Construct Validation of the Salutogenetic Subjective Work Analysis Questionnaire with Perceived Health and Biological Parameters in Industrial Workers

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Summary

The present study examines the relation between employees' health status and their perception of job characteristics in a airplane manufacturing plant in Germany. The Salutogenetic Subjective Work Analysis Questionnaire (SALSA) was employed to assess the perceived resources and task loads. Health was assessed as the biological health status via physiological indicators as well as the subjective well being. Therefore analysis was separated into two parts: (1) SALSA and subjective well-being, and (2) SALSA and biological health status. With respect to the intended use of the SALSA, namely characterizing perceived working conditions and differences between company units, we analyzed in a last step two teams with similar tasks but different team structures.

Results show an apparently strong association between the task load and resources scales of the SALSA and parameters of subjective well being, namely SF-12 mental summary score, vital exhaustion and depression. The allostatic load parameters, as markers of biological health showed a remarkable relation with the task characteristics and resources scales of the SALSA. Finally, the comparison of the two teams on the SALSA scales exactly mirrored the a priori assessment of the two groups.

In summary, we demonstrated that the SALSA-questionnaire is strongly associated with perceived well-being and biological health parameters. The results support measuring perceived work characteristics may not only provide information about the work place, but may also predict the current and future employees' health status.

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1. Introduction

Healthy employees represent the human capital of every company. Most contemporary corporations acknowledge the importance of their human resources in the mission statement (e. g. CreditSuisse, 2005; Johnson and Johnson, 2005). However, the employee's work reality is increasingly characterized by job insecurity, rapid successions of restructuring, mergers, up- and downsizing. Reports on the causes of employee absenteeism indicate that technical and ergonomic aspects or work-related accidents only play a minor role, whereas psychosomatic and psychiatric illnesses show a sharp increase (Badura, Schellschmidt, & Vetter, 2004).

During the past decades several attempts have been made to operationalize job load, job strain and job equity in questionnaires and to relate adverse working conditions to health outcomes (Bosma, Peter, Siegrist, & Marmot, 1998; Caplan, Cobb, French, Harrison, & Pinneau, 1975; Estryn-Behar et al., 1990; Jönsson, Rosengren, Dotevall, Lappas, & Wilhelmsen, 1999; Kageyama et al., 1998; Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981; Karasek et al., 1988; Kivimaki et al., 2002; Siegrist, 1996). Substantial progress has not only been made in the characterization of working conditions, but also in the measurement of health-related quality of life (HRQoL), by means of standardized questionnaires, and in the operationalization of preclinical alterations in physiological functioning (Bullinger, 1995). For example, the MacArthur studies on successful aging (McEwen, 1998b) showed that a set of biological measures, summarized as the allostatic load, predicts functional health as well as morbidity in retired individuals. It has been previously shown that working conditions are related to alterations in self-reported health and in measures of biological systems, ranging from lipid metabolism thru hemostasis to immune function (Kudielka et al., 2005; Schnorpfeil et al., 2002).

Hitherto, conceptualizations of work characteristics that were prospectively linked to health outcomes have largely been derived from two specific measures, namely the Karasek-Theorell job content questionnaire (Karasek et al., 1998) and Siegrist's effort-

reward-imbalance construct (Siegrist & Peter, 1997). The former questionnaire assesses job demands and the amount of decision latitude that is perceived by an individual. The latter questionnaire aims to elucidate the balance between the perceived burden elicited by job demands and the perceived rewards from work. Reward items assess the subjective adequacy of remuneration, career opportunities, appreciation, and job security. Ample data supports the notion that adverse job conditions as described by either questionnaire are associated with increased risk of a variety of undesirable health outcomes, including myocardial infarction. However, these two questionnaires only indirectly assess a potentially important risk modifier, namely the resources provided by the work environment for the individual (Siegrist, 1998). For example, highly supportive supervisor behavior and excellent social support by coworkers may compensate for otherwise unhealthy conditions, such as tight deadlines and severe time constraints.

More recently the group around Udris and coworkers (Mussmann, Kraft, Thalmann, & Muheim, 1993; Rimann & Udris, 1993; Udris, Kraft, & Mussmann, 1990) attempted to include these potentially protective factors arising from the work environment in a questionnaire for the assessment of self-reported work conditions. Udris and coworkers expanded on Antonovsky's concept of salutogenesis (Antonovsky, 1979; Antonovsky 1987; Rimann & Udris, 1997a). In the development of the *Salutogenetic Subjective Work Analysis Questionnaire* (SALSA) they attempted to blend Antonovsky's concept with existing and well-established scales for the assessment of working conditions. For example, job demands are evaluated by items corresponding to items on Karasek's job content questionnaire (Rimann & Udris, 1997b). From a theoretical perspective, the SALSA promises a more comprehensive assessment of the perceived working conditions than most previously used scales. The SALSA has been validated in a large sample of white-collar and blue-collar employees (Rimann & Udris, 1997b).

However, there is a scarcity of data assessing whether the SALSA predicts self-reported and physiological health outcomes. To address this question, we conducted a large, multi-center, cross-sectional study in the airplane manufacturing industry to answer

the following four questions: a) can the psychometric properties of the SALSA be reproduced in a high-tech industrial setting? b) are SALSA scales related to self-reported health (acknowledging that cross-sectional surveys cannot prove causality)? c) are adverse scores on SALSA scales related to impaired biological measures operationalized by the allostatic load? d) do average unit SALSA scales discriminate between teams with similar production processes but externally objectified differences in social and organizational resources?

This dissertation is organized as follows: The first chapters provide an introduction to the theoretical framework of salutogenesis, the underlying measurement model and the methods of the present study. The next chapters provide the results on each of the aforementioned questions. The study is concluded by a detailed discussion of the four research foci and by the general outlook for future research linking the concept of salutogenesis in the work context to health outcomes.

2. Theoretical background

2.1 Defining health

In order to define the relationship between the *Salutogenetic Subjective Work Analysis Questionnaire* (SALSA) and health status, the term health has to be operationalized. The following chapter gives, firstly, an overview of the different health models in recent research and provides our health definition. In the second step, generally accepted indicators for subjective as well as physiological health status are defined.

At first glance the terms health and illness seems to be clearly defined. Health is a status of well-being and absence of symptoms and disorders. Whereas illness is described by disorders, pains and restrictions. One of the most popular and broad health definitions is from the World Health Organization (WHO): “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” (WHO, 1986).

With this definition the WHO sets a high standard. Yet this definition remains partially elusive, as such a state can hardly be achieved. In addition this definition is circular, health is explained with the term well-being, which in turn is not defined. On closer examination it appears that health can be defined in highly different ways. On the one hand, health may mean well-being and happiness, on the other hand, health means the absence of physical complaints. In addition, health can also be regarded as the organism's ability to adapt to complaints. Although health is a multidimensional concept, in the past most definitions were formed around the presence or absence of biological and psychological pathologies.

These perspectives comprise a pathogenetic view in which health is the absence of illness. The work of Antonovsky (1979; 1987) suggested a change in this paradigm. He introduced the salutogenesis concept, which defined health positively in terms of existing personal, social and organizational resources (Ducki, 2000; Udris, Kraft, Mussmann, & Rimann, 1992; Udris, Kraft, & Mussmann, 1991).

The last twenty years have witnessed a boom in health psychology, e.g., increasing numbers of empirical research studies and articles about health psychology (Schwarzer, 1997; Schwarzer, 2004). They provide a multitude of different health models and theories (Baumann & Perrez, 1998; Schwarzer, 1997), each with specific emphasis on complex interactions between different protective and risk factors.

Most recent health definitions emphasize a comprehensive view of health (Baumann & Perrez, 1998; Schwarzer, 1997). They consider psychological, social and biological dimensions as well as the process character of health. Almost all health definitions include the following facets (cf. Udris et al., 1992; Noack, 1987; Baumann & Perrez, 1998): Health as the absence of disease, handicap or infirmity; health as a positive psychological experience; health as the balance between an individual and his or her environment; health as the potential to attain personal goals and to be able to deal with environmental and social demands; health as a process of purposeful action and a process of successful coverage. Thus, health is seen as a complex, multidimensional, holistic, dynamical and process-oriented concept (Bullinger & Kirchberger, 1997; Schwarzer, 1997).

Because of the general health definition and the many different health models, no commonly accepted operationalization exists. Moreover, historical and biographical perspectives have to be integrated when trying to operationalize the term health (Udris, 1993). In addition, there are differences between subjective well-being and the objective/biological health status of a person (Bullinger & Kirchberger, 1998; Bullinger & Kirchberger, 1997; Udris et al., 1992).

Hence in this empirical study, health is assessed in two different ways: the biological health status via physiological indicators and the subjective well-being. These indicators will provide a complex and holistic impression of the current health status of an individual.

2.2. Operationalization in the present study

For the present study we selected the following domains of health or well-being as the operationalization of health: first, regarding psychosocial well-being, we employed self-reported measures using standardized questionnaires that describe relevant facets of health-related quality of life. Second, regarding biological well-being, we chose the comprehensive measure of allostatic load, which includes the major risk factors of cardiovascular disease, as well as the variables required to assess the existence of the metabolic syndrome.

2.2.1 Self-reported health

For a comprehensive characterization of subjective well-being we assessed the following indicators:

1. Health-related quality of life
2. Vital exhaustion
3. Depression
4. Sleep
5. Somatic complaints

Health-related quality of life

Within the last decades the health-related quality of life (HRQoL) has been accepted as a relevant outcome measure in the patient population (Bullinger, 2002; Bullinger & Kirchberger, 1997). Now, HRQoL is also becoming increasingly recognized as an important outcome measure in diverse healthy populations, like middle-aged or elderly people, employees in various work environments and groups with different socioeconomic backgrounds (Stansfeld, Bosma, Hemingway, & Marmot, 1998; Stansfeld, Head, Fuhrer, Wardle, & Cattell, 2003). In occupational research, many studies attest the warranty of the relationship between HRQoL and work environment, especially those investigating job

strain and the negative impact on biological health indices (Alfredsson, Karasek, & Theorell, 1982; Karasek et al., 1981; Karasek et al., 1988; Karasek, Theorell, Schwartz, Pieper, & Alfredsson, 1982; Kivimaki et al., 2002; Kuper, Singh-Manoux, Siegrist, & Marmot, 2002; Schlussel, Schnall, Zimbler, Warren, & Pickering, 1990; Schnall, Landsbergis, & Baker, 1994; Theorell, 1987) and, more recently, those on adverse health effects related to perceived effort-reward imbalance (Siegrist, 1996; Bosma et al., 1998; Stansfeld, Fuhrer, Shipley, & Marmot, 1999; Joksimovic, Starke, v d Knesebeck, & Siegrist, 2002). .

Vital exhaustion

The concept of vital exhaustion was introduced by Appels and coworkers. They interviewed a large number of patients with myocardial infarction about their mental and emotional state during the months preceding their coronary event. Appels frequently encountered a psychological state characterized by a combination of fatigue, lack of energy, loss of libido, feelings of hopelessness, increased irritability and feelings of demoralization (Appels & Mulder, 1988; Appels, 1990; Appels, 1999). The Dutch investigator described these mental precursors of myocardial infarction as vital exhaustion. Appels used the term “vital” to indicate that this is a more severe state of exhaustion, with close proximity to burnout. A study of 3,877 healthy men (Appels & Mulder, 1988) proved vital exhaustion to be an independent predictor of first myocardial infarction. Appels suggested that vital exhaustion is a mental state at which people arrive when their resources for adaption of stress are exhausted. Individuals at risk are those unable to solve problems like overwork, conflicts at work or private problems (Appels, Falger, & Schouten, 1993). Occupational research studies showed a relationship between working conditions and vital exhaustion. According to Falger (1992) working overtime is a predictor for vital exhaustion and myocardial infarction. In employees in the manufacturing industry high levels of exhaustion were related to excessive workload, to adverse physical working conditions and to qualification potential (Schnorpfeil et al., 2002). While the

epidemiological link between vital exhaustion and adverse health outcomes has been established, the biological mechanisms linking a state of exhaustion to more rapid progression of physical disease, such as atherosclerosis, remain to be elucidated. Some evidence points to a link via an activated inflammatory pathway under prolonged exposure to stress (e.g. severely adverse work conditions). The increase in inflammation may also sustain the state of exhaustion by concurrent cytokine release and the related induction of sickness behavior (Appels, 1999).

Depression

Depression is the most commonly diagnosed psychiatric illness. Briefly, depression is characterized by a profound sadness and hopelessness. This state may show a cyclic clinical course with undulating symptoms, as well as a chronic, stable adverse situation that impedes normal daily activities. Depression is classically diagnosed by a psychiatric clinical interview reviewing the DSM IV (Sass, 2003) criteria for diagnosis of depression. These DSM IV criteria are mirrored to some extent in the WHO definition of depression, which suggests the following primary criteria: feelings of fatigue, feelings of worthlessness, self-reproach or inappropriate guilt, diminished ability to think or concentrate, recurrent thoughts of death or suicide, poor appetite accompanied by weight loss or increased appetite accompanied by weight gain, insomnia or excessive sleep habits (hypersomnia), physical hyperactivity or inactivity, loss of interest or pleasure in usual activities, decrease in sexual drive (WHO, 1999). A significant prospective relationship between the occurrence of depression and the number of cardiovascular events has been demonstrated by numerous epidemiological studies (Hemingway & Marmot, 1999; Krantz & McCeney, 2002). Rozanski et al. (1999) showed that even minor depressive symptomatology is associated with an increased risk of cardiac events.

With his systematic review Hemingway (1999) revealed that individuals with depressive symptoms are more likely to develop coronary disease over time. A number of prognostic studies confirmed this result (Barefoot et al., 1996; Barefoot & Schroll, 1996; Everson et

al., 1996).

The impact of working conditions on depression has been analyzed in occupational stress research by several authors. Symptoms of depression have been associated with job strain (Karasek & Theorell, 1990), shift work (Kaneko et al., 2004) and low social support (Park, Wilson, & Lee, 2004). The Whitehall II study reported similar results (Stansfeld et al., 1999). Beyond that Strazdins et al. (2004) demonstrated that job insecurity, a macro-economic stressor becoming increasingly relevant in contemporary economies, shows synergistic associations with depressed mood.

One concept related to depression is vital exhaustion. At first glance depression and vital exhaustion seem to have a conceptual and empirical overlap. Raikkonen et al. (1996) reported a correlation of r = .73 between vital exhaustion and depression. Virtually all depressive patients have increased vital exhaustion scores, whereas half of the vitally exhausted patients have symptoms that suggest a depression or imply dysphoria (van Diest & Appels, 1991). Vital exhaustion is, as mentioned before, characterized by decreased vigor and increased fatigue (Kop, 1994). The characteristics of depression, e.g. depressed mood, lowered self-esteem and feelings of guilt, are not components of vital exhaustion. However, it has been shown recently that vital exhaustion and depression are more likely to represent distinct entities and to covary, rather than vital exhaustion being another synonym for depression (Kudielka, von Känel, Gander, & Fischer, 2004).

Sleep

Sleep problems (sleep disturbances, insomnia, poor sleep quality) are amongst the most common subjective complaints of patients in general medical practice (Cirignotta, Mondini, Zucconi, Lenzi, & Lugaresi, 1985; Hammond, 1964). The prevalence of sleep disturbances increases with age and is higher among women (Lugaresi, Zucconi, & Bixler, 1987; Reyner, Horne, & Reyner, 1995; Quera-Salva, Orluc, Goldenberg, & Guilleminault, 1991). Adverse health behavior, like smoking, coffee consumption and little

physical exercise, a high body mass index (BMI) and low socioeconomic status (SES) are identified as traditional risk factors of poor sleep quality (Bixler, Kales, Soldatos, Kales, & Healey, 1979; Cirignotta et al., 1985; Habte-Gabr et al., 1991; Janson et al., 1995; Karacan et al., 1976). In addition to these risk factors, recent research has focused on occupational characteristics, working conditions and aspects of the work environment (Ancoli-Israel & Roth, 1999; Urponen, Vuori, Hasan, & Partinen, 1988). Ribet and Derriennic (1999) found changes in objective working conditions (shift work, exposure to vibrations, work week > 48 hrs.) and psychosocial aspects to be associated with the incidence/disappearance of sleep complaints in the five-year follow-up. Other investigators showed that there are associations between poor working conditions, like high physical demands, shift work and low social support (Akerstedt, Fredlund, Gillberg, & Jansson, 2002; Estryn-Behar et al., 1990; Marquie & Foret, 1999a; Akerstedt et al., 2002b; Jacquinet-Salord, Lang, Fouriaud, Nicoulet, & Bingham, 1993; Kageyama et al., 1998), and sleep disturbances and fatigue at work. Some authors (Kageyama et al., 1998; Marquie & Foret, 1999a; Marquie, Foret, & Queinnec, 1999b) suggest that a person's job perception has an important effect on self-reported sleep complaints.

Non-specific somatic complaints

Besides specific symptoms or states, such as sleep problems or depression, individuals often suffer from a range of non-specific somatic complaints, such as muscle tenderness, aches or irritable bowels, that do not have an underlying medical condition. These non-specific somatic complaints are a common occurrence worldwide (Heinrich, 2004). Gureje et al. (1997) reported a prevalence of somatization approaching 20% in a study of 15 primary care centers in 14 countries. In this sense somatization represents a severe problem in medical care (Fink, 1992). For example, the level of life satisfaction experienced is lower if a person suffers from medically unexplained symptoms (Noyes, Holt, & Kathol, 1995). Yet, these unspecific complaints are a major cause of consultations in primary care practice (deGruy, Columbia, & Dickinson, 1987; Marquie et al., 1999b;

Smith, Monson, & Ray, 1986). Hence the presence or absence of multiple non-specific complaints may make a substantial difference to an individual's perception of health, regardless of the presence or absence of more specific illnesses or disorders. While conceptually one may expect considerable overlap with HRQoL concepts, employing a specific complaint list that focuses on non-characteristic and psychosomatic complaints considerably enhances the ability to differentiate amongst populations with impaired HRQoL. For this reason, we included the list of complaints (Zerrsen v., 1976) in our study.

2.2.2 Physiological measures

Allostasis and the allostatic load

The term allostasis was first introduced by Sterling and Eyer (1988). They define allostasis as the organism's ability to adapt its internal physiologic milieu to external demands. In other words, the body's ability to achieve stability through change. In contrast to the narrow borders of the homeostatic systems like blood oxygen, blood pH and body temperature, the allostatic systems have much broader boundaries. The allostatic systems enable the body to cope with different stressful situations (e.g. extremes of temperatures, danger and isolation) and respond to our physical status (e.g. awake or asleep) (B. S. McEwen, 1998a). The allostatic response to a stressful situation takes place in two steps: 1. Initiation of a complex adaptive pathway by turning on an allostatic response. 2. Shutting off the response when the stress subsides. The allostatic stress response primarily includes the activation of the autonomic nervous system and the hypothalamo-pituitary-adrenal (HPA) axis. Activation of these systems releases catecholamines from the adrenal medulla and nerves. Hypothalamic nuclei secrete a corticotropin-releasing hormone, which in turn elicits a release of corticotropin from the pituitary. Corticotropin enhances the production and excretion of cortisol from the adrenal cortex, the primary effector hormone of the endocrine stress response. The shutting off or inactivation of the allostatic systems returns the systems to a base-line level of cortisol and catecholamine secretion when adaption is no longer needed (McEwen, 2000b).

Disregulation of this system caused by excessive cycles of allostasis as a response to chronic stress for example, may cause wear and tear of the organism and support disease progression. Longitudinal studies have indeed shown an inverse relation between allostatic load scores (high allostatic burden) and physical or mental performance several years later (Karlamangla, Singer, McEwen, Rowe, & Seeman, 2002; McEwen, 1998a).

Figure 2.1 illustrates the concept of allostasis and the allostatic load. A person's perception of stress is influenced by individual differences in experience, genetics and behavior. Allostasis and adaption (physiologic and behavioral response) are initiated when the brain perceives an experience as stressful. As mentioned before, over time allostatic load can accumulate, and this overexposure can have adverse affects on various organ systems, leading to disease.

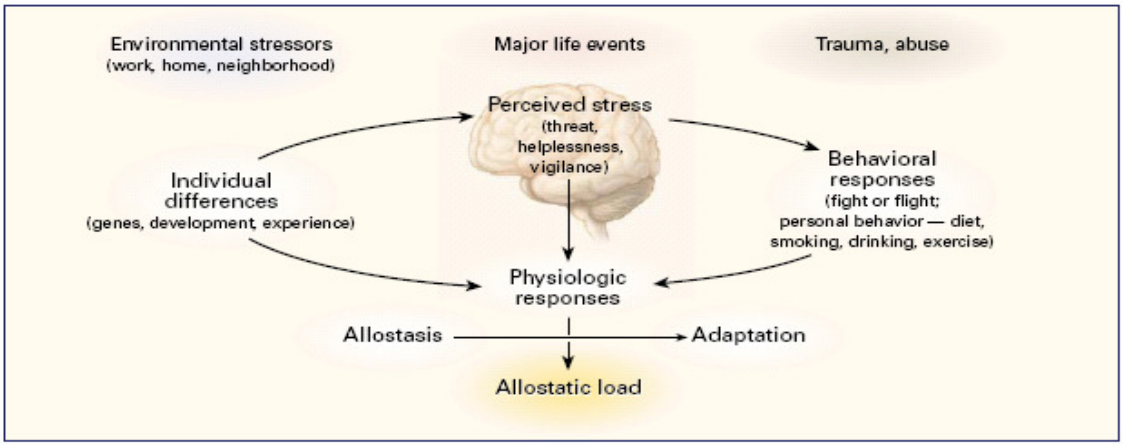

Figure 2.1. The Stress response and development of the allostatic load. (Mc Ewen1998a, p172)

With the term allostatic load Mc Ewen (2000b) characterized the inefficient management of the allostatic system. The most important aspect of the allostasis concept is the positive adaptive effect in the short run, but the probably damaging effect over longer periods of time if an individual encounters multiple or sustained stressors (McEwen, Hsieh, Mattheyses, & Rieder, 1998c; McEwen, 1998b). Mc Ewen (1998a) describes four situations which are associated with allostatic load: (1) frequent stress, (2) lack of adaption, (3) prolonged physiologic stress and (4) inadequate response. Figure

2.2 shows the normal allostatic response and four conditions that lead to allostatic load. These situations can be described as follows:

The first type, recurrent severe stress, is too much "stress" in the form of repeated, novel events that cause repeated elevations of stress mediators over long periods of time (McEwen & Seeman, 1999). A typical example of this would be war. In peacetime, though, the amount and frequency of economic hardship predicts the decline in physical and mental functioning as well as increased mortality (Lynch, Kaplan, & Shema, 1997).

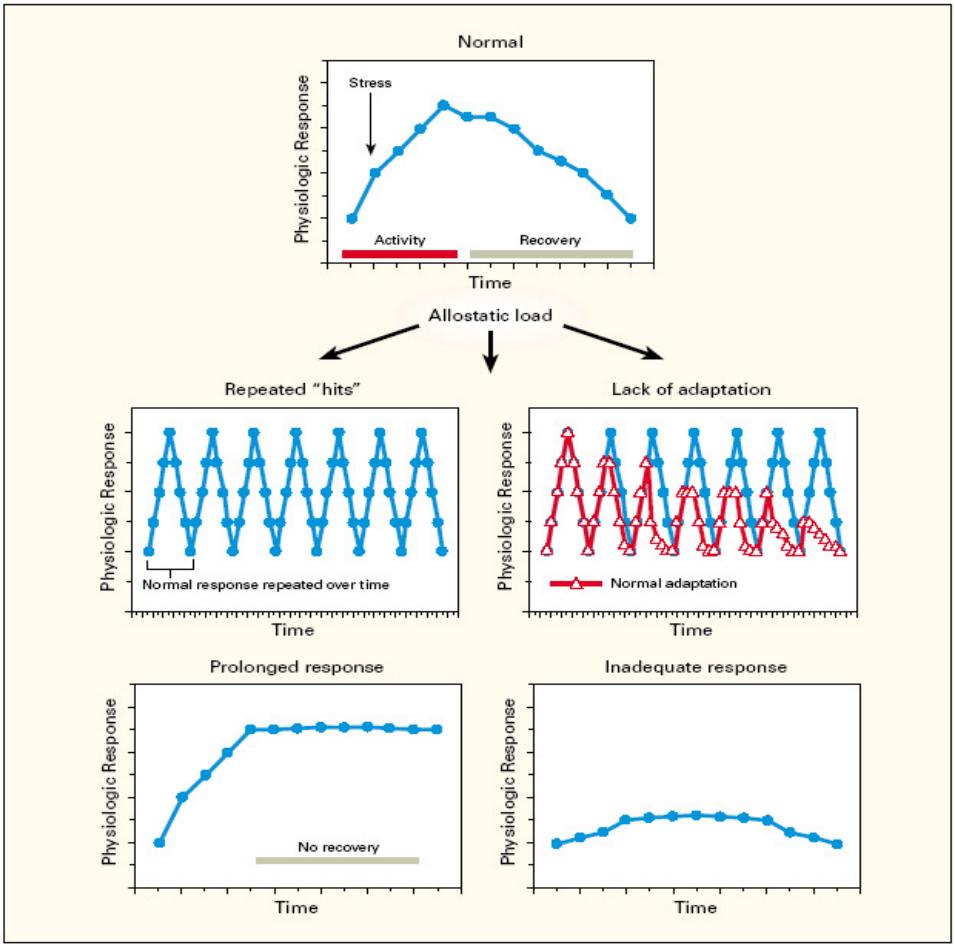

Figure 2.2. Different types of allostatic load (Mc Ewen1998a)

The second type of allostatic load, lack of adaption, involves a failure to habituate or adapt to the same stressor. This leads to over-exposure to stress mediators because of the failure of the body to dampen or eliminate the hormonal stress response to a repeated

event. One example of this is the finding that during repeated public-speaking challenges, most individuals adapted their cortisol response, but a significant minority of individuals failed to habituate and continued to show cortisol response (Kirschbaum et al., 1995).

The third type of response pattern, prolonged physiologic stress, involves the failure to shut off either the hormonal stress response or to display the normal trough of the diurnal cortisol pattern. One example of this is blood pressure elevation in work-related stress which is turned off only slowly in some individuals with a family history of hypertension (Gerin & Pickering, 1995). Another example of perturbing the normal diurnal rhythm is that of sleep deprivation, which leads to elevated evening cortisol and hyperglycemia within 5d (Van Cauter, Polonsky, & Scheen, 1997) and depressive illness leading to chronically elevated cortisol and loss of bone mineral mass (Michelson et al., 1996).

The fourth type of allostatic load depicted in Figure 3 involves an inadequate hormonal stress response, e.g. little or no increase in cortisol secretion, which allows other systems, such as the inflammatory cytokines, to become overactive. The Lewis rat is an example of an animal strain in which increased susceptibility to inflammatory and autoimmune disturbances is related to inadequate levels of cortisol (Sternberg, 1997; Sternberg, Hill, & Chrousos, 1996). Several studies (Crofford et al., 1994; Heim, Ehlert, Hanker, & Hellhammer, 1998; Poteliakhoff, 1981; Ur, White, & Grossman, 1992) showed that the human counterpart with HPA hyporesponsiveness includes adults with fibromyalgia and chronic fatique syndrome. Even in post-traumatic stress disorder, basal HPA activity is still low, although reactivity to stress may not be indifferent (Yehuda, Giller, Southwick, Lowy, & Mason, 1991; Yehuda, Teicher, Trestman, Levengood, & Siever, 1996).

2.3 Salutogenesis

The following chapter presents a brief introduction to the concept of salutogenesis, which provided the conceptual framework for the developers of the SALSA questionnaire. The medical sociologist, Aaron Antonovsky, suggested the concept of salutogenesis to refer to a new approach to health promotion and needs assessment. Salutogenesis examines the achievement of well-being by looking at successful coping strategies and health. Aaron Antonovsky describes the concept of salutogenesis in his two main works *Health, stress and coping: New perspective on mental and physical well-being* (1979) and *Unraveling the mystery of health. How people manage stress and stay well* (1987).

To emphasize the contrast to the pathogenetic model of the biomedical approach (Faltermaier, 1994), Antonovsky coined the neologism salutogenesis. The biomedical approach defines disease as the deviation from health. Antonovsky criticizes this kind of definition as inappropriate (Antonovsky, 1979). Instead of the classical dichotomy health vs. disease, Antonovsky posits the continuum “health ease/dis-ease”, in which the WHO definition (cf. section 2.1) may represent one end of the spectrum and impending death the other. This continuum classifies people as more or less healthy or diseased. According to Antonovsky, during life these virtual poles of total well-being/health or absolute disease can only be approximated.

2.3.1 Sense of coherence

The central questions of the salutogenetic model are: Why do people stay healthy? How do individuals manage to recover from disease? What is specific to people who stay healthy despite high levels of stress (Antonovsky, 1979; Antonovsky, 1987)? According to Antonovsky, these questions cannot be appropriately answered without considering an individual's personal background. Hence, it is important to consider the social and historical perspective of a person, since people do not exist in a societal vacuum (Miller, 1978; Noack, 1987). Antonovsky introduces the “sense of coherence” (SOC) as the key source of salutogenetic ability referring to an individual's aptitude and experience with

regard to coping. He defines the SOC

> "...as 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 environment are predictable and that there is a high probability that things will work out as well as can reasonably be expected." (Antonovsky, 1979, p. 10)

In this sense, dynamic means reciprocity between SOC and experience of life. The SOC aims to describe a personality characteristic that captures to what extent people use their available resources. The SOC includes three intertwined and distinguishable components. (1) The first is *comprehensibility*, referring to the belief that the world is orderable. (2) To cope well, however, one also needs to believe that the resources necessary are at one's disposal. This component is called manageability. (3) Finally and crucially, the motivational component of *meaningfulness*, the wish to cope, provides the motive power. The higher the SOC, the merrier one's position on the health ease/dis-ease continuum.

According to Antonovsky the SOC develops itself over life-span finding its peak-level at the age of 30, and is fairly stable. Current longitudinal studies showed – in contrast to Antonovskys stability assumption – the convertibility and persuasibility of the SOC over life-time. Bengel (1998, p. 115) and Udris (2000, p. 139) showed that the SOC is positively affected by increased supervisor's social support or decision latitude. Those employees who experienced a worsening in the organizational climate and in the supervisor-employee relationship showed lower SOC scores than the year before. These studies support the assumption that the SOC is dynamic and process-related in character (Udris & Rimann, 2000, p. 140).

2.3.2 Antonovsky's theoretical concept linking SOC to health

Which processes in the SOC influence physical health? Antonovsky expected different modes of functioning: The SOC directly influences different systems in the organism (e.g. the central nervous system, immune system and hormone system). Cognitions are supported by the SOC to evaluate whether a situation is dangerous, safe or welcome. There is a direct link between the SOC and the eliciting of complex reactions from the organism. The SOC acts as a filter in the processing of information. The SOC also mobilizes existing resources. The effective assignment of the resources to the external threat or challenge leads directly to stress reduction. This indirectly affects psychological coping systems.

According to Antonovsky, individuals with a high SOC have the ability to opt for beneficial health behavior (e.g. preventive medical checkups, healthy nutrition style). By supporting an individual in the choice of beneficial behavior, the SOC has an indirect influence on health status.

2.3.3 Research on the relationship between SOC and health

Antonovsky's model of salutogenesis is used by many investigators as a landmark theory of health (cf. Faltermaier, 1994; Dlugosch, 1994). With this model, Antonovsky created a new perspective for health research. Salutogenesis mandates an interdisciplinary research approach (e.g. medicine, psychology and sociology). Despite these advances, it should be noted that Antonovsky painstakingly avoided providing clear cut definitions for the terms health and disease. Moreover, his theoretical work yields only a few practical hints as to how health should be operationalized in studies concerning the SOC (Lorenz, 2004). The complexity of his model virtually inhibits the evaluation of the entire model within health research frameworks. Predominantly, the relationship between SOC and psychological and physical health has been assessed. The results contradict Antonovsky's assumption that there is a pure association between SOC and physical health, and that the SOC is predominantly associated with psychological health.

Chamberlain et al. (1992) reported a high SOC in connection with life satisfaction and well-being. The few existing studies referring to a relationship between the SOC and physical health found little association (Callahan & Pincus, 1995; Gebert, Broda, & Lauterbach, 1997).

This lack of research on the SOC with respect to physical health may stem from two causes: firstly, none of the major prospective cohort studies on work and health (e.g. Whitehall II, GAZEL) have included the SOC questionnaire. Secondly, it is conceivable that differences in SOC may first affect regulatory systems, such as the vegetative nervous system and the endocrine adaptation to environmental stressors, before manifesting in altered health endpoints. It is, however, noteworthy that individuals with higher self-efficacy - a construct showing some overlap with SOC - have lower LDL-cholesterol levels. LDL-cholesterol is a major contributor to the risk of adverse cardiovascular outcomes.

2.4 The SALSA questionnaire

2.4.1 The SALUTE study

The SALSA questionnaire was developed by Rimann and Udris (1993) within the research project “personal and organizational resources of salutogenesis” (Udris et al., 1990; Mussmann et al., 1993; Rimann & Udris, 1993). This research project was named “SALUTE”, as an abbreviation for salutogenesis and as the Italian word for health.

SALUTE analyzed topics regarding health as well as industrial and organizational psychology. Udris summarized the different aspects in one question: “Why are healthy people healthy?” (1990, p. 1). Following Antonovsky's salutogenesis, the question can be rephrased (cf. section 2.1): Why and how do people keep well and fit despite strain?

According to the salutogenetic concept, health was understood as a process of activation, maintenance and recreation of a dynamic balance: A balance within the person and a balance between the person and his or her environment. Rimann (1997b) argues

that the maintenance of this balance is dependent on the disposability and the use of personal, organizational, social and situational resources regarding health.

The term personal resources integrates cognitive processes and behavior patterns (Rimann & Udris, 1997b). A cognitive process like self-efficacy allows a person to perceive a situation or a job requirement as sensible and influenceable. A coping style is a learned and habitualized as a behavior pattern.

Organizational resources are, for example, activity conditions, institutional facilities, task variety, action and decision latitude, opportunities for learning and development, opportunities for participation, opportunities for communication and cooperation (Rimann & Udris, 1997a).

The term social resources is characterized by a cooperative-participative leadership style, social support by the supervisor and the co-workers, as well as social support in the private sector and a positive social working atmosphere (Udris & Rimann, 1999).

2.4.2 Development of the SALSA

The SALSA was generated in a deductive way. Due to the theoretical concept of health, Rimann and Udris (1993) examined hampering working conditions and working conditions which are recognized as social and organizational health resources. The development of the SALSA was, like the SALUTE project, structured into three sections. (1) In the first step, 30 healthy persons were interviewed concerning psychosocial health and health resources. (2) The second step was the development of a questionnaire. The authors combined the analysis of the interviews with preexisting instruments of occupational psychology in line with the theoretical distinction of the study (Rimann & Udris, 1993, p. 22) (Table 2.1). The new questionnaire was tested in an employee sample (300 people). (3) In the third step the questionnaire was deployed in different companies in the service sector.

Table 2.1: Questionnaires and scales used for the development of the SALSA

Questionnaire and Scales	Authors
Inventory for stress-related task analysis (ISTA)	(Semmer, 1984)
Subjective activity analysis (SAA)	(Udris & Alioth, 1980)
Job Content Questionnaire (JCQ)	(R. Karasek et al., 1998)
Questionnaire for assessing intensity of work and decision latitude (FIS)	(Richter, 1984)
Scales of the project "Job Demands and Worker Health"	(Caplan et al., 1975; Caplan, Cobb, French, Harrison, & Pinneau, 1982)
Scales for assessing social stressors at the work place	(Frese & Zapf, 1987)
Questionnaire for assessing the working atmosphere	(Rosenstiel, 1985)
Work environment scale (WES)	(Moos & Insel, 1974)
Characteristics of the organizational atmosphere	(Neuberger, 1990)
Characteristics of work complexity	(Kohn & Schooler, 1982)

For an in-depth appreciation of this approach, it is necessary to classify the SALSA questionnaire. Occupational psychology differentiates between objective job analysis and personal psychological job analysis (Ulich, 2001). The SALSA assesses a person's perception, opinion, attitude and estimation of their workplace, their job and their working conditions. According to this, the SALSA can be classified as an instrument of personal psychological job analysis.

2.4.3 Reliability

Within the research project SALUTE participants filled out a "questionnaire for personal situation in job and company". The questionnaire contained the following parts: A: personal data, B: job and company, D: personal attitude, E: health and disease. (part C was missed out). Part B is identical to the SALSA questionnaire.

In summary the SALSA includes 61 items, separated into 17 scales (Table 2.2). Of the 61 items, 51 were rated on a five-grade Likert scale ranging from "hardly ever" to "nearly always". Ten items concerning hampering physical working conditions were rated on a six-grade Likert scale ranging from "does not appear" to "very highly". Out of the 61 items the authors generated 17 scales in a deductive way. These scales were examined with

Cronbach's α for internal consistency. In the second step the scales were grouped into the categories: task characteristics, task load, organizational resources and social resources. These categories underwent factorial validation with a principal component analysis. In the next step the differential validity was verified. The variety of groups concerning the scale mean and the homogeneity of variance were examined.

Table 2.2: SALSA scales and reliability

Categories and scales	Number of Items	Cronbach's alpha
Task characteristics		
Completeness of working tasks	3	.75
Responsibility and required qualification	4	.71
Task load		
Qualitative and quantitative overload	6	.78
Qualitative underload	3	.62
Hampering social climate	3	.60
Hampering supervisor behavior	3	.78
Exposure due to external activity/conditions		
Hampering physical working conditions	10	-
Organizational resources		
Task variety	3	.76
Qualification potential	3	.85
Decision latitude	3	.50
Extent of participation	3	.62
Personal scope for workplace design	1	*
Scope for personal and private things at work	1	*
Social resources at work		
Positive social climate	4	.72
Employee-centered supervisor behavior	4	.80
Social support by supervisor	3	.90
Social support by coworkers	3	.87

Note. * Single-Item Scales. N = 1655.

2.4.4 Results from the SALUTE study and suggestions for further research

The authors (Rimann & Udris, 1997b) examined the SALSA with a total of N = 1,655 (955 employees from 14 service-sector companies and with 700 employees in the production sector).

> "In summary it can be said that SALSA is a useful, valid and reliable instrument both for the whole sample and for specific gender, age or professional groups. Results show that the evaluation of problems and resources at work are mainly dependent on the kind of job and the working conditions. The influence of gender and age for those questioned is in contrast small. With regard to capturing personal resources and health indicators ... gender- and age-specific bias is hardly found." (Rimann & Udris, 1997b, p. 285)

3. Objectives and hypotheses

We shall expand on earlier work done by our group, in a more restricted sample, with respect to sample size and extent of in-depth psychosocial as well as biomedical assessments. The SALSA questionnaire is a widely used instrument for personal psychological job analysis. The primary aim of this dissertation project is to analyze the relationship between the SALSA questionnaire and health. To meet the challenge of operationalizing health, we differentiated between self-reported health and externally measured indicators of physiological functioning. The operationalization of subjective well-being includes questionnaires for health-related quality of life, vital exhaustion, depression, sleep and somatic complaints. The biological parameters are summarized in the allostatic load score and comprise the assessment of a variety of biological systems from blood pressure regulation thru inflammation and lipid metabolism to hemostasis.

The present study has the following objectives:

1. Are the psychometric properties of the slightly revised SALSA instrument in our study sample comparable to the psychometric properties of the SALSA reported by Rimann and Udris (1993)?

   To assess this objective, we compared the Cronbachs' alpha in the SALUTE study with Cronbach's alpha in our Work and Health-study sample. In a next step we calculated the means and standard deviations. Furthermore, as a preparation for the following objectives we grouped the study sample into quartiles along SALSA scales.

2. Are the SALSA scales related to self-reported health?

   To assess this relation, we tested whether the SALSA scales correlate with health-related quality of life, vital exhaustion, depression, sleep quality and somatic complaints after controlling for age and sex. The large sample size implies that a clinically irrelevant correlation may become statistically significant. To elucidate the

effect size, we determined the differences for each of the six self-reported health measures (dependent variable) between the lowest and the highest quartiles in each SALSA scale (predictor variable). To acknowledge the correlation amongst SALSA scales, we finally calculated multivariate regression models stratified for sex.

3. Are the SALSA scales related to physiological measures of health?

   Following a recent methodological proposal by the MacArthur study group (Seeman, McEwen, Rowe, & Singer, 2001), we tested the hypothesis of a significant canonical correlation between the allostatic load measures and the SALSA scales. From our previous work we expected only a small bivariate correlation (e.g. between plasma levels of C-reactive protein and supportive supervisor behavior). Using the simple allostatic load summary score as a dependent variable in this predominantly healthy population (as in our previous study) unnecessarily reduces the existing variance in outcome measures. Because describing physiological health within the allostatic load framework implies a multivariate outcome measure, simple regression analysis is not appropriate and multivariate methods must be employed. We considered canonical correlation to be the more preferable statistical technique to structural equation modeling, by reason of of the uncertainties as to the factorial structure of the biomedical measurement model.

4. Are the SALSA scales able to discriminate between two teams with almost similar tasks and production processes, but substantial differences in social and organizational resources?

   For this purpose we tested the hypothesis that there are significant differences in the SALSA scale means for different teams. From external information, we knew a priori that one of the teams had undergone specific restructuring with the aim of enhancing participation, supportive leadership style and non-monetary rewards. This knowledge enabled specific sub-hypotheses about the expected direction of differences.

4. Methods

4.1 Study design

4.1.1 Type of study

The present thesis reports on data which were obtained at entry of a longitudinal designed research project entitled “Work and Health”. For this reason all analyses are based on cross-sectional data.

4.1.2 Participants

Study participants were recruited from two airplane manufacturing plants in Southern Germany belonging to the European Aeronautic Defense and Space Company (EADS). For the first plant (Augsburg), the recruitment procedure followed a stratified random sampling strategy where approximately half of the 2,000 employees were invited to participate. At the second plant (Manching), participation was offered to all employees. A total of 1,794 subjects (plant Augsburg: n = 860, response rate = 41%; plant Manching: n = 934, response rate = 57%) volunteered to complete self-report health questionnaires providing medical and psychosocial data. Of these, 1,437 decided to take part in further medical examinations. All subjects participated voluntarily and gave written informed consent. Temporary workers were excluded. Because of the employment structure of the company, the resulting sample consisted predominantly of men (86.60 %) between 15 and 64 years of age (mean 39,7 years +- 11.3). The majority of the sample was qualified skilled workers (73.80 %), 12 % were foremen, 6,50 % trainees, about 3.40 % semi-skilled workers, and about 4 % supervisors or managers. Based on the characteristics of the study sample (preponderance of men, age range), the present population is an average at-risk population for the male German industrial context. Further characteristics of the sample are given in Table 4.1.

Table 4.1. Characteristics of the study population

Characteristics	N	(SD)	Percent
Number of participants	1794		
Sex (men/women)	1554/240		86.6/13.4
Mean age in years	39.71	(11.32)	
Mean duration of employment in years	15.87	(10.38)	
Position			
Supervisor or manager	78		4.0
Foreman	214		12.0
Skilled workers	1314		73.8
Semi-skilled workers	60		3.4
Trainees	115		6.5
Educational level			
Primary school	22		1.2
Lower secondary school	932		52.0
Intermediate secondary school	531		29.6
Vocational College/Higher secondary level	248		13.8
Family status			
Single	614		35.3
Married	1033		59.4
Divorced	88		5.1
Widowed	4		0.2

4.1.3 Survey administration

The Ethic Committee of the Swiss Federal Institute of Technology, Zurich, Switzerland and the EADS board, formally approved the study protocol. To minimize biases arising from seasonal external factors, all questionnaire data were obtained in short periods: At the Augsburg plant within a two-week period in the summer; at the Manching plant within a five-week period in November. Due to the only marginal differences between the two plants the analysis seems to be independent of the season. Following a standardized oral introduction, assessment of the questionnaire data took place in groups of 10 to 50 people during the regular working time in rooms separate from the working place. Beyond paid working time, a personal feedback and the possibility to request personal health counseling by a study physician, no other incentive was offered.

4.1.4 Study protocol

All employees were subject to the three-part study protocol. (1) The survey administration was the first step. (2) The second step, a salivary cortisol examination, was offered to all employees, who participated in step one. Step two included an individual anonymous feedback about their circadian salivary cortisol secretion and a brief report.

(3) In the third step employees who successfully completed the salivary cortisol collection proceeded to the medical examination. Anthropometric measures and blood pressure were determined. Participants were then scheduled for collection of a blood sample and a 20-hour heart-rate recording. A written feedback was provided to all participants.

4.1.5 Statistical measures

For data analysis, we used miscellaneous statistical procedures depending on the quality of data and the objectives. The following section gives a short summary of the statistical techniques used, in the order of the objectives.

Descriptive parameters and reliability

The internal consistency of the SALSA scales was assessed by calculating the reliability coefficient Cronbach's alpha. Mean and standard deviation were used as descriptive parameters for the SALSA scales and the six subjective health outcomes. For comparison of the extreme groups (1^{st} and 4^{th} quartiles) we divided the population into four subgroups according to their rank on the SALSA scales.

SALSA and self-reported health

To analyze the relationship between each SALSA scale and each subjective health parameter, we first calculated a partial correlation (controlling for age and sex). A partial correlation is a correlation between two variables when the effects of one or more related variables (in our case age and sex) are removed.

In the second step, we performed a univariate analysis of covariance for each SALSA scale as a factor and each of the six subjective health parameters as dependent variables controlled for the effect of age (covariate). Each SALSA scale was divided into the first and fourth quartile according to the aforementioned procedure. Due to the small number of women in the quartiles we limited this analysis to the male sex only.

On the basis of these results, we employed multivariate regression analysis in the third step to determine how SALSA scales, when considered together, explain variance in each of the six subjective health parameters.

SALSA and alterations in physiological measures (allostatic load)

To analyze the relationship between the SALSA scales and the 15 allostatic load parameters we performed a canonical correlation analysis. Canonical correlation analyses are typically used to examine potential relations between two multivariate data sets. For example, an environmental survey might result in observations on both physical and biological attributes. One obvious question is: how do the physical attributes associate with the biological measures? In canonical correlation analyses, linear combinations of the attributes (canonical variables) are created for each data set so that the correlations between the canonical variables of the two data sets are maximized. These combinations are analogous to the eigenvectors of principal component analysis (PCA). The correlations between or among the new canonical variables and the original variables are then interpreted. While this type of analysis does not imply causality, it can provide insight into potential relationships within the complete data set (Bortz, 2004).

The ability of the SALSA to discriminate teams

For this objective, we used the descriptive parameters (mean, SD) of two a priori selected teams.

4.2 Measurement

4.2.1 SALSA short form

We used the SALSA questionnaire in our study Work and Health (cf. 4.1). In the preparation for the study all authorities of the company including the workers council reviewed the study questionnaires. The management and the workers council made their consent to the study contingent on removing nine items of the original SALSA questionnaire (cf Table 1 in the appendix). These nine items were related to the attitude towards personal tolerance (items B10 and B24), to sufficient time to complete work (item B04), and the attitude towards social support by coworkers and supervisors (Items D40, D41, D44, D45; D48 and D49). Table 1 in the appendix gives a review of the original SALSA scales and items, the excluded items, Cronbach's alpha reported by Rimann (1997b) and Cronbach's alpha for our sample.

4.2.2 Self-reported health

Health-related quality of life

Health-related quality of life was measured by the German short form of the SF-36 health survey. The SF-36 as well as its short form SF-12 has proved to be a psychometrically robust and practicable instrument for use in outcome evaluation of subjective health functioning in different countries and a wide range of populations (Ware, Snow, Kosinski, & Gandek, 1993; Ware, Kosinski, & Keller, 1996; Bullinger, 1995; Bullinger & Kirchberger, 1998). The 12-item SF-12 is a self-report form of subjective health which assesses the following dimensions: physical functioning, role limitation due to physical/emotional health problems, freedom from bodily pain, general health perception, vitality, social functioning and mental health. From these eight dimensions a physical and a mental summary health score can be calculated following the scoring algorithm outlined in the manual, rendering scores with a mean of 50±10 (SD). Both

summary scores show a normal distribution. The lower the resulting summary score, the lower self-reported subjective health functioning.

Vital exhaustion

Vital exhaustion was assessed with the nine-item short form of the Maastricht Vital Exhaustion Questionnaire (Appels, Hoppener, & Mulder, 1987; Appels & Mulder, 1989). The single items survey undue fatigue, troubles falling asleep, waking up at night, general malaise, apathy, irritability, loss of energy, demoralization and waking up unrefreshed. For the purpose of this study the nine items were translated into German in cooperation with the authors of the original questionnaire (Schnorpfeil et al., 2002). The possible answers are “no”, scored as 0; “don’t know”, scored as 1 and “yes”, scored as 2. Due to that the sum score ranks between 0 and 18. According to Appels, values between 3 and 10 describe moderate vital exhaustion, values greater than 11 characterize severe vital exhaustion. The vital exhaustion distribution is skewed. Median 7.44, range 0 – 18, 1st quartile 3.75, 3rd quartile 11.

Depression

Depression mood was measured by the depression scale of the German version of the Hospital Anxiety and Depression Scale (HADS) (Herrmann, Buss, & Snaith, 1995). The HADS is a 14-item, self-report screening tool originally developed to measure the severity of anxious and depressed mood (Zigmond & Snaith, 1983). The depression scale (HADS-D) consists of seven items. Each item was rated on a four-grade Likert scale ranging from 0 = “not at all” to 3 = “severe”. The sum score ranks between 0 and 21. According to Herrmann (1995), values greater than 11 indicate possible depression. Again the distribution of the HADS depression scores is skewed (median 4, range 0-17 of a possible range of 0-21, 1st quartile = 2, 3rd quartile = 7, a score of 11 or higher is indicative of clinical depression).

Sleep quality

Sleep quality was assessed by the Jenkins sleep-quality index (Jenkins, Stanton, Niemcryk, & Rose, 1988). This scale contains four items focusing on the most common sleep problems ("difficulties falling asleep", "waking up during night", "waking up having difficulties falling asleep again", "waking up tired"). Items are rated on a six-grade Likert scale, indicating how often the stated condition occurs during an average month ("not at all" = 0, "up to 3 nights a month" = 1, "4-7 nights a month" = 2, "8-14 nights a month" = 3, "15-21 nights a month" = 4, "22-31 nights a month" = 5). The score ranks between 0 and 20. The sleep distribution is skewed. (median 4, range 0-20, 1st quartile = 2, 3rd quartile = 8).

List of complaints

To investigate somatic symptoms we used the list of complaints (Zerrsen v., 1976). This inventory consists of 24 items, which ask about general somatic complaints (e.g. pain in neck or shoulder, sleeplessness, shortness of breath) The intensity of the complaints was assessed on a four-grade Likert scale ("not at all" = 0; "not much" = 1; "moderate" = 2; "severe" = 3). Due to that the sum score ranks between 0 and 72. According to von Zerssen (Zerrsen v., 1976) a score between 22 and 27 is classified as slightly abnormal, a score higher than 27 is considered to be definitely abnormal. The distribution of the list of complaints is skewed (median 17, range 0-61, 1st quartile 9,39; 3rd quartile 26,09).

Demographics and socioeconomic status (SES)

The assessment included questions asking about demographic factors (age, sex), SES (education, job position, marital status), shift work (no shift work, 2 or 3/4-shift system) and health behavior life-style factors (smoking, physical activity, alcohol consumption, coffee consumption). Respective questions were derived from the Nurses Health Study (Michael,et al.,1999) and from the MONICA study (Jönsson et al., 1999).

4.2.3 Physiological Health

4.2.3.1 Allostatic load, variables and score

The classical allostatic load score consists of the following 10 components which reflect parameters of regulatory systems whose activity contribute importantly to wear and tear of the body (Seeman, Singer, Rowe, Horwitz, & McEwen, 1997b): Systolic and diastolic blood pressure, waist-to-hip ratio, serum high density lipoprotein (HDL) and total cholesterol levels, blood plasma levels of total glycosyslated hemoglobin (HbA1c), serum dehydroepiandrosterone sulfate (DHEA-S), overnight urinary excretion of cortisol as well as norepinephrine and epinephrine.

In addition to these parameters, we followed Seeman's suggestion (Seeman, McEwen, Rowe, & Singer, 2001) to extend the allostatic load panel. We included five indicators of inflammatory activity and hemostatic function. Our revised version of the allostatic load contains the 10 above-mentioned parameters and five measures classically used to determine the future risk of cardiovascular events and to assess the metabolic syndrome. The metabolic syndrome is a pre-clinical derangement of a variety of metabolic systems. There is a high prevalence of this syndrome in Western societies and it is an important risk factor both for cardiovascular disease and diabetes type II.

We assessed inflammatory activity by determining plasma levels of C-reactive protein (CRP) using a high density assay. Hak et al. (2001) and Blake et al. (1999) showed that CRP is an independent risk factor for cardiovascular disease.

As an additional measurement to the waist-to-hip ratio, we employed the body mass index to estimate chronic excess of nutritional index (Hecker, Kris-Etherton, Zhao, Coval, & St Jeor, 1999).

Hemostatic functioning was determined from plasma levels of D-Dimer and fibrinogen (Danesh, Whincup, & Walker, 2003).

As an indicator of subclinical renal impairment and as a risk factor for mortality and cardiovascular diseases, we employed micro-albuminuria (Kannel, Stampfer, Castelli, & Verter, 1984). Table 4.2 displays the 15 allostatic load parameters.

Table 4.2. Measures of allostatic load

Physical examination	
Systolic and diastolic blood pressure	Indexes of cardiovascular activity
Waist-hip ratio and body mass index	Indexes for more chronic levels of metabolism and adipose tissue deposition, thought to be influenced by increasing glucocorticoid activity
Blood parameters	
Serum HDL, LDL and total cholesterol levels	Indexes of long-term atherosclerotic risk
Blood plasma levels of total glycosyslated hemoglobin (HbA1c), and fastening glucose	An integrated measure of glucose metabolism during a period of several days
High sensitivity C-reactive Protein (CRP)	Inflammatory marker, risk factor for cardiovascular disease
D-dimer, Fibrinogen	Indexes or hemostatic functioning
DHEA-S	A functional HPA axis antagonist
Urinary excretion	
12-hour urinary cortisol excretion	An integrated measure of 12-hour HPA axis activity
12-hour urinary norepinephrine and epinephrine excretion levels	Integrated indexes of 12-hour sympathetic nervous system activity
Urinary albumine	Subclinical nephropathy

Allostatic load was composed by summing up the number of parameters for which the subject fell into the highest risk quartile. For HDL and DHEA-S the lowest quartiles correspond to the high risk quartiles. For all other parameters the top quartile is equivalent to the highest risk.

4.2.3.2 Measurement of the parameters

Physical examination

- Systolic and diastolic blood pressure

Systolic and diastolic blood pressure were calculated as the average of two blood pressure readings after a fifteen-minute resting period sitting, using a blood pressuure cuff.

- Waist-hip ratio

Waist-hip ratio was calculated based on waist circumference (measured at the narrowest point between the ribs and iliac crest) and hip circumference (measured at the maximal part of the buttocks).

- Body mass index

Body mass index was obtained by using the following metric BMI formula. BMI = (Weight in Kilograms /Height in centimeters^2) x 10.

Blood parameters

All blood samples were obtained two hours after awakening in order to minimize circadian effects. Blood samples were processed within six hours of collection in a commercial laboratory (Synlab, Augsburg, Germany) using standard laboratory procedures. Sensitivity and coefficients of interassay and intraassay variance are displayed in Table 4.2.

- Serum HDL and total cholesterol levels

HDL and cholesterol were determined using proprietary assays on the Olympus AU2700 analyzer (Olympus, Hamburg, Germany).

- HbA1c

HbA1c was measured using the HPLC method on a Biorad analyzer (Biorad, München, Germany).

- CRP

The high-sensitivity assay for CRP was purchased from Dade-Behring (Dade-Behring, Schwalbach, Germany) for determination on a standard Nephelometer.

- D-dimer and fibrinogen

D-Dimer was measured using turbidimetric assays (Dade-Behring, Schwalbach, Germany), Fibrinogen was measured using the Clauss method (assay purchased from Dade-Behring, Schwalbach, Germany) on the BCS analyzer (Dade-Behring, Schwalbach, Germany).

- DHEA-S

DHEA-S was determined using a turbidimetric assay on the MODULAR 2400 analyzer (Roche/Hitachi, Basel, Switzerland).

Urinary excretion

For the urine collection we followed the method employed in the normative aging study (T. Seeman et al., 1997a). Subjects were asked to collect overnight urine from 9 pm on the evening before the blood samples were drawn, up to and including the first collection after waking the next morning. Samples were processed by a commercial laboratory (Synlab, Augsburg, Germany) using standard automated analyzers. Sensitivity and coefficients of interassay and intraassay variance are displayed in Table 4.3.

- Urinary cortisol excretion

Urinary cortisol was measured using an HPLC kit purchased from Pharmacia, Freiburg, Germany.

- Urinary norepinephrine and epinephrine excretion levels

Catecholamines were measured using an HPLC kit purchased from Pharmacia, Freiburg, Germany.

- Urinary albumine

The assay for urinary albumine was purchased from Dade-Behring (Dade-Behring, Schwalbach, Germany) for determination on a standard Nephelometer.

Table 4.3. Specifications for sensitivity and variance of laboratory analysis

	Sensitivity	Coefficient of Intraassay variance*	Coefficient of Interassay variance*
	Blood parameters		
HDL	3.5 mg/dl	2.8	2.4
Cholesterol	3.5 mg/dl	1.3	2.1
HbA1c	4.00%	1.3	1.9
CRP	0.2 mg/l	5.9	4.1
D-dimer	50 µg/l	1.7	4.6
Fibrinogen	80 mg/dl	1.2	2.6
DHEA-S	0.1µg/ml	1.5	4.2
	Urinary excretion		
Cortisol	5 µg/l	1.2	9.0
Epinephrine	5 µg/l	3.7	5.7
Norepinephrine	1.5 µg/l	2.4	5.0
Albumine	2.3 mg/l	2.2	5.6

Note. * data in %.

5. Results

5.1 Descriptive statistics

The study comprised N = 1,437 individuals, who took part in the biomedical examination. From these, 155 participants were excluded from the analysis either due to extreme physiological values suggestive of manifest disease or missing data in relevant parts of the questionnaire. Reasons for exclusion were: past myocardial infarction (n = 3), systolic blood pressure exceeding 200 mm Hg (n = 1), diastolic blood pressure above 120 mm Hg (n = 3), body mass index above 45 (n = 2), active inflammation as evidenced by a plasma level of C-reactive protein above 19 mg/l (n = 14), cholesterol plasma levels above 400 mg/dl (n = 1), LDL above 300 mg/dl (n = 1), HDL above 120 mg/dl (n = 1), manifest diabetes with glycosylated hemoglobin above 8% (n = 1), fibrinogen above 600 mg/dl (n = 6), missing age (n = 12), missing information on health behavior (n = 108), incomplete details on scales assessing work characteristics (n = 15). Some individuals fulfilled more than one exclusion criterion. Thus, the following analytical steps are based on a final study population of 1,282 participants.

1. Reliability analysis with coefficient Cronbach's alpha
2. Descriptive parameters (mean and standard deviation) of the SALSA scales
3. First and fourth quartiles of the SALSA scales
4. Description of the parameters (mean and standard deviation) of the six subjective health outcomes.

5.1.1 Reliability analysis with coefficient Cronbach's alpha

Internal consistency of the SALSA scales was assessed by calculating the reliability coefficient Cronbach's alpha. Table 5.1 shows the alpha coefficient of the SALSA scales reported by Rimann (1997b) and the alpha coefficient in the work and health study.

Table 5.1: SALSA scales and reliability

Categories and subordinated scales	Number of items	Cronbach's alpha in the SALUTE study	Cronbach's alpha in the Work and Health study
Task characteristics			
Completeness of working tasks	3	.75	.64
Responsibility and required qualification	4	.71	.68
Task load			
Qualitative and quantitative overload	6	.78	.71*
Qualitative underload	3	.62	.64
Hampering social climate	3	.60	.62
Hampering supervisor behavior	3	.78	.78
Exposure due to external activity/conditions			
Hampering physical working conditions	10	-	.70
Organizational resources			
Task variety	3	.76	.84
Qualification potential	3	.85	.62
Decision latitude	3	.50	.65
Extent of participation	3	.62	.55
Personal scope for workplace design	1	-	**
Scope for personal and private things at work	1	-	**
Social resources at work			
Positive social climate	4	.72	.70
Employee-centered supervisor behavior	4	.80	.80
Social support by supervisor	3	.90	**
Social support by coworkers	3	.87	**

Note. N = 1282. *This scale was reduced to 5 items in the work and health study. **These scales were excluded in the work and health study.

As mentioned in 4.2.1, the scale for q*ualitative and quantitative overload* was reduced to five items. The scales for *social support by supervisor, social support by coworkers* and the two one-item scales p*ersonal scope for workplace design* and *scope for personal and private things at work* were excluded from the work and health study. The Cronbach's alpha coefficients in the work and health study show nearly the same pattern as the Cronbach's alpha coefficient in the SALUTE study. All alpha coefficients in the work and

health study are ≥ .55. The widely used social science cutoff (alpha = ≥ .70) (Bortz, 2004) is only reached by the following six scales: *Qualitative and quantitative overload, hampering supervisor behavior, hampering physical working conditions, task variety, positive social climate* and *employee-centered supervisor behavior.*

5.1.2 Central tendency and dispersion of the SALSA scales

Table 5.2 displays mean and standard deviation (SD) of the 13 SALSA scales used in the work and health study. Our study sample shows lower *task load* and high *organizational resources* as well as high *social resources* at work. Most of the scales reasonably approximated normal distribution, except for the scale *responsibility and required qualification* which was right skewed.

Table 5.2: Descriptive parameters of the SALSA scales

Categories and subordinated scales	Number of items	Possible range	Mean	SD
Task characteristics				
Completeness of working tasks	3	5	3.45	0.86
Responsibility and required qualification	4	5	4.17	0.67
Task load				
Qualitative and quantitative overload	5	5	2.48	0.62
Qualitative underload	3	5	2.56	0.72
Hampering social climate	3	5	2.53	0.72
Hampering supervisor behavior	3	5	2.20	0.86
Exposure due to external activity/conditions				
Hampering physical working conditions	10	6	3.31	0.74
Organizational resources				
Task variety	3	5	3.58	0.90
Qualification potential	3	5	3.43	0.80
Decision latitude	3	5	3.16	0.87
Extent of participation	3	5	2.71	0.68
Social resources at work				
Positive social climate	4	5	3.48	0.68
Employee-centered supervisor behavior	5	5	3.29	0.76

Note. N = 1282. For comparability, the mean was divided by number of items.

5.1.3 1st and 4th quartiles of the SALSA scales

Grouping the population into quartiles along SALSA scales served several purposes. First, Pearson correlation statistics, as well as multivariate regression models, are based on the assumption of a linear relationship between the dependent and the independent variables. This assumption may not be necessarily tenable for all associations (e.g. *hampering social climate* would only affect self-reported health measures at extreme values). Therefore, we divided the population into four subgroups according to ranking on the SALSA scales to obtain four homogeneous groups of individuals with low, moderately low, moderately high and high expression of the work characteristic of interest. Table 5.3 displays the data for the low and high group (1st and 4th quartiles).

Table 5.3: Descriptive parameters of the 1st and 4th quartiles of the SALSA scale

Categories and subordinated scales	25th percentile	Mean 1st quartile	SD	N	75th percentile	Mean 4th quartile	SD	N
Task characteristics								
Completeness of working tasks	3.00	2.52	.50	470	4.00	4.35	.35	459
Responsibility and required qualification	3.75	3.33	.46	386	4.75	4.87	.13	389
Task load								
Qualitative and quantitative overload	2.00	1.74	.27	364	2.80	3.15	.37	445
Qualitative underload	2.00	1.77	.30	403	3.00	3.36	.41	446
Hampering social climate	2.00	1.73	.31	402	3.00	3.35	.41	415
Hampering supervisor behavior	1.67	1.38	.27	476	2.67	3.26	.59	391
Exposure due to external activity/conditions								
Hampering physical working conditions	2.80	2.38	.37	343	3.90	4.23	.33	324
Organizational resources								
Task variety	3.00	2.0	1.13	398	4.33	4.60	.28	362
Qualification potential	3.00	2.56	.50	457	4.00	4.29	.32	418
Decision latitude	2.58	2.23	.41	473	3.75	4.10	.39	470
Extent of participation	2.33	2.03	.35	493	3.00	3.35	.39	538
Social resources at work								
Positive social climate	3.00	2.65	.39	367	4.00	4.28	.31	359
Employee-centered supervisor behavior	2.80	2.34	.44	365	3.80	4.12	.31	410

Note. N = 1282. Independent Samples t-Test for all scales: $\underline{p} < .001$.

To elucidate the clinical relevance of possible effect size and to allow for discussion of the results in the light of external data, we compared the self-reported health measures of these extreme groups. This also allowed us to assess the magnitude of difference obtained in the analysis regarding the ability of the SALSA to discriminate between teams.

5.1.4 Descriptive values of the six subjective health parameters

Table 5.4 displays the descriptive values of the six subjective health parameters. According to chapter 4.2.2 psychosomatic health, none of the population means for the reported six parameters falls above a critical clinical cutoff. For example, the *SF-12 physical summary score* is almost identical to the German norm population and approximates normal distribution. The scale *vital exhaustion* is skewed to the left with many individuals reporting low levels of exhaustion and only a few reaching clinically relevant scores above 11. This also applies to the scales *depression, sleep quality* and *somatic complaints*.

Table 5.4: Descriptive values of the subjective health parameters

Parameters	Number of items	Likert grades per item	Range	Mean	SD	Clinical cutoff
Physical summary score	12	*	*	50,00	7,98	**
Mental summary score	12	*	*	47,62	9,85	**
Vital exhaustion	9	3	0-18	7,44	5,03	10
Depression	7	4	0-21	4,76	3,12	11
Sleep quality	4	6	0-20	5,29	4,19	**
Somatic complaints	24	4	0-72	18,52	11,54	27

Note. N = 1282. * The single items are rated on different grade Likert scales. Due to that it is not possible to report a range. The physical and mental summary score are calculated by using a scoring algorithm. ** These scales have no clearly defined cutoff value.

5.2 SALSA and self-reported health

Are the SALSA scales related to psychological health outcomes, operationalized as *health-related quality of life, vital exhaustion, depression, sleep quality* and *somatic complaints*? To assess this question, the following steps were taken:

1. Partial correlation between the SALSA scales and the six subjective health outcomes controlled for *age* and *sex*.
2. Comparison of the means in the dependent variables (health outcomes) across the first and fourth quartiles of each SALSA scale (analysis of covariance with *age* as a covariate).
3. Sex stratified prediction of the scores in the dependent variables (health outcomes) by linear combinations of multiple SALSA scales controlling for *age* (multivariate regression analysis).

5.2.1 Partial correlation

Table 5.4 displays the partial correlation between 13 SALSA scales and six subjective health parameters controlled for *age* and *sex*. The data reveal small to moderate effect sizes for the correlation of all SALSA scales with the SF-12 health-related physical quality of life. The most prominent effects in this context are that better *physical health* was associated with larger *decision latitude* and that *adverse physical working conditions* were related to impaired *physical health*. With respect to *mental health*, *exhaustion*, and *depression*, *hampering social climate* shows the most adverse effect (correlations > .3) as evidenced by a negative association with the *mental health score* and a positive association with the *depression* and *exhaustion* scale. For the scales *sleep quality* and *somatic complaints*, relations were of a similar magnitude, and direction was as for the aforementioned mental health outcomes.

Several associations are of medium effect size according to Cohen's definitions with correlation exceeding r = .33. Noteworthy is the relationship of h*ampering social climate*

with *vital exhaustion, depression* and the *mental summary score*. *Social resources at work* show the strongest correlation with the *HADS depression scale* (-.32 and -.34).

Table 5.5. Partial correlation between the SALSA scales and subjective health parameters controlled for age and sex.

Categories and subordinated scales	Physical summary score	Mental summary score	Vital exhaustion	Depression	Sleep quality	Somatic complaints
Task characteristics						
Completeness of working tasks	.10	.19	-.20	-.23	-.11	-.17
Responsibility and required qualification	.20	.09	-.11	-.17	-.09	-.12
Task load						
Qualitative and quantitative overload	-.07	**-.32**	**.38**	**.30**	.22	**.31**
Qualitative underload	-.16	-.23	.23	.26	.17	.16
Hampering social climate	-.11	**-.36**	**.38**	**.32**	.21	.27
Hampering supervisor behavior	-.14	-.26	.28	.26	.16	.25
Exposure due to external activity/conditions						
Hampering physical working conditions	-.19	-.24	**.33**	.26	.25	**.35**
Organizational resources						
Task variety	.16	.13	-.15	-.17	-.12	-.16
Qualification potential	.19	.20	-.20	-.26	-.14	-.20
Decision latitude	.24	.10	-.17	-.15	-.15	-.24
Extent of participation	.14	.20	-.24	-.24	-.14	-.18
Social resources at work						
Positive social climate	.13	.26	-.25	**-.34**	-.17	-.21
Employee-centered supervisor behavior	.16	27	-.28	**-.32**	-.15	-.22

Note. N = 1282. All coefficients are significant at $\underline{p} < .001$. Boldface indicates coefficients $\geq .3$.

5.2.2 Analysis of covariance

A univariate analysis of covariance was performed for each SALSA scale as a factor and the six subjective health outcomes as dependent variables. Each SALSA scale was divided into the first and fourth quartile (cf. section 5.1.3). In sum we calculated 13 x 6 = 78 univariate analyses of covariance. SPSS MANOVA was used for the analysis. Because of the small number of women in each quartile of the SALSA scale, we limited these analyses to the male sex only. Table 3 in the appendix displays the results for each of the 78 analyses of covariance including the adjusted R-square and the adjusted means for the first and fourth quartiles. Effect sizes range from non-existent (e.g. *task variety* and *sleep quality*) to substantial associations (e.g. *vital exhaustion* and *hampering physical working conditions* with R-square of 0.18).

The following figures 5.1 to 5.6 graphically explore the mean differences between the first and fourth quartiles of each SALSA scale from the data presented in Table 3 in the appendix. For convenience, the figures are sorted by the six subjective health outcomes.

Figure 5.1 displays the values of *SF-12 physical summary score* in the first and fourth quartiles for each SALSA scale in men. Sample size N for the first and fourth quartiles for each SALSA scale are shown in Table 5.3. The scale *qualitative and quantitative overload* showed the only non-significant difference in the analysis of covariance (Table 3, appendix). Neither the values in the first quartile nor those in the fourth quartile exceed the average of the distribution (± 1 SD) in the physical summary score. The scale *task variety* shows the highest difference of 9.68 points in the physical summary score between the first and fourth quartiles. The differences in the remaining 12 SALSA scales show a range of 1.02 to 3.79 points in the physical summary score. As the SF-12 summary score is scaled to a mean of 50 and a standard deviation of 10, the differences observed in task variety amount to a substantial effect size warranting further examination. The next largest effects are observed for the scales *decision latitude* and *responsibility and required qualification*, which are intercorrelated with the scale *task variety* (Table 4, appendix).

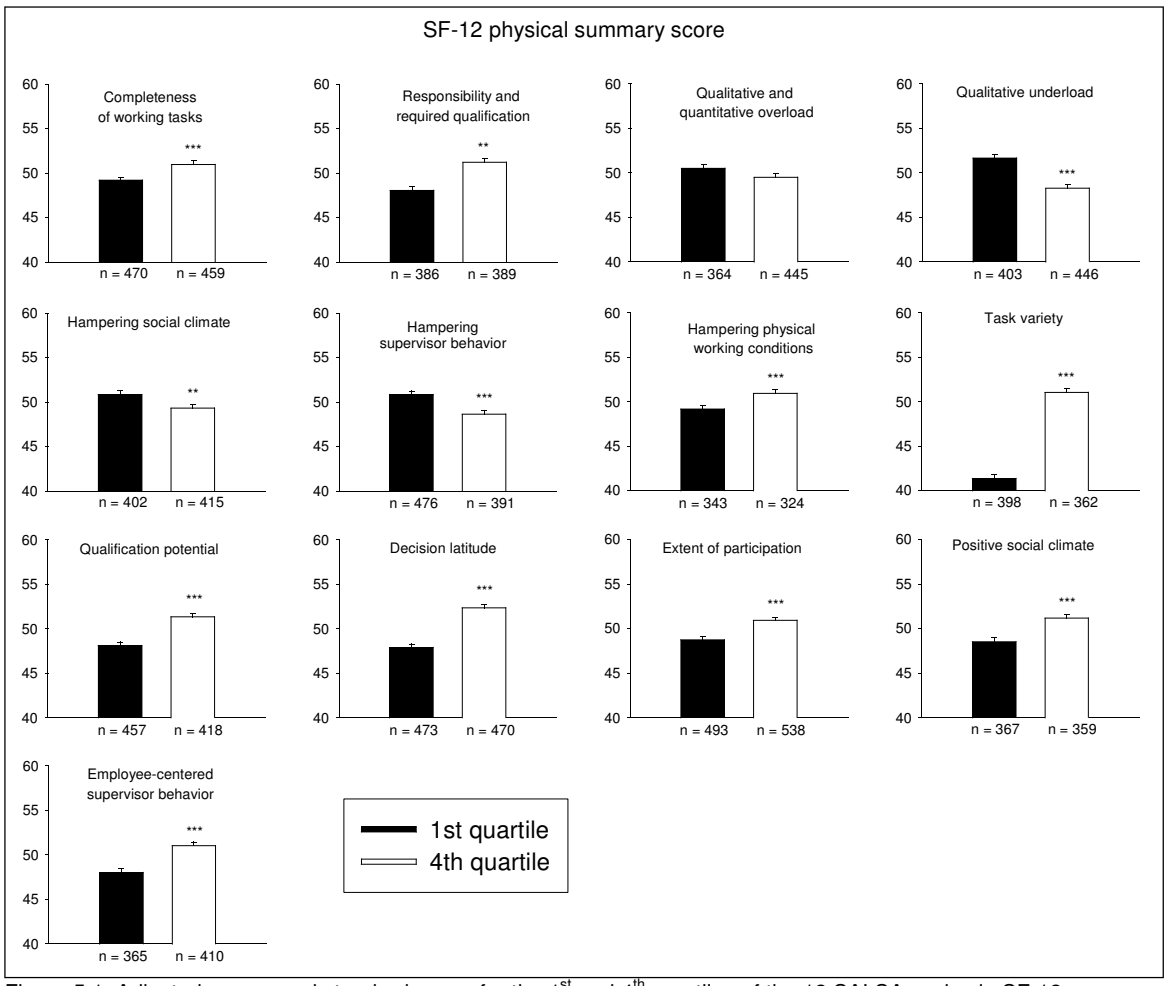

Figure 5.1. Adjusted means and standard errors for the 1st and 4th quartiles of the 13 SALSA scales in SF-12 physical summary score in men. N for 1st and 4th quartile differ in each SALSA scale according to Table 5.3. ** significant at p < . 01. ***significant at p < .001.

The values of the first and fourth quartiles of the 13 SALSA scales in the *SF-12 mental summary score* are shown in Figure 5.2. In contrast to the association with the physical summary score, the SALSA scale *task variety showed* the single non-significant difference between the lowest and the highest quartile on the respective SALSA scales. For the other SALSA scales, the differences observed for the mental summary score were higher. The scale *decision latitude* shows the smallest significant difference between first and fourth quartiles with 1.5 points. The highest difference was found with 7.75 points for the scale *hampering social climate*.

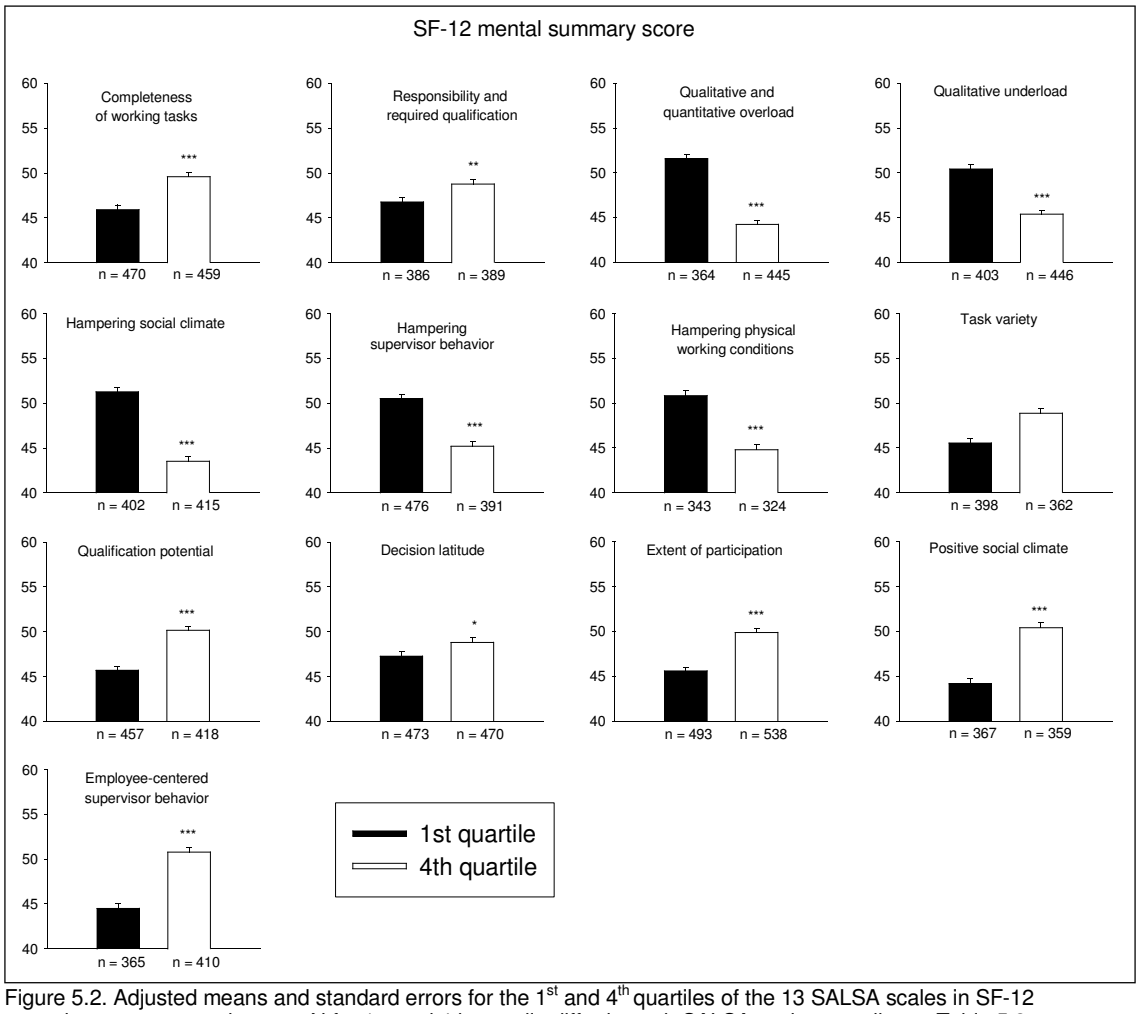

Figure 5.2. Adjusted means and standard errors for the 1st and 4th quartiles of the 13 SALSA scales in SF-12 mental summary score in men. N for 1st and 4th quartile differ in each SALSA scale according to Table 5.3. * significant at p < . 05. ** significant at p < .01. ***significant at p < .001.

The SALSA scales *qualitative and quantitative overload, qualitative underload, hampering social climate, hampering supervisor behavior, hampering physical working conditions, positive social climate* and *employee-centered supervisor behavior* showed more than five-point differences in the *mental summary score* between the first and fourth quartiles. Thus workload, social resources at work and organizational resources appear to be related to mental health.

Figure 5.3 displays the values for *vital exhaustion* in the first and fourth quartiles of the SALSA scales. The figure shows substantial differences in clinical relevance for most of

the SALSA scales. The difference between the first and the fourth quartiles ranges between 0.93 points in the scale r*esponsibility and required qualification* and 4.5 points in the scale *hampering physical working conditions*. For example, participants in the upper quartile for hampering social climate show the same difference to those in the lowest quartile as do individuals in the upper quartile for *hampering physical working conditions*.

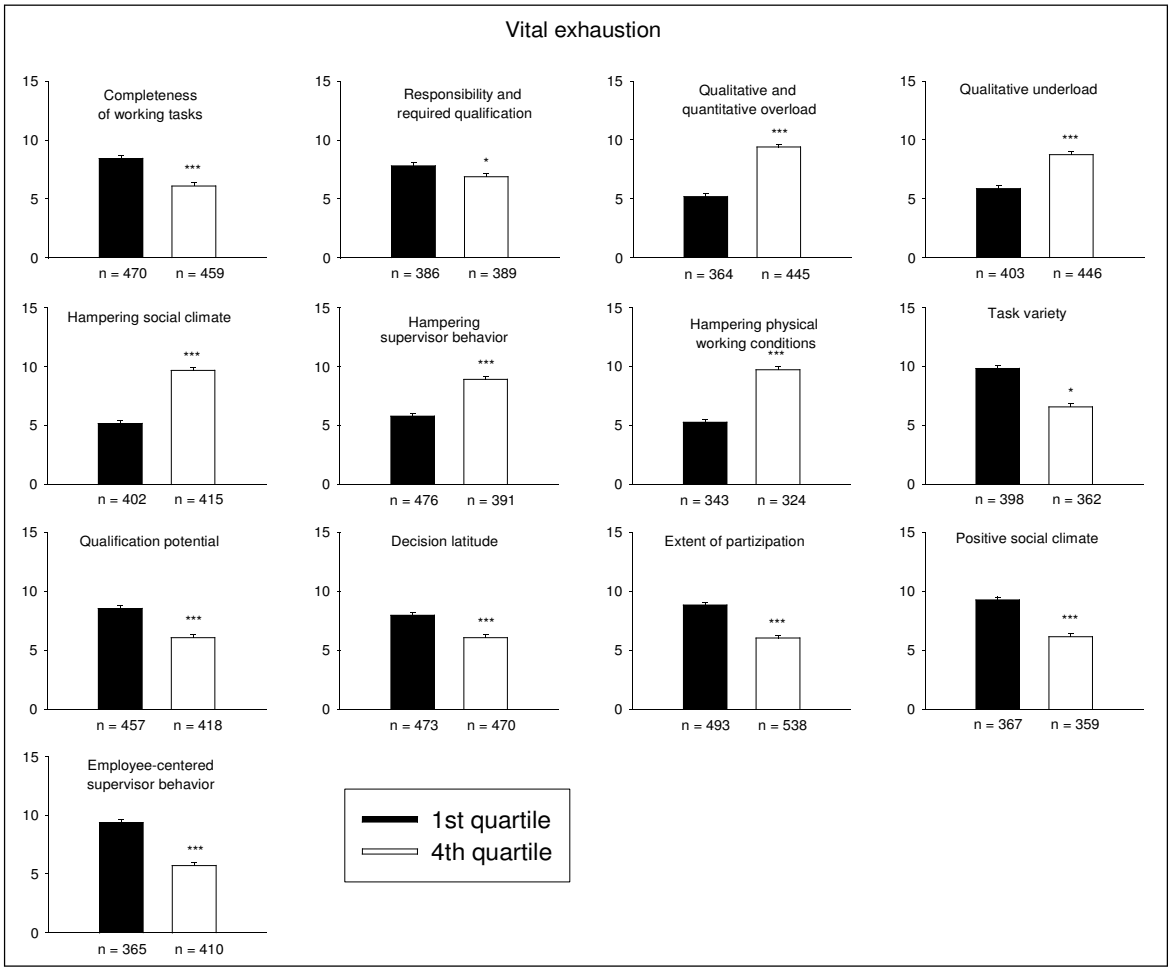

Figure 5.3. Adjusted means and standard errors for the 1st and 4th quartile of the 13 SALSA-scales in vital exhaustion in men. N for 1st and 4th quartile differ in each SALSA-scale according to Table 5.3.
* significant at p < . 05. ***significant at p < .001.

The differences in means of almost 5 score points implies that a considerable proportion of those participants in the upper quartile express clinically relevant levels of exhaustion, while severe exhaustion is virtually absent in those subjects in the lowest quartile of the SALSA scale. The scales *qualitative and quantitative overload, hampering*

supervisor behavior, positive social climate and *employee-centered supervisor behavior* also show more than three-point differences between the first and fourth quartiles in vital exhaustion score.

The values of the first and fourth quartiles of the 13 SALSA scales in *depression* are shown in Figure 5.4. With the exception of *task variety*, all analyses of covariance showed significant differences at the $p < 0.001$ level (cf. Table 3 in the appendix). However the absolute differences in the depression score were probably not of clinical relevance. Differences between the first and fourth quartiles amounted to 0.91 points in the scale *decision latitude* and to 2.64 points in the scale *employee-centered supervisor behavior*.

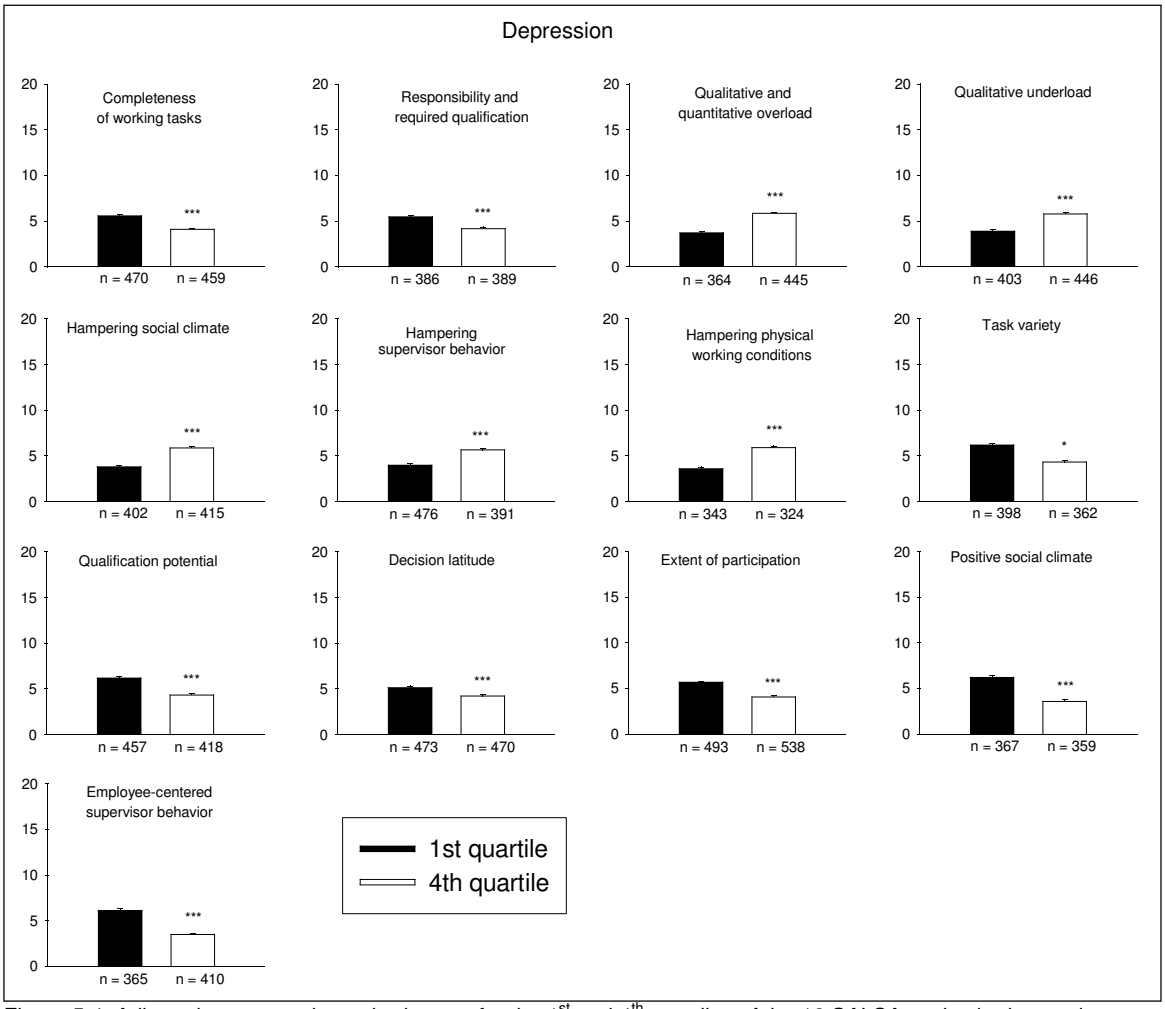

Figure 5.4. Adjusted means and standard errors for the 1st and 4th quartiles of the 13 SALSA scales in depression in men. N for 1st and 4th quartile differ in each SALSA scale according to Table 5.3.
* significant at p < . 05. ***significant at p < .001.

For all scales, subjects in the more favorable quartile of the distribution of the SALSA scale have lower points on the *depression* -score. As patients with clinical depression usually score 11 or more points, only a minor proportion of participants achieved levels of psychiatric relevance. Nevertheless, the observed differences may well be associated with different shades of self-perceived zest for life.

Figure 5.5 displays the values of *sleep quality*. Again the large sample size renders all differences statistically significant at the $p < 0.001$ level except for *task variety* (Table 3 in the appendix).

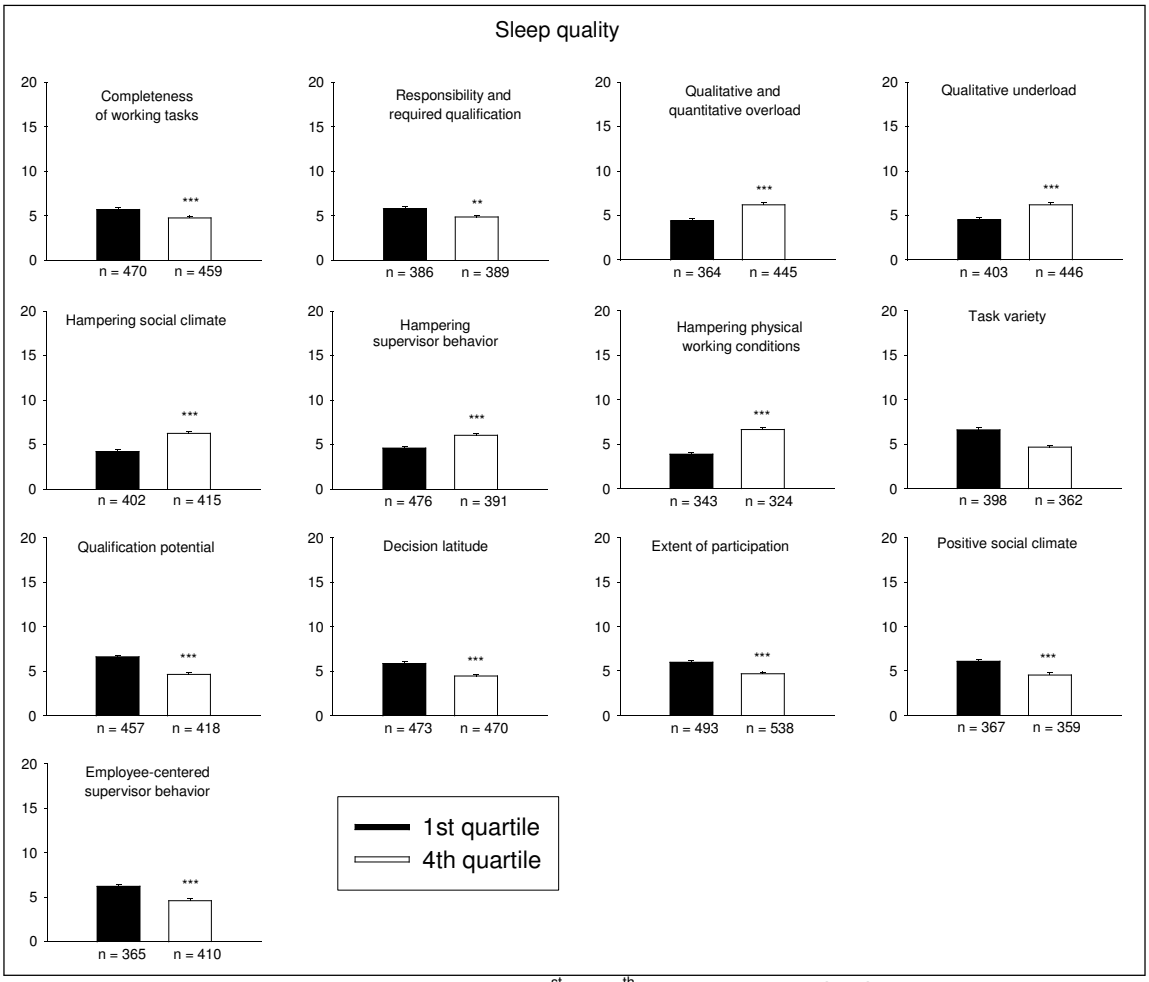

Figure 5.5. Adjusted means and standard errors for the 1st and 4th quartiles of the 13 SALSA scales in depression in men. N for 1st and 4th quartile differ in each SALSA scale according to Table 5.3. ** significant at p < .01. ***significant at p < .001.

All scales show only low differences between the quartiles. The smallest difference between the first and fourth quartiles appears on the scale *completeness of working tasks* with 0.93 points, the highest difference was 2.8 points in the scale *hampering physical working conditions*. In practical terms the latter difference corresponds to double the frequency of sleep problems in three of the four items (e.g. from up to three nights per month to 4-7 nights per month).

The values of first and fourth quartiles of the 13 SALSA scales in *somatic complaints* are shown in Figure 5.6. All SALSA scales show significant differences between the lowest and the highest quartiles of the SALSA scales (Table 3 in the appendix).

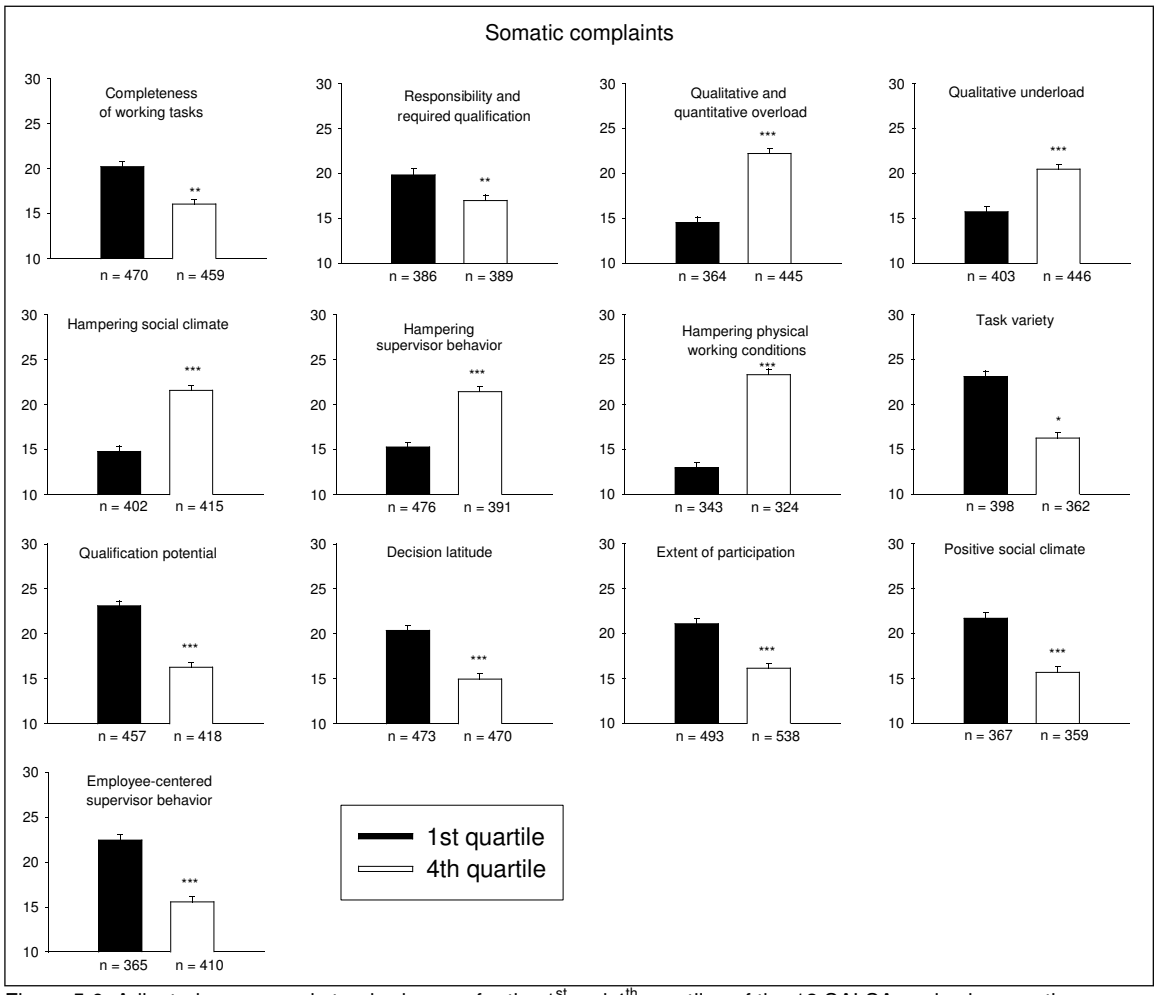

Figure 5.6. Adjusted means and standard errors for the 1st and 4th quartiles of the 13 SALSA scales in somatic complaints in men. N for 1st and 4th quartile differ in each SALSA scale according to Table 5.3.
* significant at p < . 05. ** significant at p < .01. ***significant at p < .001.

The *somatic complaint list* comprises items related to pain; these are predominantly non-specific complaints where no corresponding anatomical pathology is found upon medical investigation. Substantial and possibly relevant differences were observed for *hampering physical working conditions* (Δ = 10.4) and for *qualitative and quantitative overload* (Δ = 7.7). Except for the scales *completeness of working tasks* with a difference of 4.17 points and *responsibility and required qualification* with a difference of 2.87 points, all other scales show more than 5-point differences.

5.2.3 Multivariable Regression

Multivariable regression was employed to determine how SALSA scales, when considered together, explain variance in subjective health outcomes. Analysis was performed using SPSS REGRESSION and SPSS FREQUENCIES for evaluation of normality assumptions.

Because of the multicollinearity with other scales (Table 4, appendix) the SALSA scale *qualification potential* was not included in this analysis. The checks for normality, linearity and homoscedasticity of residuals did not lead to further requirements for adaptation of the dataset. *Age* was added as an independent variable to control its effect on the subjective health outcomes. The effect of *sex* was controlled by calculating separate multiple regressions for men and women, rather than entering *sex* as an additional independent variable with the need to model additional interaction terms. Intercorrelations of the SALSA scales and of the six subjective health parameters are shown in the appendix (Tables 4-5).

Due to the 10-fold smaller sample size for women, the analysis was less powered to detect small effect sizes. Therefore, only the most important explanatory variables will show up as statistically significant predictors in all analyses for the women's subgroup.

Table 5.5 shows the summary of multivariate regression analyses for the *SF-12 physical summary score* as dependent variable and the SALSA scales and age as independent variables, separately for men and women. Complete analyses are shown in Tables 6 and 12 in the appendix. For men the analysis revealed that *age* and three SALSA scales explained 15.2 percent of the observed variance. These three SALSA scales were *decision latitude, hampering physical working conditions* and *responsibility and required qualification*. The same scales also showed the highest correlation in the bivariate partial correlation analysis (Table 5.6). In contrast, for women this effect was stronger, as due to the smaller size of the subsample only marked effects attained statistical significance. In women, *age* and the scale *decision latitude* explained 11.8 percent of the observed variance of SF-12 physical summary scores. Here, the SALSA scale contributed to about half of the explained variance.

Table 5.6: Summary of Multivariate Regression Analysis for variables predicting SF-12 physical summary score in men and women.

Predictor variables	B	SE B	β	R^2
Men				
				.154**
Age	-1.25	.11	-.34	
Hampering physical working conditions	-0.17	.03	-.16	
Decision latitude	0.42	.10	.14	
Responsibility and required qualification	0.43	.09	.14	
Women				
				.133**
Age	-1.34	.35	-.34	
Decision latitude	0.76	.28	.24	

Note. **p < .01. N = 1165 men. N = 117 women. Adjusted R-Square for step 4 in men = .152. Adjusted R-Square for step 2 in women = .118. Complete Regression Analyses are shown in the appendix. In contrast to the tables in the appendix, scales are sorted by β.

The summary of the multivariate regression analyses separated by sex with the *SF-12 mental summary score* as dependent variable and the SALSA scales and age as independent variables are shown in Table 5.7. Complete analyses are shown in Tables 7 and 13 in the appendix. Analysis for men revealed that *age* and six SALSA scales

explained 20.6 percent of the observed variance in the SF-12 mental summary score. The SALSA scales were *hampering social climate, qualitative and quantitative overload, qualitative underload, employee-centered supervisor behavior, positive social climate* and *hampering physical working conditions*. In women, the task load scale *hampering social climate* explained 15.6 % of the observed variance in *SF-12 mental summary score*.

Table 5.7 also reveals an important gender difference. The effect of h*ampering social climate* is about three times greater in women than in men with regard to its inverse association with mental health-related quality of life. In men, the scale *qualitative and quantitative overload* reveals a moderate association with *mental health*, while all other effect sizes are small. In essence, the analysis again corroborates the observations already made in the results section reporting on the partial correlation (cf. 5.2.1) and the analysis of covariance (cf. 5.2.2).

Table 5.7: Summary of Multivariable Regression Analysis for variables predicting SF-12 mental summary score in men and women. Complete Regression Analyses are shown in the appendix.

Predictor variables	B	SE B	β	R^2
Men				
				.211*
Qualitative and quantitative overload	-0.74	.09	-.24	
Hampering social climate	-0.59	.15	-.13	
Age	0.43	.12	.10	
Positive social climate	0.31	.11	.09	
Qualitative underload	-0.38	.13	-.08	
Employee-centered supervisor behavior	0.18	.08	.07	
Hampering physical working conditions	-0.09	.04	-.07	
Women				
				.163**
Hampering social climate	-2.03	.43	-.40	

Note. *p < .05. **p < .01. N = 1165 men. N = 117 women. Adjusted R-Square for step 7 in men = .206. Adjusted R-Square for step 1 in women = .156. Complete Regression Analysis are shown in the appendix. In contrast to the tables in the appendix, scales are sorted by β.

Table 5.8 displays the regression analyses for v*ital exhaustion* as dependent variable. (Full data, Appendix Tables 8 and 14). In men, a substantial proportion of the variance (26.7%) in the *vital exhaustion scale* was explained by six SALSA scales. These were *qualitative and quantitative overload, hampering social climate, hampering physical working conditions, task variety, employee-centered supervisor behavior* and *positive social climate*. In women, the scales had similar standardized beta-coefficients, suggesting small gender differences in the main variables explaining the variance. Interestingly, women with higher *decision latitude* reported less exhaustion. *Age* was not associated with *vital exhaustion* after considering the SALSA scales.

Table 5.8: Summary of Multivariable Regression Analysis for variables predicting vital exhaustion in men and women.

Predictor variables	B	SE B	β	R^2
Men				
				.271*
Qualitative and quantitative overload	0.44	.05	.27	
Hampering physical working conditions	0.11	.02	.17	
Hampering social climate	0.34	.08	.14	
Task variety	-0.20	.05	-.11	
Employee-centered supervisor behavior	-0.09	.04	-.07	
Positive social climate	-0.11	.06	-.06	
Women				
				.156*
Qualitative and quantitative overload	0.35	.16	.21	
Decision latitude	-0.38	.18	-.19	
Hampering social climate	0.38	.21	.18	

Note. *p < .05. N = 1165 men. N = 117 women. Adjusted R-Square for step 6 in men = .267. Adjusted R-Square for Step 3 = .134. Complete Regression Analyses are shown in the appendix. In contract to the tables in the appendix, scales are sorted by β.

Table 5.9 displays the summary of the multivariate regression analyses of the *HADS depression score* (Full data, Appendix, Tables 8 and 14). Again, just a few SALSA scales explained a considerable part of the variance in men (25.4%). These were *positive social climate, qualitative and quantitative overload, hampering physical working conditions, employee-centered supervisor behavior, responsibility and required qualification* and *qualitative underload*. The largest effect sizes were observed for q*ualitative and quantitative overload*, and for *positive social climate*. On face validity, the items of the *HADS depression scale* used, which give rise to the majority of the observed summary scores in this study, refer rather to the absence of joyfulness or zest for life than to symptoms of clinical depression. Hence, it is conceivable that *positive social climate* is associated with lower *HADS depression scores*. This is in line with the finding for women, in whom *hampering social climate* alone explained 13.5% of the variance in *HADS depression scores*. Again these findings are in line with the partial correlation and covariance analysis.

Table 5.9: Summary of Multivariable Regression Analysis for variables predicting depression in men and women.

Predictor variables	B	SE B	β	R^2
Men				
				.259*
Qualitative and quantitative overload	0.25	.03	.25	
Positive social climate	-0.21	.04	-.18	
Age	0.18	.04	.12	
Hampering physical working conditions	0.05	.01	.12	
Employee-centered supervisor behavior	-0.08	.03	-.10	
Responsibility and required qualification	-0.11	.03	-.09	
Qualitative underload	0.10	.04	.07	
Women				
				.142**
Hampering social climate	0.58	.12	-.38	

Note. *p < .05. **p < .01. N = 1165 men. N = 117 women. Adjusted R-Square for step 7 in men = .254. Adjusted R-Square for step 1 in women = .135. Complete Regression Analyses are shown in the appendix. In contrast to the tables in the appendix, scales are sorted by β.

Table 5.10 shows the data for *sleep quality* as dependent variable. It is known that the quality of sleep gradually declines with age. Therefore, the comparison with the effect of age offers a convenient scale against which other effects can be compared. Of the five SALSA scales significantly contributing to the explained 12.1 % of the observed variance, the scales *hampering physical working conditions* and *qualitative and quantitative overload* have standardized beta-coefficients similar in magnitude to *age*. In women, *age* is not retained as a significant statistical predictor, once *qualitative and quantitative overload* and *positive social climate* are considered.

Table 5.10: Summary of Multivariable Regression Analysis for variables predicting sleep quality in men and women.

Predictor variables	B	SE B	β	R^2
Men				
				.125*
Qualitative and quantitative overload	0.23	.04	.17	
Hampering physical working conditions	0.09	.02	.16	
Age	0.24	.06	.13	
Task variety	-0.12	.05	-.08	
Positive social climate	-0.11	.05	-.07	
Decision latitude	-0.12	.05	-.07	
Women				
				.078*
Qualitative and quantitative overload	0.29	.13	.20	
Positive social climate	-0.29	.14	-.19	

Note. *p < .05. N = 1165 men. N = 117 women. Adjusted R-Square for step 6 in men = . 121. Adjusted R-Square for step 1 in women = .062. Complete Regression Analyses are shown in the appendix. In contrast to the tables in the appendix, scales are sorted by β.

The final table, Table 5.11, displays the multivariate regression analysis for *somatic complaints*. In men, *age, qualitative and quantitative overload* as well as *hampering physical working conditions* were the main variables associated with *non-specific somatic complaints.* The explained variance of 24.2% is of considerable magnitude. The effect sizes are moderate and similar to that of age. In women, *hampering physical working conditions* emerged as the only significant explanatory variable. As previously mentioned, this may be due to the 10-fold smaller sample size for the women's subgroup.

Table 5.11: Summary of Multivariable Regression Analysis for variables predicting somatic complaints in men and women.

Predictor variables	B	SE B	β	R^2
Men				
				.246**
Qualitative and quantitative overload	0.92	.10	.25	
Hampering physical working conditions	0.34	.04	.22	
Age	1.02	.15	.19	
Decision latitude	-0.53	.14	-.12	
Positive social climate	-0.37	.12	-.09	
Task variety	-0.38	.12	-.09	
Women				
				.073.**
Hampering physical working conditions	0.44	.15	.27	

Note. **p < .01. N = 1165 men. N = 117 women. Adjusted R-Square for step 6 in men = .242. Adjusted R-Square for step 1 in women = .065. Complete Regression Analyses are shown in the appendix. In contrast to the tables in the appendix, scales are sorted by β.

5.3 SALSA and alterations in physiological measures (allostatic load)

Are the SALSA scales related to measures describing downstream changes in health status, operationalized by the measures indicating allostatic load? The following analytical steps were taken to assess this question:

1. Descriptive statistics (Mean, standard deviation and cutoffs)
2. Canonical correlations

5.3.1 Descriptive parameters

Table 5.12 displays the descriptive statistic of the medical parameters used to calculate the allostatic load score. The population cutoff was defined as the quartile with the most adverse expression or highest risk group for each parameter, e.g. the highest quartile for blood pressure measurements. Data reveal that a little less than a quarter of the population had blood pressure levels above the WHO definition for high blood pressure (140/90 mm Hg), and about a quarter of the population were considered overweight. Total cholesterol to HDL ratio exceeded the recommended ratio in more than half of the population. With regard to urinary excretion of epinephrine, about 40% of the participants had values below the assay's detection level. In general, these data are comparable to the health variables published in the Augsburg MONICA cohort study, underscoring that our participants are reasonably representative of the normal, apparently healthy working population of 20- to 60-year-old women and men.

Table 5.12. Descriptive values of the allostatic load parameters and their cutoff values

Parameters	Mean	SD	Cutoff*
Physical examination			
Systolic blood pressure (mm Hg)	125	15.4	135
Diastolic blood pressure (mm Hg)	81	9.9	87.5
Waist-hip ratio	0.92	0.07	0.97
Body mass index (kg/m^2)	26.3	3.81	28.4
Blood measurement			
HDL (mg/dl)	54.4	12.9	45.8
Total cholesterol to HDL ratio	4.12	1.28	4.8
HbA1c (%)	5.31	0.5	5.5
CRP (mg/l)	1.8	2.3	2.1
D-dimer (µg/l)	149	97	195
Fibrinogen (mg/dl)	275	59.8	305
DHEA-S (mg/l)	2.6	1.24	1.67
Urinary excretion			
Cortisol (µg/)	45.8	39.4	53.9
Norepinephrine (µg/l)	21.6	13	26.1
Ephinephrine (µg/l)	3.2	3.2	4.1
Albumine (mg/l)	8.15	41	7.3
Allostatic load score	2.49	1.79	

Notes. N for all measures = 1282. * cutoff for HDL and DHEA-S is the 25th percentile, for all other parameters the 75th percentile is the cutoff according to the allostatic load definition.

5.3.2 Canonical correlation

Canonical correlation analysis is typically used to examine the potential relationship between two multivariate data sets. For example, an environmental survey might result in observations on both physical and biological attributes. One of the obvious questions is: how are the physical attributes associated with the biological measures? In canonical correlation analysis, linear combinations of the attributes (canonical variables) are created for each data set so that the correlations between the canonical variables of the two data sets are maximized. These combinations are analogous to the eigenvectors of principal component analysis (PCA). The correlations between, or among, the new canonical variables and the original variables are then interpreted. While this type of analysis does not imply causality, it can provide insight into potential relationships within the whole data

set (Bortz, 2004).

Canonical correlation was performed between the set of biological variables describing the extended allostatic load and the SALSA scales using SAS CANCORR.

To improve the linearity of the relationship between variables and to approximate normality of their distributions, logarithmic transformations were applied to the following biological variables: C-reactive protein, D-dimer, urinary cortisol, urinary norepinephrine, urinary epinephrine, and urinary albumine. The ratio of total cholesterol to HDL was skewed and had a high kurtosis. Therefore, we used the LDL value as a substitute (mean = 136, SD = 37.5, cutoff = 159). After these procedures, no within-set multivariate outliers were identified at $p < 0.001$.

The first canonical correlation amounted to 0.38 (14.5% overlapping variance); the second was 0.25 (6.2% overlapping variance). With all canonical correlations included, the F approximation yielded $F = 2.14$, $df = 195/11406$, $p < 0.0001$; with the first canonical correlation removed the F was 1.38, $df = 168/110596$, $p = 0.0009$. Subsequent F statistics were not significant. Data on the first two pairs of canonical variates are presented in Table 5.13.

The table shows the correlations between the variables and the canonical variates, standardized canonical variate coefficients, within-set variance accounted for by the canonical variates (percent of variance), redundancies and canonical correlations. The total percent of variance and the total redundancy suggest that the first pair of canonical variates was moderately related, and that the second pair of variates was only minimally related. Therefore, the interpretation of the second pair of canonical variates is questionable. Employing a cutoff of 0.3, the variables in the health outcomes set that were correlated with the first canonical variate were: systolic and diastolic blood pressure, body mass index and waist-to-hip ratio, DHEA-S and low density lipoprotein.

Table 5.13. Correlations and standardized canonical coefficients between allostatic load parameters and SALSA scales and their canonical variates.

	First variate		Second Variate	
	Correlation	Canonical coefficient	Correlation	Canonical coefficient
Allostatic load parameters				
Systolic blood pressure	**.41**	-.11	**.32**	.20
Diastolic blood pressure	***.59***	**.44**	.20	-.17
Waist-to-hip ratio	**.38**	.17	**.49**	**.35**
Body mass index	**.47**	.16	.62	**.37**
HDL	.17	.28	***-.57***	**-.32**
LDL	.24	.13	.02	.03
HbA1c	***-.59***	**-.46**	**.39**	.25
CRP	-.02	-.15	-.30	-.23
D-dimer	***.58***	.32	-.03	-.17
Fibrinogen	.04	-.08	-.21	-.26
DHEA-S	-.26	-.14	-.23	-.11
Cortisol	.06	.07	.01	-.15
Norepinephrine	.07	.04	**.31**	.01
Ephinephrine	.11	.18	**.38**	.23
Albumine	-.19	-.25	.28	.17
Percent of variance	.12		.12	Total: .24
Redundancy	.02		.01	Total: .03
SALSA scales				
Completeness of working tasks	**.32**	.30	.23	-.18
Responsibility and required qualification	.28	**.37**	.19	.50
Qualitative and quantitative overload	.08	.13	0	.16
Qualitative underload	**-.39**	***-.78***	-.07	-.04
Hampering social climate	**.41**	**.33**	**-.45**	***-.59***
Hampering supervisor behavior	.07	.23	.25	***.78***
Hampering physical working conditions	.29	.26	.09	-.15
Task variety	-.12	**-.33**	**.31**	.26
Qualification potential	-.28	-.22	-.23	.01
Decision latitude	-.28	-.22	**-.33**	**-.38**
Extent of participation	.17	.04	**.39**	**.33**
Positive social climate	.07	.02	**.37**	.07
Employee-centered supervisor behavior	-.06	-.16	**.33**	.17
Percent of variance	.06		.08	Total: .14
Redundancy	.01		.01	Total: .02
Canonical Correlation	.38		.25	

Note. N = 1285. Boldface indicates coefficients ≥ .3. Boldface and italic print indicates coefficients ≥ .5.

For the canonical variate of the SALSA scales, the scales correlating were completeness of working tasks (0.32), qualification potential (-0.39) and decision latitude (0.41). The scales positive social climate and employee-centered supervisor behavior were inversely correlated at – 0.28, the scale qualitative and quantitative overload was positively related to the canonical variate (0.29). The first pair of canonical variates therefore suggests that adverse biological health outcomes (hypertension, increased waist-to-hip ratio, declining DHEA-S, higher LDL) are associated with more adverse working conditions.

In order to further investigate the surprising result in this study population that higher decision latitude was related to adverse health outcomes, we performed a subgroup analysis amongst the 110 managers (high decision latitude, more homogeneous age) in the study population. Because of the smaller number of participants in this subsample, we had to restrict the variables entered into the canonical correlation analysis. Therefore, we employed the health variables describing the metabolic syndrome (blood pressure, body mass index, waist-to-hip ratio, glycosylated hemoglobin and LDL), and we restricted the set of SALSA scales to those describing task characteristics and task load. For the managers we found a canonical correlation of r = 0.59 (35.2% overlapping variance), F = 1.74, df = 48/456.7, p = 0.0024. After excluding the first pair of variates, no further F statistics were significant.

Table 5.14 displays the correlations between the variables and the canonical variates, standardized canonical variate coefficients, within-set variance accounted for by the canonical variates (percent of variance), redundancies and canonical correlations. The overlapping variance suggests a moderate to substantial association between the two variates. Employing a cutoff of 0.3, the variables in the health outcomes set that were correlated with the first canonical variate were: diastolic blood pressure, glycosylated hemoglobin and low density lipoprotein – suggesting that this canonical variate measured the extent of the metabolic syndrome.

Table 5.14. Correlations and standardized canonical coefficients between metabolic syndrome parameters and task characteristics/resources scales.

	Correlation	Canonical Coefficient
Parameters of the metabolic syndrome		
Systolic blood pressure	.24	**-.49**
Diastolic blood pressure	***.61***	***.68***
Body mass index	.19	-.24
Waist-to-hip ratio	.26	.17
HbA1c	***.46***	.27
LDL	***.83***	***.70***
Percent of variance	.24	
Redundancy	.08	
Task characteristics/resources scales		
Completeness of working tasks	-.17	-.27
Responsibility and required qualification	.03	.29
Task variety	-.25	.29
Qualification potential	***-.78***	***-.77***
Decision latitude	.16	.27
Extent of participation	***-.76***	***-.46***
Positive social climate	-.27	.19
Employee-centered supervisor behavior	***-.55***	-.15
Percent of variance	.21	
Redundancy	.07	
Canonical correlation	.59	

Note. Reduced data to N = 110 managers. Boldface indicates coefficients $\geq$ .3. Boldface and italic print indicates coefficients $\geq$ .5.

The SALSA scales inversely correlated with the corresponding canonical variate were: qualification potential, extent of participation and employee-centered supervisor behavior. Thus, the data suggest that in managers a lack of social and organizational resources at work is associated with an increased risk of the metabolic syndrome.

5.4 The ability of the SALSA to discriminate between teams

One important practical question is whether the SALSA scales are able to discriminate between two teams, who have similar tasks but for whom one may expect substantial differences in perceived work characteristics. Our study allowed for such a comparison, as two teams had comparable tasks with respect to airplane manufacturing, but differed as to organizational structure and management style. External evidence for the comparability of the tasks is the fact that Team B recruited many young workers from Team A during a period of expansion in Team B. The differences in management style and organizational structure resulted from a two-year change process in Team A that had been completed about 18 months prior to our investigation. This change process was geared towards increasing profitability of the unit by promoting an employee-centered leadership style, worker participation in product refinement and increases in decision latitude. Within the plant, Team A is now viewed as a role model regarding profitability and successful change management that is compatible with healthy working conditions. In contrast, Team B is currently working under unfavorable organizational conditions that are only in part amenable to the organization. The confidentiality conditions in the contract between the ETH and the EADS do not allow us to reveal more details of the specific tasks of the manufacturing units under investigation. In this specific case, our aim was to investigate if the externally known differences show up as significant group mean differences in the respective SALSA scales (with respect to the indended use of the Salsa, namely characterizing perceived working characteristics and differences between company units).

Specifically we hypothesized that there would be a positive non-significant difference for decision latitude, employee-centered supervisor behavior and participation between Team A and Team B, with negligible differences as to the scales describing qualitative and quantitative overload, qualification potential and responsibility and required qualification. Because of the known differences in age (recruitment of young workers to Team B), the detailed population characteristics. including questionnaire-assessed health

outcomes and physiological measures, are presented below.

5.4.1 Description of the teams

Population characteristics are shown in Table 5.15. The data reveal that members of Team B were on average eight years younger, and that they had been employed by the company less than half the time that members of Team A had. While the physical health summery score showed the differences expected due to the age difference between Team A and Team B, the younger workers in Team B had significantly lower mental health summary scores and higher levels of exhaustion. Differences in physiological parameters were of the magnitude expected from the age difference.

Table 5.15. Characteristics and descriptive parameters of Team A and B.

Team characteristics						
	Team A			Team B		
Characteristics	N / mean	(SD)	Percent	N	(SD)	Percent
Number of participants	65			112		
Sex (men/women)	64/1		98.5/1.5	106/6		94.6/5.4
Mean age in years	39.7	(11.71)		31.8	(8.90)	
Mean duration of employment in years	7	(3.86)		2.8	(1.65)	
Position						
Supervisor or manager	-			1		0.9
Foreman	3		4.6	6		5.4
Skilled workers	62		95.4	103		92.0
Semi-skilled workers	-			-		
Trainees	-			2		1.8
Health parameters						
Parameters	N	Mean	SD	N	Mean	SD
Physical summary score	62	49.89	7.89	107	51.20	6.79
Mental summary score**	62	49.31	8.25	107	46.29	9.63
Vital exhaustion*	65	6.98	4.52	112	8.32	5.15
Depression	65	4.85	3.13	112	4.76	2.95
Sleep quality	65	5.86	4.10	112	6.38	4.45
Somatic complaints	65	19.37	11.71	112	18.92	10.93
Allostatic load score**	38	2.76	1.55	61	2.03	1.41

Notes.* significant difference between Team A and B $p < .10$. ** significant difference between Team A and B $p < .05$.

5.4.2 SALSA values for the two teams

Figure 5.7 shows the mean SALSA scales for Team A and Team B. The teams differed significantly with respect to all scales except for qualitative and quantitative overload, qualitative underload, hampering supervisor behavior and qualification potential. The largest differences were perceived in the extent of participation and decision latitude. The change process in Team A had focused on increasing participation.

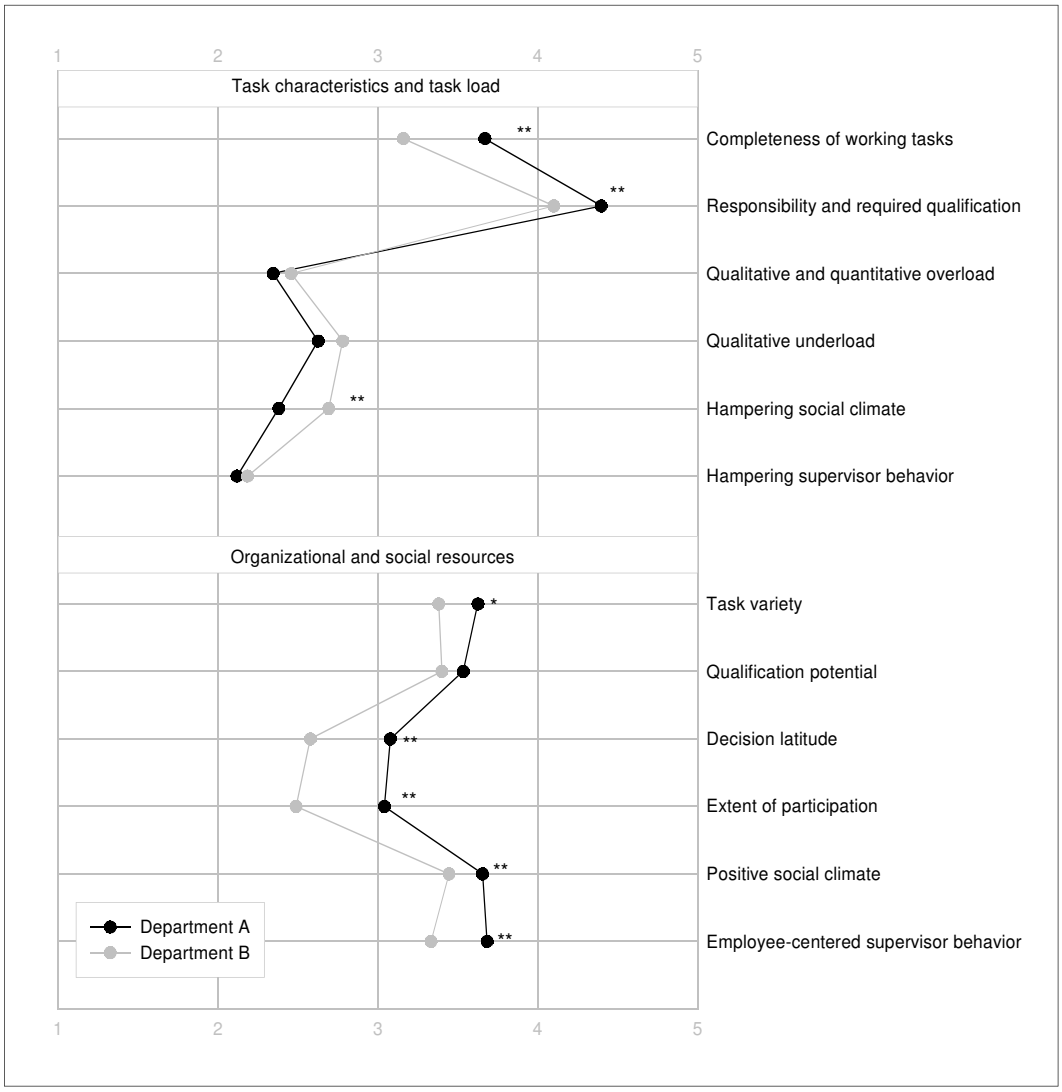

Figure 5.7. SALSA profiles for team A and B. * significant difference between team A and B $p < .10$.
**significant difference between team A and B $p < .01$.

Thus, the SALSA scales discriminated well between the two groups regarding the previously known differences. The profile also reveals some of the collateral effects or multicollinearity between the scales. For example, participation usually goes hand-in-hand with decision latitude and furthers the perception of completeness of working tasks.

Employee-centered supervisor behavior has the propensity to improve social climate within a working unit. It should be noted that the largest differences amounted to about 1 standard deviation of the respective scales.

6. Discussion

The present study addressed the construct validity of the SALSA questionnaire as to the prediction of health parameters. We employed a cross-sectional design with self-reported measures of health, as well as biological markers (allostatic load) used in previous studies on successful aging (McEwen & Seeman, 1999; Seeman et al., 2001; Seeman et al., 1997b). The SALSA is a well-known and frequently used questionnaire in German-speaking countries (Rimann & Udris, 1997b) for assessment of personal psychological job characteristics. Despite its widespread use in organizational psychology, it has never been scrutinized as to its validity regarding the prediction of health outcomes. Moreover, the available validation data stem predominantly from white-collar workers in the service sector. To fill the gap in knowledge, we conducted the present study amongst industrial employees (primarily male blue-collar workers) with simultaneous assessment of subjective and objective health measures.

One major conceptual challenge for the present study was the operationalization of health. As the SALSA was developed with the salutogenetic framework in mind, emphasizing a comprehensive view of health (Baumann & Perrez, 1998; Schwarzer, 1997; Udris et al., 1992), we aimed at employing a rather broad conceptualization both of subjective health perception as well as objective health assessment. For assessment of subjective health, we used several independent scales that capture overlapping, but independent, facets of the multivariate outcome *subjective health* (Kudielka et al., 2004). Reasoning that relationships between work characteristics and single biological measures, such as diastolic blood pressure or C-reactive protein, might be negligible in healthy workers and might therefore erroneously give rise to the assumption thatassociations are absent, we pursued the avenue of research put forth by the MacArthur studies on successful aging. In these studies, biological health risk was operationalized by a multivariate measure, the allostatic load. We followed the recent recommendations by Seeman and Mc Ewen (1997b), expanding their original

operationalization by additional measures, e.g. inflammatory activity and the hemostatic system. This led to a revised allostatic load score comprising 15 medical parameters.

However, the basis of this analysis is cross-sectional data from 1,285 employees of two airplane manufacturing plants in southern Germany. These skilled workers represent the upper range of the socioeconomic status of blue-collar workers in Germany. Therefore, our data may not be able to be generalized to very low socio-economic status jobs, such as unskilled labor.

The discussion first summarizes the findings regarding the different objectives. Subsequently the strengths and limitations, as well as the theoretical and practical implications of the results, are explained.

6.1 Reliability of the SALSA

The first objective was to assess the reliability of the SALSA questionnaire in our study sample. It should be noted that we were not able to employ the full, original instrument containing 61 items, as the management, as well as the workers council, objected to the use of two scales on work-related social support by the supervisor/coworkers and three items concerning personal scope not applicable to industrial workers. Examininginternal consistency using Cronbach's alpha for each SALSA scale revealed almost the same pattern as the coefficients in the original SALUTE study (Rimann & Udris, 1997b).Internal consistency was lower in the scales *completeness of working tasks* and *qualification potential* and was substantially higher for the scale *decision latitude.* This finding underscores that, from an internal consistency perspective, the instrument performs equally as well in blue-collar workers as in the original white- and blue-collar worker sample used for derivation of the scales. Compared to the low internal consistency of the scale *decision latitude* in the original study, this scale achieved an alpha of 0.65. This suggests that the SALSA captures a uniform construct for the present study sample. This is of importance as face validity reveals considerable overlap with the items assessing *decision latitude* in the widely used Karasek-Theorell job-content questionnaire – which was intended in the design of the SALSA (Rimann & Udris, 1993).

6.2 SALSA and self-reported health

This section discusses the findings regarding a possible association between SALSA scales and subjective or self-reported health. Two issues require consideration prior to delving into detailed discussion of our findings. First, there is the issue of correlating self-reported work-characteristics with self-reported health. Individuals taking a negative stance towards their working conditions may simultaneously perceive or report their own health as inferior. In that case, the observed relation would be confounded by an underlying personality trait often referred to as negative affectivity (Zapf & Semmer, 2004; Udris & Frese, 1999; Mohr & Semmer, 2002). In an analysis not presented in this thesis, we therefore investigated whether similar associations were found if we aggregated the SALSA scales scores of all members of a working group to department level. Indeed, this analysis revealed associations of a similar direction, as discussed in the following. Finally, as mentioned in the limitations section, the cross-sectional nature of our study does not permit causal inferences, as it is theoretically conceivable that subjects with poorer self-reported health end up in poorer work conditions. However, a main feature of our study population was that individuals usually kept the same workplace for extended periods of time. In the blue-collar workers the mean value regarding time in the same workplace was more than 10 years, while the usual recall period for our health outcome scales is four weeks to several months.

In general, the present analyses revealed a robust association between the SALSA scales and subjective well-being operationalized as six parameters of subjective health (*SF-12 physical summary score, SF-12 mental summary score, vital exhaustion, depression, sleep quality and somatic complaints*), regardless of whether these were carried out as partial correlation, as analysis of covariance or as multivariate regression analysis. In the following the six subjective health parameters are discussed separately.

Health-related quality of life

SF-12 physical summary score

The data of the partial correlation showed only small to moderate effects (r ranging from 0.07 to 0.24). The SALSA scales *decision latitude* and *responsibility and required qualification* showed the strongest positive correlation. We refrained from adjusting for socioeconomic status, as the manager jobs are characterized by higher decision latitude. Thus, controlling for job status would induce excessive controlling. The finding that the greatest difference between the first and fourth quartiles (9.68 points) was observed for the scale *task variety* suggests that the observed association is not solely mediated by job status, as we found striking differences as to perceived *task variety* amongst workers with similar job status (data not shown). The multivariate regression analysis revealed that the scales *hampering physical working conditions, decision latitude* and *responsibility and required qualification* together with age explained 15 % of the variance in the *physical summary score*. Thus, the three aforementioned scales show a small but significant association with the physical summary score.

SF-12 mental summary score

One specific strength of the SF-12 instrument is that it assesses two almost orthogonal summary scales, namely a *physical* and a *mental health component*. In contrast to the *physical health component*, the SALSA scales revealed a substantial association with the *SF-12 mental summary score*. The categories *task load* and *social resources* showed the highest coefficients in the partial correlation analysis. The same categories displayed the greatest differences between the first and fourth quartiles in the *mental summary score*. In line with this, multivariate regression explained 21 % of variance of the *mental summary score* in men and 16 % of the variance in women for the categories *task load* and *social resources scales*.

Our findings corroborate other reports showing that health-related quality of life are

associated with work characteristics. Cheng et al. (2000) found that low job control, high job demands and low work-related social support were associated with poor health status (investigated via the SF-36) in a four-year follow-up. Likewise Ibrahim et al. (2001) reported that high job strain was strongly associated with poor self-reported health. Amick et. al. (1998) further delineated the potentially toxic work characteristics by showing that iso-strain jobs characterized by high strain and low social support (Amick et al. defined these as iso-strain jobs) are associated with lower vitality, mental health and more pain. In summary, perceived psychosocial work characteristics and social support at work explain significant proportions of subjective health – if one accepts subjective health as characterizing a person's ability to function effectively physically, emotionally and socially and to maintain a sense of well-being. Because work characteristics may first impact on psychological well-being and perception of one's self before affecting physical functioning, it is conceivable that greater associations can be expected with the *mental health summary score* than with a score reflecting physical functioning more directly.

Vital exhaustion

Vital exhaustion, a state of unusual tiredness, increased irritability and feelings of demoralization, was originally described as a precursor of acute coronary events (Appels et al., 1987). Appels (1988) showed that *vital exhaustion* is an independent risk factor of myocardial infarction. *Vital exhaustion* is strongly correlated with the *mental health summary score* (Kudielka et al., 2004). Therefore, it is of interest to investigate the size of the association between work characteristics and exhaustion in comparison to the already discussed relation with the *mental heath summary score*. The analysis revealed the strongest association between the SALSA scales and any of the six subjective health measures for the scale vital exhaustion. Partial correlation found the highest coefficients for the *task load* and *social resources* scales as well as for the scale *hampering physical working conditions*. These findings were supported by the other analytical approaches, with the scales explaining 27 % of variance in men and 16 % of variance in women in

multivariate regression analysis. Moreover, the proportion of individuals with an exhaustion score over 11, indicating severe exhaustion, was substantially larger in the group of participants with the most adverse SALSA scores. These results support earlier findings by our group (Schnorpfeil et al., 2002).

In the present study, we did not examine the simultaneous effect of overcommitment, effort and reward according to the effort-reward-imbalance model (Siegrist, 1996). In essence, the effort-reward-imbalance model assumes that a lack of reciprocity between costs and rewards is experienced as very stressful and results in strain, e.g. high autonomic arousal. Numerous studies showed that high effort and low reward predicted low self-reported health, cardiovascular risk factors and manifestations of coronary heart disease (Bosma et al., 1998; de Jonge, Bosma, Peter, & Siegrist, 2000; Peter, Geissler, & Siegrist, 1998). Previous work from our group has shown that overcommitment and effort-reward imbalance also explain considerable proportions of the variance in exhaustion levels. These findings might be reconciled when viewing exhaustion as the primary subjective health outcome that is affected by adverse job conditions. These adverse job conditions “get under an individual's skin” by affecting the perception of effort-reward imbalance and are facilitated by the personal coping style of overcommitment. Once individuals perceive themselves to be exhausted, which subjectively manifests itself as depressive mood, lack of energy and sleep problems, subjective mental health may secondarily be affected. This hypothesis is still to be tested in longitudinal studies on subjects experiencing drastic changes in work conditions.

Depression

Like exhaustion, *task load* and *social resources scales* showed the strongest correlation with the *HADS depression score.* Our analysis does not disentangle to what extent higher scores on the *depression scale* were, in fact, a facet of *exhaustion*. Face validity of the scale suggests that medium scores in the *HADS depression scale* should be interpreted as a loss of life enjoyment rather than as being indicative of clinical

depression. To this extent, our findings again corroborate previous work in other study populations. For example, the Whitehall II study (Stansfeld et al., 1999) reported a relationship between adverse working conditions, low social support and depression. Within the job demand-job control model, Karasek (1990) revealed associations between job strain and depression. Park et al. (2004) found a strong relation between low social support at work and depression. Evidence from other longitudinal studies also suggests that stressful work situations are associated with increased levels of depressive symptoms (Schonfeld, 1992; Zohar, 1999). Thus, job-related stress, in terms of low support and high task load, may increase vulnerability for mood disturbances.

Sleep quality

Our analysis revealed only a small but significant relation between the SALSA scales and *sleep quality*. The impact in our data appears to be less profound than previously reported in the literature (Ribet & Derriennic, 1999). Several investigators have shown that high psychological demands and low social support from coworkers and supervisors have an important impact on sleep disturbances and fatigue at work (Akerstedt et al., 2002b; Jacquinet-Salord et al., 1993; Kageyama et al., 1998). Kageyama (1998) and Marquie (1999a; 1999b) reported that a person's perception of his or her job conditions are associated with self-reported sleep complaints. These other studies did not simultaneously employ a specific exhaustion scale, containing items related to sleep quality. We therefore suggest that future studies regarding the association between sleep problems and work stress should investigate whether the former are at least in part a secondary effect of *exhaustion*.

Somatic complaints

The *somatic complaints list* captures a range of symptoms that usually do not correspond to medically sound anatomical diagnosis. Although these complaints may be severely disabling and may impede an individual's perception of health, they are difficult

to capture by biomedical measures. On the other hand, these complaints are a frequent cause of absence from work, medical shopping and, ultimately, an increase in the risk of invalidity. These complaints may heuristically be viewed as the somatic sensation of distress that in other individuals manifest themselves as sleep problems or mood disturbances. Consistent with this heuristic, we found substantial associations between the adverse conditions on the SALSA scales (especially the s*cales hampering physical working conditions* and *qualitative and quantitative overload*) and increased scores in *somatic complaints*. These results suggest that occupational physicians and psychologists should consider exploring a patient's work characteristics if confronted with unspecific somatic complaints. A lagged effect between stressors at work (defined as low social support and high task load) and somatic health complaints should be kept in mind (Frese, 1985; Carayon, 1993).

Conclusion

These observations reveal a dose-response relationship between perceived *high task load*, *low organizational* and *low social resources* and adverse self-reported health. The aforementioned categories were strongly related to the measurements of *SF-12 mental summary score*, *vital exhaustion*, *HADS depression score* and *somatic complaints* and, to a lesser extent, to the subjective perception of *physical health* and *sleep quality*. Our findings are in line with recent literature (Karasek et al., 1982; Kivimaki et al., 2002; Siegrist, 1998). With regard to the purpose of present study, our data support the external validity of the SALSA scales for elucidating the relationship between work characteristics and subjective health. If one views alterations in subjective health as potential precursors of subsequent manifestations of irreversible health problems, this study underscores the usefulness of SALSA for assessing working conditions in environments challenged by the demographic change. Expanding on the SALUTE study, our data show that the SALSA is rightfully applicable in blue-collar working environments.

6.3 SALSA and physiological measures

While one may suggest that the association between self-reported work characteristics and self-reported health may be confounded by negative affectivity, this is less likely to occur for the possible association between work characteristics and biological measures of health. The concept of *allostatic load* suggests that, ultimately, perceived psychosocial stressors lead to increased arousal and chronic stress responses, which in turn create a biological burden of chronic stress and adverse health behavior (McEwen & Seeman, 1999) by altering the set point of biological parameters, such as the diastolic blood pressure. Recent findings from the Whitehall II study suggest that the biological pathway linking psychosocial stress to changed biological functioning is an altered autonomic function (Hemingway et al., 2005). Because allostatic reactions regulate a multitude of downstream systems, it is mandatory to assess these symptoms simultaneously. In the same way that multiple items are employed in psychometry to increase the reliability of a scale and to reduce measurement error, biological variables should be viewed as the items on a scale defining biological health. Such endeavors should ideally be supported by confirmatory factor analysis and structural equation modeling. Using canonical correlation we expanded on the approach pursued by the MacArthur researchers (Karlamangla et al., 2002), who found a canonical correlate of r = 0.39 for a pair of allostatic load variables and biological measures of physical and mental ability in the elderly. Our analysis revealed a canonical correlation of r = 0.38 for all *allostatic load variables*. Moreover, a subgroup analysis on managers, which removed the effect of social status revealed a canonical correlation of r = 0.59 between a subset of *allostatic load variables* defining the *metabolic syndrome* and the SALSA scales. These data suggest that a lack of resources at work is associated with an increased risk of the *metabolic syndrome* in managers. Our work elaborates on earlier reports from our group (Schnorpfeil et al., 2003) showing that the SALSA scales even explain variance in biological indicators of health.

6.4 Discriminative ability of the SALSA questionnaire

The previous sections showed the association between the SALSA scales and individual employees' subjective and objective health measures. This did not include the question of whether the SALSA provides discriminative information when assessing working groups or units. However, this is of paramount importance if the SALSA is to be used in occupational health counseling. Therefore, we compared two working groups; we knew a priori that there were markedly different work characteristics, despite comparable tasks and work force composition. Moreover, these groups were located within the same company but several buildings apart. We knew from a preparational qualitative study using workplace group interviews that the two work places differed as to their leadership style. The leaders' emphasis in one group was to stimulate participation of the workers, while the other group was led in a more authoritative style providing for less decision latitude and participation. The profiles of the two teams on the SALSA scales exactly mirrored the a priori assessments for the two groups. Moreover, the differences in the scales amounted to about 0.5 – 0.8 standard deviations, suggesting that the SALSA would have been able to detect group differences with statistical significance in groups of about 30 or more participants.

6.5 Limitations, strengths and future research

The primary limitation of this study is the cross-sectional design. Furthermore, many researchers have rightfully criticized the research approach using self-reported measures (Frese & Zapf, 1988; Kasl, 1978; Zapf, Dormann, & Frese, 1996). One of the strengths of our study is the additional use of a comprehensive set of biological parameters. Moreover, the study will be continued in the future with a 3- to 5-year recall of the subjects seen at baseline for the present analysis. As already mentioned, the cross-sectional data do not allow us to make inferences about causality. Empirical relationships between the SALSA and health might be due to third variables, such as negative affectivity. Moreover, the one-time measurement of the biological parameters increases the contribution of random error, particularly in variables that might change rapidly, like overnight catecholamine secretion or blood pressure (Kamarck et al., 1998; Kirschbaum & Hellhammer, 1999; Pickering et al., 1996). Therefore, in future studies, multiple physiological measurements over long intervals are preferable. In our study, increased random error would have impaired our ability to detect associations.

While the *allostatic load* framework offers a compelling way to view the cascading events from the perception of psychosocial stressors or altered health behavior, thru primary mediators and secondary changes in adaptive systems to tertiary outcomes, its operationalization is less elaborate. The original reports from the MacArthur studies had to use the data that was available (McEwen & Seeman, 1999). Our study had the advantage that it was the first purpose-designed attempt to relate working conditions to allostatic load. However, monetary restraints, practicality and compliance considerations, as well as pre-analytical and sampling issues, constrained the number of potential parameters. For example, one would also like to perform biological function tests, such as an oral glucose tolerance test to assess the reactivity of the glucose metabolism, or a CO2 inhalation test to assess the biological response to extreme biological stress (Bailey, Argyropoulos, Lightman, & Nutt, 2003). Furthermore, the elimination of the scales s*ocial support by supervisor* (items D40, D44 and D48) and *social support by coworkers* (item

D41, D45 and D49) is a strong limitation. Social support is of tremendous interest for a holistic view of this research field. Our aim is to include this scales into the following data collections

Finally, our study sample comprised a predominantly male blue-collar working population. These skilled workers in the highly competitive European airplane manufacturing industry represent the upper range of the socioeconomic status of blue-collar workers. Although our sample comprised more than 1,000 participants, it remains open whether our data can be generalized to the population. Support for the generalization comes from the MONICA Augsburg cohort study, in which some of our subjects took part. Comparing the general health descriptors provided in publications on that study with our medical variables suggests that our sample is representative for males, at least with respect to the underlying biology.

7 Summary and conclusion

In summary, we demonstrated that the SALSA questionnaire, particularly the *task load* and *resources scales*, is associated with health. The results measuring perceived work characteristics may not only provide information about the work place, but may also predict the current and future health status of an individual. Thus, organizational health management may be able to use the SALSA as a starting point for work assessment. Contrary to pure health measures, the SALSA provides common ground for discussing changes in the workplace with non-experts in health issues, such as the management of a company; this may not only improve productivity but also have beneficial effects on employees' health.

As in the Whitehall II study or the GAZEL study for highly selected employees (civil servants), future research should longitudinally explore the relationship between perceived work characteristics and health. Additional workplace measurements (e.g. job demand/job control model, effort-reward-imbalance model), including objective descriptors of work as well as more sophisticated statistical models (e.g. structural equation modeling), may further elucidate the intricate relationship between work and health. And finally, our findings ultimately relate to sickness prevention in the work place.

8. References

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9 Appendix

List of abbreviations

SALSA questionnaire sorted by scales (Table 1)

Original SALSA questionnaire (Table 2)

Analysis of Covariance (Table 3)

Intercorrelation and Multivariable Regression Analyses (Tables 4-16)

List of abbreviations

β	Beta; standardized multiple regression coefficient
BMI	Body mass index
CRP	C-reactive protein
df	degree of freedom
DHEA-S	Dehydroepiandrosterone sulfate
DSM IV	Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition
HADS	Hospital Anxiety and Depression scale
HbA1c	Glycosyslated hemoglobin
HDL	High density lipoprotein
HPA axis	Hypothalamic-pituitary-adrenal axis
HRQoL	Health Related Quality of Life
LDL	Low density lipoprotein
MS	Mean Square
p	Probability
SALSA	Salutogenetic Subjective Work Analysis
SD	Standard deviation
SE B	Standard error of the unstandardized coefficient B
SEM	Standard error of mean
SES	Socioeconomic status
SOC	Sense of Coherence
SS	Sum of squares
WHO	World Health Organization

9. Appendix

Table 1. SALSA questionnaire sorted by scales

		Excluded items	Cronbach's alpha SALUTE study	Cronbach's alpha Work and health study
Task characteristics				
Completeness of working tasks			0.75	0.64
B01	In this job I do something in its entirety.			
B27	This work is so divided up, one carries out only a small part of the task.			
B33	In my work I do or make something from beginning to end.			
Responsibility and required qualification			0.71	0.68
B02	For this job one has to be well qualified/trained.			
B09	One has to be able to make decisions independently.			
B20	This work demands that I take on a great deal of responsibility.			
B31	For this work no special skills are required.			
Task load				
Qualitative and quantitative overload			0.78	0.71
B04	There is enough time to do the work.	ex.		
B11	Sometimes I have to do things for which I am not sufficiently trained.			
B12	There is so much to do that I am getting out of my depth.			
B18	Sometimes the work is too difficult.			
B23	So many things happen at once that one can hardly deal with them all.			
B34	At work some things are too complicated.			
Qualitative underload			0.62	0.64
B07	In this job I rarely have the chance to use my skills.			
B16	I have little chance of doing the things which I do really well.			
B25	Here I have the feeling that I could do more than is required.			
Hampering social climate			0.6	0.62
B14	One has to work with people who cannot take a joke.			
B30	There is often tension at the workplace.			
B40	One has to take the consequences for the things others have done wrongly.			
Hampering supervisor behavior			0.78	0.78
B22	If there is a mistake, the supervisor always thinks it is our fault and not his/hers.			
B28	The supervisor makes working more difficult by giving instructions.			
B35	The supervisor treats us unfairly.			
Exposure due to external activity/conditions				
Hampering physical working conditions			-	0.7
B46	Noise			
B47	Bad lighting			
B48	Uncomfortable temperatures			
B51	Waiting periods			

		Excluded items	Cronbach's alpha SALUTE study	Cronbach's alpha Work and health study
B53	Defective technical instruments/equipment			
B55	Air-conditioning (draughts, noise, etc.)			
Z05	Shift-work or unattractive working hours			
Z06	Posture/position (too much sitting, standing etc.)			
Z07	Time pressure			
	Organizational resources			
Task variety			0.76	0.84
B26	Nearly every day there is something different to do.			
B29	This work is varied.			
B41	In this work I always have to do the same thing.			
Qualification potential			0.62	0.62
B06	In this job I am losing many of the skills I had before.			
B08	This job offers good chances for promotion.			
B21	In this work I can always learn something new.			
Decision latitude			0.5	0.65
B05	We are given exact instructions on how to do our work.			
B15	This work allows me to make a lot of my own decisions.			
B36	I can schedule my work myself.			
Extent of participation			0.62	0.55
B13	If someone has a good idea, it is possible to put it into practice in this company.			
B39	In this company it sometimes happens that we are confronted with a fait accompli.			
B42	In this company we can join in the discussion and help with important decision making.			
Personal scope for workplace design			-	-
B10	We can decorate the workplace how we like (e.g. with pictures, plants, lights).	ex.		
Scope for personal and private things at work			-	-
B24	At my workplace there is sometimes the possibility to do things which are not directly connected with my tasks (e.g. short breaks, telephone calls).	ex.		
	Social resources at work			
Positive social climate			0.72	0.7
B19	We all trust each other here so we can talk openly about everything, even very personal matters.			
B37	The people with whom I work are friendly.			
B43	The people with whom I work help me to fulfil my tasks.			
B45	The people with whom I work are interested in me as a person.			
Employee-centered supervisor behavior			0.8	0.8
B03	The supervisor lets us know how well we have done our work.			

		Excluded items	Cronbach's alpha SALUTE study	Cronbach's alpha Work and health study
B17	The supervisor helps me to fulfil my tasks.			
B32	The supervisor is concerned about the well being of his/her empoyees.			
B38	It is easy to approach the supervisor.			
B44	The supervisor pays attention to what I say.			
Social support by supervisor			0.9	-
D40	How much can you rely on your supervisor if problems occur at work?	ex.		
D44	How willing is your supervisor to listen to your problems at work?	ex.		
D48	To what extent does your supervisor actively support you to make your work easier?	ex.		
Social support by coworkers			0.87	-
D41	How much can you rely on your colleagues if problems occur at work?	ex.		
D45	How willing are your colleagues to listen to your problems at work?	ex.		
D49	To what extent do your colleagues actively support you to make your work easier?	ex.		

Note. N in the SALUTE study = 1655. N in the work and health study = 1282. ex = Item was excluded in the work and health study.

Table 2. Original SALSA questionnaire

Following are some questions which concern your work situation. Please check off the apt rank for <u>each</u> sentence.		hardly ever isn't true at all	rare rather not true	some-times a bit of both	often true	almost always abso-lutely true
B01	In this job I do something in its entirety.	☐	☐	☐	☐	☐
B02	For this job one has to be well qualified/trained.	☐	☐	☐	☐	☐
B03	The supervisor lets us know how well we have done our work.	☐	☐	☐	☐	☐
B04	There is enough time to do the work.	☐	☐	☐	☐	☐
B05	We are given exact instructions on how to do our work.	☐	☐	☐	☐	☐
B06	In this job I am losing many of the skills I had before.	☐	☐	☐	☐	☐
B07	In this job I rarely have the chance to use my skills.	☐	☐	☐	☐	☐
B08	This job offers good chances for promotion.	☐	☐	☐	☐	☐
B09	One has to be able to make decisions independently.	☐	☐	☐	☐	☐
B10	We can decorate the workplace how we like (e.g. with pictures, plants, lights).	☐	☐	☐	☐	☐
B11	Sometimes I have to do things for which I am not sufficiently trained.	☐	☐	☐	☐	☐
B12	There is so much to do that I am getting out of my depth.	☐	☐	☐	☐	☐
B13	If someone has a good idea, it is possible to put it into practice in this company.	☐	☐	☐	☐	☐
B14	One has to work with people who cannot take a joke.	☐	☐	☐	☐	☐

		hardly ever isn't true at all	rare rather not true	some-times a bit of both	often true	almost always abso-lutely true
B15	This work allows me to make a lot of my own decisions.	☐	☐	☐	☐	☐
B16	I have little chance of doing the things which I do really well.	☐	☐	☐	☐	☐
B17	The supervisor helps me to fulfil my tasks.	☐	☐	☐	☐	☐
B18	Sometimes the work is too difficult.	☐	☐	☐	☐	☐
B19	We all trust each other here so we can talk openly about everything, even very personal matters.	☐	☐	☐	☐	☐
B20	This work demands that I take on a great deal of responsibility.	☐	☐	☐	☐	☐
B21	In this work I can always learn something new.	☐	☐	☐	☐	☐
B22	If there is a mistake, the supervisor always thinks it is our fault and not his/hers.	☐	☐	☐	☐	☐
B23	So many things happen at once that one can hardly deal with them all.	☐	☐	☐	☐	☐
B24	At my workplace there is sometimes the possibility to do things which are not directly connected with my tasks (e.g. short breaks, telephone calls).	☐	☐	☐	☐	☐
B25	Here I have the feeling that I could do more than is required.	☐	☐	☐	☐	☐
B26	Nearly every day there is something different to do.	☐	☐	☐	☐	☐
B27	This work is so divided up, one carries out only a small part of the task.	☐	☐	☐	☐	☐
B28	The supervisor makes working more difficult by giving instructions.	☐	☐	☐	☐	☐
B29	This work is varied.	☐	☐	☐	☐	☐

		hardly ever isn't true at all	rare rather not true	some-times a bit of both	often true	almost always abso-lutely true
B30	There is often tension at the workplace.	☐	☐	☐	☐	☐
B31	For this work no special skills are required.	☐	☐	☐	☐	☐
B32	The supervisor is concerned about the well being of his/her empoyees.	☐	☐	☐	☐	☐
B33	In my work I do or make something from beginning to end.	☐	☐	☐	☐	☐
B34	At work some things are too complicated.	☐	☐	☐	☐	☐
B35	The supervisor treats us unfairly.	☐	☐	☐	☐	☐
B36	I can schedule my work myself.	☐	☐	☐	☐	☐
B37	The people with whom I work are friendly.	☐	☐	☐	☐	☐
B38	It is easy to approach the supervisor.	☐	☐	☐	☐	☐
B39	In this company it sometimes happens that we are confronted with a fait accompli.	☐	☐	☐	☐	☐
B40	One has to take the consequences for the things others have done wrongly.	☐	☐	☐	☐	☐
B41	In this work I always have to do the same thing.	☐	☐	☐	☐	☐
B42	In this company we can join in the discussion and help with important decision making.	☐	☐	☐	☐	☐
B43	The people with whom I work help me to fulfil my tasks.	☐	☐	☐	☐	☐
B44	The supervisor pays attention to what I say.	☐	☐	☐	☐	☐

		hardly ever isn't true at all	rare rather not true	some-times a bit of both	often true	almost always abso-lutely true
B45	The people with whom I work are interested in me as a person.	☐	☐	☐	☐	☐

Are you affected at your workplace by the following things?		does not occur	very little	rather little	so-so	rather strong	very strong
B46	Noise.	☐	☐	☐	☐	☐	☐
B47	Bad lighting.	☐	☐	☐	☐	☐	☐
B48	Uncomfortable temperatures.	☐	☐	☐	☐	☐	☐
B51	Waiting periods.	☐	☐	☐	☐	☐	☐
B53	Defective technical instruments/equipment	☐	☐	☐	☐	☐	☐
B54	Working long periods on a computer.	☐	☐	☐	☐	☐	☐
B55	Air-conditioning (draughts, noise, etc.)	☐	☐	☐	☐	☐	☐
Z05	Shift-work or unattractive working hours.	☐	☐	☐	☐	☐	☐
Z06	Posture/position (too much sitting, standing etc.)	☐	☐	☐	☐	☐	☐
Z07	Time pressure	☐	☐	☐	☐	☐	☐

	How much can you rely on the following people if problems occur at work?	not at all	a little	to some degree	usually	abso-lutely
D40	On your supervisor	☐	☐	☐	☐	☐
D41	On your colleagues	☐	☐	☐	☐	☐

	How willing are these people to listen to your problems at work?	not at all	a little	to some degree	usually	abso-lutely
D44	Your supervisor	☐	☐	☐	☐	☐
D45	Your colleagues	☐	☐	☐	☐	☐

	To what extent do these people actively support you to make your work easier?	not at all	a little	to some degree	usually	abso-lutely
D48	Your supervisor	☐	☐	☐	☐	☐
D49	Your colleages	☐	☐	☐	☐	☐

Table 3: Analysis of covariance for the SALSA scales as factors and the six subjective health outcomes as dependent variables controlled for age

	Physical summary score			Mental summary score			Vital exhaustion			Depression			Sleep quality			Somatic complaints		
	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile	Adj. R2	Adj. Mean 1st quartile	Adj. Mean 4th quartile
Task characteristics																		
Completeness of working tasks	.064***	49.17	50.95	.041***	45.92	49.60	.049***	8.43	6.11	.063***	5.57	4.08	.018***	5.67	4.74	.045**	20.23	16.06
Responsibility and required qualification	.107**	48.03	51.20	.014**	46.74	48.74	0.01*	7.81	6.88	.054***	5.46	4.18	.026**	5.79	4.86	.041**	19.88	17.01
Task load																		
Qualitative and quantitative overload	.073	50.51	49.49	.133***	51.56	44.24	.180***	5.17	9.40	.148***	3.67	5.83	.069***	4.40	6.19	.151***	14.51	22.22
Qualitative underload	.113***	51.65	48.27	.074***	50.41	45.38	.081***	5.86	8.76	.105***	3.88	5.75	.050***	4.52	6.21	.070***	15.74	20.49
Hampering social climate	.068**	50.83	49.29	.148***	51.28	43.53	.168***	5.18	9.67	.126***	3.81	5.86	.064***	4.17	6.23	.104***	14.81	21.58
Hampering supervisor behavior	.086***	50.81	48.64	.074***	50.54	45.21	.085***	5.79	8.93	.103***	4.00	5.68	.044***	4.58	6.02	.109***	15.29	21.44
Exposure due to ext. activity-conditions																		
Hampering physical working conditions	.096***	52.00	48.21	.090***	50.83	44.78	.180***	5.26	9.72	.155***	3.59	5.89	.118***	3.87	6.66	.218***	12.94	23.31
Organizational resources																		
Task variety	.103***	41.36	51.04	.013	45.54	48.89	.011*	9.85	6.58	.015*	6.16	4.31	.020	6.61	4.66	.016*	23.11	16.26
Qualification potential	.118***	48.11	51.34	.050***	45.68	50.14	.058***	8.55	6.08	.129***	5.80	3.74	.040***	6.09	4.62	.087***	21.08	15.57
Decision latitude	.122***	47.90	52.35	.006*	47.27	48.80	.028***	7.99	6.07	.035***	5.13	4.22	.026***	5.85	4.48	.060***	20.35	14.97
Extent of participation	.084***	48.75	50.93	.052***	45.58	49.90	.076***	8.83	6.03	.079***	5.68	4.09	.035***	5.98	4.68	.074***	21.09	16.15
Social resources at work																		
Positive social climate	.094***	48.54	51.20	.094***	44.19	50.42	.101***	9.25	6.13	.186***	6.21	3.60	.054***	6.11	4.56	.109***	21.71	15.70
Employee-centered supervisor behavior	.107***	48.01	51.03	.099***	44.49	50.78	.127***	9.37	5.72	.179***	6.13	3.49	.049***	6.20	4.59	.130***	22.41	15.59

Note.* significant at $p < .05$.**significant at $p < .01$. ***significant at $p < .001$.Bonferoni adjustment was employed to calculate the adjusted mean. N for each scale according to Table 5.3.

Table 4: Intercorrelations and coefficent alphas for the SALSA scales

	Measure	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Completeness of working tasks	**.64**												
2	Responsibility and required qualification	.31**	**.68**											
3	Qualitative and quantitative overload	-.12**	.16**	**.71**										
4	Qualitative underload	-.33**	-.33**	.07*	**.64**									
5	Hampering social climate	-.24**	-.09**	.42**	.32**	**.62**								
6	Hampering supervisor behavior	-.27**	-.19**	.27**	.36**	.55**	**.78**							
7	Hampering physical working conditions	-.22**	-.01	.30**	.33**	.33**	.31	**.70**						
8	Task variety	.27**	.51**	.13**	-.44**	-.14**	-.23**	-.20**	**.84**					
9	Qualification potential	.29**	.45**	.00	-.54**	-.24**	-.24**	-.29**	.61**	**.62**				
10	Decision latitude	.32**	.39**	.06*	-.28**	-.14**	-.29**	-.27**	.41**	.28**	**.65**			
11	Extent of participation	.32**	.23**	-.15**	-.40**	-.36**	-.38**	-.36**	.33**	.43**	.28**	**.55**		
12	Positive social climate	.23**	.24**	-.15**	-.30**	-.48**	-.36**	-.17**	.25**	.34**	.19**	.32**	**.70**	
13	Employee-centered supervisor behavior	.27**	.26**	-.16**	-.37**	-.47**	-.62**	-.31**	.32**	.44**	.21**	.47**	.52**	**.80**

Note. Coefficent alphas are presented in boldface along the diagonal. *significant at $p < .05$. **significant at $p < .01$.

Table 5. Intercorrelations and coefficent alphas for the subjective health parameters

	Measure	1	2	3	4	5	6
1	Physical summary score	**-**[a]					
2	Mental summary score	-.05**	**-**[a]				
3	Vital exhaustion	-.31**	-.62**	**.84**			
4	Depression	-.27**	-.56**	.58**	**.76**		
5	Sleep quality	-.26**	-.38**	.64**	.43**	**.80**	
6	Somatic complaints	-.42**	-.46**	.65**	.50**	.54**	**.94**

Note. N = 1282. Coefficent alphas are presented in boldface along the diagonal. *significant at p < .05. **significant at p < .01. [a] physical and mental summary score are calculated by an algorithm, due to that no coefficent alphas are reported.

Table 6. Summary of Multivariate Regression Analysis for variables predicting SF-12 physical summary score in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.068	
Age	-0.97	.11	-.26		
Step 2				.118	.051**
Age	-1.29	.11	-.35		
Decision latitude	0.73	.09	.24		
Step 3				.138	.019**
Age	-1.23	.11	-.33		
Decision latitude	0.60	.09	.20		
Hampering physical working conditions	-0.16	.03	-.16		
Step 4				.154	.017**
Age	-1.25	.11	-.34		
Decision latitude	0.42	.10	.14		
Hampering physical working conditions	-0.17	.03	-.16		
Responsibility and required qualification	0.43	.09	.14		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Sqare for Step 4 = .152.

Table 7. Summary of Multivariate Regression Analysis for variables predicting SF-12 mental summary score in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.122	
Hampering social climate	-1.58	.13	-.35		
Step 2				.168	.045**
Hampering social climate	-1.14	.13	-.25		
Qualitative and quantitative overload	-0.72	.09	-.23		
Step 3				.186	.018**
Hampering social climate	-0.92	.14	-.20		
Qualitative and quantitative overload	-0.74	.09	-.24		
Qualitative underload	-0.64	.13	-.14		
Step 4				.194	.008*
Hampering social climate	-0.73	.15	-.16		
Qualitative and quantitative overload	-0.75	.09	-.25		
Qualitative underload	-0.53	.13	-.12		
Employee-centered supervisor behavior	0.27	.08	.11		
Step 5				.203	.009**
Hampering social climate	-0.73	.15	-.16		
Qualitative and quantitative overload	-0.78	.09	-.26		
Qualitative underload	-0.48	.13	-.11		
Employee-centered supervisor behavior	0.29	.08	.11		
Age	0.42	.12	.09		
Step 6				.207	.004*
Hampering social climate	-0.62	.15	-.14		
Qualitative and quantitative overload	-0.79	.09	-.26		
Qualitative underload	-0.45	.13	-.10		
Employee-centered supervisor behavior	0.22	.08	.09		
Age	0.44	.12	.10		
Positive social climate	0.28	.11	.08		
Step 7				.211	.004*
Hampering social climate	-0.59	.15	-.13		
Qualitative and quantitative overload	-0.74	.09	-.24		
Qualitative underload	-0.38	.13	-.08		
Employee-centered supervisor behavior	0.18	.08	.07		
Age	0.43	.12	.10		
Positive social climate	0.31	.11	.09		
Hampering physical working conditions	-0.09	.04	-.07		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Square for Step 7 = .206.

Table 8. Summary of Multivariate Regression Analysis for variables predicting vital exhaustion in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.152	
Qualitative and quantitative overload	0.62	.04	.39		
Step 2				.212	.060**
Qualitative and quantitative overload	0.44	.05	.28		
Hampering social climate	0.64	.07	.27		
Step 3				.248	.036**
Qualitative and quantitative overload	0.38	.05	.24		
Hampering social climate	0.52	.07	.22		
Hampering physical working conditions	0.14	.02	.20		
Step 4				.263	.016**
Qualitative and quantitative overload	0.44	.05	.27		
Hampering social climate	0.46	.07	.20		
Hampering physical working conditions	0.12	.02	.17		
Task variety	-0.25	.05	-.13		
Step 5				.269	.005**
Qualitative and quantitative overload	0.44	.05	.27		
Hampering social climate	0.38	.07	.16		
Hampering physical working conditions	0.11	.02	.16		
Task variety	-0.21	.05	-.11		
Employee-centered supervisor behavior	-0.12	.04	-.09		
Step 6				.271	.002*
Qualitative and quantitative overload	0.44	.05	.27		
Hampering social climate	0.34	.08	.14		
Hampering physical working conditions	0.11	.02	.17		
Task variety	-0.20	.05	-.11		
Employee-centered supervisor behavior	-0.09	.04	-.07		
Positive social climate	-0.11	.06	-.06		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Square for Step 6 = .267.

Table 9. Summary of Multivariate Regression Analysis for variables predicting depression in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.121	
Positive social climate	-0.40	.03	-.35		
Step 2				.199	.078**
Positive social climate	-0.35	.03	-.30		
Qualitative and quantitative overload	0.28	.03	.28		
Step 3				.222	.024**
Positive social climate	-0.33	.03	-.28		
Qualitative and quantitative overload	0.24	.03	.24		
Hampering physical working conditions	0.07	.01	.16		
Step 4				.236	.013**
Positive social climate	-0.25	.04	-.22		
Qualitative and quantitative overload	0.23	.03	.24		
Hampering physical working conditions	0.05	.01	.13		
Employee-centered supervisor behavior	-0.12	.03	-.14		
Step 5				.245	.009**
Positive social climate	-0.24	.03	-.21		
Qualitative and quantitative overload	0.22	.03	.22		
Hampering physical working conditions	0.06	.01	.14		
Employee-centered supervisor behavior	-0.11	.03	-.14		
Age	0.14	.04	.10		
Step 6				.255	.001**
Positive social climate	-0.22	.04	-.19		
Qualitative and quantitative overload	0.25	.03	.25		
Hampering physical working conditions	0.06	.01	.14		
Employee-centered supervisor behavior	-0.09	.03	-.11		
Age	0.17	.04	.12		
Responsibility and required qualification	-0.13	.03	-.11		
Step 7				.259	.004*
Positive social climate	-0.21	.04	-.18		
Qualitative and quantitative overload	0.25	.03	.25		
Hampering physical working conditions	0.05	.01	.12		
Employee-centered supervisor behavior	-0.08	.03	-.10		
Age	0.18	.04	.12		
Responsibility and required qualification	-0.11	.03	-.09		
Qualitative underload	0.10	.04	.07		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Square for Step 7 = .254.

Table 10. Summary of Multivariate Regression Analysis for variables predicting sleep quality in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.066	
Hampering physical working conditions	0.15	.02	.26		
Step 2				.092	.026**
Hampering physical working conditions	0.12	.02	.21		
Qualitative and quantitative overload	0.22	.04	.17		
Step 3				.105	.013**
Hampering physical working conditions	0.11	.02	.19		
Qualitative and quantitative overload	0.21	.04	.15		
Positive social climate	-0.18	.04	-.12		
Step 4				.113	.008**
Hampering physical working conditions	0.11	.02	.20		
Qualitative and quantitative overload	0.19	.04	.14		
Positive social climate	-0.17	.04	-.11		
Age	0.18	.05	.09		
Step 5				.122	.008**
Hampering physical working conditions	0.10	.02	.18		
Qualitative and quantitative overload	0.22	.04	.17		
Positive social climate	-0.13	.05	-.08		
Age	0.20	.05	.10		
Task variety	-0.15	.05	-.10		
Step 6				.125	.003*
Hampering physical working conditions	0.09	.02	.16		
Qualitative and quantitative overload	0.23	.04	.17		
Positive social climate	-0.11	.05	-.07		
Age	0.24	.06	.13		
Task variety	-0.12	.05	-.08		
Decision latitude	-0.12	.05	-.07		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Square for Step 6 = .121.

Table 11. Summary of Multivariate Regression Analysis for variables predicting somatic complaints in men.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.128	
Hampering physical working conditions	0.55	.04	.36		
Step 2				.184	.056**
Hampering physical working conditions	0.44	.04	.28		
Qualitative and quantitative overload	0.91	.10	.25		
Step 3				.206	.022**
Hampering physical working conditions	0.45	.04	.29		
Qualitative and quantitative overload	0.84	.10	.23		
Age	0.80	.14	.15		
Step 4				.230	.025**
Hampering physical working conditions	0.37	.04	.24		
Qualitative and quantitative overload	0.91	.10	.25		
Age	1.12	.15	.21		
Decision latitude	-0.77	.13	-.18		
Step 5				.240	.010**
Hampering physical working conditions	0.36	.04	.23		
Qualitative and quantitative overload	0.86	.10	.24		
Age	1.03	.15	.19		
Decision latitude	-0.66	.13	-.15		
Positive social climate	-0.44	.11	-.10		
Step 6				.246	.006**
Hampering physical working conditions	0.34	.04	.22		
Qualitative and quantitative overload	0.92	.10	.25		
Age	1.02	.15	.19		
Decision latitude	-0.53	.14	-.12		
Positive social climate	-0.37	.12	-.09		
Task variety	-0.38	.12	-.09		

Note. *p < .05. **p < .01. N = 1165. Adjusted R-Square for Step 6 = .242.

Table 12. Summary of Multivariate Regression Analysis for variables predicting SF-12 physical summary score in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.079	
Age	-1.09	.35	-.28		
Step 2				.133	.055**
Age	-1.34	.35	-.34		
Decision latitude	0.76	.28	.24		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Square for Step 2 = .118.

Table 13. Summary of Multivariate Regression Analysis for variables predicting SF-12 mental summary score in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.163**	
Hampering social climate	-2.03	.43	-.40		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Square for Step 1 = .156.

Table 14. Summary of Multivariate Regression Analysis for variables predicting vital exhaustion in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.089	
Hampering social climate	0.64	.19	.30		
Step 2				.124	.035*
Hampering social climate	0.48	.21	.22		
Qualitative and quantitative overload	0.33	.16	.20		
Step 3				.156	.032*
Hampering social climate	0.38	.21	.18		
Qualitative and quantitative overload	0.35	.16	.21		
Decision latitude	-0.38	.18	-.19		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Sqare for Step 3 = .134.

Table 15. Summary of Multivariate Regression Analysis for variables predicting depression in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.142**	
Hampering social climate	0.58	.12	-.38		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Square for Step 1 = .135.

Table 16. Summary of Multivariate Regression Analysis for variables predicting sleep quality in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.043	
Qualitative and quantitative overload	0.31	.13	.21		
Step 2				.078	.034*
Qualitative and quantitative overload	0.29	.13	.20		
Positive social climate	-0.29	.14	-.19		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Square for Step 2 = .062.

Table 17. Summary of Multivariate Regression Analysis for variables predicting somatic complaints in women.

Step and predictor variable	B	SE B	β	R^2	ΔR^2
Step 1				.073.**	
Hampering physical working conditions	0.44	.15	.27		

Note. *p < .05. **p < .01. N = 117. Adjusted R-Square for Step 1 = .065.

Curriculum Vitae

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Ausbildung

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09/94 – 06/97	Ausbildung zum Industriekaufmann bei der Firma Thyssengas GmbH, Duisburg
10/98 – 10/03	Studium der Psychologie an der Universität Bielefeld
01/04 – heute	Promotion an der Universität Zürich Construct-Validation of the Salutgenetic Subjective Work Analysis Questionnaire with Perceived Health and Biological Parameters in Industrial Workers.

Arbeitsverhältnisse

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04/03 – 07/03	**Kienbaum Management Consultants GmbH, Gummersbach** Praktikum im Bereich Human Ressource Management
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06/04 – 12/04	**EADS, Manching** Referent im Rahmen des Studienprojektes „Arbeit und Gesundheit“
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12/00 – 10/03	**Studentische Unternehmensberatung stunt e.V., Bielefeld** Gründung, Aufbau und Mitarbeit im Human Ressource Management
01/00 – 03/03	**Johanniter-Unfall-Hilfe, Bielefeld** Gesetzlicher Betreuer
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