitivity of

glucocorticoid receptors) (Bhatia & Tandon, 2005; Mayer, 2000). These changes may also affect the brain-gut axis, causing secondary effects on gut immune cells or the ENS. In the long term, these secondary effects are expected to increase the risk for gastrointestinal diseases such as IBD, reflux disease, or peptic ulcer disease (Bhatia & Tandon, 2005; Mayer, 2000).

### 3.3.5 Mental health and psychiatric disorders

An extensive number of studies provide evidence for the association of an adverse working environment and mental health problems as well as psychiatric disorders (Stansfeld & Candy, 2006; Stansfeld, Fuhrer, Shipley, & Marmot, 1999). Both retrospective and prospective studies have demonstrated that work-related stressors are strongly related to an increased risk of depressive symptoms or clinical depression (Bonde, 2008; Harvey et al., 2017; Madsen et al., 2017; Netterstrøm et al., 2008; Siegrist, 2008; Theorell et al., 2015), burnout (Cordes & Dougherty, 1993; Finney, Stergiopoulos, Hensel, Bonato, & Dewa, 2013; Hakanen & Bakker, 2017; Lloyd, King, & Chenoweth, 2002; Maslach, Schaufeli, & Leiter, 2001), anxiety symptoms or anxiety disorders (Cropley & Purvis, 2003; Griffin, Greiner, Stansfeld, & Marmot, 2007; Harvey et al., 2017), cognitive impairment (Marquié, Tucker, Folkard, Gentil, & Ansiau, 2015; Then et al., 2014), sleep disturbances (Åkerstedt, 2006; Åkerstedt, Hallvig, & Kecklund, 2017; Vahle-Hinz, Bamberg, Dettmers, Friedrich, & Keller, 2014), as well as nervousness, irritability, or tension (Rusli, Edimansyah, & Naing, 2008; Thorsteinsson, Brown, & Richards, 2014).

The underlying mechanisms of the link between an adverse working environment and mental health have been described in detail in section 3.2. In essence, specific work characteristics (e.g. high job demands, low job resources, ERI), in combination with specific person-related characteristics (e.g. lacking the ability to cope, low resources), provoke mental strain responses and lead to negative mood states (Hockey, 1997). This phenomenon may also be related to physiological changes as well as health-adverse coping behaviours (e.g. smoking, drinking), all of which can cause long-lasting damage to health, and, in turn, increase the risk of developing mental and somatic health problems (McEwen, 2008).

### 3.3.6 Single and composite measures of health

Rather than focusing on disease, an alternative way of conceptualizing health is to use a composite symptom score of diverse symptoms or health problems. In line with Antonovsky's (1972, 1979) health ease/dis-ease continuum (see section 3.2.1), health is defined as a continuous measure ranging from 'good health' to 'poor health'. In the context of occupational health research, Spector and Jex (1998) developed a self-report

inventory of physical symptoms (e.g. backache, chest pain, and headache) and found in a meta-analysis that the resulting composite symptom score (representing the number of reported symptoms) correlated positively with the burden due to work-related stressors.

In a more recent meta-analysis, Nixon et al. (2011) summarized studies on the relationship between physical symptoms and different types of occupational stressors. As regards analyses of cross-sectional studies, the authors observed that seven out of seven different types of occupational stressors had a significant positive association with composite measures of physical symptoms; a longitudinal relationship to the composite symptom score was found in five out of seven different types of occupational stressors. Moreover, this meta-analysis illustrated that health effects can vary substantially depending on the types of occupational stressors to which workers are exposed. It has been observed that the occupational stressor interpersonal conflicts recorded a stronger (weighted) effect on sleep disturbances (.26) than on fatigue (.09), whereas high workload had a stronger association with fatigue (0.31) than with sleep disturbances (.14) (see also Mayerl, Stolz, Waxenegger, & Freidl, 2017). Gastrointestinal problems revealed the strongest relationship to the stressor organizational constraints (.26) and the weakest relationship to the stressor role ambiguity (.06). Fatigue, in turn, was more strongly related to workload (.31) than to role conflict (.09). All of these examples indicate that single stressors can impact health in very different ways.

These findings also conform to allostatic load theory (see section 3.1.3). Repeated and chronic (work-related) stressors are assumed to cause continuously activated stress responses, which, in the long run, lead to wear and tear of the affected physiological systems and thereby increase vulnerability to health damages (McEwen, 2004, 2008). The fact that health effects vary according to the type of stressors to which individuals are exposed underlines the assumption that different kinds of stressors place an allostatic (over)load on different systems of the organism. Thus, the widely used approach of analysing stress-health effects on the basis of composite scores may result in somewhat unreliable estimates.

### 3.3.7 Individual and group differences

Allostatic load theory, however, also considers the origins of and the responses to stressors to be multifaceted and not limited to physical or biological aspects alone. Factors such as personality, resources and coping strategies, or the socio-economic status are thought to play an important role in the stress process (McEwen, 1998).

### Sex and gender[2]

One important aspect in this context are sex and gender differences.[3] Frankenhaeuser et al. (1989) and Lundberg and Frankenhaeuser (1999) published two influential studies on the role of sex and gender in terms of work-related stress responses. The researchers examined the cardiovascular and neuroendocrine parameters of 60 white-collar employees during both a normal working day and the work-free time at home. They found that, although men and women exhibited a similar physiological response (blood pressure, noradrenaline) to stressors at work, the physiological stress levels of women remained elevated also after finishing work, whereas the physiological stress levels of men rapidly decreased after working hours and remained in a resting state until the end of the day. One possible explanation might be that women have more responsibilities waiting at home, such as child care or household tasks, and thus have fewer opportunities to relax and recover (Lundberg, 2005).

Several studies have indeed demonstrated that the total workload perceived from both paid and unpaid work is higher among women than men, given the higher responsibilities of women for household duties or family issues, whether attributed or adopted (Lundberg & Frankenhaeuser, 1999; Lundberg, Mårdberg, & Frankenhaeuser, 1994). Moreover, Lundberg et al. (1994) have found the total workload to significantly increase with the number of children at home; this effect was more pronounced among women than men. Given the current gender roles, women seem to be especially challenged when it comes to harmonising their paid job, family, housework, and leisure time (see e.g. Krantz, Berntsson, & Lundberg, 2005).

This conclusion is also supported by the findings of Kunz-Ebrecht, Kirschbaum, Marmot, and Steptoe (2004). They investigated cortisol awakening response (a marker of HPA activity in response to stressors) on both a working day and a weekend day. On the working day, the increase in cortisol awakening response was higher in women than in men. On the weekend day, by contrast, no differences in cortisol levels were observed between men and women. The cumulative effects of both work-related and non-work-related demands seem to be particularly stressful for women.

[2]Parts of this section are based on an exposé for a funding application (Project leader: Wolfgang Freidl): Mayerl, H., Rásky, É., Stolz, E., & Freidl, W. (2017). Effects of negative working conditions on health in later life: Gender differences. *Funding application to the OeNB Anniversary Fund*. Unpublished manuscript.

[3]A short note on the terminology: While the term *sex* usually refers to the physical characteristics of males and females, *gender* is more broadly defined and includes "the psychological, behavioural, social, and cultural aspects of being male or female" (VandenBos, 2015, p. 450).

### Socio-economic factors

Another study found similar effects for socio-economic status (SES). In this study, Kunz-Ebrecht et al. (2004) examined the effects of work-related stressors and SES (high SES: administrative employment grades vs. low SES: clerical and office support employment grades) on physiological stress responses in terms of salivary cortisol response to wakening as well as mean cortisol levels over a typical working day. They found that high levels of work-related stressors evoked greater cortisol response to wakening in lower SES participants than in higher SES participants. As regards mean cortisol levels over a typical working day, the findings differed by sex. Low SES women exhibited greater mean cortisol levels in response to work-related stressors than high SES women. Men, however, did not differ in mean cortisol levels as a function of work-related stress levels or SES. In general, it seemed that high SES has the potential to attenuate the physiological response to work-related stressors, although this effect partly differed by sex.

On the basis of these findings, it may be argued that the effect of work-related stressors on health is not causal. Rather, the stress-health link may be explained by confounding with SES. This research question has also been asked by Bruner et al. (2004). In their prospective study, they analysed the confounding effects of SES in the relationship between work-related stressors and cardiovascular mortality. First of all, they found work-related stressor levels to be a good predictor of cardiovascular mortality. After controlling for socio-economic factors (i.e. education, occupational group, and income), the effects decreased slightly, but nevertheless remained substantial. Therefore, it has been argued that SES cannot entirely explain the causal link between work-related stressors and health.

Although the stress-health link is not entirely attributable to the confounding effects of SES or sex and gender, it is nevertheless important to control for these factors in work-related stress research. Since sources of stressors, responses to stressors, as well as stress coping capacities can differ according to SES and sex/gender (see e.g. Almeida, Neupert, Banks, & Serido, 2005; Denton, Prus, & Walters, 2004; Macintyre, Hunt, & Sweeting, 1996; Szanton, Gill, & Allen, 2005), it is essential to consider sex/gender as well as SES in order to provide a better understanding of the work-related stress phenomenon.

## 3.4 Improving workplace health

T. Cox (1997) has stressed that the 'maintenance of health and the quality of life' (p. 1) is one of the greatest challenges in modern societies. Given that work plays a major

role in most people's lives and a large proportion of time is spent at work, workplace health promotion turns out to be a key factor to address this challenge. Occupations are urged to allocate interventions aimed at optimizing working conditions on the one hand, and to change unhealthy behaviours or promote a healthy lifestyle on the other hand. This may not only lower the risk of work-related health issues, but can also go along with increased well-being, job satisfaction, and increased productivity. The possibilities for such interventions are manifold and can be actioned at both the individual and contextual levels (T. Cox, 1997; Day & Helson, 2016).

### 3.4.1 Individual-level interventions

The individual-focused approach of workplace health promotion can take place on two levels (T. Cox, 1997): interventions concerning salutogenic factors that promote health on the one hand, and interventions concerning pathogenic factors that damage health on the other hand. These include smoking cessation programmes, counselling on high-risk drinking behaviour, nutrition counselling, and organizational fitness or wellness programmes (Day & Helson, 2016). Hartfiel et al. (2012), for example, examined the effects of a yoga-based organizational intervention programme on psychological well-being and back pain. Participants received one 50-minute yoga session each week during or after work and a 20-minute DVD for home practice. After eight weeks, the yoga practitioners reported decreased stress levels, lower levels of back pain, and improved well-being in comparison to the control group. In a meta-analysis, Conn, Hafdahl, Cooper, Brown, and Lusk (2009) summarized the effects of workplace physical fitness interventions on both workers' health and work-related outcomes. The synthesized results across approximately 38,000 subjects revealed that these interventions went along with improved health (i.e. fitness, ratio of cholesterol to high-density lipoproteins, body-mass-index), lower absenteeism, and decreased job stress.

T. Cox (1997), however, argued that interventions exclusively focusing on the individual level do not go far enough to attain optimal effects, since contextual aspects are still in play and may contribute more strongly to poor health and negative work-related outcomes than the behaviours and lifestyle of the individual. For example, if an individual has to work in an extremely physically strenuous environment or is exposed to harmful substances, the benefits of individual-focused approaches (e.g. yoga sessions) may not counterbalance the detrimental health effects of these contextual factors. Thus, workplace interventions should aim to improve both individual and contextual factors.

### 3.4.2 Contextual-level interventions

Contextual-focused approaches to workplace health promotion may involve aspects related to workplace policies, organization and culture, and environment. One example of an effective workplace policy is smoke-free workplaces. In a systematic review of 26 studies, Fichtenberg and Glantz (2002) found that totally smoke-free workplaces went along with a 3.8 % reduction in the prevalence of smoking. Moreover, continuing smokers were found to reduce the number of cigarettes on average by three per day.

An example of interventions at the organizational level concerns management and leadership. Maellaro and Whittington (2015) argued that one important occupational objective should be the development of so-called *whole leaders*. 'A whole leader possesses intellectual abilities and technical expertise, self-awareness, interpersonal proficiency and leadership know-how to balance the needs of employees with the requirements of the business ...' (Maellaro & Whittington, 2015, p. 322). The theory behind this argument is that management has the power to create a great place to work and to keep overwhelming stressors to a minimum. Management development programmes aiming to promote the development of whole leaders are thus considered to be a key factor to an organization's success in terms of both the productivity and the health and well-being of the entire workforce.

Organisational aspects are strongly related to culture. Culture may exert positive effects on workers' health and well-being through trust, mutual respect, and active communication between management and employees, through the perception of a common and unique organizational identity, through a clearly communicated vision, and through a well-defined set of values that are lived by all members of the organization in their day-to-day work (Kets de Vries, Ramo, & Korotov, 2015).

Lastly, interventions at the environment level refer to all (e.g. physical, technological, social, and organizational) aspects of the work setting. It is well known that the working environment represents an important factor determining workers' behaviour as well as workers' health and well-being. The effect of the environment can be either positive or negative (T. Cox, 1997). On the one hand, the working environment can be a safe and healthy place that stimulates creativity and that offers possibilities to exploit one's full potential. On the hand, the working environment can put the life and health of workers at considerable risk and can represent a great obstacle for personal self-realisation. Interventions aimed at improving the working environment may thus contribute to increases in workers' well-being and health, and in job satisfaction, and job performance. Kim (2014) reviewed previous research findings on the effects of workplace design (e.g. space arrangement, air quality, lighting, supporting technologies) on organizational performance outcomes, and demonstrated that the physical work-

place design might contribute to improvements in both affective (e.g. job satisfaction, creativity) and behavioural (e.g. communication, collaboration) outcomes, and, in turn, to improvements in performance outcomes (e.g. job performance).

### 3.4.3 Specific strategies to tackle workplace stress

There are also a number of possibilities to prevent and tackle work-related stress and its negative consequences. Cooper and Cartwright (1997) defined three levels for managing stress at work: *primary*, *secondary*, and *tertiary* interventions. Primary interventions are concerned with the sources of stress, and try to modify the stressful situation or to eliminate the stressor itself. According to person-environment fit approaches to stress, psychological, physiological, and behavioural stress responses result when the personal needs, demands, motives, goals, skills, or abilities of an individual do not correspond to the supplies of the working environment (Edwards & Cooper, 1990). Primary interventions thus focus on modifications to the working environment in order to match the individual (Cooper & Cartwright, 1997). The goal is to alter the nature of the stressor before stress-related responses are experienced by the individual (Lamontagne, Keegel, Louie, Ostry, & Landsbergis, 2007). Interventions at the primary level may concern physical, psychosocial, or organisational working conditions, and include strategies such as job or task redesign, workload reduction, or conflict management (Lamontagne et al., 2007).

Secondary interventions are concerned with the detection and management of stress experiences (Cooper & Cartwright, 1997). Unlike primary interventions, secondary interventions do not focus on the modification of the stressor itself, but are supposed to improve the stress management abilities and skills of individuals. In other words, secondary interventions strengthen an individual's resources in order to modify the way the individual perceives and responds to the demanding situation. As already discussed in section 3.2, negative stress responses result when an individual's resources are not sufficient to cope with the stressors of the environment and their consequences. Next to the modification of the nature of the stressor, an alternative way is therefore to enhance the individual's resources in order to increase her/his resilience to different kinds of stressors and their consequences.

Secondary interventions relate to action on different dimensions of resources. As already mentioned above, regular physical fitness sessions have been illustrated to be effective in strengthening the physical resources of individuals, and were found to lower the level of stress experienced at work (Conn et al., 2009). Regarding the mental resource dimension, a number of different occupational stress management programmes have been established and studied to date (Richardson & Rothstein, 2008). These interventions include treatment approaches such as relaxation, meditation, and

breathing techniques (e.g. Alexander et al., 1993; Fiedler, Vivona-Vaughan, & Gochfeld, 1989), cognitive-behavioural skill training (e.g. de Vente, Kamphuis, Emmelkamp, & Blonk, 2008), and mindfulness-based stress reduction programmes (e.g. Shapiro, Astin, Bishop, & Cordova, 2005). As regards social resources, interventions focus particularly on social support (e.g. Carson et al., 1999). Social support is considered to buffer the negative impact of stress through the effects of emotional relationships, instrumental aid, or helpful advice (Cohen & Wills, 1985). Organizational interventions may aim to provide a supportive working environment in which employees and executives can help each other and that allows open and effective communication among the entire workforce.

Tertiary interventions refer to actions when the consequences of stress are already visible in terms of serious health problems or diseases (Cooper & Cartwright, 1997). The main goal is to treat, recover, and rehabilitate individuals with chronic work-stress-related health issues. Interventions at the tertiary level include counselling, and worksite-based or other specific rehabilitation programmes. Brattberg (2006), for example, examined the utilization of an internet-based rehabilitation programme (with a focus on cognitive-behavioural techniques) in the rehabilitation of individuals on long-term sick leave that suffered particularly from chronic pain and/or burnout. Upon completion of the rehabilitation programme 20 weeks later, the treatment group (vs. a waiting list group) exhibited significant improvements in variables assessing depression, pain, vitality, and stress. Moreover, the intervention made it possible that a considerable portion of individuals on long-term sick leave were able to return to working life (either part-time or full-time). Nevertheless, problems related to workplace stress should already be identified at the primary and secondary levels. This might prevent individuals from suffering the consequences of long-term stress exposure.

## 3.5 Concluding remarks and unanswered research questions

There is extensive evidence that demonstrates the adverse effects of a chronically stressful working environment on both mental and somatic health. Although to date a number of (work-related) stress models have been established in order to explain how stressors and resources together affect health and well-being, the underlying mechanisms have not yet been clarified in detail. While the JD-C model considers the combination of high job demands and low job control (as well as low social support) to be particularly stressful, the ERI model assumes work-related health problems to result when an individual has the feeling that the high efforts made at work are rewarded inappropriately. The JD-R model, in turn, is supposed to integrate these models and considers any job demands and any resources to be important in stress-related processes. All of these models have

one thing in common: it is assumed that work-related stress responses can be predicted by a combination of both positive and negative aspects of the working environment. However, it is less clear how these positive and negative factors interact with each other and what role the individual characteristics of workers play in this context. This thesis aims to shed new light on these relationships in order to better understand the more or less complex interactions between different kinds of both work-related stressors and resources in explaining workers' health.

## 3.6 Research objectives and hypotheses

This thesis relies on the JD-R model as a theoretical framework. Given its flexibility, this model is well suited to provide a theoretical basis for analysing the rather unspecific survey data used in this thesis. First of all, this thesis aims to investigate the combined and single health effects of both job demands and job resources. Following the definitions of the JD-R model (Bakker, Demerouti, De Boer, & Schaufeli, 2003; Demerouti et al., 2001, see section 3.2.6 for more detailed explanations), job demands represent all aspects of the job that require increased efforts from a worker and that are therefore associated with health problems. Job resources, in turn, involve all beneficial aspects of a job that mitigate job demands and facilitate goal achievement or personal growth. Moreover, since recent research highlights the importance of individual differences in work-stress-related processes (see e.g. Xanthopoulou et al., 2007, section 3.2.6), this thesis also analyses the role of person-related resources in the relationship between job demands and health. Whereas previous studies including person-related resources focused on mental/psychological aspects (such as optimism or self-efficacy; Airila et al., 2014; Xanthopoulou et al., 2007, 2009a), this thesis follows a bio-psycho-social way of thinking (see e.g. Engel, 1977). That is, person-related resources were defined more broadly, 'as those physical, mental, and social characteristics of an individual which strengthen the resilience against several kinds of challenges, not only related to the work environment, but rather to a broad array of contexts' (Mayerl, Stolz, Waxenegger, Rásky, & Freidl, 2016, p. 3; see also section 3.2.1). The outcome variables of this thesis project comprised indicators of both mental and somatic health, namely self-reported mental strain reactions and self-reported somatic health symptoms. More precisely, this thesis aims to answer three specific research questions, which are described in the following subsections.

### 3.6.1 The buffering role of resources in the job demands-health link

First of all, separate and combined health effects of both job demands and different dimensions of person-related (i.e. physical, mental, and social aspects) and job-related

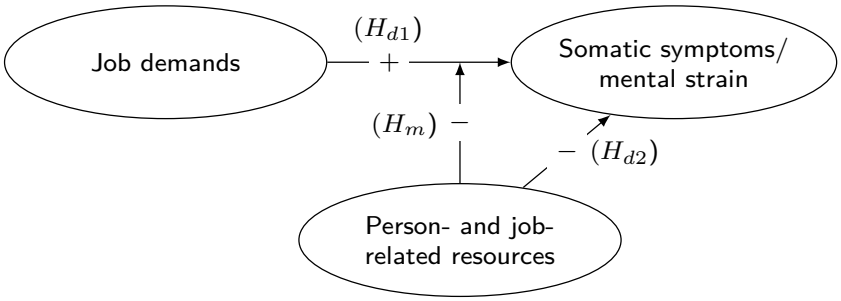


**Figure 3.2:** Graphical representation of direct and moderating effects of job demands and resources. '+' indicates a hypothesized positive association and '−' a hypothesized negative association. See the text for further explanations.

resources on both mental strain and somatic symptoms are examined. While previous research in this context often focused on single dimensions of resources, this approach allowed exploring the relative importance of different kinds of resources in predicting both mental and somatic health. More specifically, three main hypotheses were defined (a graphical representation of these hypotheses is presented in Figure 3.2; see also Mayerl, Stolz, Großschädl, Rásky, & Freidl, 2017):

1. *Direct effects of job demands* (see $H_{d1}$ in Figure 3.2): based on a wealth of evidence for the adverse effects of high job demands on health (e.g. Nixon et al., 2011), a positive relationship was hypothesized to exist between job demands and both mental strain and somatic symptoms.
2. *Direct effects of resources* (see $H_{d2}$ in Figure 3.2): as resources in general have been demonstrated to positively affect health and well-being (e.g. Freidl, Rásky, & Stronegger, 1999; Kalimo, Pahkin, & Mutanen, 2002), it was hypothesized that individuals high in both person- and job-related resources would report less mental strain and fewer somatic symptoms.
3. *Buffering effects of resources* (see $H_m$ in Figure 3.2): given that a great pool of resources strengthens resilience against several kinds of stressors (Antonovsky, 1979; Hobfoll, 1989; Lazarus & Folkman, 1984), it was hypothesized that each of the person- and job-related resources buffers the negative impact of job demands on both mental strain and somatic symptoms. That is, it was assumed that the health effects of job demands would be less harmful for individuals who have a great pool of resources at their disposal.

### 3.6.2 An alternative stress model: job demands, resources, and health

The second research objective was to establish and test an alternative stress model to explain the relationships between (1) job demands, (2) person- and job-related resources, and (3) mental strain and somatic symptoms. Section 3.2.6 described several

ways in which person- and job-related resources may be related to each other and have been integrated into previous work-related stress models. This thesis proposes an alternative approach of integrating both person- and job-related resources into the health-impairment process of the JD-R model. Rather than considering person-related resources and job-related resources as two stand-alone constructs, an alternative way of thinking is to see these resources as domains of a common underlying resources factor (Mayerl et al., 2016). This underlying resources factor seems to be conceptually comparable to Antonovsky's (1979) GRRs, representing a multifaceted hypothetical construct that helps to prevent or combat any kind of stressful situation (Antonovsky, 1979, p. 103).

Empirical evidence supports this reasoning. Xanthopoulou et al. (2007) found in their study that different indicators of person- and job-related resources demonstrated a positive and substantial relationship to each other. Thus, it may be argued that different types of person- and job-related resources overlap to a substantial extent. For example, a worker who appraises his or her own abilities and skills as sufficient to deal with a variety of demanding situations (i.e. exhibiting high levels of personal resources) is more likely to interpret a particular working situation as controllable and therefore reports more decision-making freedom and autonomy (i.e. exhibiting high levels of job resources). This overlap between different kinds of resources may reflect the existence of an underlying core or, to put it differently, different aspects of person- and job-related resources can be seen as indicators of one and the same common factor (see also Mayerl et al., 2016).

The integration of the resources factor in the health-impairment process of the JD-R model as well as the hypothesized relationships are illustrated in Figure 3.3 (this figure and the resulting hypotheses are partly based on Mayerl et al., 2016). It was expected that the resources factor predicts job demands, as well as mental strain and somatic symptoms. More precisely, it was assumed that the perceived burden due to job demands depends on how workers appraised their own physical, mental, social, and job resources (Karasek, 1979; Lazarus & Folkman, 1984; Siegrist, 1996). A worker rich in both person- and job-related resources will be more likely to appraise a particular situation as challenging rather than threatening. It was hypothesized that: the greater the pool of resources, the lower the perceived burden due to job demands ($H_1$). Moreover, since previous research found person- and job-related resources to directly affect health and well-being (e.g. Freidl et al., 1999; Kalimo et al., 2002), a negative relationship between resources and health was hypothesized: the more the available resources, the less mental strain ($H_{2a}$) and the fewer somatic symptoms ($H_{2b}$) would be reported.

Based on previous research findings on the revised version of the JD-R model (see

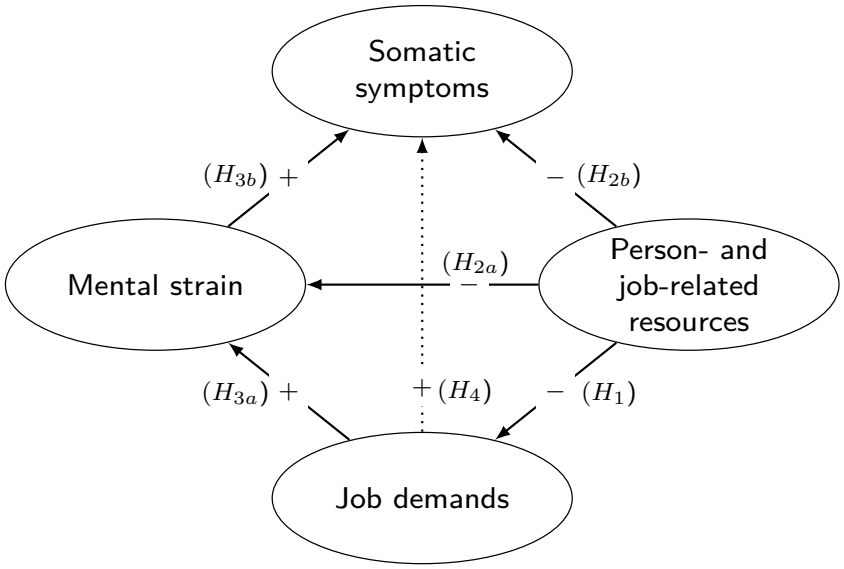


**Figure 3.3:** Adapted from 'The role of personal and job resources in the relationship between psychosocial job demands, mental strain, and health problems' by H. Mayerl, E. Stolz, A. Waxenegger, É. Rásky, and W. Freidl, 2015, *Frontiers in Psychology, 7*, p. 4. '+' indicates a hypothesized positive association and '−' a hypothesized negative association. See the text for further explanations.

section 3.2.6), it was hypothesized that the effect of job demands on somatic health is mediated by mental strain. According to the state regulation model of compensatory control (Hockey, 1997), extensive demands exceeding an individual's reserve limits go along with mental strain, which, in turn, have long-term consequences for the physiological systems of the body. Thus, it was expected that: higher levels of perceived job demands lead to more mental strain in a first step ($H_{3a}$), and higher levels of mental strain result in more somatic symptoms in a second step ($H_{3b}$). However, previous research findings in this context are inconsistent regarding the question as to whether mental strain completely or only partially mediates the link between job demands and somatic health problems. Whereas Schaufeli and Bakker (2004) and Hakanen et al. (2006) found mental strain to account entirely for the job demands-somatic health link, Korunka et al. (2009) found a partial mediation by demonstrating that job demands also had a direct effect on somatic health. Thus, this thesis aims to further investigate the direct link (see dotted line in Figure 3.3) between job demands and somatic health symptoms. If this direct pathway exists at all, it is hypothesized that this is a positive relationship: the more the perceived job demands, the more somatic health symptoms would be reported ($H_4$).

### 3.6.3 Exploring differential health effects of different constellations of job demands

Finally, in the third part of the analysis the focus has been shifted from the classic variable-centred approach to a person-centred approach (parts of this section are based on Mayerl, Stolz, Waxenegger, & Freidl, 2017). Whereas the variable-centred approach focuses on relationships *among variables* (e.g. correlation analysis), the person-centred approach concentrates on similarities and common features *among individuals* and strives to reveal distinct profiles of individuals regarding particular characteristics (for more details, see B. O. Muthén & Muthén, 2000).

The variable-centred approach usually requires a homogenous population. In this regard, homogeneity means that responses to job demands do not differ across individuals or groups of individuals, and that the relationship between job demands and health can be represented by an averaged measure of all the data of a particular sample. Individual and group differences in terms of both stressor patterns (e.g. physical demands vs. psychosocial demands) and stress response patterns (e.g. back pain vs. burnout) are therefore disregarded. However, this homogeneity assumption is often not feasible, since the level of exposure to different kinds of stressors as well as the vulnerability to specific stress-related health problems depend on individual and group differences with regard to genetic disposition, lifestyle and health behaviours, available resources and coping strategies, life histories, sex/gender, and socio-economic status (McEwen, 1998). One way to account for such a heterogeneity is to group individuals that share certain characteristics, and then perform group-specific analyses. For example, individuals may be stratified by sex, and analysis may then be conducted for men and women separately.

However, if specific characteristics are not directly observable, an alternative approach would be to identify groups of individuals that exhibit a similar response pattern with regard to particular variables. For instance, workers may be categorized according to their vulnerability to health problems. It may be conceivable that one group of individuals is more vulnerable with regard to the cardiovascular system, another group might be more susceptible with respect to the musculoskeletal system, and others might be more prone with respect to mental health (see also Mayerl, Stolz, Waxenegger, & Freidl, 2017). In a similar vein, workers may be grouped with regard to different demand constellations: one group of workers might be more heavily burdened by physically demanding stressors, while others might experience stress particularly due to psychosocial aspects.

In essence, this approach can serve to reveal a typology of both health symptoms and working conditions. The third research objective is therefore to identify both *health symptom clusters* and *job demand profiles*, and to explore the relationship between

these clusters and profiles in order to examine the differential health effects of distinct constellations of job demands. The main advantage of this person-centred approach is that it allows considering a broad set of both different health indicators and diverse job demands, while also accounting for potential heterogeneity in the working population.

Recent occupational health research supports the validity and usefulness of the person-centred approach (or a combined person- and variable-centred approach). Burkert, Raml, Beier, and Freidl (2015), for example, revealed a health taxonomy within wage and salary earners, using both negative (e.g. somatic symptoms) and positive (e.g. self-efficacy) indicators of health. They identified four clusters: (1) a physically healthy cluster with signs of mental symptoms (e.g. demotivation); (2) a generally healthy cluster in terms of both positive and negative indicators; (3) a cluster with signs of psychological impairment; and (4) a generally unhealthy cluster (i.e. multiple health problems and low levels of positive indicators).

In another study, Vanroelen, Louckx, Moors, and Levecque (2010) used a set of scales assessing different dimensions of the working environment (i.e. quantitative and emotional demands, as well as physical, social, and organizational work stressors). Five distinct stress and demand profiles were identified: (1) a 'low stress' profile indicating a generally low level of job demands; (2) a 'passive-manual' profile reporting stress particularly due to detrimental physical working conditions, monotonous work, and low job control; (3) a 'human contact' profile characterized by a high risk of experiencing emotional demands, and conflicts with colleagues or supervisors; (4) a 'high stress' profile perceiving a generally high level of demands and stressors of any kind; and (5) a 'high demand' profile indicating a high risk of being exposed to emotional and quantitative demands, as well as demonstrating a low risk of experiencing physical stressors and adverse organizational conditions. Moreover, Vanroelen et al. (2010) demonstrated that each of these profiles exhibited differential effects on health (i.e. emotional issues and musculoskeletal problems; see also section 3.3.6), and thereby highlighted the importance of considering potential heterogeneity in the stress-health relationship.

This thesis proposes a combined person- and variable-centred approach that accounts for (see also Mayerl, Stolz, Waxenegger, & Freidl, 2017): (1) potential heterogeneity in the susceptibility to health issues; (2) potential heterogeneity in the perceived exposure to job demands; and (3) the differential effects of different job demand profiles on health. Based on previous research (Burkert et al., 2015; Jenull & Wiedermann, 2015; Vanroelen et al., 2010), it is hypothesized that the working population is heterogeneous with regard to both health symptoms (i.e. existence of distinct symptom clusters) and job demands (i.e. existence of distinct job demand profiles). Since this analysis is of exploratory nature, no specific assumptions about the number of symptom clusters

and job demand profiles – or their characteristic patterns – are made. Moreover, it is assumed that the likelihood of exhibiting a specific symptom cluster depends on the job demand profile to which individuals were assigned.

As regards person- and job-related resources, it is expected that individuals are homogeneous, i.e. that individuals *do not* exhibit typological patterns in terms of different resource dimensions. Given that different facets of person- and job-related resources overlap to a considerable extent (Xanthopoulou et al., 2007) and that resources tend to develop in aggregate (Hobfoll, 1989, 2011), there is no need to identify a typology of different resource constellations. However, it is expected that individuals high in both person- and job-related resources are more likely to belong to the more healthy symptom clusters.

# CHAPTER 4

# Materials and methods

PARTS of this chapter are based on the following publications: Mayerl et al. (2016); Mayerl, Stolz, Waxenegger, and Freidl (2017); and Mayerl, Stolz, Großschädl, et al. (2017).

## 4.1 Research design

In this thesis project, secondary data extracted from a cross-sectional survey study were analysed. The design of the research is correlational, or more specific, *ex-post facto* (see e.g. Montero & León, 2007). In other words, this thesis project sought to examine potential relationships between events and outcomes that had already occurred. This implies that there is no direct control over the manipulation of potential explanatory variables (as would be the case in experimental research). Moreover, the cross-sectional nature of the data implies that the candidate-dependent and -independent variables were measured at the same time. Experimental manipulations of independent variables and temporal ordering of independent and dependent variable measurements are, however, necessary criteria for establishing causation. As a consequence, this research design does *not* allow making causal inferences; potentially observed relationships are only correlational and do not prove any cause-and-effect associations. Instead, it has to be borne in mind that there may be a number of rival hypotheses which might explain the observed results (Lord, 1973).

Despite these constraints, the research design allowed the testing of complex hypotheses about the potential causes of an observed phenomenon in a large number

of participants and across different settings and 'real world' contexts. The extensive body of knowledge resulting from the huge amount of work undertaken in the field of occupational health research to date permits defining specific hypotheses and ruling out inconsistent or incoherent approaches of explanation. Moreover, this gathered knowledge can be used to establish the statistical models to be tested, i.e. researchers can focus on variables previously found to be important and statistically control for a number of evident as well as suspected confounding factors. A well-defined set of hypotheses derived from previous research findings as well as comprehensive statistical analysis thus seem to be essential to avoid drawing unjustified conclusions.

## 4.2 Data

This thesis project was based on self-reported data provided by a survey conducted for the *Austrian Work Climate Index (AWCI)*. The AWCI was developed in 1997 on behalf of the *Upper Austrian Chamber of Labour (Arbeiterkammer Oberösterreich)*, and represents a barometer of the work climate in the Austrian working population (Raml, 2009). To collect data, the *Institute for Empirical Social Studies (IFES)* questions approximately 900 employed and self-employed persons each quarter, by means of personal face-to-face interviews at participants' homes. The samples are drawn using proportionally stratified random sampling. The IFES uses a standardized questionnaire covering 26 different subjects, including working conditions, satisfaction with income and operational services, and satisfaction with career and development opportunities. In 2009, the AWCI was extended by the *Austrian Employee Health Monitor (AEHM)*, additionally assessing (psycho-)somatic symptoms and complaints, mental/psychological impairments, and different indicators of health-related resources (Michenthaler & Raml, 2009). This then enabled examining the relationships between work-related factors, resources, health, and well-being.

This thesis project used data collected in the years 2009 to 2014. Since the AEHM data were only available for employed persons, self-employed persons were excluded from all analyses. Moreover, since part-time employees were expected to differ considerably from full-time employees in factors such as the level of stress exposure, the amount of time to recover from work, and the work-life balance, part-time employees were excluded as well. The resulting sample size was $N = 17{,}941$ employees working full-time.

## 4.3 Ethical statement

Data collection for the AWCI was carried out in compliance with the principles defined in the *WMA Declaration of Helsinki*.[1] Interviews were conducted by trained interviewers who informed the participants about the study objectives, and the anonymity and confidentiality of all data. All interviews were conducted after verbal informed consent had been obtained from the participants, or legal guardians in the case of 15- to 17-year-olds. The *Ethics Committee of the Medical University of Graz* approved the implementation of the current thesis project (EK-number: 29-034 ex 16/17; see Appendix A).

## 4.4 Measures

Items used in this thesis project were partly derived from well-known and well-studied instruments (e.g. the self-efficacy scale), but were also selected as proxy variables representing the construct of interest (e.g. average frequency of somatic symptoms as an indicator for somatic health status).

### 4.4.1 Somatic health symptoms

Somatic symptoms ($SS$) were measured using 14 items in total. The items referred to complaints regarding the digestive system, the circulatory system, the musculoskeletal system, the respiratory system, the skin tissue, and psychosomatic aspects. Participants had to indicate on a 5-point rating scale, ranging from *1 = never* to *5 = very often*, how often in the previous weeks they had suffered from: ($SS_1$) digestive problems, ($SS_2$) stomach troubles, ($SS_3$) migraine or headaches, ($SS_4$) difficulties falling or remaining asleep, ($SS_5$) weakness of memory or lack of concentration, ($SS_6$) muscle tenseness in neck and shoulder regions, ($SS_7$) back pain, ($SS_8$) leg pain, ($SS_9$) hypertension, ($SS_{10}$) tachycardia/palpitations/feeling of pressure on the chest, ($SS_{11}$) skin rash/ itching/skin redness, ($SS_{12}$) respiratory problems/shortness of breath/breathlessness/ asthma, ($SS_{13}$) a chronic cough, or ($SS_{14}$) eye problems (burning, itching, inflammation, allergies). These variables were chosen because they were previously found to be related to work-related stress responses (Nixon et al., 2011) and because comparable sets of items are commonly used in large-scale occupational health research (see e.g. Zijlema et al., 2013).

[1] https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/

### 4.4.2 Mental strain

Subjectively perceived mental/psychological responses to stressors are often referred to as *mental strain* (see e.g. Hockey, 1997; Karasek, 1979; Schaufeli & Taris, 2014; Siegrist, 1996). In this regard, mental strain is usually operationalized by the core dimensions of burnout, such as exhaustion, cynicism, or reduced professional efficacy (Maslach et al., 2001). However, the AWCI data do not provide a validated measurement of burnout. This thesis thus relied on an alternative way of assessing mental strain, using three dimensions of mental strain reactions previously found to be associated with a burden due to extensive demands at work: *emotional exhaustion*, *irritation*, and *alienation*. This operationalization also allows generalizing previous findings on the health-impairment process beyond burnout. The three sub-dimensions were operationalized as follows:

**Emotional exhaustion** Emotional exhaustion referred to feelings of being depleted and overtaxed beyond one's resources (Maslach et al., 2001). Three items were used to measure this construct: (1) 'I feel exhausted due to work'; (2) 'I look forward to the end of work right from the start'; and (3) 'At work I am often tired and rather strained'.

**Irritation** Irritation was measured using a modified version of the *German Irritation Scale* (Mohr, Rigotti, & Müller, 2005). This scale was originally developed for the assessment of mental responses to extensive work-related stressors. The German Irritation Scale assesses two dimensions: emotional irritation (i.e. *irritability*) and cognitive irritation (i.e. *rumination*). The AWCI survey uses as modified version of this scale, accounting for irritability with three items ([1] 'I anger quickly'; [2] 'I get grumpy when others approach me'; [3] 'I get irritated easily, although I don't want this to happen'), and for rumination with two items ([4] 'I have difficulty relaxing after work'; [5] 'Even at home I often think of my problems at work'). Previous research confirmed the validity and reliability of the original irritation scale (Mohr, Müller, Rigotti, Aycan, & Tschan, 2006; Mohr et al., 2005).

**Alienation** Alienation represents a cognitive state or feeling of being estranged or separated from the self (Freidl, 1997; Fromm, 1955; Kanungo, 1979). This construct was measured using three items: (1) 'I often do not understand what is actually happening'; (2) 'Sometimes I do not know at all what to do in a certain situation'; and (3) 'Today things change so fast that I often don't know what to go by'.

Each of these items had to be rated on a 5-point scale, with response categories ranging from *1 = I do not agree* to *5 = I strongly agree*.

### 4.4.3 Job demands

The definition of job demands (*JD*) was based on the JD-R model (see section 3.2.6). As a reminder, job demands refer to 'those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort and are therefore associated with certain physiological and/or psychological costs' (Bakker, Demerouti, De Boer, & Schaufeli, 2003, p. 344). The items used in this thesis project thus cover a broad spectrum of potential demands at work, including physical, psychosocial, as well as organizational demands. Too specific items that concern only particular occupational groups (e.g. exposure to chemicals) were not included in the analysis. This resulted in 18 items in total.

Participants were asked to indicate the extent to which they felt burdened by: ($JD_1$) standing activity/forced posture, ($JD_2$) heavy physical exertion/heavy lifting tasks, ($JD_3$) one-sided physical strain, ($JD_4$) isolation at the workplace, ($JD_5$) time pressure, ($JD_6$) emotionally burdening and annoying work, ($JD_7$) a lack of opportunity to retreat, ($JD_8$) constant demand to be highly concentrated, ($JD_9$) high responsibility for goods and people, ($JD_{10}$) permanent monitoring and surveillance, ($JD_{11}$) permanent contact with customers/clients, ($JD_{12}$) permanent contact with seriously ill or needy persons, ($JD_{13}$) lack of support from the supervisor, ($JD_{14}$) lack of support from colleagues, ($JD_{15}$) technical and organizational changes, ($JD_{16}$) changes to work routines, ($JD_{17}$) irregular working hours, and ($JD_{18}$) excessive working hours. For each item, response categories ranged from *1 = not burdened* to *5 = strongly burdened*.

### 4.4.4 Person-related resources

In order to reflect a bio-psycho-social way of thinking, person-related resources (*PR*) were represented by three dimensions, namely a physical dimension, a mental dimension, and a social dimension:

**Physical** The physical dimension was addressed using two items that assessed employees' physical fitness: (1) 'How would you assess your physical fitness?' (response categories ranged from *1 = very poor* to *5 = very good*); and (2) 'How often do you feel fit enough to do everything you want?' (response categories ranged from *1 = never* to *5 = very often*).

**Mental** As an indicator for the mental/psychological dimension, the concept of *generalized self-efficacy* was used (see also section 3.2.2). Generalized self-efficacy refers to a stable and global confidence in one's own capability to cope with a variety of challenging and novel situations (Bandura, 1982; Schwarzer et al., 1997). Three items

from the German version of the *Generalized Self-efficacy Scale* (Schwarzer & Jerusalem, 1995, 1999) are applied in the AWCI survey: (1) 'I can always manage to solve difficult problems if I try hard enough'; (2) 'I am confident that I could deal efficiently with unexpected events'; and (3) 'Thanks to my resourcefulness, I know how to handle unforeseen situations'. For each item, response categories ranged from *1 = I do not agree* to *5 = I strongly agree*. Previous research supports the validity and reliability of the original (10-item) scale (Schwarzer et al., 1997).

**Social** As regards the social dimension, the focus was on an individual's evaluation of perceived social support outside of work. Participants had to indicate how strongly they would agree or disagree (on a 5-point rating scale ranging from *1 = I do not agree* to *5 = I strongly agree*) with the following three statements: 'I have persons beyond my immediate family circle' – (1) 'on whom I can count in case of emergency', (2) 'with whom to talk about very personal things', and (3) 'with whom I can spend my spare time'.

### 4.4.5 Job resources

The conceptualization of job resources ($JR$) follows the definition of the JD-R model (see section 3.2.6). Job resources are defined as all the beneficial factors of the job that attenuate job demands and the related costs, that are functional in achieving work goals, and that facilitate personal growth and development (Bakker, Demerouti, De Boer, & Schaufeli, 2003; Demerouti et al., 2001). To assess job resources, six items were selected. Participants had to rate the level of satisfaction with: ($JR_1$) the possibilities to decide on work processes, ($JR_2$) the opportunities for co-determination at work, ($JR_3$) their working rights as employees, ($JR_4$) their income, ($JR_5$) the career and development opportunities, and ($JR_6$) the occupational training opportunities. Each item had to be rated on a 5-point rating scale, ranging from *1 = not at all satisfied* to *5 = very satisfied*.

### 4.4.6 Health behaviour

To assess health-related behaviour, participants were asked to indicate whether they (1) ate healthy food (0 = *yes*; 1 = *no*), (2) performed regular exercise in leisure time (0 = *yes*; 1 = *no*), or (3) smoked (*0 = not at all*; *1 = occasionally/regularly*). Additionally, participants were asked to indicate how often they consumed alcohol (scale ranging from *1 = not at all* to *6 = nearly every day*).

### 4.4.7 Educational level, marital status, sex, and age

Educational level was classified into four groups, reflecting the highest level of education reached: (1) compulsory school, (2) skilled workers holding an apprenticeship certificate or a diploma from vocational school, (3) high school diploma, and (4) university degree. Marital status was divided into three categories: (1) single, (2) in a partnership/married, and (3) divorced/widowed. Sex was categorized as female and male, and the age of participants was measured in years.

## 4.5 Statistical analysis

The statistical analysis was performed using R 3.4.3 (R Core Team, 2017), and the respective R-packages. In a first step, patterns of missing data were examined and plausible values for the missing cases were imputed. Next, psychometric analysis was conducted in order to examine the psychometric properties of the hypothesized measurement models. Finally, statistical analysis was conducted to test the hypotheses regarding work-related stress processes. The measurement models were thus examined (and modified, where necessary) prior to the investigation of the hypothesized relationships between the constructs of interest. According to Anderson and Gerbing (1988), this two-step approach is a comprehensive way of performing statistical analysis that includes both psychometric analysis and hypothesis testing.

As it is well known that significance tests are highly dependent upon sample size, a more stringent significance criterion of $\alpha = 1\,\%$ was used. This prevents very weak effects with negligible practical implications from recording a significant result.

### 4.5.1 Missing data

Missing values in the data set were assumed to be *missing at random (MAR)*. This means that the missingness on a variable $Y$ is conditional on other measured variables in the data set (Enders, 2010, p. 6), or, to put it differently, MAR means that any missingness on a variable $Y$ can be considered as completely random (i.e. the missingness does not depend on unobserved variables) after one has controlled for other important variables in the data set (Graham, 2009). Therefore, the relevant variables in the data set can be used to impute plausible values for the missing data on a variable $Y$. To date a number of different approaches have been proposed for missing data imputation (e.g. arithmetic mean imputation, regression imputation, multiple imputation, and random forest imputation).

In this thesis project, *multiple random forest imputation* from the R-package

MissForest 1.4 (Stekhoven & Bühlmann, 2012) was applied. This method uses an iterative multiple imputation scheme based on a random forest (Stekhoven & Bühlmann, 2012). In simulation studies, multiple random forest imputation was found to perform well across different conditions (e.g. mixed-type data, complex interactions), and was even found to outperform more classic approaches (such as multiple imputation methods) in terms of efficiency and accuracy (Hunt, 2017; Liao et al., 2014; Stekhoven & Bühlmann, 2012; Waljee et al., 2013).

### 4.5.2 Psychometric analysis

To investigate the dimensionality of the scales for somatic health symptoms, mental strain, job demands, and person- and job-related resources, confirmatory factor analysis (CFA) was conducted. In order to correct potential specification errors in the hypothesized measurement models, this step often requires the use of so-called *specification searches* (MacCallum, 1986). A useful tool to detect potential misspecifications in the measurement models is *modification indexes*. These indexes estimate the amount by which the overall model fit would improve (or worsen) if a particular single path is added to the model (Kline, 2011, pp. 216–217). However, such a data-driven approach is often prone to capitalization on chance (MacCallum, Roznowski, & Necowitz, 1992). Thus, modifications to the initially defined models were only applied if they were theoretically warranted.

Given the ordinal character (based on the Likert-type response categories) of the indicator variables, polychoric correlations and *Diagonally Weighted Least Squares (DWLS)* estimation with robust standard errors and mean- and variance-adjusted test statistics (also known as *WLSMV* estimation; Jöreskog, 1994; B. O. Muthén, 1984) were used. Model fit was evaluated using a set of fit indexes: the $\chi^2$-statistic; the *Tucker-Lewis-Index (TLI)* (Tucker & Lewis, 1973); the *Comparative-Fit-Index (CFI)* (Bentler, 1990); the *Standardized Root Mean Square Residual (SRMR)*; and the *Root Mean Square Error of Approximation (RMSEA)* (Steiger, 1990) with 90 % confidence intervals (CI). As the $\chi^2$-statistic is sensitive to sample size (Brannick, 1995; Cheung & Rensvold, 2002), the focus was placed on the *CFI*, the *TLI*, the *SRMR*, and the *RMSEA*.

The *TLI* and *CFI* values range from 0 to 1, and larger values indicate better fit. A value $\geq .95$ is indicative of satisfactory model fit (L.-t. Hu & Bentler, 1999). As regards *RMSEA*, values also range from 0 to 1, but lower values indicate better fit. The *RMSEA* values $\leq .06$ and $\leq .08$ were used to indicate good and acceptable model fit, respectively (L.-t. Hu & Bentler, 1999; MacCallum, Browne, & Sugawara, 1996). Similarly, *SRMR* values range from 0 to 1, and values $\leq .08$ were usually used to indicate good fit (Bentler, 1990). The CFA was performed with the R-package lavaan 0.5-23.1097 (Rosseel, 2012).

To assess the composite reliabilities of the first- and second-order factors, coefficient $\omega$, as proposed by Raykov (2001), was computed. Coefficient $\omega$ estimates reliability from a factorial analysis framework, and allows for examining model-based reliability by accounting for the hierarchical structure of the measurement models as well as correlated measurement errors (Raykov, 2001). Given the numerous deficiencies of the commonly used coefficient $\alpha$ (Cronbach, 1951) reported in the literature (e.g. underestimation of true reliability if the assumption of $\tau$-equivalence is violated; overestimation of reliability if the assumption of unidimensionality does not hold; Raykov, 2001; Sijtsma, 2009), coefficient $\omega$ always seems to be the better choice for estimating reliability (Dunn, Baguley, & Brunsden, 2014; Trizano-Hermosilla & Alvarado, 2016). Like coefficient $\alpha$, coefficient $\omega$ values range from 0 to 1, and larger values indicate higher reliability. The R-package semTools 0.4-14 (Pornprasertmanit, Miller, Schoemann, & Rosseel, 2014) was used to estimate coefficient $\omega$ based on the specified CFA models.

### 4.5.3 Moderated regression analysis

Multiple regression analysis was performed to examine the effects of the independent variables (i.e. job demands and the different dimensions of person- and job-related resources) on the dependent variables (i.e. somatic health symptoms and mental strain). Moreover, the moderating effects of the different dimensions of person- and job-related resources in the relationship between job demands and health were examined. That is, the product terms of the corresponding demands and resources scores were included as independent variables in the regression models.

In order to investigate the relative importance of both job demands and the different dimensions of resources (as well as their moderating effects), a hierarchical approach was applied. In Model 1, each of the two dependent variables were regressed on health behaviour, educational level, marital status, sex, and age. In Model 2, both the job demands and the different dimensions of job- and person-related resources were added to the models. In Model 3, the interactions between job demands and the different dimensions of job- and person-related resources were additionally considered. This hierarchical approach permits estimation of the amount by which the prediction of the dependent variables would improve if additional independent variables (namely job demands, job- and person-related resources, and their interactions) were included in the models.

A measure that quantifies how well a dependent variable can be predicted by a set of independent variables is the *coefficient of determination* (or $R^2$). This measure estimates the proportion of the variance in the dependent variable that can be explained by the combined effects of the independent variables. Usually, an adjusted $R^2$ is reported. This measure accounts for the fact that additional explanatory variables automatically

and often spuriously increase $R^2$. An adjusted $R^2$ is more appropriate when models with different numbers of variables are compared with each other (see e.g. Hedderich & Sachs, 2016, p. 779).

### 4.5.4 Structural equation modelling

To test the hypothesized stress model as defined in subsection 3.6.2, structural equation modelling (SEM) was used. SEM refers to a family of different procedures and approaches aiming to model the associations between *manifest* and *latent* variables. Manifest variables are represented by the observed values in a data set. Latent variables, in turn, correspond to factors that are not directly observable. These factors represent hypothetical constructs that have to be inferred from a set of manifest variables (so-called *indicator variables*).

One variant of SEM has already been described in the psychometric subsection (see subsection 4.5.2), namely CFA. While CFA focuses on the measurement parts of a model (i.e. the associations between factors and their indicators), SEM considers both the measurement parts and the structural parts (i.e. the associations between particular factors) of a model. The main strength of SEM is that both the measurement parts and the structural parts can be combined in one single model. Since the measurement models were already investigated in the psychometric analysis section, the current step of analysis concentrates on the structural paths of the hypothesized stress model. To test the model as a whole, the same estimation procedure (*WLSMV* estimation based on polychoric correlations) as well as model fit statistics ($\chi^2$-statistic, *TLI*, *CFI*, *SRMR*, *RMSEA*) as in the CFA step were used.

The structural paths of the model were specified, as summarized in Figure 3.3 (including the direct pathway [$H_4$] from job demands to somatic symptoms). This model was also tested against an alternative nested model that restricts the direct effect of job demands on somatic symptoms to be zero (i.e. omitting the direct pathway $H_4$). This *model trimming* approach (see e.g. Kline, 2011, p. 214) allows examining whether mental strain fully, or only partially, mediated the link between job demands and somatic symptoms. Full mediation would mean that mental strain completely accounts for the relationship between job demands and somatic symptoms. Partial mediation, in turn, would mean that mental strain can explain some but not all of the relationship between job demands and somatic health. To test the models against each other, a scaled $\chi^2$-difference test (Satorra & Bentler, 2001, 2010) was conducted. As this test is sensitive to sample size, the decline in fit indexes after including the direct pathway ($H_4$) from job demands to somatic symptoms was also considered (for a similar approach, see Hakanen et al., 2006; Korunka et al., 2009; Schaufeli & Bakker, 2004).

Having found a well-fitting model, multiple-group analysis was conducted in order to test invariance regarding both the measurement and the structural parts of the model. This allowed examining whether the final model held across sex, different age groups, and different educational levels. To achieve this, a sequential procedure was applied, gradually imposing equality constraints across groups (e.g. females vs. males; for more detailed information on invariance testing, see e.g. Beaujean, 2014; Hirschfeld & von Brachel, 2014). The invariance hypothesis was rejected (vs. retained) if the fit of a more restrictive model worsened significantly (vs. did not worsen significantly) compared to a less restrictive model. In a first step, the same factor structure was imposed on the groups (so-called *configural invariance*). In second, third, and fourth steps, the factor loadings (*weak invariance*), the thresholds (*strong invariance*), and the residual variances as well as the residual covariances (*strict invariance*) were constrained to be equal across groups. Configural, weak, strong, and strict invariance refer to the measurement parts of the model. Measurement invariance would mean that the manifest scores of the hypothetical constructs have the same meaning among males and females, different age groups, and different educational levels. Moreover, invariance of the structural parts of the model were tested by additionally constraining the coefficients of the corresponding structural paths. Structural invariance would mean that the relationships of the constructs of interest are equally strong across the tested groups.

SEM and multiple-group analysis were accomplished with the R-package lavaan 0.5-23.1097 (Rosseel, 2012).

### 4.5.5 Latent class cluster analysis

To identify the symptom clusters and job demand profiles, *latent class (LC) cluster analysis* was used. Technically, LC analysis is a special case of SEM. Whereas most SEM approaches assume the latent variables to be continuous, LC analysis is based on the assumption that the latent variables are categorical. The categories of latent variables represent the *latent classes*, and each individual is assumed to belong to one of these mutually exclusive latent classes. The number of classes and their sizes are unknown a priori and have to be estimated as part of the analysis procedure. LC cluster analysis aims to identify these latent classes and to cluster or group a set of individuals accordingly.

LC cluster analysis is usually used as a statistical method for analysing multivariate categorical data. Two main parameter categories are important in the estimation process of LC analysis: the *prior probability of class membership* and the *class-conditional item response probability*. The prior probability of class membership refers to the prevalences or sizes of the latent classes. These parameter values answer the question: How many individuals are expected to belong to a particular class? The class-conditional item

response probability, in turn, refers to the probability that an observation in class $k$ produces the $m$th response category on the $j$th item. To put it differently: How likely is it that an individual belonging to a particular class chooses a specific answer on a corresponding item? Moreover, the class-conditional item response probability is based on the assumption that the observed scores of individuals belonging to the same class will fall in the same probability distribution (Hagenaars & McCutcheon, 2002).

The prior probability of class membership and the class-conditional item response probability are then used to calculate the *posterior* probability of class membership. The resulting values indicate how likely it is that an individual exhibiting a specific response pattern on a set of manifest items belongs to each of the latent classes. In turn, cases can be classified according to their most likely latent class.

Since the number of latent classes is unknown a priori, a commonly used approach is to estimate several LC models with gradually increasing numbers of classes. The model that fulfils certain criteria is then used for further analysis. In this thesis, LC models with up to seven classes were evaluated. The number of classes was defined on the basis of both statistical and substantive grounds (Lawrence & Zyphur, 2011; Marsh, Lüdtke, Trautwein, & Morin, 2009). This means that a set of statistical model selection criteria was considered on the one hand, and the competing models were evaluated with regard to the interpretability and meaningfulness of the item probability profiles on the other hand. As regards statistical model selection, the *Bayesian Information Criterion (BIC)* (Schwarz, 1978) was used. In simulation studies, the BIC was revealed to be a useful indicator for the purpose of statistical model selection (Nylund, Asparouhov, & Muthén, 2007). Moreover, the relative improvement in model fit (reflected by the log-likelihood function) between a $k$-class model and a $(k + 1)$-class model (Bacher & Vermunt, 2010) was considered. A further useful criterion for model selection is a measure of *entropy* (Celeux & Soromenho, 1996), which indicates classification quality. Entropy measures range from 0 to 1, with higher values indicating better classification of individuals (Clark & Muthén, 2009).

The indicator variables for the symptom clusters included all items assessing somatic health symptoms ($SS_1$–$SS_{14}$), as well as the subscale scores with regard to mental strain (i.e. emotional exhaustion, irritation, and alienation). As regards the indicator variables for the job demand profiles, all items measuring the perceived burden due to job demands ($JD_1$–$JD_{18}$) were used. Although latent class programs and packages can handle data of multicategorical or ordinal measurement scales, the indicator variables were dichotomized prior to performing the LC analysis. The first reason for dichotomization is the relatively high number of indicator variables included in the models. The five-point rating scales of the variables would have resulted in a huge number of possible response patterns. Since a considerable proportion of these

patterns were very infrequently (if at all) observed in the current sample, boundary parameters may be the consequence. Boundary parameters are probabilities estimated to be zero or one, and may cause serious problems in the estimation process (Galea et al., 1997; Vermunt & Magidson, 2004; Wurpts & Geiser, 2014).

The second reason concerns the interpretation of the resulting item probability profiles. Dichotomization of indicator variables makes the interpretation of latent classes easier and more intuitive. Therefore, the response categories for each of the indicator variables of somatic health symptoms and job demands were combined: response categories 1 and 2, and response categories 3 to 5 were merged into one category, respectively. As regards the subscales of mental strain, the variables were dichotomized by means of a median split.

Having found a meaningful and well-fitting LC solution for both job demands and health symptoms, each case was classified according to her/his most likely latent class membership. This resulted in two categorical variables: (1) latent class membership for job demands (i.e. representing the job demand profiles); and (2) latent class membership for health symptoms (i.e. representing the symptom clusters). In order to examine the relationship between these two variables, the latent variable for health symptoms was then regressed on the latent variable for job demands, by means of a multinomial logistic regression model. Moreover, job- and person-related resources, health behaviour, educational level, marital status, sex, and age were considered in the final regression models.

LC analysis was performed using the R-package poLCA 1.4.1 (Linzer & Lewis, 2011) and multinomial regression analysis was accomplished with the R-package nnet 7.3-8 (Venables & Ripley, 2003).

# CHAPTER 5

# Results

## 5.1 Sample characteristics

The sample characteristics of all employees working full-time can be found in Table 5.1. Regarding the highest level of education, the vast majority were skilled workers holding an apprenticeship certificate or employees holding a diploma from vocational school. The next largest group were employees with a high school diploma, followed by employees holding a university degree, and employees with compulsory education. More than half of employees were married or living in a partnership. Less than a third of employees were single, and the smallest group was divorced or widowed. The sex ratio was almost balanced. The mean age of employees was about 40 years, with a minimum and maximum age of 15 and 85 years, respectively.

## 5.2 Missing data

Overall, there was a small amount of missing data (only 0.60 %) in the used data set. The amount of missing data was small for the health symptoms items (range: 0.01 % to 0.04 %; see Appendix Table B.1), the mental strain items (range: 0.01 % to 0.04 %; see Appendix Table B.2), the job demands items (range: 0.19 % to 1.29 %; see Appendix Table B.3), the person-related resources items (range: 0.01 % to 0.02 %; see Appendix Table B.5); and the items regarding health behaviour (range: 0.09 % to 0.46 %; see Appendix Table B.6), whereas the amount of missing data was comparatively large for job resources (range: 0.17 % to 5.85 %; see Appendix Table B.4). It can only be

**Table 5.1:** Sample characteristics

| Variable | |
|---|---|
| **Educational level** | |
| compulsory school | 1672 (9.32 %) |
| skilled workers/vocational school | 11502 (64.11 %) |
| high school diploma | 2514 (14.01 %) |
| university degree | 2253 (12.56 %) |
| **Marital status** | |
| single | 4864 (27.11 %) |
| in partnership/married | 10467 (58.34 %) |
| divorced/widowed | 2610 (14.55 %) |
| **Sex** | |
| female | 8911 (49.67 %) |
| male | 9030 (50.33 %) |
| **Age** | |
| $M$ ($SD$) | 39.51 (11.22) |
| minimum | 15 |
| maximum | 85 |

*Table notes.* $N = 17,941$. The table reports frequencies (and percentages) for educational level, marital status, and sex, and mean (and standard deviation) for age. No missings. $M$ = Mean. $SD$ = Standard Deviation.

speculated why some of the job resources measures have higher missing data levels than the other variables. One reason might be that some employees are satisfied with their current work situation and do not wish to develop in the job or to start a successful career, and thus refused to answer some of these questions.

In order to avoid bias and to prevent loss of power due to missing data, random forest imputation (Stekhoven & Bühlmann, 2012) was used to impute plausible values for the missing data. The average out-of-bag imputation error (*proportion of falsely classified*) across variables was acceptable ($M = 0.29$, $SD = 0.13$), yet it has to be noted that two variables exhibited rather high error rates: The variable assessing the burden due to time pressure ($JD_6$) and the variable assessing alcohol consumption recorded imputation errors of 0.51 and 0.65, respectively. However, since the amount of missing data was very small for these two variables (time pressure: 37 missing values in total; alcohol consumption: 73 missing values in total), there is no need to expect any bias due to a potential imputation error.

## 5.3 Psychometric analysis

In this section, a description of psychometric analysis with regard to the measurement models of somatic health symptoms, mental strain, job demands, and job- and person-related resources is presented.

### 5.3.1 Somatic health symptoms

For somatic health symptoms, a first-order factor model with 14 items as indicators was tested. By examining the modification indexes, it was found that model fit could be improved by allowing the residual variances of the following items to covary among themselves: between variables $SS_1$ and $SS_2$, between variables $SS_6$ and $SS_7$, and between variables $SS_{12}$ and $SS_{13}$. The redefined model indicated good fit ($\chi^2[74] = 3769$, $p < .001$; $CFI = .971$; $TLI = .964$; $SRMR = .042$; $RMSEA = .053$ [90 % $CI$ .051; .054]), and reliability was satisfactory ($\omega = .86$).

### 5.3.2 Mental strain

As regards the measurement model of mental strain, a second-order factor model with irritation, emotional exhaustion, and alienation as the three latent first-order factors was tested. The irritation scale had five indicator variables, and the exhaustion and alienation scales each had three indicator variables. Due to the two-dimensional model structure of the irritation scale, it was a priori decided to include a residual covariance between items within each dimension (i.e. covariation between irritability items and between rumination items). The model fit was good ($\chi^2[37] = 1860$, $p < .001$; $CFI = .995$; $TLI = .993$; $SRMR = .024$; $RMSEA = .052$ [.050; .054]). The reliability of this model was also satisfactory: $\omega = .80$ on level 1 and $\omega = .84$ on level 2. Level 1 and level 2 reliability values indicate the proportion of the second-order factor explaining the variance of the total score and the variance of the first-order factors, respectively (for further information, see Pornprasertmanit et al., 2014).

### 5.3.3 Job demands

To assess job demands, a first-order factor model with 18 indicator items was examined. It was found to be reasonable to let the residual variances of the following indicator items covary among themselves: between variables $JD_1$, $JD_2$, and $JD_3$; between variables $JD_7$ and $JD_{10}$; between variables $JD_8$ and $JD_9$; between variables $JD_{13}$ and $JD_{14}$; between variables $JD_{15}$ and $JD_{16}$; and between variables $JD_{17}$ and $JD_{18}$. The modified model

exhibited acceptable model fit ($\chi^2[127] = 12175$, $p < .001$; $CFI = .960$; $TLI = .952$; $SRMR = .062$; $RMSEA = .073$ [.072; .074]), and reliability was satisfactory ($\omega = .85$).

### 5.3.4 Resources

#### Person-related resources

First, a first-order factor model for each dimension of person-related resources was tested. Models with a total of two or three indicator items are, however, saturated and no model fit statistics are available. Therefore, only the range of the standardized factor loadings and the reliability can be reported. The factor loadings for the physical dimension of person-related resources (two items) were $\lambda = .86$ and $\lambda = .76$. As for the mental dimension (three items), the factor loadings were between $\lambda = .81$ and $\lambda = .87$. The factor loadings for the social dimension were between $\lambda = .88$ and $\lambda = .92$. Reliability for the physical dimension ($\omega = .71$) was acceptable, whereas reliabilities for the mental ($\omega = .84$) and the social ($\omega = .88$) dimensions were good.

Second, a second-order model for person-related resources (as a second-order factor) was tested, based on the physical, mental, and social dimensions of person-related resources as first-order factors. This model exhibited good fit with the data ($\chi^2[17] = 359$, $p < .001$; $CFI = .998$; $TLI = .997$; $SRMR = .017$; $RMSEA = .033$ [.031; .037]). The reliability measures on both level 1 ($\omega = .61$) and level 2 ($\omega = .66$) were, however, mediocre.

#### Job resources

Next, a first-order model for job resources with six indicator items was evaluated. It was found that model fit considerably improved by allowing the residual variances of items $JR_1$ and $JR_2$, of items $JR_3$ and $JR_4$, and of items $JR_5$ and $JR_6$, to covary. This model exhibited good fit ($\chi^2[6] = 325$, $p < .001$; $CFI = .998$; $TLI = .995$; $SRMR = .012$; $RMSEA = .055$ [.050; .060]), and satisfactory reliability ($\omega = .79$).

#### Person- and job-related resources combined

Finally, the assumption whether person- and job-related resources can be considered as indicators of a common resources factor was tested. For this, a second-order factor model based on the four first-order factors defined above (namely physical resources, mental resources, social resources, and job resources) was tested. This model exhibited good fit with the data ($\chi^2[70] = 1274$, $p < .001$; $CFI = .997$; $TLI = .997$; $SRMR = .023$;

**Table 5.2:** Descriptive statistics and correlations of (sub-)scales

| Variable | *M (SD)* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Health sympt. | 1.49 (0.49) | 1.00 | | | | | | | | |
| 2 Irritation | 1.80 (0.85) | 0.50 | 1.00 | | | | | | | |
| 3 Exhaustion | 2.06 (0.99) | 0.46 | 0.81 | 1.00 | | | | | | |
| 4 Alienation | 1.80 (1.02) | 0.35 | 0.66 | 0.67 | 1.00 | | | | | |
| 5 Job demands | 1.79 (0.65) | 0.46 | 0.64 | 0.64 | 0.45 | 1.00 | | | | |
| 6 Physical res. | 4.11 (0.67) | −0.46 | −0.37 | −0.41 | −0.29 | −0.35 | 1.00 | | | |
| 7 Mental res. | 3.86 (0.78) | −0.24 | −0.34 | −0.37 | −0.43 | −0.27 | 0.32 | 1.00 | | |
| 8 Social res. | 4.34 (0.85) | −0.19 | −0.28 | −0.28 | −0.29 | −0.24 | 0.27 | 0.31 | 1.00 | |
| 9 Job res. | 3.69 (0.77) | −0.33 | −0.36 | −0.43 | −0.28 | −0.43 | 0.38 | 0.40 | 0.26 | 1.00 |

*Table notes.* Pearson correlation coefficients. $M$ = Mean. $SD$ = Standard Deviation. sympt. = symptoms. res. = resources.

$RMSEA = .031$ [.029; .032]). Reliability was acceptable on both level 1 ($\omega = .68$) and level 2 ($\omega = .75$).

### 5.3.5 Summary

To sum up, the redefined measurement models exhibited good model fit and satisfactory to acceptable reliability. All of the model modifications seemed to be theoretically justifiable. For example, it is reasonable to assume a covariance between digestive problems and stomach troubles, between muscle tenseness in the neck and shoulder regions and back pain, or between respiratory problems and chronic cough. It is also justifiable to expect a covariance between the burden due to a lack of opportunity to retreat and the burden due to permanent monitoring and surveillance, or between the burden due to technical and organizational changes and the burden due to changes in work routines. Moreover, there is reason to believe that there is an unexplained covariance between the level of satisfaction with the possibilities to decide on work processes and the level of satisfaction with the opportunities for co-determination, or between the satisfaction with career and development opportunities and the satisfaction with occupational training opportunities. However, modification searches may also be associated with negative implications (e.g. capitalization on chance), and the modified measurement models may not generalize to other samples and contexts. Since this thesis project aims to examine the relationships between the hypothesized constructs and *does not* aim to establish new instruments to measure these constructs, potential issues due to the inclusion of correlated residuals seemed to be of minor importance.

Table 5.2 presents the average mean scores of participants and correlations of the factor scores extracted from the CFA. It has to be noted that mean scores of (sub-)scales may be biased due to the fact that some of the residuals of the measurement models covary. This bias is assumed to be rather weak, since the mean scores highly correlated with the corresponding CFA factor scores (correlations between .94 and .99).

Nevertheless, these mean scores were only used for descriptive analysis, whereas the extracted CFA factor scores are used in further statistical hypothesis testing, in order to take the specific features of the measurement models into account.

## 5.4 Moderated regression analysis

### 5.4.1 Somatic health symptoms

The results of the three regression models for somatic health symptoms are depicted in Table 5.3. According to Models 2 and 3, there was a moderately strong effect of job demands on somatic health symptoms. Higher levels of job demands were related to higher levels of somatic symptoms. By contrast, each of the four resource dimensions were negatively associated with somatic symptoms. That is, higher levels of resources were accompanied with lower levels of somatic symptoms. The physical dimension exhibited the relatively highest effect, while there was a rather weak effect for job resources. The very slight effect of mental and social resources has no or very little practical relevance.

The results of Model 3 also indicated interaction effects between job demands and the four resource dimensions. To clarify these interaction effects, Figure 5.1 illustrates the predicted values of somatic symptoms as a function of job demands and each of the four resource dimensions. The lines represent the simple slopes of job demands, separately for low ($10^{\text{th}}$ quantile), middle ($50^{\text{th}}$ quantile), and high ($90^{\text{th}}$ quantile) values of resources. As indicated in the upper row on the left, individuals low in physical resources generally reported more somatic symptoms than individuals high in physical resources. The interaction effect, however, is very weak and thus negligible. In a similar vein, although there is a significant interaction effect between job demands and mental (upper row on the right) as well as social (bottom row on the left) resources, the effects are very weak and do not have practical implications. Only the interaction effect between job demands and job resources (bottom row on the right) was as hypothesized. The effect of job demands on somatic symptoms was stronger in persons with low levels of job resources than in persons with high levels of job resources.

As regards health-related behaviour, the effects were generally weak and not substantial. People who exercised regularly in their leisure time reported slightly fewer symptoms than people who did not exercise regularly. This effect was only found in Models 2 and 3, that is, after controlling for job demands and resources. An unhealthy diet was related to more symptoms, albeit this significant effect disappeared in Models 2 and 3. Smoking was related to more somatic health symptoms in all three models.

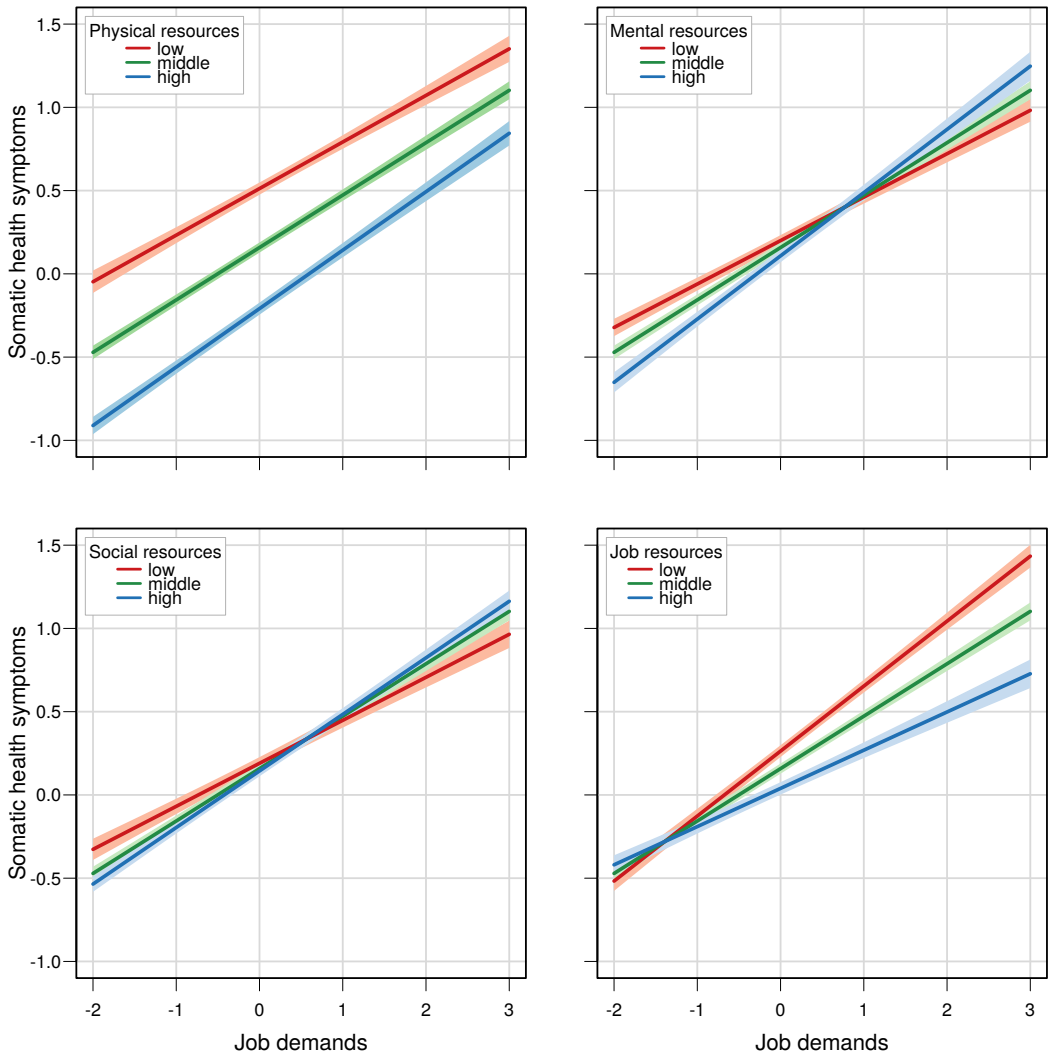


**Figure 5.1:** Prediction of somatic health symptoms as a function of job demands and resources (Model 3). The red, the green, and the blue lines refer to the classification of resources in low ($10^{\text{th}}$ quantile), middle ($50^{\text{th}}$ quantile), and high ($90^{\text{th}}$ quantile), respectively. The coloured area around the lines represents the 99 % confidence bands of the predicted values.

Somatic symptoms accompanied more frequent alcohol use in Model 1, but not in Models 2 and 3.

As regards educational level, workers holding an apprenticeship certificate or a diploma from vocational school, as well as workers with a high school diploma, reported fewer somatic symptoms than workers with compulsory education (Model 1). However, the effect of educational level changed considerably after including job demands and resources (see Models 2 and 3): workers with higher levels of education (i.e. high school or university) were found to report more somatic symptoms than workers with compulsory education. Moreover, there was a slight tendency that married persons and persons in partnerships reported more symptoms than single persons, and that divorced and widowed persons reported fewer symptoms than single persons. Sex recorded a

**Table 5.3:** Regression coefficients for somatic health symptoms

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Variable** | $\beta$ [99 % $CI$] | $p$-value | $\beta$ [99 % $CI$] | $p$-value | $\beta$ [99 % $CI$] | $p$-value |
| (Intercept) | −1.04 [−1.15; −0.94] | 0.000 | −0.77 [−0.86; −0.68] | 0.000 | −0.76 [−0.85; −0.67] | 0.000 |
| Job demands | - | - | 0.31 [0.30; 0.33] | 0.000 | 0.31 [0.29; 0.33] | 0.000 |
| Physical resources | - | - | −0.26 [−0.28; −0.24] | 0.000 | −0.26 [−0.28; −0.25] | 0.000 |
| Mental resources | - | - | −0.03 [−0.05; −0.01] | 0.000 | −0.03 [−0.05; −0.02] | 0.000 |
| Social resources | - | - | −0.02 [−0.03; 0.00] | 0.017 | −0.02 [−0.04; −0.00] | 0.004 |
| Job resources | - | - | −0.09 [−0.11; −0.07] | 0.000 | −0.08 [−0.10; −0.06] | 0.000 |
| Exercise (ref.: yes) | | | | | | |
| no | 0.03 [−0.01; 0.07] | 0.033 | −0.08 [−0.12; −0.05] | 0.000 | −0.08 [−0.11; −0.04] | 0.000 |
| Healthy diet (ref.: yes) | | | | | | |
| no | 0.04 [0.00; 0.08] | 0.009 | 0.02 [−0.01; 0.05] | 0.106 | 0.03 [−0.01; 0.06] | 0.028 |
| Smoking (ref.: not at all) | | | | | | |
| occasionally/regularly | 0.11 [0.07; 0.15] | 0.000 | 0.04 [0.00; 0.07] | 0.005 | 0.04 [0.00; 0.07] | 0.004 |
| Alcohol | 0.02 [0.00; 0.04] | 0.009 | −0.01 [−0.03; 0.01] | 0.203 | −0.01 [−0.03; 0.01] | 0.188 |
| Education (ref.: compulsory) | | | | | | |
| skilled/vocational | −0.15 [−0.21; −0.08] | 0.000 | 0.05 [−0.01; 0.10] | 0.022 | 0.05 [−0.01; 0.11] | 0.020 |
| high school | −0.10 [−0.18; −0.02] | 0.001 | 0.11 [0.04; 0.17] | 0.000 | 0.10 [0.04; 0.17] | 0.000 |
| university | −0.01 [−0.10; 0.07] | 0.673 | 0.11 [0.04; 0.18] | 0.000 | 0.11 [0.04; 0.18] | 0.000 |
| Marital status (ref.: single) | | | | | | |
| in partnership/married | 0.05 [0.00; 0.10] | 0.006 | 0.03 [−0.01; 0.07] | 0.033 | 0.03 [−0.01; 0.07] | 0.035 |
| divorced/widowed | −0.08 [−0.14; −0.01] | 0.003 | −0.07 [−0.12; −0.01] | 0.002 | −0.06 [−0.12; −0.01] | 0.004 |
| Sex (ref.: male) | | | | | | |
| female | 0.27 [0.23; 0.31] | 0.000 | 0.26 [0.23; 0.29] | 0.000 | 0.26 [0.23; 0.29] | 0.000 |
| Age | 0.02 [0.02; 0.02] | 0.000 | 0.02 [0.01; 0.02] | 0.000 | 0.01 [0.01; 0.02] | 0.000 |
| Job demands × physical resources | - | - | - | - | 0.03 [0.01; 0.04] | 0.000 |
| Job demands × mental resources | - | - | - | - | 0.04 [0.03; 0.06] | 0.000 |
| Job demands × social resources | - | - | - | - | 0.03 [0.02; 0.05] | 0.000 |
| Job demands × job resources | - | - | - | - | −0.06 [−0.08; −0.04] | 0.000 |
| Adjusted $R^2$ | 0.083 | | 0.355 | | 0.361 | |

*Table notes.* $\beta$ = standardized regression coefficient. $CI$ = confidence interval. All continuous measures were standardized, except for age. Categorical variables were included as dummy variables.

comparatively strong effect, with females reporting more symptoms than men. Higher levels in somatic symptoms also accompanied increasing age.

Overall, health-related lifestyle and socio-demographic factors only slightly contributed to the prediction of somatic health symptoms. A proportion of 8.3 % of the variance in somatic health can be explained by differences in health behaviour, educational level, marital status, sex, and age. After including job demands and resources, the proportion of explained variance considerably increased to 35.5 %. However, the inclusion of the product terms did not enhance the proportion of explained variance dramatically, indicating that the interaction effects only slightly contributed to explaining the variance in somatic health status.

### 5.4.2 Mental strain

The effect of job demands was even stronger for mental strain than for somatic health symptoms (see Table 5.4). Higher levels of job demands were associated with higher levels of mental strain. The four dimensions of resources were again negatively related to mental strain: the more the available resources, the less mental strain was reported. The strongest effect was found for mental resources, followed by physical resources, social resources, and job resources. There was also a significant interaction effect between job demands and social resources, as well as between job demands and job resources. The interactions between job demands and the physical and mental resource dimensions were insignificant. To clarify these interactions, Figure 5.2 presents the predicted values of mental strain as a function of job demands and resources. As can be seen in the upper row, neither physical nor mental resources attenuated the negative impact of job demands on mental strain. In the bottom row, there is a weak interaction effect. This effect is as hypothesized: the increase in mental strain as a function of job demands was less strong in people who reported high levels of both social resources and job resources. However, this effect was very weak and the practical relevance is questionable.

As regards health behaviour, people who exercised regularly reported less mental strain than people who did not exercise regularly. However, this effect became insignificant after including job demands and resources. A healthy diet did not exhibit any association with mental strain. Smokers reported higher levels of mental strain than non-smokers, even after controlling for job demands and resources. Higher levels of alcohol consumption were related to more mental strain in Model 1, but not in Models 2 or 3.

Educational level also exhibited an association. Workers holding an apprenticeship certificate or a diploma from vocational school, as well as workers with high school education, reported less mental strain than workers with compulsory education. An

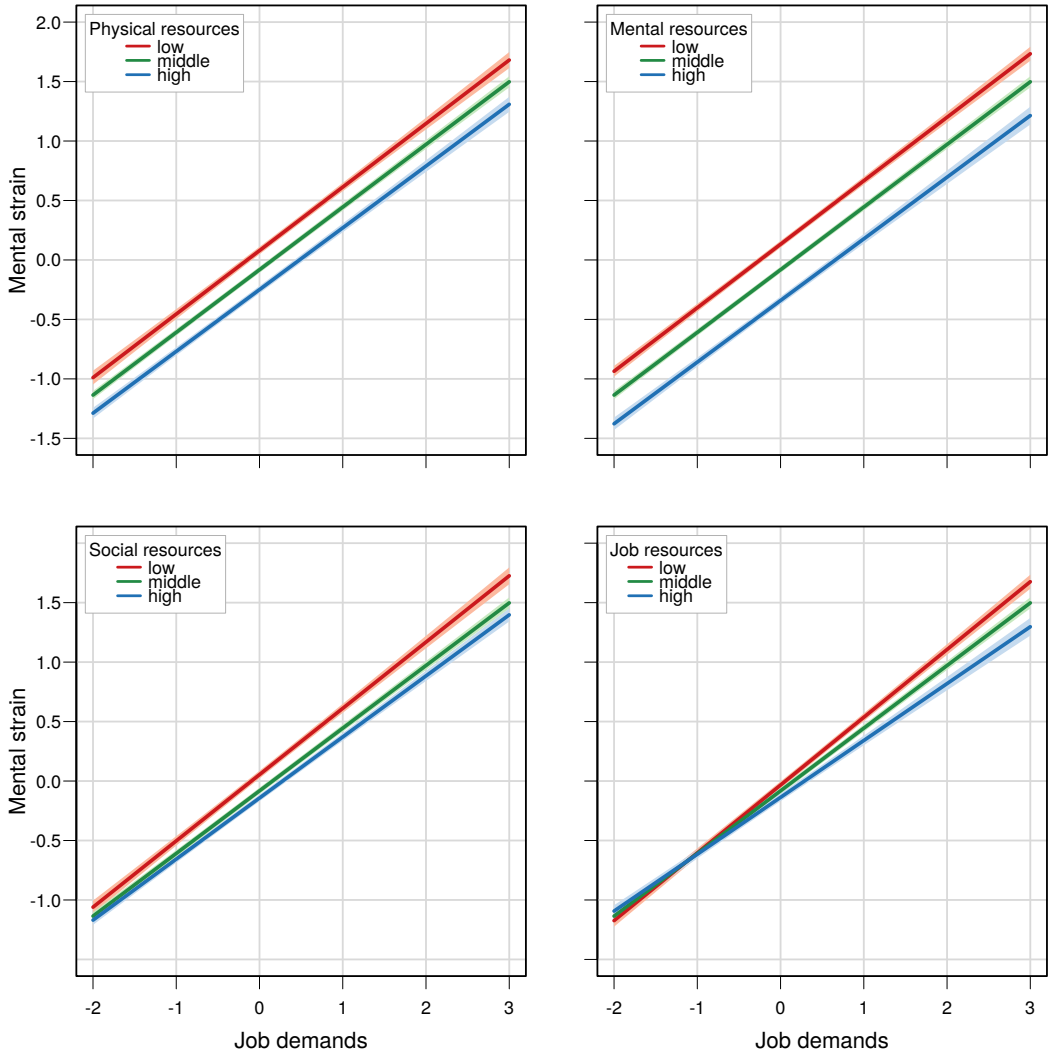


**Figure 5.2:** Prediction of mental strain as a function of job demands and resources (Model 3). The red, the green, and the blue lines refer to the classification of resources in low ($10^{\text{th}}$ quantile), middle ($50^{\text{th}}$ quantile), and high ($90^{\text{th}}$ quantile), respectively. The coloured area around the lines represents the 99 % confidence bands of the predicted values.

academic education was related to more mental strain in Model 3, but not in Models 1 and 2. Generally, single persons reported less mental strain than married persons, persons in partnerships and divorced/widowed persons. Females indicated slightly more mental strain than men, and mental strain slightly increased with age.

Again, the explanatory value of health behaviour and socio-demographic factors alone was weak. Only 4 % of the variation in mental strain can be explained by these variables. After including job demands and resources, the proportion of explained variance dramatically increased; Model 2 was able to explain 52 % of the variation in mental strain. Again, the proportion of explained variance did not markedly enhance prediction after including the product terms in Model 3.

**Table 5.4:** Regression coefficients for mental strain

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Variable** | $\beta$ [99 % $CI$] | $p$-value | $\beta$ [99 % $CI$] | $p$-value | $\beta$ [99 % $CI$] | $p$-value |
| (Intercept) | −0.17 [−0.27; −0.06] | 0.000 | −0.05 [−0.12; 0.03] | 0.126 | −0.08 [−0.15; 0.00] | 0.011 |
| Job demands | - | - | 0.53 [0.51; 0.54] | 0.000 | 0.53 [0.51; 0.55] | 0.000 |
| Physical resources | - | - | −0.12 [−0.14; −0.11] | 0.000 | −0.12 [−0.14; −0.10] | 0.000 |
| Mental resources | - | - | −0.17 [−0.18; −0.15] | 0.000 | −0.17 [−0.19; −0.16] | 0.000 |
| Social resources | - | - | −0.08 [−0.10; −0.07] | 0.000 | −0.08 [−0.10; −0.07] | 0.000 |
| Job resources | - | - | −0.04 [−0.05; −0.02] | 0.000 | −0.04 [−0.05; −0.02] | 0.000 |
| Exercise (ref.: yes) | | | | | | |
| no | 0.14 [0.09; 0.18] | 0.000 | 0.02 [−0.01; 0.05] | 0.158 | 0.02 [−0.01; 0.05] | 0.155 |
| Healthy diet (ref.: yes) | | | | | | |
| no | −0.01 [−0.05; 0.03] | 0.556 | −0.01 [−0.03; 0.02] | 0.653 | −0.01 [−0.04; 0.02] | 0.455 |
| Smoking (ref.: not at all) | | | | | | |
| occasionally/regularly | 0.20 [0.16; 0.24] | 0.000 | 0.10 [0.07; 0.13] | 0.000 | 0.10 [0.07; 0.13] | 0.000 |
| Alcohol | 0.03 [0.01; 0.05] | 0.000 | −0.01 [−0.02; 0.01] | 0.133 | −0.01 [−0.02; 0.01] | 0.225 |
| Education (ref.: compulsory) | | | | | | |
| skilled/vocational | −0.35 [−0.42; −0.29] | 0.000 | −0.10 [−0.14; −0.05] | 0.000 | −0.09 [−0.14; −0.04] | 0.000 |
| high school | −0.37 [−0.45; −0.29] | 0.000 | −0.09 [−0.15; −0.03] | 0.000 | −0.09 [−0.14; −0.03] | 0.000 |
| university | −0.07 [−0.15; 0.02] | 0.045 | 0.06 [0.00; 0.12] | 0.010 | 0.07 [0.01; 0.13] | 0.002 |
| Marital status (ref.: single) | | | | | | - |
| in partnership/married | −0.03 [−0.08; 0.01] | 0.074 | −0.05 [−0.08; −0.01] | 0.000 | −0.04 [−0.07; −0.01] | 0.002 |
| divorced/widowed | −0.12 [−0.19; −0.05] | 0.000 | −0.10 [−0.14; −0.05] | 0.000 | −0.10 [−0.15; −0.05] | 0.000 |
| Sex (ref.: male) | | | | | | |
| female | 0.03 [−0.01; 0.08] | 0.030 | 0.05 [0.02; 0.08] | 0.000 | 0.05 [0.02; 0.08] | 0.000 |
| Age | 0.01 [0.01; 0.01] | 0.000 | 0.00 [0.00; 0.00] | 0.000 | 0.00 [0.00; 0.00] | 0.000 |
| Job demands × physical resources | - | - | - | - | −0.01 [−0.02; 0.01] | 0.358 |
| Job demands × mental resources | - | - | - | - | −0.01 [−0.02; 0.01] | 0.309 |
| Job demands × social resources | - | - | - | - | −0.02 [−0.03; −0.00] | 0.002 |
| Job demands × job resources | - | - | - | - | −0.03 [−0.05; −0.02] | 0.000 |
| Adjusted $R^2$ | 0.040 | | 0.522 | | 0.524 | |

*Table notes.* $\beta$ = standardized regression coefficient. $CI$ = confidence interval. All continuous measures were standardized, except for age. Categorical variables were included as dummy variables.

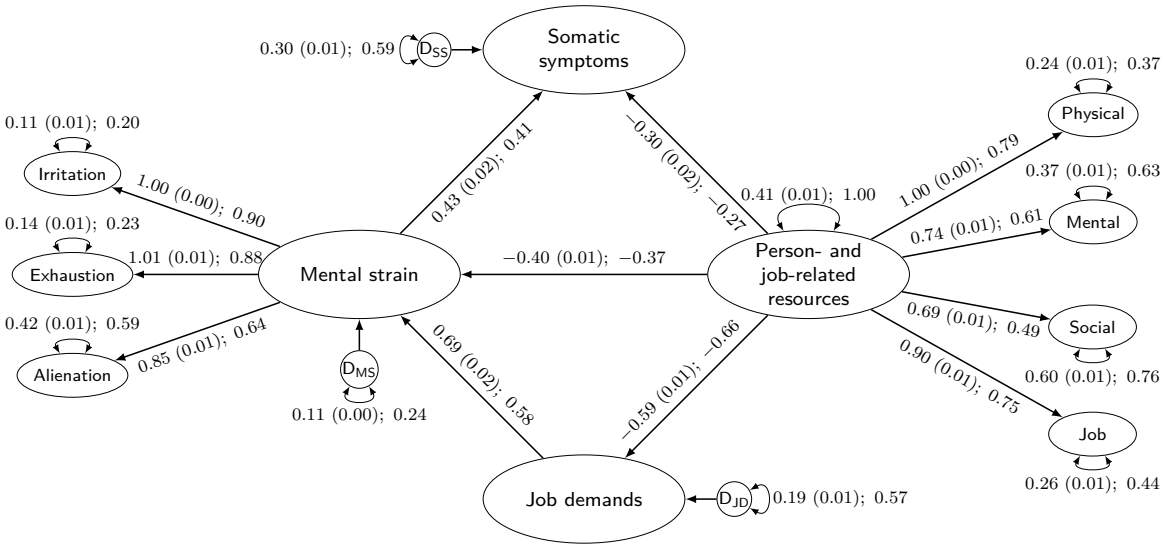


**Figure 5.3:** Results of the structural equation model. The coefficients in this model represent unstandardized estimates (standard errors in parentheses), followed by standardized estimates. $D_{JD}$, $D_{MS}$, and $D_{SS}$ stand for the disturbance variances of the endogenous variables. All reported parameter estimates showed a significant effect (all $p$-values $< .001$). Model fit was acceptable: $\chi^2(1509) = 58061$, $p < .001$; $CFI = .944$; $TLI = .940$; $SRMR = .056$; $RMSEA = .046$ [.045; .046].

## 5.5 Structural equation modelling

### 5.5.1 Testing the stress model

In order to test the hypothesized stress model as illustrated in Figure 3.3 (including the directed pathway [$H_4$] from job demands to somatic health symptoms), SEM was used. Although the *CFI* and the *TLI* did not reach the threshold of .95, model fit ($\chi^2[1508] = 59080$, $p < .001$; $CFI = .942$; $TLI = .939$; $SRMR = .056$; $RMSEA = .046$ [.046; .046]) was considered to be acceptable, since *CFI/TLI* had deviated only slightly from the recommended threshold on the one hand, and since the *SRMR* as well as the *RMSEA* exhibited good model fit on the other hand. In a next step, it was investigated whether restricting the direct pathway from job demands to somatic health symptoms (effect in the original model: unstandardized $b = 0.03$, $SE = 0.03$, $p = .900$; standardized $\beta = 0.03$) to be zero caused a significant decline in model fit. The scaled $\chi^2$-difference test was not significant ($\Delta\chi^2(1) = 0.003$, $p = .953$), indicating that this restriction did not result in a decline in model fit. Moreover, model fit even improved with regard to *CFI* and *TLI* ($\Delta TLI = .001$, $\Delta CFI = .001$), while *SRMR* and *RMSEA* did not change at all. The direct pathway $H_4$ was thus excluded from the model, and this redefined model was used in further analysis.

The results of this final model are summarized in Figure 5.3. This figure illustrates the parameter estimates for the latent variables included in the model. All hypotheses

**Table 5.5:** Fit statistics of multiple group analysis for sex

| Invariance model | $\chi^2$ | *df* | *TLI* | *CFI* | *SRMR* | *RMSEA* |
|---|---|---|---|---|---|---|
| Configural | 61211 | 3018 | 0.939 | 0.942 | 0.058 | 0.046 |
| Weak | 51781 | 3071 | 0.949 | 0.951 | 0.059 | 0.042 |
| Strong | 62998 | 3231 | 0.941 | 0.940 | 0.058 | 0.045 |
| Strict | 62656 | 3249 | 0.942 | 0.941 | 0.059 | 0.045 |
| Structural | 60729 | 3254 | 0.944 | 0.943 | 0.059 | 0.044 |

*Table notes.* *df* = Degrees of freedom. *TLI* = Tucker-Lewis-Index. *CFI* = Comparative-Fit-Index. *SRMR* = Standardized Root Mean Square Residual. *RMSEA* = Root Mean Square Error of Approximation.

were confirmed. The resources factor was negatively associated with job demands ($H_1$), and with mental strain ($H_{2a}$) and somatic health symptoms ($H_{2b}$). This means that persons high in person- and job-related resources reported a lesser burden due to job demands, experienced lower levels of mental strain, and indicated fewer somatic health symptoms. Furthermore, a greater burden due to job demands was associated with higher levels of mental strain ($H_{3a}$), which, in turn, was related to more somatic health ($H_{3b}$) symptoms. Using Sobel's test (Sobel, 1982, also known as the *delta method*), this indirect effect (i.e. job demands → mental strain → somatic health symptoms) was found to be significant, with a standardized coefficient of $\beta = .24$ (unstandardized $b = .30$, $SE = 0.01$, $p < .001$). These findings confirm the full mediation hypothesis, i.e. mental strain completely accounts for the association between job demands and somatic health symptoms.

### 5.5.2 Multiple group analysis

#### Sex

The configural invariance model for sex exhibited acceptable model fit (see Table 5.5). By constraining the factor loadings (weak invariance), the thresholds (strong invariance), and the residual variances/covariances (strict invariance), the scaled $\chi^2$-difference test recorded a significant result ($\Delta\chi^2(53) = 122$, $p < .001$; $\Delta\chi^2(40) = 726$, $p < .001$; and $\Delta\chi^2(18) = 132$, $p < .001$, respectively). However, as can be seen in Table 5.5, model fit indexes did not worsen considerably, and, partly, even improved. Thus the weak, strong, and strict invariance hypotheses were not rejected. By additionally constraining the structural pathways (structural invariance), the scaled $\chi^2$-difference test was insignificant, and model fit indexes improved slightly.

**Table 5.6:** Fit statistics of multiple group analysis for age

| Invariance model | $\chi^2$ | *df* | *TLI* | *CFI* | *SRMR* | *RMSEA* |
|---|---|---|---|---|---|---|
| Configural | 59136 | 4527 | 0.941 | 0.944 | 0.058 | 0.045 |
| Weak | 45275 | 4633 | 0.957 | 0.958 | 0.058 | 0.038 |
| Strong | 56267 | 4953 | 0.949 | 0.947 | 0.058 | 0.042 |
| Strict | 55441 | 4989 | 0.950 | 0.948 | 0.058 | 0.041 |
| Structural | 53694 | 4999 | 0.952 | 0.950 | 0.059 | 0.040 |

*Table notes.* *df* = Degrees of freedom. *TLI* = Tucker-Lewis-Index. *CFI* = Comparative-Fit-Index. *SRMR* = Standardized Root Mean Square Residual. *RMSEA* = Root Mean Square Error of Approximation.

### Age groups

Age was categorized into three age groups: 15–29 years, 30–49 years, and 50–85 years. Again, the configural model exhibited acceptable fit with the data (see Table 5.6). The scaled $\chi^2$-difference test was insignificant regarding the weak and strict invariance hypotheses ($\Delta\chi^2(106) = 79$, $p = .976$ and $\Delta\chi^2(36) = 56$, $p = .017$, respectively), but recorded a significant result in terms of strong and structural invariance ($\Delta\chi^2(26) = 87$, $p < .001$ and $\Delta\chi^2(10) = 33$, $p < .001$, respectively). Model fit indexes, however, did not worsen considerably in any of the models. Therefore, weak, strong, strict, and structural invariance can be assumed.

### Educational level

By imposing the same factor structure (configural invariance) across the educational levels, the fit of the model was acceptable (see Table 5.7). The scaled $\chi^2$-difference test was significant with regard to the weak ($\Delta\chi^2(159) = 214$, $p = .002$), strong ($\Delta\chi^2(18) = 211$, $p < .001$), and strict ($\Delta\chi^2(54) = 230$, $p < .001$) invariance hypotheses, but insignificant with regard to structural ($\Delta\chi^2(15) = 30$, $p = .014$) invariance. Based on the fit indexes, deviations in model fit are only minor. Thus, measurement and structural invariance were assumed.

### Summary

To sum up, multiple group analysis demonstrated that the measurement models largely held across sex, age groups, and educational levels. This means that the observed scores of the hypothetical concepts have the same meaning across males and females, as well as across different age groups and educational levels. Furthermore, the effects of the structural pathways were considered to be invariant, indicating that the hypothesized effects are equally strong across the groups. This underscores the robustness of the

**Table 5.7:** Fit statistics of multiple group analysis for education

| Invariance model | $\chi^2$ | *df* | *TLI* | *CFI* | *SRMR* | *RMSEA* |
|---|---|---|---|---|---|---|
| Configural | 55440 | 6036 | 0.949 | 0.952 | 0.058 | 0.043 |
| Weak | 43735 | 6195 | 0.962 | 0.963 | 0.060 | 0.037 |
| Strong | 57928 | 6675 | 0.952 | 0.950 | 0.059 | 0.041 |
| Strict | 57716 | 6729 | 0.953 | 0.950 | 0.059 | 0.041 |
| Structural | 55625 | 6744 | 0.955 | 0.952 | 0.059 | 0.040 |

*Table notes.* *df* = Degrees of freedom. *TLI* = Tucker-Lewis-Index. *CFI* = Comparative-Fit-Index. *SRMR* = Standardized Root Mean Square Residual. *RMSEA* = Root Mean Square Error of Approximation.

hypothesized stress model and rules out potentially confounding effects related to socio-demographic/socio-economic factors.

## 5.6 Latent class cluster analysis

### 5.6.1 Symptom clusters

Fit selection criteria for the seven different models regarding health symptoms are summarized in Table 5.8. Regarding $PV1$, the likelihood values increased only slightly from the four-class model to the seven-class model. The $BIC$ values gradually improved with an increasing number of classes, although the difference in $BIC$ values became steadily smaller. The entropy measure, in turn, improved with a decreasing number of classes (ranging from acceptable [entropy = 0.71] to good [entropy = 0.78] classification quality). In a next step, the eligible models were evaluated with regard to the interpretability of the class solutions. The four-class model was found to provide a good representation of the data, and the class solution was well interpretable in terms

**Table 5.8:** Model selection criteria for the seven models of symptom clusters

| Model | *LL* | *PV*1 | *df* | *BIC* | $\Delta BIC$ | Entropy |
|---|---|---|---|---|---|---|
| 1 class | −129523.42 | NA | 17 | 259213.35 | - | - |
| 2 class | −115692.36 | 10.68 | 35 | 231727.54 | 27485.81 | 0.78 |
| 3 class | −112981.20 | 2.34 | 53 | 226481.53 | 5246.01 | 0.76 |
| 4 class | −111319.78 | 1.47 | 71 | 223335.00 | 3146.53 | 0.73 |
| 5 class | −110724.97 | 0.53 | 89 | 222321.69 | 1013.31 | 0.72 |
| 6 class | −110364.42 | 0.33 | 107 | 221776.88 | 544.81 | 0.71 |
| 7 class | −110156.39 | 0.19 | 125 | 221537.13 | 239.75 | 0.71 |

*Table notes.* *LL* = Log-likelihood. $PV1_k = (-2 \cdot LL_{k-1}) - (-2 \cdot LL_k))/(-2 \cdot LL_k) \cdot 100$. *df* = degrees of freedom. *BIC* = Bayes Information Criterion. $\Delta BIC$ = Difference in the *BIC* between the $k-1$ and the $k$ class model.

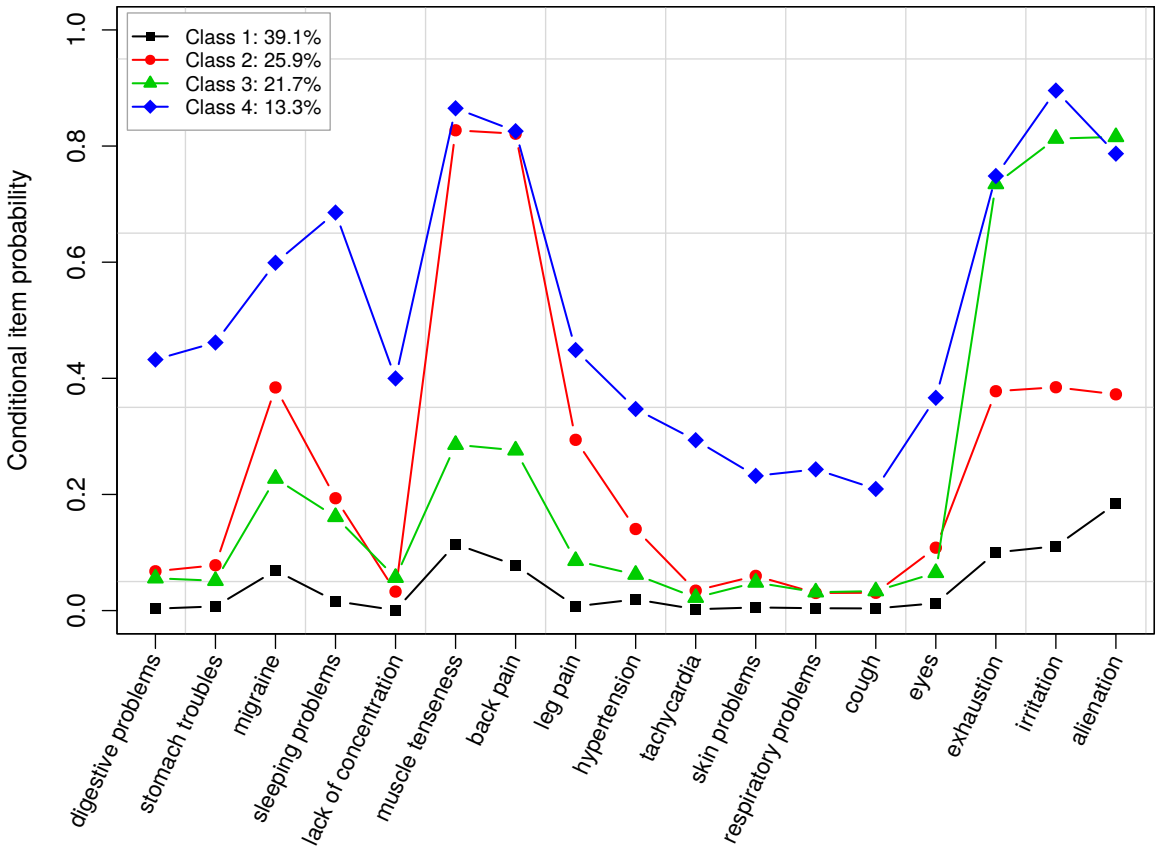


**Figure 5.4:** Conditional item probabilities of the 4-class solution of symptom clusters

of the posterior probability profiles. This four-class model was thus used to represent the symptom clusters.

Figure 5.4 illustrates the conditional item probabilities of the four-class solution of symptom clusters. Class 1 had an estimated population size of 39.1 %. This class demonstrated a generally low probability for any health symptoms. Class 2, the second-largest class, had a population size of 25.9 % and was characterized by a high likelihood of suffering from muscle tenseness and back pain, and a moderately high likelihood of suffering from migraine, mental strain (exhaustion, irritation, and alienation), leg pain, and sleeping problems. The third-largest class (class 3) had a population size of 21.7 % and indicated a high probability for irritation, alienation, and exhaustion, and a low to moderately high probability for reporting muscle tenseness, back pain, migraine, and sleeping problems. The smallest class (class 4) had an estimated population share of 13.3 % and demonstrated relatively high probabilities for any of the health symptoms. Based on these item probability patterns, these four classes (i.e. representing the symptom clusters) were identified as *healthy* (class 1), *tensed up* (class 2), *mentally strained* (class 3), and *heavily suffering* (class 4; see also Mayerl, Stolz, Waxenegger, & Freidl, 2017).

**Table 5.9:** Distribution of the class probabilities for the symptom clusters across sex, age, and educational level

| | | Symptom cluster | | | |
|---|---|---|---|---|---|
| | *N* | healthy | tensed up | mentally strained | heavily suffering |
| **Overall** | 17941 | 38.8 % | 24.9 % | 22.8 % | 13.5 % |
| **Sex** | | | | | |
| male | 8911 | 41.4 % (7.1*) | 22.5 % (−7.4*) | 24.4 % (4.8*) | 11.8 % (−6.6*) |
| female | 9030 | 36.2 % (−7.1*) | 27.3 % (7.4*) | 21.3 % (−4.8*) | 15.1 % (6.6*) |
| **Age** | | | | | |
| 15–29 years | 4256 | 51.5 % (19.5*) | 14.8 % (−17.4*) | 25.5 % (4.7*) | 8.2 % (−11.6*) |
| 30–49 years | 10137 | 37.3 % (−4.7*) | 25.9 % (3.5*) | 23.4 % (1.9) | 13.5 % (−0.0) |
| 50+ years | 3548 | 27.8 % (−14.9*) | 34.1 % (14.2*) | 18.2 % (−7.4*) | 19.9 % (12.4*) |
| **Education** | | | | | |
| compulsory school | 1672 | 29.2 % (−8.4*) | 25.5 % (0.6) | 27.3 % (4.5*) | 18.0 % (5.7*) |
| skilled/vocational | 11502 | 40.1 % (4.9*) | 25.8 % (3.9*) | 21.5 % (−5.8*) | 12.6 % (−4.7*) |
| high school | 2514 | 43.0 % (4.7*) | 23.1 % (−2.3) | 21.1 % (−2.2) | 12.8 % (−1.1) |
| university | 2253 | 34.4 % (−4.6*) | 21.7 % (−3.8*) | 28.5 % (6.8*) | 15.5 % (3.1) |

*Table notes.* All $\chi^2$-tests of independence were significant ($p$-values $< .001$). In parentheses, the standardized residuals of the corresponding $\chi^2$-tests are reported. These residuals can be calculated by dividing the difference between the observed and expected frequencies by its standard error (Agresti, 2007). '*' indicates a significantly larger (or lower) cell frequency as expected by chance, after Bonferroni-correction for multiple-testing.

Table 5.9 presents the distribution of the class probabilities for the symptom clusters across sex, age, and education. There was a significant effect for sex. Men (vs. women) were more likely to be classified as *healthy* or *mentally strained*, and less likely to be classified as *tensed up* or *heavily suffering*. As regards age, the younger age group (15–29 years) was more likely to belong to the *healthy* and *mentally strained* clusters, and less likely to belong to the *tensed up* and *heavily suffering* clusters. The middle age group (30–49 years) was less likely to be categorized as *healthy* and more likely to be categorized as *tensed up*. The older age group (50+ years) had a lower probability of belonging to the *healthy* and *mentally strained* clusters, and a higher probability of belonging to the *tensed up* and *heavily suffering* clusters.

Moreover, there was a significant effect for education. Persons with compulsory education were less likely to belong to the *healthy* cluster, and more likely to belong to the *mentally strained* and *heavily suffering* clusters. Skilled workers holding an apprenticeship certificate or a diploma from vocational school were more likely to be classified as *healthy* and *tensed up*, and less likely to be classified as *mentally strained* and *heavily suffering*. Persons with high school education were more likely to belong to the *healthy* cluster. Persons holding a university degree were less likely to be classified as *healthy* and *tensed up*, whereas the probability of belonging to the *mentally strained* cluster was higher than expected by chance. In general, there was no clear evidence for systematic inequalities regarding different educational levels.

**Table 5.10:** Model selection criteria for the seven models of job demand profiles

| Model | $LL$ | $PV1$ | $df$ | $BIC$ | $\Delta BIC$ | Entropy |
|---|---|---|---|---|---|---|
| 1 class | −170723.60 | NA | 18 | 341623.50 | - | - |
| 2 class | −148532.97 | 13.00 | 37 | 297428.35 | 44195.15 | 0.84 |
| 3 class | −144562.15 | 2.67 | 56 | 289672.81 | 7755.54 | 0.80 |
| 4 class | −142018.56 | 1.76 | 75 | 284771.73 | 4901.09 | 0.80 |
| 5 class | −141004.53 | 0.71 | 94 | 282929.78 | 1841.95 | 0.80 |
| 6 class | −140176.64 | 0.59 | 113 | 281460.09 | 1469.69 | 0.79 |
| 7 class | −139520.92 | 0.47 | 132 | 280334.76 | 1125.33 | 0.79 |

*Table notes.* $LL$ = Log-likelihood. $PV1_k = (-2 \cdot LL_{k-1}) - (-2 \cdot LL_k))/(-2 \cdot LL_k) \cdot 100$. $df$ = degrees of freedom. $BIC$ = Bayes Information Criterion. $\Delta BIC$ = Difference in the $BIC$ between the $k-1$ and the $k$ class model.

### 5.6.2 Job demand profiles

Model selection criteria for the seven models of job demands are depicted in Table 5.10. According to $PV1$, the improvement in model fit was only minor for the five-class model to the seven-class model. Again, $BIC$ values increased with increasing numbers of classes, while $\Delta BIC$ values became steadily smaller. Entropy measures ranged from 0.79 to 0.84 and indicated good classification quality for all seven models. Further examination of the competing models revealed that the four-class model was well interpretable in terms of the conditional item probabilities, while not being over- or underfitted. This four-class solution was used to represent the job demand profiles.

Figure 5.5 illustrates the conditional item probabilities of the job demand profiles. The largest class (class 1) had an estimated population size of 37.2 % and was characterized by a generally low likelihood of reporting a burden due to any of the job demands (except for time pressure, for which the probability was slightly increased). Class 2, the second-largest class, had a prevalence of 28.6 % and demonstrated a moderately high to high probability of feeling burdened by high concentration and responsibility, time pressure, contact with customers/clients, or emotionally burdening work, and exhibited a slightly to moderately increased probability of reporting a burden due to technological/organizational changes, changing working routines, lack of opportunity to retreat, or constant monitoring/surveillance. The third-largest class (class 3) had an estimated population size of 18 % and was characterized by an increased probability of feeling burdened by any job demands, and even exhibited the highest probabilities of all four classes with regard to 15 out of 18 measures of job demands. It was expected that 16.2 % of the employed persons would belong to class 4. This class exhibited the highest probabilities regarding a burden due to physically demanding aspects (i.e. standing/forced posture, physical exertion, one-sided physical strain), and a relatively high probability of feeling burdened by time pressure, high responsibility, and high

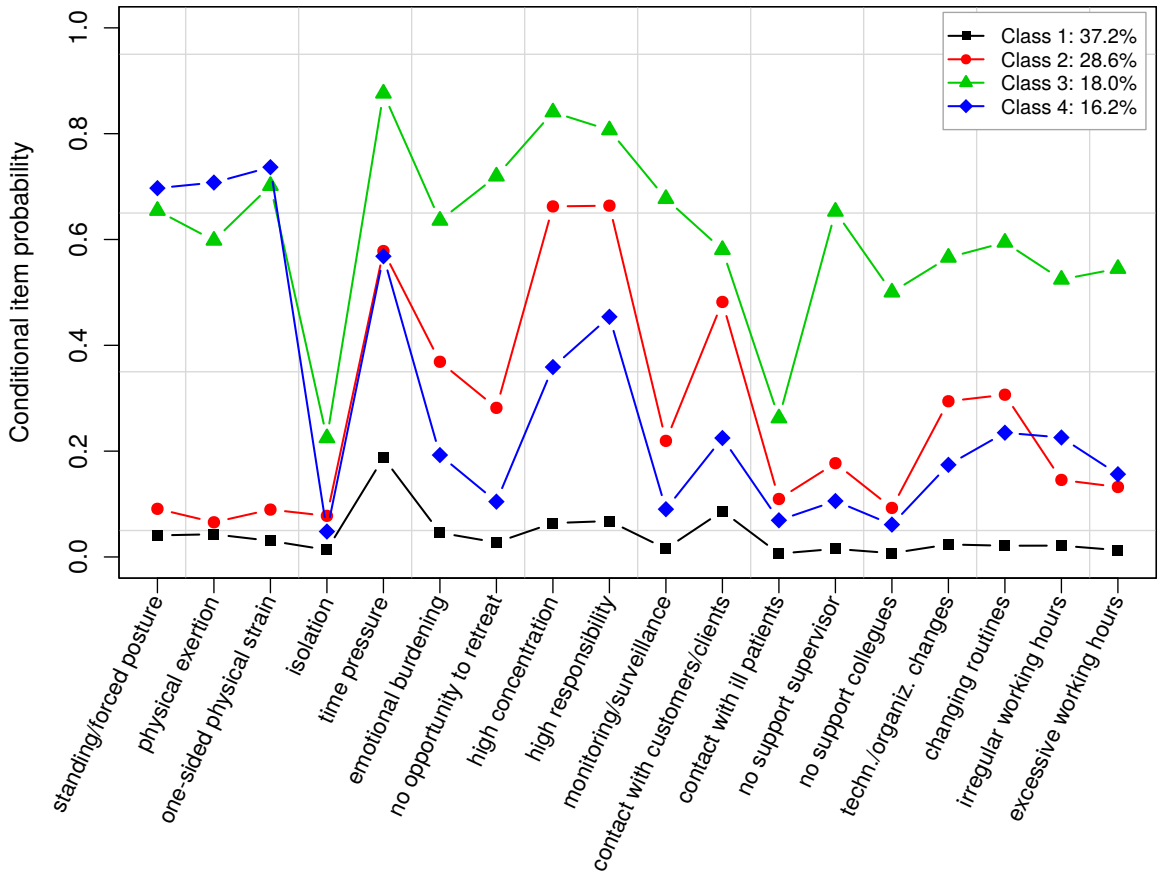


**Figure 5.5:** Conditional item probabilities of the 4-class solution of job demand profiles

concentration. Based on these latent class probabilities, the classes (i.e. the job demand profiles) were labelled as follows: *low burden* (class 1), *psychosocial burden* (class 2), *high burden* (class 3), and *physical burden* (class 4; see also Mayerl, Stolz, Waxenegger, & Freidl, 2017).

Table 5.11 indicates the distribution of the estimated class probabilities for job demands across sex, age, and education. Men (vs. women) were more likely to belong to the *low burden* and *psychosocial burden* classes, but were less likely to belong to the *high burden* and *physical burden* classes. As regards age, the *low burden* class was more likely among the younger age group (15–29 years), and less likely among the middle age group (30–49 years). The younger age group was also less likely to belong to the *psychosocial burden* class. Significant effects were also found for education. Employees with compulsory education were less likely to belong to the *low burden* and *psychosocial burden* classes, and were more likely to belong to the *high burden* and *physical burden* classes. Skilled workers holding an apprenticeship certificate or a diploma from vocational school were more likely classified as *low burdened* and *physically burdened*, and were less likely classified as *psychosocially* and *highly burdened*. Persons with high school education were more likely to belong to the *low burden* and *psychosocial burden* classes, and less likely to belong to the *high burden* and *physical burden* classes.

**Table 5.11:** Distribution of the class probabilities for the job demand profiles across sex, age, and educational level

| | | Job demand profiles | | | |
|---|---|---|---|---|---|
| | *N* | low burden | psychosocial burden | high burden | physical burden |
| **Overall** | 17941 | 37.8 % | 28.7 % | 17.8 % | 15.7 % |
| **Sex** | | | | | |
| male | 8911 | 34.6 % (−8.8*) | 27.5 % (−3.5*) | 19.2 % (4.8*) | 18.7 % (11.1*) |
| female | 9030 | 41.0 % (8.8*) | 29.9 % (3.5*) | 16.4 % (−4.8*) | 12.7 % (−11.1*) |
| **Age** | | | | | |
| 15–29 years | 4256 | 43.0 % (7.9*) | 25.5 % (−5.3*) | 16.3 % (−3.0) | 15.3 % (−0.9) |
| 30–49 years | 10137 | 36.4 % (−4.5*) | 29.3 % (2.1) | 18.6 % (3.3) | 15.7 % (−0.1) |
| 50+ years | 3548 | 35.7 % (−2.9) | 30.8 % (3.1) | 17.3 % (−0.9) | 16.3 % (1.0) |
| **Education** | | | | | |
| compulsory school | 1672 | 30.6 % (−6.4*) | 15.0 % (−13.1*) | 26.6 % (9.9*) | 27.8 % (14.3*) |
| skilled/vocational | 11502 | 39.0 % (4.6*) | 25.3 % (−13.5*) | 17.2 % (−2.8) | 18.5 % (13.6*) |
| high school | 2514 | 42.1 % (4.8*) | 39.1 % (12.4*) | 13.0 % (−6.8*) | 5.8 % (−14.6*) |
| university | 2253 | 32.0 % (−6.1*) | 44.7 % (17.9*) | 19.8 % (2.6) | 3.6 % (−16.9*) |

*Table notes.* $\chi^2$-tests of independence were significant ($p$-values $< .001$). In parentheses, the standardized residuals of the corresponding $\chi^2$-tests are reported. These residuals can be calculated by dividing the difference between the observed and expected frequencies by its standard error (Agresti, 2007). '*' indicate a significantly larger (or lower) cell frequency as expected by chance, after Bonferroni-correction.

Persons holding a university degree were less likely classified as *low burdened* and *physically burdened*, and were more likely classified as *psychosocially burdened*.

### 5.6.3 Regressing the symptom clusters on the job demand profiles

In a next step, the symptom clusters were regressed on the job demand profiles in order to examine their relationship. The results of this multinomial logistic regression analysis (including all covariates) are presented in Table 5.12. All three job demand profiles (each compared to the *low burden* profile) had a significantly higher chance of belonging to the *tensed up*, *mentally strained*, and *heavily suffering* clusters than to the *healthy* cluster. The strongest effects were found for the *high burden* profile, followed by the *physical burden* profile, and the *psychosocial burden* profile.

By contrast, all four resources (physical, mental, social, and job resources) indicated a negative relationship to the symptom clusters (except for only one insignificant result). This means that the odds of belonging to the three symptom clusters (in comparison to the healthy cluster) decreased with increasing levels of physical, mental, social, and job resources.

As regards health-related behaviour, the results reveal a negative relationship between people who exercised regularly in their leisure time and the odds of belonging to the *heavily suffering* class. This effect may be explained by the fact that people who are *heavily suffering* due to a number of health problems are not able to exercise

**Table 5.12:** Multinomial logistic regression analysis for symptom clusters

| | Symptom cluster (ref.: healthy) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | tensed up | | | mentally strained | | | heavily suffering | | |
| **Variable** | $\beta$ | $OR$ [99 % $CI$] | $p$-value | $\beta$ | $OR$ [99 % $CI$] | $p$-value | $\beta$ | $OR$ [99 % $CI$] | $p$-value |
| (Intercept) | −2.97 | 0.05 [0.04, 0.07] | 0.000 | −1.70 | 0.18 [0.13, 0.26] | 0.000 | −4.87 | 0.01 [0.00, 0.01] | 0.000 |
| Job demand profiles (ref.: low burden) | | | | | | | | | |
| psychosocial burden | 0.73 | 2.07 [1.81, 2.37] | 0.000 | 1.11 | 3.04 [2.64, 3.50] | 0.000 | 1.65 | 5.19 [4.18, 6.45] | 0.000 |
| high burden | 2.33 | 10.29 [8.02, 13.20] | 0.000 | 3.00 | 20.10 [15.72, 25.69] | 0.000 | 3.84 | 46.54 [34.68, 62.44] | 0.000 |
| physical burden | 1.32 | 3.75 [3.19, 4.41] | 0.000 | 0.85 | 2.33 [1.94, 2.82] | 0.000 | 1.83 | 6.22 [4.83, 8.00] | 0.000 |
| Resources | | | | | | | | | |
| physical resources | −0.57 | 0.57 [0.53, 0.61] | 0.000 | −0.35 | 0.70 [0.65, 0.76] | 0.000 | −0.97 | 0.38 [0.35, 0.42] | 0.000 |
| mental resources | −0.25 | 0.78 [0.73, 0.83] | 0.000 | −0.64 | 0.53 [0.49, 0.57] | 0.000 | −0.47 | 0.63 [0.57, 0.68] | 0.000 |
| social resources | −0.02 | 0.98 [0.92, 1.04] | 0.434 | −0.30 | 0.74 [0.70, 0.79] | 0.000 | −0.19 | 0.83 [0.77, 0.90] | 0.000 |
| job resources | −0.24 | 0.79 [0.74, 0.84] | 0.000 | −0.20 | 0.82 [0.77, 0.88] | 0.000 | −0.47 | 0.62 [0.57, 0.68] | 0.000 |
| Exercise (ref.: yes) | | | | | | | | | |
| no | −0.07 | 0.93 [0.82, 1.06] | 0.146 | −0.02 | 0.98 [0.86, 1.12] | 0.727 | −0.26 | 0.77 [0.65, 0.91] | 0.000 |
| Healthy diet (ref.: yes) | | | | | | | | | |
| no | −0.20 | 0.82 [0.73, 0.93] | 0.000 | −0.33 | 0.72 [0.63, 0.81] | 0.000 | 0.02 | 1.02 [0.87, 1.20] | 0.744 |
| Smoking (ref.: not at all) | | | | | | | | | |
| occasionally/regularly | 0.15 | 1.16 [1.03, 1.31] | 0.001 | 0.35 | 1.41 [1.25, 1.60] | 0.000 | 0.18 | 1.19 [1.02, 1.40] | 0.004 |
| Alcohol | 0.01 | 1.01 [0.95, 1.07] | 0.785 | −0.06 | 0.94 [0.88, 1.01] | 0.023 | −0.10 | 0.90 [0.83, 0.98] | 0.001 |
| Education (ref.: compulsory) | | | | | | | | | |
| skilled/vocational | 0.14 | 1.15 [0.94, 1.42] | 0.080 | 0.02 | 1.02 [0.82, 1.26] | 0.807 | 0.18 | 1.20 [0.93, 1.56] | 0.067 |
| high school | 0.11 | 1.12 [0.87, 1.44] | 0.256 | 0.02 | 1.02 [0.79, 1.32] | 0.860 | 0.39 | 1.47 [1.07, 2.03] | 0.002 |
| university | 0.07 | 1.07 [0.82, 1.40] | 0.494 | 0.43 | 1.53 [1.17, 2.00] | 0.000 | 0.60 | 1.82 [1.31, 2.53] | 0.000 |
| Marital status (ref.: single) | | | | | | | | | |
| in partnership/married | 0.08 | 1.09 [0.94, 1.26] | 0.131 | −0.22 | 0.80 [0.69, 0.92] | 0.000 | 0.02 | 1.02 [0.84, 1.23] | 0.829 |
| divorced/widowed | −0.12 | 0.89 [0.73, 1.09] | 0.147 | −0.34 | 0.71 [0.57, 0.89] | 0.000 | −0.23 | 0.79 [0.61, 1.03] | 0.024 |
| Sex (ref.: male) | | | | | | | | | |
| female | 0.58 | 1.78 [1.57, 2.02] | 0.000 | 0.12 | 1.12 [0.99, 1.28] | 0.020 | 0.68 | 1.98 [1.68, 2.33] | 0.000 |
| Age | 0.04 | 1.04 [1.04, 1.05] | 0.000 | 0.01 | 1.01 [1.01, 1.02] | 0.000 | 0.04 | 1.04 [1.04, 1.05] | 0.000 |

*Table notes.* $\beta$ = standardized regression coefficient. $OR$ = Odds ratio. $CI$ = confidence interval. ref. = reference group. All continuous measures were standardized, except for age. Categorical variables were included as dummy variables. Pseudo $R^2$ (D. R. Cox & Snell, 1989; McFadden, 1973; Nagelkerke, 1991): Cox & Snell = 0.41; McFadden = 0.20; Nagelkerke = 0.44.

regularly. The results regarding diet are ambiguous. While an unhealthy diet was related to decreased odds of belonging to the *tensed up* cluster, the odds of belonging to the *mentally strained* cluster were increased. The effects for smoking status, in turn, were relatively clear. Smokers (vs. non-smokers) were more likely to belong to the three symptom clusters (vs. the *healthy* cluster). Alcohol consumption indicated one significant result: increasing levels of alcohol consumption were related to decreased odds of belonging to the *heavily suffering* symptom cluster.

As for education, persons with high school education (vs. compulsory education) were more likely classified as *heavily suffering*, and persons with a university degree (vs. persons with compulsory education) were more likely classified as both *mentally strained* and *heavily suffering*. The results also revealed that singles (vs. married persons, persons in partnerships, and divorced or widowed persons) were more likely to be categorized as *mentally strained*. Sex and age also exhibited an effect. Females (vs. males) were more likely to belong to the *tensed up* and *heavily suffering* clusters. The odds of belonging to the three symptom clusters (compared to the *healthy* cluster) also increased with increasing age.

# CHAPTER 6

# Discussion

This thesis project aimed to analyse the effects different kinds of job demands may have on both mental and somatic health and to examine the role of person- and job-related resources in this relationship. These research objectives were tackled from three different angles: first, this thesis project aimed to uncover the different dimensions of person- and job-related resources that might be helpful in maintaining health despite a high burden due to various demands experienced at work. Second, a heuristic stress model was established and tested. This stress model was intended to explain the more or less complex pathways linking job demands, person- and job-related resources, and mental and somatic health. The third objective was to explore the differential health effects of different constellations of job demands. The findings of these research issues are discussed in more detail in the following paragraphs.

## 6.1 The buffering role of resources in the link between job demands and health

In line with a wealth of evidence (see e.g. De Lange et al., 2003; Nixon et al., 2011), a moderate to strong positive association between job demands and both mental strain and somatic health problems was found in this thesis project (parts of this section are based on a previous publication of Mayerl, Stolz, Großschädl, et al., 2017). The study results found in this thesis conform with those from previous prospective studies demonstrating that individuals working in a demanding environment are more likely to

report somatic symptoms (Head et al., 2006; Kuper & Marmot, 2003) or mental health problems (Godin, Kittel, Coppieters, & Siegrist, 2005; Stansfeld & Candy, 2006).

Second, it was assumed that resources have a beneficial effect on health (Freidl et al., 1999; Kalimo et al., 2002). Thus, it was expected that there would exist a negative relationship between each resource dimension and the level of health problems. Moreover, given that resources are thought to strengthen resilience to demanding situations (Antonovsky, 1979; Hobfoll, 1989; Lazarus & Folkman, 1984), it was hypothesized that each of the person- and job-related resources attenuates the negative effect of job demands on health. This means that both a direct effect of resources on health and a moderating effect of resources in the relationship between job demands and health were expected. The findings with regard to this research issue are discussed in more detail below.

### 6.1.1 Direct and moderating effects of resources with regard to somatic health

Regarding somatic health, although the results of this thesis indeed revealed each resource dimension to be negatively related to the level of somatic symptoms, the effect sizes differed considerably. The effects of the mental, social, and job resources were rather weak and the practical relevance remains questionable. Physical resources, by contrast, demonstrated a moderately strong effect on somatic health symptoms. However, whether physical fitness (as an indicator of physical resources) constitutes a beneficial factor for somatic health (physical fitness affects somatic health) or, vice versa, whether persons suffering from various somatic health problems perceive their own physical fitness to be poor (somatic health affects physical fitness) remains unanswered, although previous research findings support the first-mentioned assumption (i.e. physical fitness as a beneficial factor for health and resilience; Silverman & Deuster, 2014).

Examining the moderating role of physical fitness also did not help to better understand the relationship between physical resources and somatic health. Although it was expected that physical fitness buffers the negative influence of job demands on somatic health (J. D. Brown, 1991; Ensel & Lin, 2004), this buffering effect was not visible in the data. Only job resources demonstrated a relevant buffering effect on the relationship between job demands and somatic health. It seemed that persons working in a resourceful environment were less vulnerable to experiencing somatic health symptoms, despite a high burden due to various job demands. This finding is in line with the assumptions of prominent work-related stress models (Demerouti et al., 2001; Karasek, 1979; Siegrist, 1996), although empirical evidence on the buffering role of job resources have exhibited rather mixed results (Bakker et al., 2005; De Lange et al., 2003; der Doef & Maes, 1999; Q. Hu et al., 2011; van Vegchel et al., 2005).

### 6.1.2 Direct and moderating effects of resources with regard to mental health

Regarding mental strain, it was again found that each resource dimension indicated a negative relationship to the level of mental strain. In general, the effects were rather weak, with slightly stronger effects for the mental dimension than for the biological, social, and job-related dimensions. This means that people who have a great pool of resources at their disposal experience less mental strain than those who lack beneficial resources. These findings largely conform to a previous longitudinal study that revealed both person- and job-related resources to be good predictors of well-being 10 years later (Kalimo et al., 2002). As hypothesized, the results of this thesis project also demonstrated significant buffering effects for each of the four resource dimensions in the relationship between job demands and mental strain. However, further examination of these findings revealed that the effects are very weak and do not have any practical implications.

### 6.1.3 Conclusion

In conclusion, good physical fitness, a stable and global confidence in one's own capabilities, a supporting circle of friends, and a resourceful working environment seemed to have a positive impact on both mental and somatic health, although the effects varied from very weak to moderately strong. The findings regarding the moderating effects of resources are, however, inconclusive. Apart from a relatively clear buffering effect found for job resources regarding the influence of job demands on somatic health, the moderating effects of resources only slightly accounted for the prediction of both mental and somatic health.

Overall, the final regression models allowed a good prediction of both mental and somatic health. The models were able to explain considerable proportions of the variation in the dependent variables: 52 % in mental strain and 36 % in somatic health symptoms.

## 6.2 An alternative stress model: The integration of job demands, resources and health

The established stress model was supposed to allow the integration of job demands, person- and job-related resources, and indicators of both mental and somatic health (parts of this section are based on a previous publication by Mayerl et al., 2016). All hypotheses of the proposed model were confirmed and the final model fitted well with the data.

Moreover, this model allowed a good prediction of both the perceived burden due to job demands and the level of mental and somatic health.

### 6.2.1 A common resources factor and its relation to job demands and health

More specifically, a preliminary assumption was that different dimensions of person- and job-related resources can be considered as domains of an underlying resources factor. Indeed, different types of resources (i.e. the physical, mental, social, and job-related dimensions) were found to be interrelated and to constitute a common resources factor. The interrelatedness of different kinds of resources is in line with the assumptions of the COR theory (Hobfoll, 1989). Loss and gain spirals (see subsection 3.2.3) probably play a key role in this context (Hobfoll & Shirom, 2001). The COR theory proposes that ongoing loss of resources increasingly depletes one's own resource pool on the one hand (loss spiral), and that gain in one resource domain facilitates enrichment of resources in other domains on the other hand (gain spirals). Resources are thus considered not to exist in isolation. Rather, the processes of both loss and gain of resources are affected by the interplay between different resource facets. The resulting resources factor therefore represents a fundamental construct comprised of different resource dimensions (Mayerl et al., 2016). To put it differently, this higher-order resources factor reflects the commonalities between both person- and job-related resources. These resource dimensions were expected to be particularly important in terms of stress processes within a working context. Future research may draw on this finding and test alternative hierarchical models of resources in other research areas as well, by considering other indicators of resources relevant for the respective contexts.

Although it was assumed that different mechanisms of action underlay the different dimensions of person- and job-related resources, it was hypothesized that the common resources factor constitutes a good predictor of both the perceived burden due to job demands and the level of suffering from mental and somatic health problems (Freidl et al., 1999; Kalimo et al., 2002). In fact, the person- and job-related resources factor revealed a negative association with the level of job demands. This means that people who had high levels of resources at their disposal reported a lesser burden due to job demands. This effect may be explained by the transactional model of Lazarus and Folkman (1984, see also subsection 3.2.2), which highlights appraisal processes in stress and coping. People who have a great pool of resources at their disposal may appraise their working situations as less demanding due to the belief that the available resources suffice to cope with the potentially demanding situation and its negative consequences. Whether or not a situation is perceived as stressful thus depends on the extent of resources available as well as on the related appraisals. The strength of association between this resources factor and the level of job demands was also relatively strong

and ensured a better prediction than previous studies, using only a single dimension of resources (Korunka et al., 2009; Schaufeli & Bakker, 2004; Xanthopoulou et al., 2007).

Moreover, in line with the findings from the moderated regression analysis, it was found that persons high in this resources factor reported less mental strain and lower levels of somatic health problems. While the size of effects of the single resource dimensions were rather weak in the moderated regression analysis, the effects of the resources factor on both mental strain and somatic symptoms were moderately strong in structural equation modelling. All of these findings not only support recent approaches of integrating both person- and job-related resources in work-related stress models (see e.g. Xanthopoulou et al., 2007, 2009a), but also highlight the strengths of a common resources factor that combines various important resource dimensions.

### 6.2.2 Testing the health-impairment process of the job demands-resources model

A further aim was to test the assumptions of the JD-R model regarding the health-impairment process. In line with previous empirical findings (Hakanen et al., 2006; Schaufeli & Bakker, 2004), the study results revealed mental strain to fully mediate the relationship between job demands and somatic health symptoms. In other words, a greater burden due to job demands was associated with higher levels of mental strain. Mental strain, in turn, was related to higher levels of somatic health symptoms. Although this indirect effect can be considered as moderately strong, it was slightly weaker in comparison to previous studies (Hakanen et al., 2006; Korunka et al., 2009; Schaufeli & Bakker, 2004). This may be due to the fact that the operationalization of mental strain differed between this project and previous studies. While previous studies operationalized mental strain by core dimensions of burnout (Maslach et al., 2001), this thesis project used the indicators of exhaustion, irritation, and alienation to account for this construct. Nevertheless, the findings of this project regarding the health-impairment process support the robustness of the JD-R model, concluding that the health-impairment process of the JD-R model is not limited to burnout only, but can also be extended to other indicators of mental states (such as irritation and alienation) as well.

### 6.2.3 Reflections on the proposed model

A major strength of the proposed model was the fact that it performed very well in explaining variations in the endogenous variables. Forty-three percent of the variance of the perceived burden due to job demands was explained by the second-order resources factor. The resources factor and the job demands factor combined were also able to

explain 76 % of the variation in mental strain. Overall, 70 % of the variation in somatic health symptoms can be ascribed to the direct and indirect effects of job demands, resources, and mental strain.

A further strength of the proposed model concerns the integration of person- and job-related resources into one factor. This results in a parsimonious model that overcomes potential statistical issues due to multicollinearity among different facets of person- and job-related resources. Due to multicollinearity, person- and job-related resources may contain redundant information and, as a consequence, meaningful effects of different resource dimensions may be obscured. This model therefore allows consideration of different facets of resources without having to worry about multicollinearity issues.

Moreover, the model proved to be robust in terms of its application across different groups. Male and female employees, employees of varying ages, and employees with different levels of education were demonstrated to be largely invariant with regard to both measurement issues and the hypothesized relationships among the relevant factors.

A potential limitation of this model, however, concerns neglect of the motivational process of the JD-R model. Future studies may also integrate the motivational aspects in this alternative stress model, in order to fully account for the assumptions of the original JD-R model.

## 6.3 Exploring differential health effects of different constellations of job demands

The combined variable- and person-oriented methodological approach used in this thesis allowed for identifying a taxonomy in terms of both the burden due to different kinds of demands experienced at work and the vulnerability to health-related problems (parts of this section are based on a previous publication by Mayerl, Stolz, Waxenegger, & Freidl, 2017). Moreover, this thesis intended to identify associations between different constellations of job demands and different manifestations of health problems, in order to explore the differential health effects of diverse work-related stress profiles.

### 6.3.1 Symptom clusters

Four different symptom clusters have been identified in this thesis. Approximately 39 % of the employees indicated a relatively low frequency of health symptoms. Employees within this class can be considered as relatively healthy; this class was thus labelled as the *healthy* cluster. The remainder of the employees (approximately 61 %) were found to suffer from specific health symptoms. This group can be further subdivided into three separate symptom clusters.

First, the *tensed up* cluster represented the greatest share (26 %). This cluster predominantly demonstrated high probabilities of suffering from musculoskeletal issues (such as muscle tenseness in the neck and shoulder regions and back pain), and moderately high probabilities of suffering from migraine and mental strain. Given that approximately one quarter of employees are expected to belong to this cluster, this finding is in line with previous research which had demonstrated musculoskeletal problems in the back, neck, and shoulder regions becoming an increasingly important issue (Fejer, Kyvik, & Hartvigsen, 2005; Freburger et al., 2009).

Second, a *mentally strained* cluster was identified. This cluster was found to suffer predominantly from symptoms of mental strain (such as exhaustion, irritation, and alienation). This class was also expected to have a relatively large population share (approximately 22 %), which conforms to previous studies indicating that psychological strain and distress are particularly pervasive in work contexts (e.g. Adriaenssens, Gucht, & Maes, 2015; Bültmann, Kant, Kasl, Beurskens, & van den Brandt, 2002; Businger, Stefenelli, & Guller, 2010; Trufelli et al., 2008).

The last cluster has an estimated population share of approximately 13 %. This class exhibited the highest probabilities for almost all symptoms across all clusters and can thus be considered as a *heavily suffering* symptom cluster. This cluster merits special attention when it comes to the prevention of work-related diseases, since this critical health status likely constitutes a manifestation of serious existing pathological conditions.

### 6.3.2 Job demand profiles

With regard to job demands, the four-class solution was again found to represent the data best. The largest class (i.e. the *low burden* profile) had an estimated population share of approximately 37 %. This profile seemed to experience a generally low burden or even no burden at all due to unfavourable aspects of the job. The remainder of employees (63 %), however, demonstrated an increased probability of feeling burdened by particular constellations of job demands.

A relatively high prevalence (estimated population share of nearly 29 %) was found for a burden due to psychosocial factors at work (i.e. representing the *psychosocially burdening* demand profile). This included aspects associated with mental (e.g. high concentration), emotional (e.g. emotionally burdening work), or social (e.g. high responsibility for goods and people or permanent contact with customers/clients) job demands. By contrast, the likelihood of feeling burdened by physical demands was very low within this class.

The probability of feeling burdened due to physically strenuous work (e.g. one-sided

physical strain) was, however, the highest within the *physically burdening* demand profile. This profile was not limited to physically burdening aspects alone, since the likelihood of experiencing a burden due to time pressure, high concentration, or high responsibility for goods and people was also moderately increased. This class was the smallest of all classes, yet with a population share of 16 %.

A slightly greater prevalence (18 %) was estimated for the *highly burdening* demand profile. This profile was characterized by a high risk of feeling burdened by physical, mental, emotional, social, and organizational demands. This profile seemed to be most severely impacted by several extensive stressors at work.

These four job demand profiles are positively comparable to the stress clusters identified by Vanroelen et al. (2010, see also subsection 3.6.3). In line with this thesis project, Vanroelen et al. (2010) revealed four subgroups (see also Mayerl, Stolz, Waxenegger, & Freidl, 2017): (1) a *low stress* cluster demonstrating no or only a slight burden due to stressors at work (similar to the *low burden* profile found in this thesis); (2) a *human contact* cluster indicating a burden particularly due to emotional and psychosocial aspects of the job (similar to the *psychosocially burdening* demand profile); (3) a *passive-manual* stress cluster experiencing a burden especially due to physically strenuous work (similar to the *physically burdening* demand profile); and (4) a *high stress* cluster reporting a generally high burden due to exposure to various stressors at work (similar to the *highly burdening* demand profile). However, Vanroelen et al. (2010) additionally identified a fifth class, namely a *high demand* cluster. This cluster was characterized by a high risk of being exposed to emotional and quantitative demands, whereas the likelihood of experiencing physical stressors and adverse organizational conditions was decreased.

The main reason for the slightly diverging findings between this thesis project and the study of Vanroelen et al. (2010) is likely due to the fact that different indicator variables were used to conduct the latent class analysis. While this thesis project focused on specific job demands on the item level, Vanroelen et al. (2010) used scale scores (which were categorized) of a set of validated scales as indicator variables in the latent class models. Moreover, in order to account for resources, this thesis project included the person- and job-related resource variables as covariates in the final regression model, whereas Vanroelen et al. (2010) considered job resources as indicator variable in the latent class model. Given these considerable differences in the specification of the models, it is nonetheless remarkable that the two studies yielded very similar results.

### 6.3.3 The relationship between the job demand profiles and the symptom clusters

The findings regarding the association between the job demand profiles and the symptom clusters suggest that different constellations of job demands seem to affect health in different ways. Employees exhibiting the *psychosocially burdening* demand profile (compared to the *low burden* profile) were two times and three times more likely to belong to the *tensed up* and the *mentally strained* symptom clusters, respectively. Although the effect on the *mentally strained* cluster was slightly stronger, the findings suggest that the psychosocially demanding aspects of the job are not only related to mental health but also to somatic health. That is, even though the employees within this class did not report any burden due to physically strenuous tasks, the burden due to psychosocial aspects of the job might have led to somatic symptoms such as muscle tenseness and pain. This interpretation conforms to bio-psycho-social conceptualizations of pain that consider psychosocial factors (i.e. chronic exposure to psychosocial job demands) to be an important aspect in the aetiology of pain (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Psychosocial demands are not only related to a number of physiological stress responses, but also to changes in behaviour (such as smoking, drinking, and diet). These indirect effects might explain why psychosocial factors lead to poor somatic health or to changes in pain perceptions (Gatchel et al., 2007; McEwen, 2008).

Moreover, employees demonstrating the *physically burdening* demand profile were almost four times and approximately two times more likely to be categorized as *tensed up* and *mentally strained*, respectively. It thus seems that psychosocial demands indicate a slightly stronger association with mental health than with somatic health, and that physical demands indicate a slightly stronger relationship to somatic health than to mental health. The odds of belonging to the *heavily suffering* symptom cluster were slightly stronger for the *physically burdening* demand profile than for the *psychosocially burdening* demand profile, although confidence intervals largely overlapped. In other words, employees working in a physically and psychosocially demanding working environment (compared to the *low burden* profile) were five times and six times more likely to be categorized as *heavily suffering*, respectively. Generally speaking, these findings suggest that both physical and psychosocial job demands reveal a moderate to strong relationship to both mental and somatic health. While previous work-related stress research focused primarily on the psychosocial aspects of work and often disregarded the physical aspects (see e.g. Nixon et al., 2011), the findings of this thesis project stress the importance of considering both psychosocial and physical factors in the relationship between job demands and health.

The *heavily burdening* job demand profile demonstrated the strongest relationship

to health; employees exhibiting this profile were 10 times more likely to belong to the *tensed up* cluster, 20 times more likely to be categorized as *mentally strained*, and almost 47 times more likely to belong to the *heavily suffering* cluster. This finding clearly supports the assumption that overall high exposure to various job demands (including physical, mental, social, emotional, and organizational facets of a working environment) cumulate to reinforce the detrimental effects on the organism, as suggested by allostatic load theory (see subsection 3.1.3; McEwen, 1998, 2008). According to this theory, extensive chronic exposure to demands causes wear and tear of the over-activated physiological processes, and, in turn, might damage the involved systems. These damaging effects on the organism may build up through cumulative exposure to various demands due to a synchronous burden on the activated systems. An alternative explanation is provided by Hobfoll's COR theory (see subsection 3.2.3; Hobfoll, 1989, 2010). The synchronous exposure to various demands is expected to increasingly deplete the individual's resource pool. This cumulative depletion of resources not only results in experiences of stress and strain, but also gradually diminishes the ability of coping with the demands to which employees are exposed (Ford et al., 2014).

The findings regarding the role of person- and job-related resources revealed a consistent pattern (except for only one result). An increase in physical, mental, social, and job resources went along with a small to moderate decrease in the odds of belonging to the *tensed up*, *mentally strained*, and *heavily suffering* symptom clusters (compared to the *healthy* cluster). This again conforms to previous study results that demonstrated resources to be a beneficial factor for health and well-being (Kalimo et al., 2002).

### 6.3.4 Reflections on the methodological approach

To conclude, the approach of this thesis project allowed the inclusion of a variety of different facets of both job demands and health symptoms, and also taking into account potential heterogeneity in the population of employees. This combined person- and variable-centred approach (B. O. Muthén & Muthén, 2000) was found capable of capturing phenomena that emerge to varying degrees across particular groups of individuals, and can thus be considered a valid alternative to the prevailing purely variable-centred approaches (see also Wang & Hanges, 2011).

A potential limitation concerns the fact that the method of categorizing employees is based on probabilities, which implies that one cannot be sure that individuals have been classified correctly. This uncertainty regarding latent class membership might also entail statistical issues (such as biased coefficient estimates or underestimated standard errors) when considering the scores of latent class membership as an observed variable in subsequent statistical analysis (Bolck, Croon, & Hagenaars, 2004). However, according to Clark and Muthén (2009, unpublished manuscript), the risk of facing

statistical problems is slight when entropy measures are not too low and a more stringent significance criterion (e.g. $\alpha = 1\,\%$ instead of $\alpha = 5\,\%$) is used. Since both aspects apply to this thesis project, this does not seem to be a considerable issue in this case.

## 6.4 General discussion

This thesis project analysed the associations between job demands, health, and resources from three different angles. Overall, the findings from these analyses converged in supporting the assumption that extensive job demands – whether physical or psychosocial – have a detrimental effect on both mental and somatic health. The sizes of effect were consistently high or at least moderately high across all analyses and demonstrated that the measure of job demands – whether represented as a score or as a category – is one of the best predictors of an individual's health status.

The overall findings also suggest that different facets of person- and job-related resources might have a beneficial impact on health. These effects were generally lower than those of job demands, but nevertheless exhibited a consistent pattern across all types of analyses. It also seemed that the magnitude of effect was dependent on the quality of both the resource and the health indicators. For example, physical resources were a better predictor of somatic than of mental health status, and mental resources were a better predictor of mental than of somatic health. This finding is in line with the *matching hypothesis*, which states that the associations between demands, resources, and stress responses (i.e. representing the *triple-match-principle*) reveal the strongest effects when they are measured on qualitatively identical dimensions (de Jonge & Dormann, 2003, 2006). De Jonge and Dormann (2006) demonstrated in two longitudinal studies that the likelihood of finding the relevant effects (i.e. the moderating effects of job resources) increased with the degree of match between job demands, job resources, and job-related strain.

The matching hypothesis was, however, not undermined by the moderation analysis of this project. Neither physical, nor mental resources moderated the relationship between job demands and indicators of mental or somatic health. Only job resources were found to have the potential to buffer the negative impact of job demands on the likelihood of reporting somatic health symptoms. Overall, the moderating effects of resources on the relationship between job demands and health did not increase prediction quality considerably. In other words, resources might have a direct beneficial effect on health, but the evidence for the protective or buffering effects of resources in the stressor-health link is rather weak.

A further argument against the matching hypothesis is the fact that the common resources factor allowed for better prediction of mental and somatic health than the

specific resource dimensions alone. It thus seemed to be a valid approach to consider resources as a multidimensional construct in work-related stress processes. While specific resource dimensions may be useful in specific contexts, the multidimensional resources factor is more general and can be applied to a number of different work-related contexts. However, the resources factor might be more appropriate in basic research, while intervention or evaluation studies should rather focus on specific resource dimensions in order to examine the effects different interventions have on specific resource development.

Moreover, it should be discussed whether the classic variable-centred approach or the person-centred approach is more appropriate in occupational health research (see also subsection 3.6.3). Whereas the variable-centred approach focuses on relationships among variables, the person-centred approach examines common features among individuals and strives to identify subgroups of individuals that exhibit a typological pattern in terms of particular characteristics. The findings of this thesis project demonstrated that the population of employees is *not* homogenous in terms of the perceived level of exposure to different kinds of demands or the vulnerability to specific health problems. Rather, the population of employees was found to consist of different latent clusters or profiles, and individuals can be categorized accordingly. The approach of categorizing individuals according to the most likely cluster/profile allows the consideration of unobserved heterogeneity in the population. This is the main advantage of the person-centred approach over the variable-centred approach.

However, categorization means that individuals have to be put into boxes. Some individuals might fit very well in a specific box, while others do not. Even though classification quality can be quantified, uncertainty regarding latent group membership remains. This problem usually does not apply to variable-centred approaches, where individual measures are used to examine the relationship to other individual measures. In sum, both the variable- and person-centred approaches seem to be legitimate and both approaches have their advantages and disadvantages. It depends on the research focus whether the variable- or person-centred approach is considered more adequate. If the research focuses on associations between variables and the study population is relatively homogenous, the variable-centred approach is more appropriate. If the research strives to identify subgroups of individuals within a heterogeneous population, the person-centred approach should be used.

### 6.4.1 Strengths and limitations of this thesis

One of the major strengths of this thesis project is that it analysed work-related stress processes from different theoretical angles and that different methodological and statistical approaches were used to examine these processes. This methodological procedure resembles the principle of methodological *triangulation*, which is borrowed from

qualitatively oriented research (although this principle has its origins in quantitatively oriented research; Campbell & Fiske, 1959; Denzin, 1970). Flick (2004, 2008) specifically highlighted the 'systematic triangulation of perspectives', in which 'different research perspectives [...] are combined with one another in a targeted way, to complement their strong points and to illustrate their respective limitations' (Flick, 2004, p. 181). In other words, triangulation is supposed to expand the possibilities of gaining knowledge and to combine the strengths and weaknesses of different methodological approaches (see e.g. the combination of the person- and variable-centred approaches).

A second strength of this thesis project concerns the representative large-size sample. This allowed for making comprehensible inferences to the population of employees working in Austria. However, it has to be mentioned that the sample was restricted to employees working full-time. The findings can thus be related only to this subgroup of the working population and no inferences can be made to self-employed persons or employees working part-time.

A third strength of this research is the fact that extensive, yet parsimonious, models were defined, which allowed for a very good prediction of the key dependent variables, namely mental strain and somatic health symptoms. For instance, the established stress model was able to explain between 70 % to 75 % of the variation in both mental strain and somatic health symptoms, even though the structural part of the model included only three first- or second-order factors as predictor variables.

The major weakness of this thesis project concerns the study design and the cross-sectional nature of the data. As already discussed in section 4.1, the study design does not permit making causal inferences. Rather, the effects found in this project are only correlational, but do not prove any cause-and-effect associations. Although the hypotheses of this thesis have been derived from prominent stress theories as well as previous research findings and thus include the predicted direction of effects (e.g. extensive job demands affect health negatively), alternative explanations cannot be ruled out completely. For example, a reversed causation explanation for the stressor-health link might also be possible, as suggested by the drift hypothesis (Frese, 1982). This hypothesis states that poor health causes individuals to *drift* to bad jobs (i.e. due to previous unemployment or their personal records of sick leave; Zapf, Dormann, & Frese, 1996). In a systematic review of longitudinal studies, Zapf et al. (1996) found that approximately 40 % of the included studies had tested the reversed causation hypothesis, of which approximately 50 % had found some evidence for reversed causation. However, the causal effects of work characteristics on health are usually stronger than the effects found in reversed causation analyses (Lange, Taris, Kompier, Houtman, & Bongers, 2004). The study by Lange et al. also suggests that future longitudinal research should examine reciprocal relationships as well, in order to better understand the complex and

dynamic interactions between stressors and responses to those stressors in a working context.

A second problem with regard to the interpretation of causal relationships concerns *third variables* (Zapf et al., 1996). Third variables might at least partly explain the relationships between demands, resources, and health. Although this project controlled for a number of potentially relevant third variables (e.g. sex, age, and education), it is almost impossible to control for all factors that might have an impact. The exclusion of relevant third factors might also cause bias due to common method variance. That is, the fact that both the dependent and independent variables were collected at the same time and were based on self-reported data from the same individuals might cause overestimation of effects. Third variables that might have an impact in this context are social desirability responding, consistent response styles, or affective dispositions and mood (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Zapf et al., 1996).

Individuals who are in a good mood at the time, for example, might generally feel better and thus report fewer symptoms of both mental strain and somatic health, and simultaneously evaluate the working environment as less demanding. By contrast, individuals who are in a bad mood might be less optimistic and thus indicate more health symptoms and also perceive the working environment as more stressful. In extreme cases, this may cause the relationship between independent and dependent variables to be completely spurious. Empirical evidence, however, provides only weak support for a substantial bias effect of negative affectivity in the stress-health link (for a short review of research, refer to Spector, Zapf, Chen, & Frese, 2000). The inclusion of negative affectivity in these studies reduced the strength of association between demands and health only slightly or not at all. It was thus assumed that the bias due to the exclusion of potential third variables is only minor in this thesis project, yet a slight overestimation of effects is likely (see e.g. Semmer, Zapf, & Greif, 1996).

A third potential limitation is that only some of the used measures were based on previously validated instruments (parts of this paragraph are based on Mayerl et al., 2016). The remainder, however, are proxy measures reflecting the constructs most important for the research questions of this project. This means that a set of items had to be selected to establish the measurement models and, in turn, to estimate the latent factor scores. However, it is often not possible to correctly specify a measurement model a priori. Researchers have to rely on specification searches in order to reveal potential specification errors and to improve fit of the hypothesized measurement models. These modifications are often necessary in order to obtain reliable and valid factor scores, whereas the failure to make the necessary modifications might result in biased estimates regarding the relationships between factors (Cole, Ciesla, & Steiger, 2007). Although it is recommended to evaluate the measurement models prior to the estimation of the

relationships between factors (Anderson & Gerbing, 1988; Raykov & Marcoulides, 2012, p. 49), a purely data-driven approach (i.e. testing and modifying the measurement models using the same data) bears the risk of capitalization on chance (MacCallum et al., 1992).

To account for these limitations and the related pitfalls, the specification of the measurement models was based on theoretical considerations on the one hand, and the findings of a comprehensive psychometric analysis on the other hand. Although a potential bias due to measurement cannot be ruled out completely, this project made a great effort to minimize this risk and to use scales that indicated both high reliability and validity.

### 6.4.2 Conclusions and practical implications

This thesis project examined the relationship between job demands, resources, and health from different theoretical and methodological perspectives. The findings from this project converged in supporting the assumption that extensive job demands might have a detrimental effect on an individual's mental and somatic health. Synchronous exposure to several demands of different nature (i.e. physical, psychosocial, emotional, and organizational) was found to be most critical in terms of exhibiting signs of poor health. Moreover, both general and specific indicators of resources seemed to have a beneficial health effect, although evidence for resources having a buffering effect in the relationship between job demands and health was weak.

The findings of this thesis project have pointed out that prevention strategies aiming to promote employees' health could take action on three levels (see also Mayerl et al., 2016):

- First of all, since job demands were found to be among the best predictors of an employee's health status, the primary objective should be to decrease overwhelming chronic job demands. Special attention should be paid to the synchronous burden resulting from different facets of job demands, which was found to be most critical in terms of the seriousness of encountered health problems.
- Second, since mental strain seemed to intervene in the relationship between job demands and somatic health, interventions should aim to reduce the symptoms of mental strain. These interventions might help employees to better cope with overwhelming demands at work and to prevent mental strain reactions from transforming into somatic health problems or serious diseases. Examples of such interventions previously found to be effective in reducing mental strain are the learning of relaxation techniques and cognitive-behavioural coping strategies (Richardson & Rothstein, 2008, see also section 3.4).

- Third, efforts could be targeted to the increase of resources. This includes both the enhancement of beneficial work-related factors as well as the enrichment of beneficial person-related factors in a bio-psycho-social way of thinking.

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# APPENDIX A

## Ethics approval

**Ethikkommission**

Medizinische Universität Graz

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ethikkommission@medunigraz.at
Tel.: +43 / 316 / 385-13928, Fax: -14348

## VOTUM

**gültig bis 17.10.2017**

| | |
|---|---|
| **EK-Nummer:** | 29-034 ex 16/17 |
| **Studientitel:** | Work, Stress and Health: A retrospective study |
| **Prüfer:** | Univ.-Prof. Dr. Wolfgang Freidl<br>Institut für Sozialmedizin und Epidemiologie |
| **Sponsor:** | Medizinische Universität Graz, Institut für Sozialmedizin und Epidemiologie |
| Ansprechpartner: | Univ.-Prof. Dr. Wolfgang Freidl, 8010 Graz, Universitätsstraße 6/I |
| **CRO:** | - |
| **Antragsteller:** | Medizinische Universität Graz, |
| Ansprechpartner: | Mag. Hannes Mayerl, 8010 Graz, Universitätsstraße 6/I |

Die o.a. Studie wurde von der Ethikkommission erstmals im 'expedited Review' am 07.10.2016 behandelt. Die Ethikkommission ist zu folgendem Schluss gekommen:

**Es besteht kein Einwand gegen die Durchführung der Studie in der vorliegenden Form.**

Kommissionsmitglieder, die für diesen Tagesordnungspunkt als befangen anzusehen waren und daher gemäß Geschäftsordnung an der Entscheidungsfindung und Abstimmung nicht teilgenommen haben: keine

**Zur Beurteilung vorliegende Dokumente:**

| | | |
|---|---|---|
| **Dokumente eingegangen am 26.09.2016, begutachtet im 'expedited Review' am 07.10.2016** | | |
| ✓ | Cover Letter | 26.09.2016 |
| ✓ | Antragsformular ECS Unterschriftenseiten | 26.09.2016 |
| ✓ | Antragsformular ECS | 26.09.2016 |
| | Originalprotokoll Studienprotokoll v1.0 | 26.09.2016 |
| ✓ | Conflict of Interest Erklärung Freidl | 26.09.2016 |
| ✓ | Sonstiges: Basisfragebogen2014_AI_GM v1.0 | 05.07.2016 |
| **Dokumente eingegangen am 10.10.2016, begutachtet im 'expedited Review' am 17.10.2016** | | |
| ✓ | Originalprotokoll 1.1 | 10.10.2016 |

Die Ethikkommission geht - rechtlich unverbindlich - davon aus, dass es sich um keine klinische Prüfung nach AMG bzw. MPG handelt.

Es handelt sich um eine Studie im Rahmen einer Dissertation.

Das Votum der Ethikkommission berührt in keiner Weise die alleinige Verantwortung der Prüferin / des Prüfers / der Prüfer für die ordnungsgemäße Durchführung der Studie unter Einhaltung aller einschlägiger gesetzlicher Bestimmungen und Richtlinien.

Weiters machen wir darauf aufmerksam, dass der Kommission unverzüglich zu melden sind:

- Abweichungen vom Protokoll aus Sicherheitsgründen oder Protokolländerungen

- Änderungen, die das Risiko der Teilnehmer/-innen erhöhen oder die Durchführung der Studie wesentlich beeinflussen



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UID: ATU 575 111 79. Bankverbindung: Bank Austria Creditanstalt BLZ 12000 Konto-Nr. 500 948 400 04, Raiffeisen Landesbank Steiermark BLZ 38000 Konto-Nr. 49510.

- Mutmaßliche unerwartete schwerwiegende Nebenwirkungen - SUSARs (AMG-Studien ab 1.5.2004) oder schwerwiegende unerwünschte Ereignisse - SAEs (andere Studien)

- Jegliche Information über sonstige Umstände, die die Sicherheit der Teilnehmer/-innen oder die Durchführung der Studie beeinträchtigen können

Dieses Votum gilt für ein Jahr ab dem Datum der Ausstellung. Bei längerer Studiendauer ist rechtzeitig vor Ablauf der Gültigkeit des Votums ein Zwischenbericht vorzulegen (Berichtsformular), um eine etwaige Verlängerung zu erlangen.

Graz, 17. Oktober 2016

Univ.Prof.DI Dr.Josef Haas
Vorsitzender

Univ.Prof.Dr.Hermann Toplak
Stv. Vorsitzender

**Achtung:** Bitte bei allen das Projekt betreffende Schreiben oder telefonischen Anfragen die EK-Nummer angeben!



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UID: ATU 575 111 79. Bankverbindung: Bank Austria Creditanstalt BLZ 12000 Konto-Nr. 500 948 400 04, Raiffeisen Landesbank Steiermark BLZ 38000 Konto-Nr. 49510.

# APPENDIX B

## Descriptive statistics

**Table B.1:** Frequencies and percentages for health symptoms

| | **Response categories** | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **1** | **2** | **3** | **4** | **5** | **Missings** |
| digestion ($SS_1$) | 13524 | 2831 | 1188 | 295 | 100 | 3 |
| | (75.38 %) | (15.78 %) | (6.62 %) | (1.64 %) | (0.56 %) | (0.02 %) |
| stomach ($SS_2$) | 13692 | 2534 | 1292 | 321 | 98 | 4 |
| | (76.32 %) | (14.12 %) | (7.20 %) | (1.79 %) | (0.55 %) | (0.02 %) |
| migraine ($SS_3$) | 9094 | 4265 | 3289 | 955 | 337 | 1 |
| | (50.69 %) | (23.77 %) | (18.33 %) | (5.32 %) | (1.88 %) | (0.01 %) |
| sleeping ($SS_4$) | 11889 | 2778 | 2133 | 806 | 331 | 4 |
| | (66.27 %) | (15.48 %) | (11.89 %) | (4.49 %) | (1.84 %) | (0.02 %) |
| memory ($SS_5$) | 14386 | 2223 | 1064 | 207 | 57 | 4 |
| | (80.19 %) | (12.39 %) | (5.93 %) | (1.15 %) | (0.32 %) | (0.02 %) |
| tenseness ($SS_6$) | 7293 | 2828 | 4663 | 2233 | 921 | 3 |
| | (40.65 %) | (15.76 %) | (25.99 %) | (12.45 %) | (5.13 %) | (0.02 %) |
| back pain ($SS_7$) | 7541 | 2997 | 4296 | 2195 | 910 | 2 |
| | (42.03 %) | (16.70 %) | (23.95 %) | (12.23 %) | (5.07 %) | (0.01 %) |
| leg pain ($SS_8$) | 12980 | 2140 | 1910 | 696 | 213 | 2 |
| | (72.35 %) | (11.93 %) | (10.65 %) | (3.88 %) | (1.19 %) | (0.01 %) |
| hypertension ($SS_9$) | 14706 | 1373 | 1115 | 521 | 219 | 7 |
| | (81.97 %) | (7.65 %) | (6.21 %) | (2.90 %) | (1.22 %) | (0.04 %) |
| tachychardia ($SS_{10}$) | 15586 | 1391 | 696 | 194 | 70 | 4 |
| | (86.87 %) | (7.75 %) | (3.88 %) | (1.08 %) | (0.39 %) | (0.02 %) |
| skin ($SS_{11}$) | 15327 | 1551 | 700 | 249 | 107 | 7 |
| | (85.43 %) | (8.65 %) | (3.90 %) | (1.39 %) | (0.60 %) | (0.04 %) |
| respiratory ($SS_{12}$) | 15992 | 1071 | 587 | 202 | 82 | 7 |
| | (89.14 %) | (5.97 %) | (3.27 %) | (1.13 %) | (0.46 %) | (0.04 %) |
| cough ($SS_{13}$) | 16020 | 1117 | 540 | 188 | 69 | 7 |
| | (89.29 %) | (6.23 %) | (3.01 %) | (1.05 %) | (0.38 %) | (0.04 %) |
| eye ($SS_{14}$) | 14398 | 1819 | 1195 | 376 | 146 | 7 |
| | (80.25 %) | (10.14 %) | (6.66 %) | (2.10 %) | (0.81 %) | (0.04 %) |

*Table notes.* Variable names are abbreviations. For detailed variable description, refer to subsection 4.4.1.

**Table B.2:** Frequencies and percentages for mental strain

| | Response categories | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **1** | **2** | **3** | **4** | **5** | **Missings** |
| **Exhaustion** | | | | | | |
| item 1 | 13524 | 2831 | 1188 | 295 | 100 | 3 |
| | (75.38 %) | (15.78 %) | (6.62 %) | (1.64 %) | (0.56 %) | (0.02 %) |
| item 2 | 13692 | 2534 | 1292 | 321 | 98 | 4 |
| | (76.32 %) | (14.12 %) | (7.20 %) | (1.79 %) | (0.55 %) | (0.02 %) |
| item 3 | 9094 | 4265 | 3289 | 955 | 337 | 1 |
| | (50.69 %) | (23.77 %) | (18.33 %) | (5.32 %) | (1.88 %) | (0.01 %) |
| **irritation** | | | | | | |
| item 1 | 11889 | 2778 | 2133 | 806 | 331 | 4 |
| | (66.27 %) | (15.48 %) | (11.89 %) | (4.49 %) | (1.84 %) | (0.02 %) |
| item 2 | 14386 | 2223 | 1064 | 207 | 57 | 4 |
| | (80.19 %) | (12.39 %) | (5.93 %) | (1.15 %) | (0.32 %) | (0.02 %) |
| item 3 | 7293 | 2828 | 4663 | 2233 | 921 | 3 |
| | (40.65 %) | (15.76 %) | (25.99 %) | (12.45 %) | (5.13 %) | (0.02 %) |
| item 4 | 7541 | 2997 | 4296 | 2195 | 910 | 2 |
| | (42.03 %) | (16.70 %) | (23.95 %) | (12.23 %) | (5.07 %) | (0.01 %) |
| item 5 | 12980 | 2140 | 1910 | 696 | 213 | 2 |
| | (72.35 %) | (11.93 %) | (10.65 %) | (3.88 %) | (1.19 %) | (0.01 %) |
| **Alienation** | | | | | | |
| item 1 | 14706 | 1373 | 1115 | 521 | 219 | 7 |
| | (81.97 %) | (7.65 %) | (6.21 %) | (2.90 %) | (1.22 %) | (0.04 %) |
| item 2 | 15586 | 1391 | 696 | 194 | 70 | 4 |
| | (86.87 %) | (7.75 %) | (3.88 %) | (1.08 %) | (0.39 %) | (0.02 %) |
| item 3 | 15327 | 1551 | 700 | 249 | 107 | 7 |
| | (85.43 %) | (8.65 %) | (3.90 %) | (1.39 %) | (0.60 %) | (0.04 %) |

*Table notes.* For detailed variable description, refer to subsection 4.4.2.

**Table B.3:** Frequencies and percentages for job demands

| | Response categories | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **1** | **2** | **3** | **4** | **5** | **Missings** |
| standing ($JD_1$) | 10962 | 2047 | 2643 | 1495 | 716 | 78 |
| | (61.10 %) | (11.41 %) | (14.73 %) | (8.33 %) | (3.99 %) | (0.43 %) |
| physical exertion ($JD_2$) | 11244 | 2038 | 2366 | 1427 | 809 | 57 |
| | (62.67 %) | (11.36 %) | (13.19 %) | (7.95 %) | (4.51 %) | (0.32 %) |
| physical strain ($JD_3$) | 10673 | 2149 | 2666 | 1682 | 700 | 71 |
| | (59.49 %) | (11.98 %) | (14.86 %) | (9.38 %) | (3.90 %) | (0.40 %) |
| isolation ($JD_4$) | 14554 | 1977 | 900 | 353 | 99 | 58 |
| | (81.12 %) | (11.02 %) | (5.02 %) | (1.97 %) | (0.55 %) | (0.32 %) |
| time pressure ($JD_5$) | 6203 | 3024 | 4424 | 2947 | 1306 | 37 |
| | (34.57 %) | (16.86 %) | (24.66 %) | (16.43 %) | (7.28 %) | (0.21 %) |
| emotionally burdening ($JD_6$) | 9802 | 3295 | 2666 | 1529 | 603 | 46 |
| | (54.63 %) | (18.37 %) | (14.86 %) | (8.52 %) | (3.36 %) | (0.26 %) |
| opportunity to retreat ($JD_7$) | 10845 | 2794 | 2343 | 1185 | 687 | 87 |
| | (60.45 %) | (15.57 %) | (13.06 %) | (6.60 %) | (3.83 %) | (0.48 %) |
| high concentration ($JD_8$) | 7065 | 3265 | 3971 | 2369 | 1225 | 46 |
| | (39.38 %) | (18.20 %) | (22.13 %) | (13.20 %) | (6.83 %) | (0.26 %) |
| high responsibility ($JD_9$) | 7334 | 2789 | 3589 | 2447 | 1723 | 59 |
| | (40.88 %) | (15.55 %) | (20.00 %) | (13.64 %) | (9.60 %) | (0.33 %) |
| monitoring ($JD_{10}$) | 11516 | 2715 | 2113 | 979 | 571 | 47 |
| | (64.19 %) | (15.13 %) | (11.78 %) | (5.46 %) | (3.18 %) | (0.26 %) |
| customers/clients ($JD_{11}$) | 9734 | 2571 | 2584 | 1756 | 1214 | 82 |
| | (54.26 %) | (14.33 %) | (14.40 %) | (9.79 %) | (6.77 %) | (0.46 %) |
| ill/needy persons ($JD_{12}$) | 14995 | 1062 | 772 | 427 | 453 | 232 |
| | (83.58 %) | (5.92 %) | (4.30 %) | (2.38 %) | (2.52 %) | (1.29 %) |
| support supervisor ($JD_{13}$) | 11767 | 2683 | 2158 | 843 | 400 | 90 |
| | (65.59 %) | (14.95 %) | (12.03 %) | (4.70 %) | (2.23 %) | (0.50 %) |
| support colleagues ($JD_{14}$) | 12785 | 2767 | 1603 | 535 | 152 | 99 |
| | (71.26 %) | (15.42 %) | (8.93 %) | (2.98 %) | (0.85 %) | (0.55 %) |
| tech./organiz. changes ($JD_{15}$) | 10647 | 3245 | 2691 | 1018 | 270 | 70 |
| | (59.34 %) | (18.09 %) | (15.00 %) | (5.67 %) | (1.50 %) | (0.39 %) |
| work routines ($JD_{16}$) | 10007 | 3578 | 2766 | 1191 | 343 | 56 |
| | (55.78 %) | (19.94 %) | (15.42 %) | (6.64 %) | (1.91 %) | (0.31 %) |
| irregular working hours ($JD_{17}$) | 12629 | 2029 | 2001 | 861 | 370 | 51 |
| | (70.39 %) | (11.31 %) | (11.15 %) | (4.80 %) | (2.06 %) | (0.28 %) |
| excessive working hours ($JD_{18}$) | 12343 | 2572 | 1799 | 741 | 431 | 55 |
| | (68.80 %) | (14.34 %) | (10.03 %) | (4.13 %) | (2.40 %) | (0.31 %) |

*Table notes.* Variable names are abbreviations. For detailed variable description, refer to subsection 4.4.3.

**Table B.4:** Frequencies and percentages for job resources

| | Response categories | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **1** | **2** | **3** | **4** | **5** | **Missings** |
| decision latitude ($JR_1$) | 5352 | 6554 | 4204 | 1153 | 472 | 206 |
| | (29.83 %) | (36.53 %) | (23.43 %) | (6.43 %) | (2.63 %) | (1.15 %) |
| co-determination ($JR_2$) | 3881 | 6397 | 5050 | 1481 | 675 | 457 |
| | (21.63 %) | (35.66 %) | (28.15 %) | (8.25 %) | (3.76 %) | (2.55 %) |
| working rights ($JR_3$) | 3331 | 9125 | 4366 | 752 | 233 | 134 |
| | (18.57 %) | (50.86 %) | (24.34 %) | (4.19 %) | (1.30 %) | (0.75 %) |
| income ($JR_4$) | 4447 | 5993 | 4041 | 1722 | 808 | 930 |
| | (24.79 %) | (33.40 %) | (22.52 %) | (9.60 %) | (4.50 %) | (5.18 %) |
| career/development ($JR_5$) | 3500 | 5580 | 4826 | 2020 | 965 | 1050 |
| | (19.51 %) | (31.10 %) | (26.90 %) | (11.26 %) | (5.38 %) | (5.85 %) |
| training ($JR_6$) | 3080 | 8081 | 4837 | 1456 | 457 | 30 |
| | (17.17 %) | (45.04 %) | (26.96 %) | (8.12 %) | (2.55 %) | (0.17 %) |

*Table notes.* Variable names are abbreviations. For detailed variable description, refer to subsection 4.4.5.

**Table B.5:** Frequencies and percentages for person-related resources

| | Response categories | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **1** | **2** | **3** | **4** | **5** | **Missings** |
| **Physical** | | | | | | |
| item 1 | 13524 | 2831 | 1188 | 295 | 100 | 3 |
| | (75.38 %) | (15.78 %) | (6.62 %) | (1.64 %) | (0.56 %) | (0.02 %) |
| item 2 | 13692 | 2534 | 1292 | 321 | 98 | 4 |
| | (76.32 %) | (14.12 %) | (7.20 %) | (1.79 %) | (0.55 %) | (0.02 %) |
| **Mental** | | | | | | |
| item 1 | 9094 | 4265 | 3289 | 955 | 337 | 1 |
| | (50.69 %) | (23.77 %) | (18.33 %) | (5.32 %) | (1.88 %) | (0.01 %) |
| item 2 | 11889 | 2778 | 2133 | 806 | 331 | 4 |
| | (66.27 %) | (15.48 %) | (11.89 %) | (4.49 %) | (1.84 %) | (0.02 %) |
| item 3 | 14386 | 2223 | 1064 | 207 | 57 | 4 |
| | (80.19 %) | (12.39 %) | (5.93 %) | (1.15 %) | (0.32 %) | (0.02 %) |
| **Social** | | | | | | |
| item 1 | 7293 | 2828 | 4663 | 2233 | 921 | 3 |
| | (40.65 %) | (15.76 %) | (25.99 %) | (12.45 %) | (5.13 %) | (0.02 %) |
| item 2 | 7541 | 2997 | 4296 | 2195 | 910 | 2 |
| | (42.03 %) | (16.70 %) | (23.95 %) | (12.23 %) | (5.07 %) | (0.01 %) |
| item 3 | 12980 | 2140 | 1910 | 696 | 213 | 2 |
| | (72.35 %) | (11.93 %) | (10.65 %) | (3.88 %) | (1.19 %) | (0.01 %) |

*Table notes.* For detailed variable description, refer to subsection 4.4.4.

**Table B.6:** Frequencies and percentages for health behaviour

| **Variable** | *N* (%) |
|---|---|
| **Healthy food** | |
| yes | 8840 (49.27 %) |
| no | 9085 (50.64 %) |
| missings | 16 (0.09 %) |
| **Exercise** | |
| yes | 6377 (35.54 %) |
| no | 11548 (64.37 %) |
| missings | 16 (0.09 %) |
| **Smoking** | |
| not at all | 10128 (56.45 %) |
| occasionally/regularly | 7731 (43.09 %) |
| missings | 82 (0.46 %) |
| **Alcohol** | |
| 1 | 2825 (15.75 %) |
| 2 | 2532 (14.11 %) |
| 3 | 2754 (15.35 %) |
| 4 | 4475 (24.94 %) |
| 5 | 4088 (22.79 %) |
| 6 | 1194 (6.66 %) |
| missings | 73 (0.41 %) |

*Table notes.* For detailed variable description, refer to subsection 4.4.6.

# APPENDIX C

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