Burnout and Sleep

Mirjam Ekstedt

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Department of Public Health Sciences
Division of Psychosocial Factors and Health

Karolinska Institutet, Stockholm Sweden
Background

Burnout is a form of extreme fatigue related to occupational stress (Maslach et al., 2001) and which is not relieved during the time normally used for recovery (evening, weekend, vacation). It has become a major complaint in society and is one cause behind the doubling of sickness absence in Sweden during the last decade (RFV, 2002). While the effects of stress may be direct, through the psychobiological stress mechanisms, one should also consider stress-induced lack of recovery through, for example disturbed sleep. This has not been studied before. Neither has the pattern of recovery during the day or week been studied. One also lacks information on how burnout is experienced and for example a qualitative approach world provide essential understanding of aspects in human life that precedes burnout.

Thus this thesis brings together four studies focusing on the relation between burnout and sleep, the relation between sleep fragmentation and stress markers, the pattern of fatigue/sleepiness across the workday and weekend and the lived experiences of time preceding burnout.

First will be reviewed some of the background literature and previous research on burnout and sleep and their possible connections. This will be followed by the methodology, a summary of the results and a discussion.

What is burnout?

Burnout has attracted considerable interest since it was first established in the early seventies (Freudenberger, 1974) and has lately reached considerable attention in scientific work as well as in mass media. The number of scientific papers on the topic is extensive and most of them have a social psychological perspective (Schaufeli & 1998).

One reason for the interest is the remarkable impact on the increase in long-term sick leave in many industrialized countries (Weber & Jaekel-Reinhard, 2000). In Sweden the total percentage of mental ill-health has almost doubled from the mid nineties until 2002, with depression, anxiety and persistent fatigue as dominating symptoms (Socialstyrelsen, 2003a). This occurred simultaneously with a significant increase in proportion of sleep disturbances, especially in the youngest age groups (18-24 years). Impaired psychological well-being is about twice as common in women compared to men (15 % women and 10% men in the age group 16-44 years) and most remarkable in the working age groups (mainly white-collar workers and within the school and the health care sector). This supports the notion of causation by occupational stress, but there is also an increase in sleep problems, anxiety and fatigue among unemployed and students as well, suggesting that life conditions in general also has great influence (Hallsten et al., 2002; RFV, 2002; Socialstyrelsen, 2003a). In the absence of a distinct conceptualization of the increase in ill health, burnout has become an assembling diagnosis in the daily language (Weber & Jaekel-Reinhard, 2000).
Theories

*Burnout* was first mentioned in the literature by Bradley (1969) as a psychological phenomenon that occurred in the helping professions, although Freudenberger (1974) is regarded as the inventor of the term. The term was adopted from empirical research where respondents used “burnout” as a metaphor to describe a state of exhaustion in which they gradually were drained of energy (Maslach & Jackson, 1984). However, the term burnout is not entirely appropriate since it triggers associations to the definite state of a burnt-out candle or fire, while the phenomenon is better represented by an analogy like an emptied battery. This reflects the gradual process of more energy expended than what has been provided for.

In Sweden there has been several attempts to arrive at a more “diagnostic” term to suit the clinical symptoms. “Exhaustion-syndrome” (utmattningssyndrom) proposed by Åsberg *et al.* (2002) is the officially preferred term, and has recently been established as an ICD diagnosis in the Swedish version (Socialstyrelsen, 1997, 2005). For lack of conceptualization, the term *burnout* is used in this thesis as “working name” because of its global acceptance in both research society and everyday language.

The historical development of the concept took place along two lines, where Freudenberger (Freudenberger, 1974) represented a more clinical approach and Maslach, (1981b) Pines (1981) and colleagues placed burnout on the scientific agenda (Schaufeli & Enzmann, 1998).

Freudenberger (1974) based his first definition of burnout on own experiences in clinical work; “to fail, wear out, or to become exhausted by making excessive demands on energy, strengths or resources” (p. 159-160). Later Freudenberger opened up to the conception of burnout as a syndrome when he expanded the definition to involve personality, work performance, social relations and life in general. Further, he suggested that the conceptualization of burnout was a process, including the individual and the organization (Freudenberger, 1983). The risk of a broad “all-inclusive” definition is that the concept soon turns out to include almost every kind of social and personal problem and thus loses its meaning.

The most frequently cited definition of burnout is that by Maslach and co-workers (1986, p 1): “burnout is a syndrome of emotional exhaustion, depersonalization and reduced personal accomplishment that can occur among individuals who do ‘people work’ of some kind”. This established the idea of a syndrome explicitly from the beginning. From the results of explorative studies a multidimensional measure of burnout was developed, called the Maslach Burnout Inventory (MBI). It was intended for use with people working in the human services, health care, and education (Maslach & Jackson, 1981a; Maslach *et al.*, 1996). An adapted version of the MBI was developed later for use beyond the human services, but in contrast to Freudenberger, Maslach never expanded burnout to apply outside work (Maslach *et al.*, 2001). Contemporary burnout research is dominated by the MBI (used in over 90% of the studies) (Schaufeli & Enzmann, 1998), which strongly has influenced the conceptualization of burnout, and has led to the development of theoretical models based on the three MBI-dimensions. The hypothesis most used is a sequential progression of burnout over time, which explicitly directs causality between the different dimensions, but the mechanism has not been described (Maslach & Leiter, 2005; Maslach *et al.*, 2001).
An integrative model that is applicable at both the interpersonal and organizational level, has been presented by Schaufeli and others (Schaufeli & Buunk, 1996). According to this model a strong initial motivation and engagement is assumed to be a necessary condition for developing burnout. This is then associated with an unfavorable job environment and with inadequate coping strategies as a self-perpetuating force.

Even though the MBI dominates the scientific arena there are several other definitions of burnout that emphasize other aspects of the concept. For example Pines, Aronson and Kafry (1981) present a broader approach and include an existential dimension where work is suggested to become the matter that expects to give meaning to the existence in a secularized western society. Characteristic symptoms involving feelings of helplessness, hopelessness and entrapment, are accompanied by low self-esteem (pp 34-35, 202-203). Hallsten (1993) in contrast, proposes self-esteem to be a prerequisite of burnout and includes “a self-esteem based on achievements” as a hypothetical contributing factor to account for the “burning-out” process. The focus in his framework is the gradual process, not the context wherein it appears (occupational or non-occupational), with regard both to the different symptoms and to the different dimensions. Cherniss (1980) and his associates constructed a process model in which burnout is viewed as a series of negative changes in attitude and behavior that occur over time, associated with a “reality shock”, for new professionals in helping organizations, (Cherniss, 1980).

Another multidimensional measure of burnout was developed by Melamed and co-workers, the Shirom-Melamed Burnout Questionnaire (SMBQ) (Kushnir & Melamed, 1992; Melamed et al., 1992), which, in contrast to the MBI, doesn’t include the antecedents or consequences. The conceptualization of burnout, based on an extensive review by Shirom (1989), concludes; “the unique content of burnout has to do with the depletion of an individual’s energetic resources – a combination of physical fatigue, emotional exhaustion and cognitive weariness” (p.33). This definition implies a long-term exposure to emotionally charged demands, in both client related and non-client related occupational settings. Social commitments as well as major life crisis, are suggested to initiate or exacerbate burnout (Kushnir & Melamed, 1992). This definition of burnout takes the life conditions into account and describes three facets of excessive fatigue, which impinges on the person as a whole with emotions, mind and body.

A synthesis

No definition of burnout has been agreed upon and the existing definitions are contradictory at least on some points. By looking at commonalities and inconsistencies in the conceptualizations so far, one tends to arrive at the notion that burnout is excessive fatigue or exhaustion as a negative affective response to stress in a broad sense. An important but implicit property in most definition of burnout is that it emphasizes chronicity in that the state of exhaustion is not relieved by daily or weekly rest (Maslach et al., 2001; Schaufeli & Buunk, 1996; Shirom, 1989). However, those features are not unique to burnout and some of the issues that need to be investigated further are discussed below.
The main discrepancy in the definitions concerns whether burnout is exclusively job related or if it can develop in relation to non-occupational settings. Since the MBI questionnaire dominates the research area and it is restricted exclusively to job-related settings, research on burnout has mainly focused on burnout and job stress (see for example Kalimo, 1999; Schaufeli & Buunk, 1996). Instruments that refer to non-occupational settings are scarce (Hallsten, 1993; Shirom, 1989). There is also a lack of descriptive and explorative studies, longitudinal approaches, physiological measures and qualitative approaches, but this is discussed in subsequent sections.

Burnout is often seen as an individual matter. But symptoms developed in relation to others, whether in a family context, on the societal level or at work in an interpersonal or organizational level, stress different explanatory perspectives on burnout development. Further clarifying data is needed however, to explain how burnout is attributed to the individual, the organization and society. An alternative view is that burnout does not exist as a syndrome but is a social construct that individualizes societal problems (Söderfeldt, 1997; Walker, 1986).

Using a “laundry list” of over 100 burnout symptoms Schaufeli and co-workers (1998) found that the most characteristic core symptoms were clustered into what is called “state definitions” of burnout, that is a negative mental condition instead of a process that develops over time. But most assessment does not explain why the concept is limited to certain dimensions, or why others are excluded. Furthermore, there are inconsistencies regarding whether prerequisites and sequelae of burnout are to be included or not. In addition, it is not agreed upon whether burnout is seen as an end state of a long-term unsuccessful struggle with stressors, or if there is an ongoing process involved in the definition.

With the inconsistencies above in mind, and attempting to avoid a wide-ranging definition of burnout that includes everything, one might attempt to extract a common denominator of the conceptualizations above. Thus, the core negative emotional experience in burnout may be identified as “the depletion of an individual’s energetic resources” (Shirom, 1989, p.33). This seems to be the dimension for which there is most support in longitudinal research and which is recognized by most constructors of burnout scales (Shirom, 1989). Thus emotional exhaustion, together with physical fatigue and cognitive weariness seem to be the core dimensions of burnout. However, the three fatigue dimensions are poorly defined and poorly differentiated. And this calls for further evaluation of the concept.

**Diagnostic assessment**

Burnout is not a formal diagnostic category and it is not included in any of the officially accepted international diagnostic classification systems: Diagnostic and Statistical Manual of Mental Disorders 4th ed. (DSM-IV), issued by the American Psychiatric Association (APA, 2000) and the International Classification of Diseases (ICD-10), issued by the World Health Organization (WHO, 1992). The diagnostic label commonly used is “Adjustment disorder” (APA, 2000) or “stress related exhaustion” (Z73.0: WHO, 1992), and if work related, burnout has been labeled Neurasthenia according to the ICD-10. Depression is another diagnosis used and other overlapping concepts as Vital Exhaustion (VE), Chronic Fatigue Syndrome (CFS)
or Fibromyalgia (FM) have probably been used in diagnosing persons with symptoms of burnout.

However, recently The National Board of Health and Welfare has added “burnout” or “exhaustion syndrome” as a supplementary diagnosis to the Swedish version. (Socialstyrelsen, 2005). The criteria are: physiological or mental symptoms of exhaustion for at least two weeks, an essential lack of psychological energy, and symptoms as difficulties to concentrate, decreased ability to cope with stress, irritability or emotional lability, sleep disturbances and/or ache or pain, dizziness or palpitations having had to occur every day during a two-week period. The symptoms must cause significant clinical suffering, with impaired work capacity, and the symptoms must not be related to other psychiatric diagnosis, substance abuse or medical diagnosis (Socialstyrelsen, 2003b).

Since the diagnostic category is new it has not been used in the present thesis. This is particularly important since the diagnosis involves disturbed sleep. Sleep was not a part of the diagnosis in the studies in the present thesis. For scientific work the MBI has been suggested, with the top third of the Human Service Scale (MBI-HSS), defining “high degree of burnout” and the bottom-third low degree of burnout. But these criteria are statistical and arbitrary, rather than based on clinical experiences and should only be used in clinical research (Schaufeli & Enzmann, 1998). However, in this thesis the SMBQ has been used for the selection of study populations because of its applicability also in non-occupational settings. The scale is positively associated with both episodic stress and chronic work stress (Melamed et al., 1992; Melamed et al., 1999). The SMBQ shows high correlations with Pines Burnout Measure and the MBI (Grossi et al., 1999).

**Fatigue and related states**

In the discussion above fatigue was introduced as the central concept of burnout. It is not a well-defined concept, however, and there is a need for a brief summary of some of the discussions of the meaning of fatigue. It may be particularly important since all burnout scales make use of a number of synonyms of fatigue that may have slightly different meanings. There is also a need for a discussion of some related concepts such as, Depression, Vital Exhaustion and The Chronic Fatigue Syndrome.

**Fatigue**

The definition and assessment of fatigue has been a subject of controversy for many years, and discussions include whether fatigue is a discrete entity, a continuum or a set of diffuse symptoms (Beurskens et al., 2000; Kant et al., 2003). In scientific work fatigue is described either from a biological/neuropsychological (Grandjean, 1970), or a social/psychological perspective (Cameron, 1973), but the definitions are vague and inconsistent, and the physiological mechanisms poorly understood. Its use in ordinary language is diffuse and
clearly has many different meanings, among which it may be difficult to differentiate (Aaronson et al., 1999; Piper, 1986; Ream & Richardson, 1996).

Most of the concepts of fatigue assume that it is the outcome of energy loss due to activity that depletes the resources for further activity. However, if fatigue is a state when energy loss exceeds energy availability (Piper, 1986), it seems reasonable to believe that imbalance between catabolic and anabolic processes is involved. Then also dysregulation of the endocrine or the immune system may yield fatigue (Schedlowski & Tewes, 1999), even without any excessive activity. This is for example what is suggested in chronic diseases where fatigue is a common complaint (Ford et al., 1998; Parker et al., 2001). But the energy drain might also be due to an insufficient anabolic function, for example, a poor restorative value of sleep.

In research a distinction between chronic and acute fatigue was pointed out at an early stage (Bartley & Chute, 1947) of which the latter signifies a temporary state that passes after a resting period, while the former is mainly observed in clinical practice as a state that does not dissipate easily with rest or sleep (Cahill, 1999; Cameron, 1973; Craig & Cooper, 1992). As noted above, a key characteristic of burnout is this chronicity. However, it appears that this temporal pattern of excessive fatigue in burnout has never been verified in longitudinal studies. This thesis will try to present at least short term longitudinal approach (see below). Acute fatigue in terms of reduced alertness: sleepiness is used in more limited sense as a desire for sleep (Dement & Carskadon, 1982; Dinges, 1989).

Fatigue, tiredness, exhaustion are often used as synonyms. However, one may perhaps see fatigue as a development from low levels to high levels - exhaustion. Tiredness, fatigue and exhaustion might also be distinct states along the same continuum. Such a model has been suggested based on explorative studies on elite athletes (fatigue due to excessive physical activity during leisure time), shift workers, and individuals experiencing “burn-out” (fatigue due to work), and individuals diagnosed with depression, cancer, or Chronic Fatigue Syndrome (fatigue due to disease) (Olson, in press). In the latter study each of the tiredness-exhaustion dimensions contained components of affective, muscular, somatic, cognitive and social character. Earlier research on fatigue has often focused on one dimension at a time, depending on context, but a multidimensional approach may be more fruitful in understanding the list of symptoms characterizing burnout and may better illustrate how the excessive fatigue in burnout may develop.

Characteristics of fatigue related to work vary due to work conditions. Studies on physical fatigue in industrial work (Chambers, 1961; Grandjean, 1979) or decreased performance in “highly skilled work” have a long history (Bartlett, 1943; Bartley & Chute, 1947). Those early studies were focused on physical fatigue related to muscular activity (Enoka, 1995) or fatigue due to extreme physical conditions of noise, exposure to heat, cold, humidity or chemical substances (Bell, 1978; Gamberale, 1985; Ramsey, 1983). Bartley and Chute (1947) maintained that the term fatigue to be used only to describe the subjective feeling of lassitude and disinclination towards activity, and the term impairment to describe the reduction in physical capacity resulting from accumulated oxygen debt in muscle tissue. Fatigue was suggested to be a biological warning that the individual’s recourses were overtaxed (Bartley & Chute, 1947). Bartlett (1953) on the other hand noted that those indicators tended to surface too late, and that performance could be maintained at an adequate level almost to the point of
total exhaustion (Cameron, 1973). This observation is interesting with regard to fatigue and burnout.

Emotional and physical fatigue are closely intertwined and related to decreased motivation, feelings of uneasiness (Cameron, 1973; Shirom, 1989), and has in several studies been suggested as a potent predictor of myocardial infarction (Appels et al., 1993; Appels & Mulder, 1988). Studies show that prolonged physical training concurrent with inadequate recovery in athletes, have resulted in the overtraining syndrome (Armstrong & VanHeest, 2002; Kenttä et al., 2001), which shares numerous characteristics with burnout. This syndrome, however, is also connected to mental stress and striving for achievements, suggesting that their combined effects could promote excessive physical fatigue.

The cognitive weariness in burnout is associated with fatigue of psychological or affective character and appears to be of central importance in occupations where continued attention is required (Shirom, 1989). Psychological fatigue has been associated with stress or emotional experiences like fear, frustration, anxiety and distress (Aaronson et al., 1999; Cahill, 1999). The label mental fatigue is used to describe a gradual development of fatigue in relation to decreased efficacy and motivation, and decreased alertness and performance with time (on task) as an important ingredient (Cameron, 1973; Grandjean, 1979). Affective fatigue, as recognized in depression, has elements of sadness, distress and feelings of worthlessness (Cahill, 1999). Still, those labels are used interchangeably in the literature and there are no sharp boundaries between them.

A multi-dimensional model of occupational fatigue has been evaluated and tested in different contexts of working life (Åhsberg, 2000). The work related fatigue due to physical work, mental work or night work was described as being composed of five dimensions: lack of energy, lack of motivation, physical exertion, physical discomfort and sleepiness. While these dimensions were identified via factor analysis there was still a rather strong common component among them, in particular represented by lack of energy.

It should be emphasized that most burnout instruments usually combine a number of fatigue-related adjectives to form scales. Thus, it is not possible to determine whether there is any particular type of fatigue that dominates in burnout. In this thesis we have included the Åhsberg approach (2000) to explore the possibility of finding a main dimension of fatigue.

In summary, it appears that fatigue is a frequently used, but vague, concept denoting energy depletion. In the present thesis I will therefore define it operationally (see Methods).

Depression

Depression and burnout share some important characteristics. Depression is characterized by: depressed mood, weight loss or weight gain, insomnia or hypersomnia, fatigue or loss of energy, feelings of insufficiency or guilt, thoughts about death and suicide, among other symptoms (APA, 2000). While many of these (particularly fatigue) may occur in burnout one distinction derives from differences in their attributional patterns and their context. Burnout is enmeshed in the social and organizational context while depression essentially reflects
personal thoughts and emotions (Leiter & Durup, 1994). Problems at work do not appear in the etiology of depression to a greater extent than problems in other life domains (Beck, 1970; Beck & Beamesderfer, 1974). A confirmatory factor analysis of the most widely used depression (Beck Depression Inventory; BDI) and burnout measure (MBI) suggests that fatigue is an underlying factor accounting for the correlation between burnout and depression (Leiter & Durup, 1994).

**Chronic Fatigue Syndrome**

The major criterion for the Chronic Fatigue Syndrome (CFS) is the new onset of severe and disabling fatigue, present for at least six months and an absence of an identifiable medical and psychiatric etiology of the fatigue (Fukuda et al., 1994; Holmes et al., 1998). This description appears to overlap with symptoms of burnout, but the onset of fatigue in CFS is not thought to result from prolonged stress, as is the case with burnout. The concurrent occurrence of symptoms like muscle pain, tender lymph nodes, sore throat, headache or other, with a vague relation to inflammatory response, also distinguish CFS from burnout, since such symptoms are not included in core definitions of burnout (Fukuda et al., 1994; Krupp et al., 1991).

**Vital Exhaustion**

Vital Exhaustion, (VE) is a construct characterized by fatigue, irritability and demoralization, developed to understand the unusual fatigue commonly reported immediately before myocardial infarction or cardiac death (Appels & Mulder, 1988). VE is suggested to result from prolonged stress, and there is a high correlation between VE and double (work+ home) work load (Appels et al., 1993). Exploratory analysis suggests that VE is related to several stressors in childhood, as well as in family life and at work, which also is what distinguishes VE from burnout according to Appels (Appels et al., 1993). But when including real life stress as a prerequisite of burnout the similarities between the two concepts are striking. However, the measure of VE; the Maastricht Questionnaire (Appels et al., 1987) uses items on sleep disturbances and depression, apart from fatigue, and doesn’t measure cognitive impairment, in contrast to the SMBQ, for example. Additionally, the Maastricht Questionnaire has dichotomous response alternatives, which imposes difficulties to answer in an early stage when symptoms may be weak, diffuse, and intermittent. Most burnout measures assess a gradual development of symptoms while the Maastricht Questionnaire is more applicable in clinical research.

**Burnout and stress**

Burnout is, by definition, caused by stress and the correlation between the two is high, at least when measured by questionnaires (Schaufeli & Enzmann, 1998). There are, however, only limited amounts of stress research in relation to burnout and it is not clear how the experiences of a stressful situation causes the fatigue and cognitive impairment that
characterize burnout (Maslach & Leiter, 2005). Below is summarized some of the views on stress and its physiological effects.

**Stress theory**

Stress is a rather ambiguous concept, possibly because it is used to describe four different phenomena: 1) the stimulus itself 2) the experience of the stimulation 3) the non-specific general (alarm) stress response and 4) the feedback and the experience of the reaction.

From a general perspective stress refers to the *rate of wear and tear in the organism*, and the biological definition of stress refers to the nonspecific response to any demand (Selye, 1956) to increase the chances of survival of an individual who is facing a life-threatening situation. According to psychological theories stress is determined by the balance between the perceived demands from the environment and the individual’s resources to meet those demands (Frankenhaeuser, 1986; Lundberg, 1995).

Cognitive Activation Theory of Stress, CATS, (Ursin & Eriksen, 2004) emphasizes the cognitive processes and the neurophysiological activation, and the individual’s *appraisal* of the stress situation seems to be the mediating link. Lazarus (1984) proposes a *transactional* approach where stress involves *both* the situation (stimuli) and the individual’s experience where the notion of appraisal is fundamental. In a phenomenological view background, meaning and the person’s concerns (that what really matters to a person), defines what counts as stressful and what the coping possibilities are (Benner & Wrubel, 1989). This is paramount to the individual differences in the stress response and depends on personality, past experiences, personal values, goals and expectations (Benner & Wrubel, 1989; Cooper, 2005; Parkes, 1994)

Ursin and Eriksen (2004) claim that the level of physiological response depends on the learned *expectancy* of being able to cope with the stressful situation. Even though stress cannot always be alleviated by coping, it might ease tension and provide access to skills that deliberate energy and allow the person to recognize a new way of being in the situation (Benner & Wrubel, 1989; Bullington, 1999). Thus adequate coping might reduce the arousal level, while lack of control over the outcome, ineffective or blocked coping, produces strong physiological stress response and is suggested to lead to helplessness, frustration and distress (Frankenhaeuser, 1981; Lazarus & Folkman, 1984; Ursin & Eriksen, 2004).

A generalized feeling of *hopelessness* might occur as a response to the enduring stress, when actions taken to relieve the stress do not help. Hopelessness and *helplessness* are entities closely related to depression and might function as a coping strategy that reduces the arousal (Ursin & Eriksen, 2004). However, there are studies suggesting that psychosocial events may play a significant role in the onset of episodes of Major Depression (Stanley & Burrows, 2005), and this is also noted in the Diagnostic Statistical Manual of mental disorders (DSM-IV) (APA, 2000).

It is important to underline that stress originally is a drive for survival and is not dangerous per se, but that sustained high tonic activation is maladaptive and may cause damages
It is hypothesized that for each individual there is an optimal level of arousal (Chrousos & Gold, 1992). This means that if the stress intensity is moderate, the effect on the brain yields increased alertness and attention, which may improve the cognitive performance at excessive levels of stress detrimental effects on performance, behavior and emotions may ensue (Chrousos, 1998b; McEwen, 2004). In fact, several studies show that stress, but only up to a certain level, improves performance, for example on selective attention tasks (Chajut & Algom, 2003), and that underload as well as overload related to advanced work processes induce frustration and stress (Frankenhaeuser & Gardell, 1976).

Among psychological approaches to research on stress and burnout one would have expected a wide application of qualitative methods. This does not seem to be the case however, and the present thesis will seek to bring in such a perspective (see below for discussion).

Physiological mechanisms

Contemporary physiological stress models derive from Cannon (1914) and Selye’s (1936, 1956) pioneering work. Selye (1946) proposed a model of stress, the General Adaptation Syndrome (GAS), comprised of three stages, alarm, resistance, and exhaustion that reflect the physiological non-specific response to a challenge. The resistance stage of GAS has profound energy requirements, which, if persistent over time, depletes the person’s capacity and leads to exhaustion.

Cannon (1914) developed the “fight-flight” concept, which linked the emotional perception of a “threat” (Dunn & Berridge, 1990; Swanson & Sawchenko, 1983) to physiological changes in the periphery. Markers of the fight-flight response are the catecholamines epinephrine and norepinephrine, and other physiological indicators associated with the autonomic nervous system (Brown, 1991; Dunn & Berridge, 1990). Thus, the Sympathetic Adrenal Medullary (SAM) system is activated in situations when the individual feels threatened, irrespective of whether the emergency reaction is to battle or escape (Lundberg, 2000).

The Hypothalamo-Pituitary-Adrenocortical (HPA) axis is also fundamental in the stress reaction. When the SAM system is activated and neuropeptides like Cortico-Releasing-Hormone (CRH) and vasopressin are released they in turn stimulate adrenocorticotropin (ACTH) release into the general blood circulation within the pituitary (Dunn & Berridge, 1990; Rock et al., 1984). An increase or decrease in the HPA-axis and SAM system produce abnormal levels of mainly cortisol and catecholamines; epinephrine and norepinephrine into the blood (Folkow, 1997; Sapolsky et al., 1984). These “stress systems” (i.e. HPA - axis and SAM system) are interacting with the major endocrine and the gastrointestinal and immune systems through complex stimulatory and inhibitory feedback pathways (Chrousos & Gold, 1992).

The acute stress response is no problem as long as the stress activation can be shut down when stress terminates. But chronic stress is much less studied and refers to the resistance and exhaustion phase in the GAS (Selye, 1946).
Recent research in psychoneuroendocrinology and neuroimmunology (Schedlowski & Tewes, 1999) and the theory of allostasis (Sterling & Eyer, 1988) and allostatic load (McEwen, 1998) elucidate how acute and chronic aspects of the stress response might lead to diseases, and thus also may be the way burnout develops. The allostasis model takes the variability of the body systems into account, and includes the ability of the body to increase or decrease the activation level of vital functions to new steady states dependent on the characteristics of the challenge and the person’s emotions and appraisal of the event (McEwen, 1998; Sterling & Eyer, 1988). Allostasis has a price - the allostatic load, which refer to the cumulative cost to the body when the systems overreact, fail to respond adequately or fail to shut down to the “normal set-point” after a stressful event (McEwen, 2004). It is suggested that serious pathophysiology can occur if overload is not relieved in some way (McEwen & Stellar, 1993).

Considering the theory of allostatic load it seems reasonable to believe that permanent or repeated exposure to stress, which one cannot adequately cope with, may cause an allostatic up regulation of the HPA-axis leading in turn to abnormal elevations in the levels of circulating glucocorticoids (Chrousos & Gold, 1992; Erikson et al., 1999; Lundberg & Frankenhaeuser, 1980). Probably high cortisol levels lead to impaired memory function through negative effects on neural structures, which have been observed particularly in hippocampus (Sapolsky et al., 1984; Watanabe et al., 1992). It has been proposed that with time, longstanding strain on the HPA-axis may lead to hypocortisolism and a blunted HPA-axis regulation in response to stress (McEwen, 1998). This might be one way of explaining the characteristics of excessive fatigue and exhaustion in burnout. This is supported by observations of excessively low levels of cortisol in diseases with high fatigue like CFS, (Demitrack, 1994), Vital Exhaustion (Nicolson & van Diest, 2000) and Fibromyalgia (Parker et al., 2001) and Post Traumatic Stress Syndrome (Yehuda, 1999), which is caused by high stress load.

**Research on physiological markers in burnout**

As suggested above it would seem reasonable to connect exhaustion in burnout to the exhaustion phase of the General Adapation Syndrome (GAS) after a long term exposure to repeated stress. Thus, one would expect to find changes in both the HPA and the SAM axis in individuals with burnout. The relatively few studies on this topic do not give any conclusive results, however. The few studies on burnout and physiological markers, cortisol in saliva has been frequently used, due to its role in the HPA-reaction to stress as discussed above, and since assessment of salivary cortisol is convenient to use in field studies (Wust et al., 2000). The results show groups with stress or increased workload often exhibit increased cortisol levels, particularly in the morning (Härenstam & Theorell, 1990; Kirschbaum et al., 1992; Schulz et al., 1998; Steptoe et al., 2000). Similar results have been found in burnout patients (De Vente et al., 2003) with increased morning salivary cortisol levels in comparison to healthy controls. This was replicated in females in another study (Grossi et al., in press). Elevated levels of morning cortisol has been demonstrated also in blue-collar workers with chronic burnout (Melamed et al., 1999). Other studies have shown contradictory results. Thus, teachers scoring high on burnout showed a lower overall salivary cortisol secretion during three consecutive mornings of saliva sampling (Pruessner et al., 1999) and in a study...
conducted among military personnel high burnout scores was associated with low morning cortisol and elevated evening levels (Morgan et al., 2002). A reduction of urine free-cortisol excretion was found in a longitudinal study on female burnout patients compared with healthy controls (Moch et al., 2003). Single blood samples have failed to demonstrate associations between cortisol and burnout (Grossi et al., 2003; Grossi et al., 1999).

The inconsistent results may derive from methodological differences (King & Hegadoren, 2003), but also the intensity and chronicity of stress, as well as the individual’s appraisal of the event and the method of coping, may have had an impact on the results (Eriksen et al., 1999; Wust et al., 2000).

In addition to responses of the hypothalamic-pituitary-adrenocortical (HPA) axis, one would expect also a sympathico-adreno-medullary (SAM) mediated stress response in burnout. Thus elevated heart rate and blood pressure have been found in burnout patients compared to controls (De Vente et al., 2003). In contrast to an expected reduction in heart rate variability in soldiers with high burnout scores, an inappropriate level of vagal inhibition of the heart was seen, which resulted in higher variability (Morgan et al., 2002).

Associations between high burnout and elevated levels of lipids and serum cholesterol were found in a civilian working force (Melamed et al., 1992; Shirom et al., 1997), while such changes were not seen in a study in women. In that group no changes in growth hormones or anabolic variables was found (Moch et al., 2003). The alterations in the HPA-axis, the SNS system and associated risk factors for CardioVascular Diseases (CVD) and metabolic syndrome seen in burnout, are not as consistent as are those found in research on stress, job strain or shift work (Grossi et al., 1999; Knutsson & Bøggild, 2000; Schnall et al., 1998; Theorell & Karasek, 1996; Yehuda, 1999).

The inflammatory response in relation to burnout has been investigated in a few studies. TNF-α was enhanced in a study of burnout among women (Grossi et al., 2003). Differences in the numbers of NK-cells and an altered NK-cell activity (Bargellini et al., 2000; Nakamura et al., 1999) and leucocytes (Lerman et al., 1999) have been found. Although important, these findings are not specific for burnout.

It appears that no physiological models described above are sufficient to explain the process from the experience of stress, through the CNS into bodily processes (Weiner, 1992). And burnout does not seem to have been well characterized in terms of stress physiology (Maslach & Leiter, 2005). One such attempt is made in the present thesis.

**Recovery**

Above, it was discussed that the energy depletion in burnout may be the “cost” of a long-term exposure to stress, and a growing body of evidence shows that the ability to shut-down the regulatory systems to a base-line level after stressful events, is beneficial for health (Chrousos & Gold, 1992; McEwen, 1998, 2000; Seeman et al., 2001).
From the perspective of balance and allostasis, recovery has been defined as “the period of time that an individual needs to return to a normal or pre-stressor level of functioning following the termination of a stressor” (Craig & Cooper, 1992). Need for recovery (time required to return to baseline) has been suggested to be a better measure of severity of stress than the immediate stress response (Depue & Monroe, 1986; van Amelsvoort et al., 2003). A prospective, large, cohort study of prolonged fatigue (Bültmann et al., 2000) showed that fatigue, need for recovery (or unwinding) and burnout were associated to each other (Kant et al., 2003). This emphasized that recovery has to be considered when prerequisites to burnout is discussed.

However, as noted earlier the individual’s ability to return to a physiological base-line (i.e. recovery) is also dependent on the interactive process between the person and the environment, and on the way the situation is experienced (Benner & Wrubel, 1989; Lazarus & Folkman, 1984). The appraisal of the event, as well as the ability to “unwind”, involves the whole person: body, mind, thoughts and emotions. Recovery in the meaning of rest has been defined as “a sense of harmony in feelings, actions and motivation” (Asp, 2002, p. 93) and a process of maintaining and/or restoring health (Torkildsen, 1999).

Health is in this thesis viewed from a multidimensional perspective, which can vary on a continuum from health to ill-health along a physiological and behavioral dimension, on a subjective dimension of wellbeing, and also on an existential dimension where personal values, motivation and meaning are essential drives for life (Eriksson, 1987; Svensson, 1981, 1990). Knowledge about why and how to rest could lead people to incorporate health-promoting behavior (Asp, 2002). Therefore, the need for such knowledge is apparent in the context of burnout.

The energy loss and excessive fatigue found in burnout may not only be an effect of stressor exposure or insufficient recovery time. It might also be due to insufficient energy mobilization as discussed above. Unfortunately, very little empirical data is available on the effects of recovery on stress or burnout. Among the studies needed are descriptions of the pattern of rest during the day and across days, as well as how such patterns contribute to or prevent burnout. The present thesis will attempt to provide such descriptive data.

Sleep

The main focus of the present thesis is not on recovery in general, however, but on recovery through sleep. Since by definition, sleep fails to give sufficient daily restitution to eliminate fatigue, sleep should be an important aspect of burnout investigation. Sleep is fundamental for the anabolic processes, intended to reconstruct the damages of the wear and tear (Adam & Oswald, 1977, 1983). But sleep is also necessary for proper brain functioning, wellbeing and daily functioning (Benington & Heller, 1995), thus basic for both body and mind. However, if the restoration through sleep is impaired, it seems reasonable to believe that an “energy debt” might occur. The arguments for this are discussed below.
It has recently been demonstrated that burnout scores are related to reports of disturbed sleep (Grossi et al., 2003; Melamed et al., 1999) and this is interesting in its own right. However, no studies of physiological sleep in burnout have been carried out and thus it is not clear if there is objective support for the reported sleep disturbances. In, for example Primary Insomnia one often fails to find objective indications of disturbances (Rosa & Bonnet, 2000). Thus there is a need for studies on physiological sleep in burnout to investigate if sleep is objectively impaired.

Another reason for studying sleep in burnout is that shortened or fragmented sleep is closely associated with sleepiness (Bonnet & Arand, 2003; Gillberg, 1995; Härmä et al., 1998; Stepanski et al., 1984). Also, organic sleep disturbances, such as sleep apnea (Guilleminault et al., 1993; Mitler, 1993) or restless legs (Rosenthal et al., 1984) increase sleepiness. Thus, if short or disrupted sleep is substantiated in burnout groups this might be one contributor to the fatigue symptoms in burnout.

Disturbed sleep, sleep loss, and sleep fragmentation are also associated with impaired performance, especially on tasks of frontal lobe or executive function, including memory, creativity and planning skills (Drummond & Brown, 2001; Horne, 1988; Jones & Harrison, 2001). Furthermore sleep disturbances are connected to emotional changes and mood disorders (Adam et al., 1986) and have been considered a risk factor for episodes of major depression and anxiety (Ford & Cooper-Patrick, 2001). Since all those features are frequently seen in burnout (Hallsten et al., 2002; Maslach et al., 2001; Åsberg et al., 2002) it is important to sort out if disturbed sleep might be a common denominator.

**Previous studies on sleep and burnout**

The very few studies that reports sleep complaints in burnout (as measured by SMBQ) are cross sectional, and based on subjective reports of disturbed sleep. Melamed et al (1999) examined whether chronic burnout was associated with somatic and physiological hyperarousal (measured by cortisol in saliva and questionnaires) in a sample of blue-collar workers. Apart from the findings of elevated levels of cortisol in saliva, they found that those complaining of burnout symptoms for more than 6 months exhibited more difficulties falling asleep, more early morning awakening, more tiredness on waking up and more difficulties maintaining sleep than those with non-chronic burnout or without burnout symptoms. They also complained from more tension and post work irritability.

The other study, by Grossi and coworkers (2003), investigated physiological correlates of burnout in women in white-collar work and the habitual sleep quality was assessed with the Karolinska Sleep Questionnaire (KSQ) in conjunction with the physiological assessments. The high burnout group revealed more sleepiness, impaired sleep quality and awakening than those scoring low on burnout.

Thus, even though sleep disturbances are common complaints in burnout, it has never been hypothesized that burnout development may be a matter of impaired sleep or restitution. Linking the emotional exhaustion and cognitive symptoms to physiological/biological functioning is a new approach to burnout development that integrates the person as a whole.
Therefore, there is a need for objective measures of sleep to determinate the characteristics of the sleep disturbances, if any. One major purpose of the present thesis was to provide such measurements of sleep.

**An overview of normal sleep**

I order to provide a broader background on sleep and its restorative function this section will present an overview of normal sleep and its restorative function and introduce the standard methods to record and quantify sleep.

**Structure and content of sleep**

According to a general behavioral definition, “sleep is a reversible behavioral state of perceptual disengagement from, and unresponsiveness to, the environment” (Carskadon & Dement, 2000, p.3). The physiological changes during sleep are well established. Thus, sleep is a cyclical process, which alternates with wakefulness. The method for physiological measurement of sleep is based on the recording of electrical brain activity – electroencephalography (EEG), of at least one EEG-lead (usually C3-A2 or C4-A1 according to the 10-20 system (Jasper, 1958). There are two main states of sleep, Non-Rapid Eye Movement (NREM) and Rapid Eye Movement (REM) sleep. Four stages of NREM sleep are recognized; stages 1-4. To differentiate between REM sleep from NREM sleep it is necessary to also record eye movements (electrooculography, EOG) and muscle tone (electromyography, EMG) (Carskadon & Dement, 2000).

The first stage is Wake (W), or stage 0, characterized by a fast frequency EEG (beta activity, > 12Hz) with an alpha rhythm (8-12 Hz) if the eyes are closed. After sleep onset, sleep gradually moves through the stages 1-4, with the EEG showing increased amplitudes in slower frequency bands. Stage 1-sleep appears when the alpha activity is replaced by a slower EEG (theta = 4-8 Hz) activity, and a short period of slow eye movements. Stage 1 sleep is associated with a low arousal threshold and a severely disrupted sleep consists of an increased percentage of stage 1-sleep. Stage 2-sleep usually constitutes 50 per cent of the total sleep period and is characterized by moderately slow frequency waves (4-7 Hz) and features slow waves (K complexes) and rapid so-called sleep spindle (14-16 Hz) activity in the EEG. Delta activity (0.5-4.0 Hz and an amplitude of > 75 microvolt), dominates Stage 3+4 sleep, and the slow waves have given this type of sleep the name Slow Wave Sleep (SWS), or Slow Wave Activity (SWA).

Parallel to the change to deeper sleep, heart rate, blood pressure and ventilation decreases progressively during NREM sleep (Parmeggiani, 2000). Brain temperature decreases, Mainly during SWS, which is important for cerebral recovery and the metabolism have slowed down. The main proportion of Growth Hormone (GH) secretion occurs during SWS. REM sleep is identified by periodic movement of the eyes (Rapid Eye Movements), increased EEG frequency and a low muscle tonus. The breathing frequency is increased and so is heart rate and blood pressure. The temperature regulation centre in hypothalamus is shut off during REM sleep (Parmeggiani, 2000).
The exact onset of sleep is often difficult to identify, since the lighter stages of NREM sleep often alternate with wakefulness during sleep onset. Stage 1 sleep generally persists for only a few (1 to 7) minutes and formally sleep starts in the 30s interval that contains more than 50 per cent of stage 1-sleep. As stage 2-sleep progresses, there is a gradual appearance of high-voltage Slow Wave Activity (SWA), delta waves in the EEG. Stage 3 + 4-sleep lasts for 20-40 minutes and is suddenly interrupted by an arousal and body movement, whereupon a short period of REM sleep appears. This marks the end of the first sleep cycle. The NREM and REM sleep continue to alternate through the night in 4-6 sleep cycles, which vary between 80-120 minutes. SWS occupy more time in the first cycles while the amount of stage 2-sleep and REM sleep expands throughout the night (Carskadon & Dement, 2000).

Measuring sleep

Standard criteria for describing sleep were developed by Rechtschaffen and Kales in the late 1960s (Rechtschaffen & Kales, 1968). They divided sleep into stages according to depth and led to the concept of “sleep architecture”. The data generated by scoring sleep can be presented in various manners. A sleep hypnogram as in fig 1 provides a visual representation of the cyclic variation of sleep stages over the course of the night. Except for the sleep stages (stage 1-4 + REM + awake), Movement time (M), and muscle artifacts are scored. Also brief transient arousals of central or peripheral character are possible to score. An arousal from sleep is defined as an EEG shift to at least alpha activity from stages 2-4 or REM, preceded by at least 10 seconds of uninterrupted sleep (stages 2-4 or REM). Micro-arousals last between 3 and 15 seconds and are too brief to be identified in the classical sleep staging system but have been added to the literature later (ASDA, 1992). Frequent arousals rather result in fragmented sleep than shortened sleep and so can provide valuable information on the restorative function of sleep. Sleep measures also include Time In Bed (TIB), Total Sleep Time (TST) and sleep efficiency (TST/TIB).

Figure 1. Progression of sleep stages presented in a hypnogram (below) and the dynamics of delta power density (mV²) over the course of the night in normal sleep (above).
New technologies have provided increased capacities to understand sleep using new computer-generated methods, like spectral analysis, through, for example, Fast Fourier Transformation, (FFT) (Borbély et al., 1981). The power spectrum is the result of a transformation from time to frequency (Aeschbach, 1995). Figure 1 provides a representation of the delta power density over the course of the night, presented together with a typical hypnogram. Power density adds information to the sleep analysis. For example SWS can be regarded as an indicator of sleep intensity, and SWS in the first sleep cycle is more intense (has higher amplitude) than SWS in the subsequent cycles (Dijk et al., 1990). The progressive decline of delta power density over sleep cycles (upper part of fig 1), illustrates the gradual fall of sleep intensity throughout the night. Thus Slow Wave Activity (SWA) shows the variation of the NREM-REM sleep cycle, in greater detail than the traditional sleep profile (see for an overview Borbély & Achermann, 1992).

In the spectral analysis all frequencies in the EEG are represented and both the period and the amplitude of the signal are integrated in the analysis. The peak of the power spectrum reflects the dominant frequencies in the EEG and, depending on the stage, the peak of the power spectrum will be different. In SWS delta frequency is dominant and just before sleep (stage W) the peak is in alpha activity (see fig 1). Power density is presented in 1 Hz bands or integrated into 0.5–4.5 Hz (delta), 4.51–7.5 Hz (theta), 7.51–12.5 Hz (alpha), 12.51–16.50 (sigma) and 16.51–32.5 Hz (beta) bands.

Sleep/wake regulation

Whether an individual is awake or asleep depends on the balance of forces promoting and inhibiting each of those two states. The mechanism determining which of the states that will predominate are poorly understood but a model of sleep/wake regulation suggests mainly three processes that interacts with each other: the homeostatic (intrinsic) drive for sleep (process S), the circadian rhythm (process C), (Borbély, 1982; Borbély & Achermann, 2000) and the level of activation or sleep inertia (Process W) (Folkard & Åkerstedt, 1991; Åkerstedt & Folkard, 1997).

The homeostatic drive to enter sleep (process S) increases with the duration since the end of the previous sleep episode. During a usual 16-h wakefulness stable levels of neurobehavioural function can be maintained, but with sustained wakefulness an increased homeostatic drive for sleep builds up. When a homeostatic threshold is exceeded, sleep is triggered, and wakefulness occurs when the sleep drive decreases. Prior time spent awake, and the quality of prior sleep, is closely related to the need for nocturnal SWS (Åkerstedt & Gillberg, 1986). Recovery sleep is also usually prolonged and deeper (with a higher arousal threshold and increased SWS) than basal sleep. Prolongation of wakefulness, sleep debt or sleep disturbances are shown to produce a rise of SWA during recovery sleep. Delta power density is thus a sensitive measure of the restorative function of sleep (Carskadon & Dement, 2000).

The circadian aspect of sleep regulation (process C) is distinct from the homeostatic or sleep-wake dependent aspects. For instance the increase in sleep propensity after extended wakefulness is attributed to the homeostatic effect, whereas the propensity in the evening hour observed even when people have been awake for 16 h or more is attributed to circadian effect (Kryger et al., 1994). The external light-dark cycle is the primary synchronizer of the endogenous circadian rhythms (Czeisler, 1995). Circadian rhythm originates in the
Suprachiasmatic Nuclei (SCN) of the hypothalamus (Meijer & Rietveld, 1989), and sends impulses to the pineal gland for melatonin production, normally at, or after the habitual sleep onset, leading to increased sleepiness. Melatonin is synthesized and secreted during darkness. Melatonin onset seems to be the hormonal signal timing the rise in blood flow in distal skin regions, and an increased vasodilatation leads to a decrease in core body temperature (Kräuchi et al., 1999). The endogenous 24-h rhythm of melatonin and body temperature expresses the circadian rhythm, and the maximum sleep propensity coincides with the nadir of the rhythm around 4AM, whereas the lowest sleep propensity is close to the peak of the rhythm 12 hour later (Borbély, 1982; Borbély & Achermann, 2000).

Sleep intensity and continuity of sleep is also dependent on the arousal level (Perlis et al., 2001a) and the wake promoting drive (process W) (Åkerstedt & Folkard, 1997). During sleep the homeostatic sleep drive (process S) decreases until it reaches a certain level and wakefulness is invoked. The homeostatic and circadian processes interact to determine neurobehavioral alertness and performance. The circadian system actively promotes wakefulness (Edgar et al., 1993), which is experienced, for example, as the spontaneously enhanced alertness in the early evening, even after a sleepless night (Czeisler & Khalsa, 2000).

Sleep can be disrupted spontaneously by an inner or external stimulus, which must be of higher intensity than the sleep propensity threshold (Staner et al., 2003). The transition into wakefulness is often characterized by short cortical events, “arousals”. The awakening stimulus may be various factors like: time spent asleep, intrasleep architecture (NREM-REM cycles), age, circadian phase, sleep disorders or environmental factors like heat, cold or noise (Muzet, 2004), as well as anxiety and worries (Morin et al., 2003). Wakefulness is maintained by a number of structures in the Reticular Activating System (RAS) (Moruzzi & Magoun, 1949) and allows sleep when it is inhibited or inactive (Shneerson, 2000). Furthermore CNS hyperarousal (intrusion of alpha activity or increase of higher frequencies in the EEG) is suggested to be involved in sleep disorders like insomnia (Hauri, 2000; Perlis et al., 2001a). Thus, if the activation level (process W) is on a higher level than the sleep propensity level (process S), sleep might be inhibited or characterized by frequently arousals.

**The restorative function of sleep**

The relation between sleep loss and sleepiness/fatigue was discussed above. However, the physiology of restitution in sleep is not well understood. Below is a summary of some of the processes that may be involved.

The effects of sleep on restoration and tissue renewal are best studied in animals. The rate of epidermal mitosis (Bullough, 1948) and myocardial protein synthesis normally increases during sleep (Rau & Meyer, 1975). However, several indirect indicators link sleep with synthetic processes in man. Growing infants sleep much of the time and the 24h hormone pattern is such that anabolic processes would be facilitated during sleep and catabolic processes during wakefulness (Adam & Oswald, 1983). Thus, body temperature and metabolism rise with the increased catabolism of the waking period and falls to its nadir during the nighttime sleep (Mills et al., 1978). Lower body temperature during sleep reduces the use of cellular energy, and thus conserve energy. The catabolic hormones, cortisol, epinephrine and norepinephrine that inhibit protein synthesis, are secreted during
wakefulness, and the principal secretion of Growth Hormone, GH, testosterone, and other anabolic hormones have their peak rates of growth and repair during sleep (Weitzman, 1975).

Recent research connects sleep to the immune system (Born, 1999). Under certain conditions immune activation enhances SWS and intensifies NREM sleep (Mullington et al., 2000; Pollmächer et al., 1993). On the other hand, sleep deprivation has been associated with alterations in the expression of cytokines and declines of cellular and natural immunity (Irwin et al., 2003; Irwin et al., 1996), indicating a health promoting meaning of sleep.

Many argue that the restorative process of sleep (especially SWS) is particularly important for proper brain functioning (for a review see Horne, 1978). This theory is supported by findings showing that sleep is involved in reprocessing memory traces and facilitates learning and memory consolidation (Huber et al., 2004; Maquet, 2001), and to reach optimal performance (Gosselin et al., 2005; Stickgold et al., 2000).

This earlier research strengthens the theories of the functions of sleep for protection and detoxification, energy conservation (Berger & Phillips, 1995), brain cooling (McGinty & Szymusiak, 1990) and tissue restitution (Adam & Oswald, 1977). It might be hypothesized that if sleep in burnout is characterized by continuous disruptions and shortage of sleep the restorative and anabolic processes will be interrupted, with detrimental effects for performance, cognitive functioning and health in burnout.

**Disturbed sleep**

As reflected in the diagnostic manual for sleep disorders disturbed sleep is mainly a matter of difficulties initiating or maintaining sleep (AASM, 2001). Below is discussed in more detail what disturbed sleep is and what characterizes the clinical entity “Primary Insomnia”. Here will not be discussed the two other clinical entities “Hypersomnia” (sleep apnea, narcolepsy, etcetera) and “Parasomnia” (night mares, sleep walking etcetera) since they do not seem relevant in relation to burnout.

**Sleep initiation and maintenance**

The ultimate sleep disturbance is of course if sleep fails to initiate when it should normally occur. This is one of the most common complaints in individuals with sleep problems (Thorpy, 1990). Normal sleep latency is around 10 minutes and wakefulness within sleep usually accounts for less than 5% of time (Carskadon & Dement, 2000) and a sleep efficiency (percentage of actual sleep from sleep onset to final awake) below 85% is considered as poor (Morin, 1993).

Some other variables are also sometimes used as indicators of disturbed sleep. These include a shortened REM latency or increased SWS latency, although clear criteria do not exist. Large deviations from normal values of SWS and REM (around 20-25% of sleep respectively, in young adults) may also be used to indicate disturbances as may deviations from the normal 80-90 minute REM-NREM cycle (Carskadon & Dement, 2000).
Sleep, in a number of sleep disorders, is punctuated by frequent, brief arousals of 3 to 15 sec duration. These arousals are characterized by bursts of EEG alpha activity and, now and then, transient increases in skeletal muscle tone. These arousals typically do not result in awakenings, but recur in some conditions, like apnea, leg movement or pain, as often as 1 to 4 times per minute. Even if the arousals or awakenings do not reduce sleep time, the quality of sleep is deteriorated since sleep may be restricted to stages 1 and 2 and REM might be reduced or phase delayed (Carskadon & Dement, 2000) (see fig 2).

![Image showing fragmented sleep with frequent microarousals, decreased amount of SWS (lower) and decreased power in delta frequency band (mV²) (upper curve).]

Results from studies on sleep fragmentation have suggested that it is the continuity of sleep that determinates its restorative function (Bonnet, 1986; Stepanski et al., 1984). However it is difficult to isolate the manipulated effects of sleep fragmentation from effect of changes in sleep structure, since when the fragmentation rate is high the amount of SWS will be low (Bonnet & Arand, 2003). Studies on spontaneous sleep disruptions (micro arousals) outside the laboratory are scarce, and are an important issue for future studies when considering effect of work stress on sleep and performance.

As indicated above frequent sleep disruption, (or destroyed sleep continuity), strongly affects sleepiness and daytime functioning (Carskadon & Dement, 2000). Thus, one microawakening every 1-4 minutes will severely impair alertness, as demonstrated in experimental studies (Bonnet, 1986; Bonnet & Arand, 2003), in sleep apnea (Guilleminault et al., 1993; Mitler, 1993) or periodic movements during sleep (Rosenthal et al., 1984). Additionally, sleep fragmentation has been associated with feelings of distress and “unclear thinking” (Bonnet, 1985, 1986).
From a subjective point of view poor sleep quality variation across many sleep episodes is most closely related to sleep duration (or sleep efficiency) plus SWS (Åkerstedt et al., 1994; Åkerstedt et al., 1997). However, also fragmentation measures were important as secondary predictors. As an example, the perception of very poor sleep was given when the sleep efficiency was down to 65%. Very good sleep quality required ≥ 90%.

**Primary Insomnia**

Insomnia complaints typically includes problems with falling asleep at bedtime, waking up in the middle of the night with difficulties going back to sleep, and awakening too early in the morning. According to the Statistic Manual of Mental Disorders (DSM-IV) (APA, 2000) and the International Classification of Sleep Disorders (ICSD) (AASM, 2001) the criteria for Primary Insomnia is defined as: difficulties initiating and/or maintaining sleep or waking up too early and complaints of non-recuperative sleep for at least one months. To fulfill the criteria for an insomnia diagnosis the deficient sleep also must occur several times a week and result in subjective reports of fatigue, impaired daytime functioning, or mood disturbances. Often used criteria are sleep latency > 30 minutes, or > 4 awakenings per night, or > 45 minute awake during the night, or > 2 hours of reduced sleep (compared to the normal) (Morin, 1993).

The etiology of insomnia may differ and there are several main diagnostic subcategories: Insomnia related to Depression or other mental or medical disorders, Restless legs etcetera. The primary focus here however is Psychophysiological (AASM, 2001) or Primary Insomnia (APA, 2000), in which emotional causes are considered to be a primary factor. This represents about 20% of the insomnia diagnoses (Hauri, 2000; Ohayon, 2002).

Major contributors to sleep disruptions are worries and inability to escape persistent thoughts often related to stressful life events (Healey et al., 1981). A reasonable hypothesis is that the arousals result from emotional activation since symptoms that include tension, irritability or mood disturbances are frequently seen in insomniacs (Hauri, 1983). A combination of stressful events interfering with sleep and the individual’s attitudes to, and interpretation of their sleep quality and sleep pattern has been suggested to induce insomnia (Lundh & Broman, 2000). Primary Insomnia is hypothesized to be a disorder of hyperarousal, which has been supported by research on the autonomic nervous system and the HPA- axis function (Born & Fehm, 1998; Huether, 1996). Increased metabolic rate (Bonnet & Arand, 1995a), body temperature and increased alpha activity on the EEG both awake and during sleep onset (Freedman, 1986; Monroe, 1967) has been found in insomnia. Poor sleep has also been associated with increased cathecholamine and cortisol excretion (Adam et al., 1986; Vgontzas et al., 1999; Vgontzas et al., 1998).

Fatigue and impaired daytime functioning are key characteristics of Primary Insomnia, (Morin, 1993). It would be expected that sleep loss or disturbed sleep also would produce sleepiness. Daytime sleepiness has been evaluated in chronic insomniacs and normal sleepers by the Multiple Sleep Latency Test (MSLT) (Seidel et al., 1984), but despite sleep loss, insomnia patients have been shown to be at least as alert as controls (Stepanski et al., 1988). This seems paradoxical but it is likely that the “masking effect”, of high physical or mental activity (Carskadon & Dement, 1982; Hockey, 1997), might mask the experience of the current degree of sleepiness.
Thus, insomnia patients seldom report sleepiness, but instead fatigue (lack of energy) and the impaired daytime functioning has mainly been attributed to concentration difficulties (Broman, 1994; Hauri, 2000). In addition insomniacs commonly reveal significant elevation of tension, depression, anger and fatigue on the Profile of Mood States (Bonnet & Arand, 1997; Hauri & Fisher, 1986; Sateia et al., 2000), and in a general population study severe insomnia in most cases appeared before or at the same time as mood disorders symptoms, or after anxiety disorders (Ohayon & Roth, 2003). Since both insomnia and impaired functioning are commonly reported in burnout the need to investigate the co-morbidity of insomnia in burnout is underscored. Also a need to explore the characteristics of the subjective sleep complaints in burnout; whether sleep continuity, specific sleep stages or sleep length is the major problem, and if the sleep complaints are related to sleepiness, fatigue or both. The present thesis tries to provide such data.

**Sleepiness**

If sleep is involved in burnout then also sleepiness should be of interest. Interestingly no studies on burnout and sleepiness are available. The distinction between sleepiness, tiredness and fatigue is often blurred. It was recently debated whether tiredness and sleepiness are different dimensions on the same continuum (Dement, 2003; Dement et al., 2003) or if they are qualitatively distinguishable from each other (Horne, 2003). As discussed earlier, a similar confusion exists concerning fatigue and sleepiness. However, sleepiness is defined as the tendency to fall asleep (Carskadon & Dement, 1982) and a period of drowsiness or sleepiness characterizes the transitional phase between wakefulness and sleep (Pivik, 1991). Since sleepiness generally increases as a response to sleep reduction (Dement & Carskadon, 1982) it is a useful indicator of sleep need.

Gillberg et al. (1995) have stressed that 1-3 h curtailment of sleep will induce sleepiness. There are no studies on sleepiness in burnout, but sleep debt (≥ 5h) and overtime work (weekly ≥ 60h) have been observed as risks for exhaustion and myocardial infarction in white-collar workers (Liu & Tanaka, 2002). A number of experimental studies (Bonnet, 1986; Stepanski et al., 1984) and studies on shift workers (Kecklund et al., 1997) show that sleepiness is an effect of sleep loss or extended wakefulness (for a review see, for example Bonnet & Arand, 2003; Gillberg, 1995). A weekly recovery of 36 h off work is normally sufficient to recover alertness whereas three days or more are needed in shift workers after periods with severely disturbed circadian rhythmicity (Åkerstedt et al., 2000).

Sleepiness is often measured physiologically as the time taken to fall asleep while lying down (while EEG, EOG, and EMG is recorded) (Carskadon & Dement, 1982). This constitutes the so-called Multiple Sleep Latency Test (MSLT). Even if it would be preferable, it is often not feasible to use physiological methods for measuring sleepiness in many field studies or when the overall weekly pattern is of interest. Subjective sleepiness is one alternative and is measured using visual analogue scales (Monk, 1989) or Likert type of scales like the Stanford Sleepiness Scale (SSS) (Hoddes et al., 1973) or the Karolinska Sleepiness Scale (KSS) (Åkerstedt & Gillberg, 1990).
Sleepiness has not been studied in relation to burnout before and it is an interesting question if sleepiness is increased considering the reported sleep disturbances (Grossi et al., 2003; Melamed et al., 1999). On the other hand, the same studies found difficulties falling asleep which suggests a lack of sleepiness.

Also the diurnal pattern might be of interest. Normally sleepiness follows the circadian rhythm with relatively high levels on awakening and at bedtime and during midday (Hoddes et al., 1973; Monk, 1989; Åkerstedt & Gillberg, 1990). But if burnout, as hypothesized, involves a lack of recovery from sleep, it is possible that, the diurnal pattern of sleepiness might be abnormal.

Another interesting question is whether there is any difference in sleepiness between work days and weekends. The workday/weekend pattern of sleepiness might provide information on the chronicity of sleepiness, or if sleepiness in burnout decreases in relation to their weekend recovery.

One purpose of the present thesis was to provide information on the diurnal and weekday/weekend pattern of sleepiness. Also (mental) fatigue was added to this study of patterns since this might provide further information on the acute variation of fatigue across the day. Since no previous data are available no particular hypothesis can be put forward, however, other than a difference between high and low burnout groups would be expected.

**Qualitative aspects**

The tradition of science is dominated by the quantitative approach and so also the discussion on burnout and sleep. Traditional quantitative data from questionnaires or diaries are usually based on interviews with patients or others to obtain the dimensions/items of interest for the scales. Even though these methods give valuable information on the relationships between variables or on predicting a specific outcome, the core characteristics and nuances of a phenomenon may be lost. Qualitative research captures experiences in life “from within” the persons mind; thoughts, feelings, motivation and expectations, and thus provides an understanding that is different from, but precedes, explanation which in turn is the basis of our knowledge (Bullington, 1999; Sandelowski, 2004; Sandelowski et al., 1997).

Different qualitative approaches have been applied with success to gain insight into suffering for example, in living with diseases, like CFS and FM (Åsbring, 2001), stroke (Nilsson et al., 1999; Sundin & Jansson, 2003), temporarily confusion (Fagerberg & Jönhagen, 2002), Parkinson’s disease (Sunvisson & Ekman, 2001) and HIV (Barosso & Powell-Cope, 2000). And phenomenological studies on, for example caring, for suicidal psychiatric inpatients or patients in the midst of dying have provided important understanding on how to deal with stress in extreme situations (Talseth et al., 2003), and how to meet persons in crisis (Talseth et al., 2001).
Even though there have been a growing number of qualitative studies in recent years, there are few on burnout and most of them are in the field of nursing. Out of these, two studies focus on the experience of work related stress and strategies for reducing stress and burnout on a personal and organizational level (Farrington, 1997; Hooley, 1997). A few studies describe antecedents to burnout. A recent study using grounded theory to investigate nurses’ experiences of the patient-nurse relation, own expectations, lack of social support and powerlessness to influence work was found to precede burnout (Billeter-Koponen & Fredén, 2005). One phenomenological study describes the commitment to nursing and found burnout to be a strong precursor to reduced commitment (Rinaldi, 1989). Another study on nurses’ leaving their profession did not explicitly concern burnout, but described oppression, a non-caring culture, as a main core bringing the nurses into suffering and exodus, which might lead to burnout if they had decided to continue (Tinsley & France, 2004).

The only study on how burnout is experienced was a phenomenological study on nursing students’ experiences of burnout in relation to one situation of overwhelming demands, time pressure and no outlet (Beck, 1995). In this study burnout was considered as a temporary state and not a result of prolonged stress and did not describe long-standing problems or a process. Thus there is clearly a lack of qualitative studies on burnout especially in non-client related professions.

In reviewing burnout literature it becomes evident that the individual and the situation wherein the persons live their lives influences burnout development (Cherniss, 1980; Demerouti et al., 2000; Etzion et al., 1998; Maslach et al., 2001; Schaufeli & Buunk, 1996). Furthermore, burnout involves experiences and feelings that may not be possible to grasp with natural science methodology. Therefore a qualitative approach would be suitable in order to provide an understanding of the meaning of burnout and the experiences of burnout development. Interestingly, this perspective has never been taken into account. One purpose of the present thesis was to provide such knowledge. In particular, it is of interest to study how the time preceding burnout and the manifestations of the state were experienced. The philosophical basis for the phenomenological life world perspective is described below.

The phenomenological life-world perspective

To provide a background for later discussions the approach to the phenomenological life world perspective is summarized here. In human science research the life world is essential. The life-world is the world in which we live our daily lives, often taken for granted in perceptions and actions. The life world precedes all knowledge in the sense that it exists prior to any reflection upon it (Dahlberg et al., 2001; Merleau-Ponty, 1945), which means that the body responds to a situation or an event with physiological adjustments prior to any consciousness reflection upon how or why.

It is through the lived body that humans have access to, and are related to the world. The body acts as a whole, and it is through the bodily experiences the surroundings become meaningful to us (Merleau-Ponty, 1995). Through the lived body the physiological and emotional
reactions are merged with the conscious mind, and the lived body is experienced as a unified whole. This implies that an imbalance or dysfunction in one part affects all other parts, and that feelings of dysfunctions or ill health may occur prior to any consciousness of psychical or biological facts.

From a phenomenological life world perspective the relations within the human being and between the organism and its milieu are not relations of linear causality but of circular causality (Merleau-Ponty, 1995). A circularity between the lived body and the life world means that if the body undergoes changes, the person’s life world is affected too, and vice versa. And there is a circularity between the subject and object within the lived body in the meaning that the lived body can reflect upon itself. This experience of body and soul as inseparable entities and an ambiguous existence of subject and object, bridges the body-mind dualism, and means that human experiences are to be viewed as more than the sum of its own parts (Merleau-Ponty, 1995).

The life world is constituted of both material things and immaterial values like feelings, intentions and expectations, which have implications for how a phenomenon is experienced. Furthermore there is no way to step outside of one's own history (Merleau-Ponty, 1995), and the implication of this is that even though man is free, people are not freely choosing all their actions all the time; old habits, skills and expectations which have became their “way of being in the world” (Heidegger, 1982) have to be taken into account. A person’s lived experiences represent these aspects.

*Intentionality* is central to phenomenology and refers to the natural way of perceiving the world. The consciousness is always directed towards an object, a perception or an event and consciousness can be directed towards the subject itself in *self-reflection*. Through that act of directed consciousness knowledge about oneself and the world is attended. This means that the person is able to understand the meaning of the things that make up our every day’s lives and that the individual is able to make an active choice of perception (Dahlberg *et al.*, 2001; Merleau-Ponty, 1995). This view of a self-organizational and “enactive” process of consciousness, instead of brain areas passively reacting to mere stimulation, is supported by neuroscience (Ellis, 1999).

From the existing research it is evident that basic conditions for burnout development are grounded in the human life world, in material facts like circumstances, events at work and in daily life and in immaterial senses like the person’s expectations, feelings and thoughts. Thus, in order to grasp the lived experiences of developing burnout, a phenomenological life world perspective is appropriate to use.
Summary and aim

Previous research has shown that burnout is closely related to occupational stress. Energy depletion, excessive fatigue and emotional exhaustion are the main dimensions in burnout. Furthermore, burnout is strongly associated with subjectively reported sleep disturbances and fatigue. Thus, the question arises if there may be a connection between prolonged stress exposure, impaired recovery or sleep in the burnout syndrome.

Previous studies on burnout have been focused on the psychological responses in relation to performance and work. Research on physiological measures and burnout are scarce and inconsistent. And to the best of my knowledge there are no studies available on burnout and objective sleep. In the present thesis it is attempted to study two “levels” of burnout: those with high burnout scores but still successfully employed, as well as patients on sick leave with high burnout scores. Additionally, most of the discussion above has focused on a natural science based methodology and thus also a qualitative understanding of the concept is needed.

Based on the review above the purpose of the present thesis is to:

- describe the burnout development from a life world perspective.
- describe the physiological characteristics of sleep in persons with burnout on sick-leave and in individuals still working but at risk for developing burnout.
- relate burnout and disturbed sleep to a number of established physiological stress indicators.
- describe the pattern of sleepiness and mental fatigue across the day and week in the same groups, as well as the chronic pattern of fatigue in the group on sickleave.

Study I

The main purpose of this study was to describe lived experiences of the time preceding burnout from a life world perspective in order to describe the complex interaction between the person and the life world, as well as to describe early signs of the burnout development.

Study II

This study aimed to provide information on whether sleep complaints in patients on long-term sick-leave due to persistent occupational stress are related to disturbed sleep architecture and if the homeostatic processes are impaired in comparison to a control group of healthy working individuals. It was also a purpose to investigate if the diurnal pattern of sleepiness and fatigue differed from that of the control group on weekdays and weekend. Subjective sleep quality and characteristics of fatigue and work were also included.
**Study III**
This study aimed to investigate physiological and subjective aspects of sleep before a workday and a day off, in a group of young, working, apparently healthy subjects scoring high on burnout, compared with a group scoring low on burnout. The purpose was also to investigate the diurnal pattern of sleepiness on a workday and on a day off in the same groups, and to describe the groups with respect to work stress, mood, recovery and burnout related variables.

**Study IV**
The purpose of the study was to look for a relation between sleep fragmentation and a number of physiological parameters related to stress, including risk factors for CVD and the metabolic syndrome. A second purpose was to search for associations between the number of arousals and mood, burnout, daily stress ratings, work related and other possible predictors in daily life.
Methods

Design of the studies

Table 1 presents an overview of the design, sample and measures used in the studies. Study I has a descriptive approach using qualitative interviews to reach a deeper understanding of the experiences of burnout. Study II and III are field studies with both a within and between groups design. The between group perspective was between groups of burnout patients and matched controls in study II and between individuals scoring high and low on burnout in study III. The diurnal pattern of sleepiness (II, II) and Mental Fatigue (MF) (II) across weekday and weekend was evaluated within each group, as was the weekday and weekend pattern of sleep, rest and mood in study II and III.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Analysis</th>
<th>Burnout inventory</th>
<th>Objective measures</th>
<th>Subjective sleep</th>
<th>Subjective sleepiness/fatigue</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Qualitative interviews</td>
<td>Phenomenology</td>
<td>SMBQ</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>II</td>
<td>Within and Between groups</td>
<td>t-test, 2-factor ANOVA</td>
<td>SMBQ, MBI</td>
<td>PSG scoring, spectral analysis</td>
<td>KSD, KSQ</td>
<td>KSS, MF, SOFI</td>
<td>Work stress, BDI, BAI</td>
</tr>
<tr>
<td>III</td>
<td>Within and Between groups</td>
<td>t-test, 2-factor ANOVA</td>
<td>SMBQ</td>
<td>PSG scoring,</td>
<td>KSD, KSQ</td>
<td>KSS</td>
<td>Work stress, HAD</td>
</tr>
<tr>
<td>IV</td>
<td>Correlational</td>
<td>t-test, single &amp; multiple regression analysis</td>
<td>SMBQ</td>
<td>PSG scoring blood measures</td>
<td>-</td>
<td>-</td>
<td>Work stress</td>
</tr>
</tbody>
</table>

Study IV made use of the same sample as in study III and has a correlational design, evaluating the relationship between physiological measures of sleep, and biological stress markers as well as possible predictors of disturbed sleep in the daily life (table 1).
Participants and setting

The studies are results from field studies in two different settings. The participants in study I and II were undergoing a treatment program at the stress clinic (Stressmottagningen), Stockholm. The population in study III-IV was recruited from an information technology company subjected to a high workload. The control group in study II was recruited to match the burnout group on gender, age and educational level. Table 2 presents an overview of participants, and in table 3 the inclusions/exclusions of participants in study II and III are presented. More details are presented in the result section.

<table>
<thead>
<tr>
<th>Study</th>
<th>No invited* to participate</th>
<th>No of participants</th>
<th>Men</th>
<th>Women</th>
<th>Age, Mean±SE</th>
<th>Age, Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>45±3</td>
<td>30-56</td>
</tr>
<tr>
<td>II</td>
<td>173</td>
<td>24</td>
<td>6</td>
<td>18</td>
<td>39±2</td>
<td>26-56</td>
</tr>
<tr>
<td>III, IV</td>
<td>26</td>
<td>24</td>
<td>10</td>
<td>14</td>
<td>30.5±1</td>
<td>24-43</td>
</tr>
</tbody>
</table>

* for details se table 3

Participants in study I were selected to represent both men and women in different ages, occupational, marital and social status in order to represent as much experiences as possible. 8 individuals: 5 women and 3 men who, in accordance with the Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (DSM-IV) of the American Psychiatric Association (APA, 2000), met the criteria for unspecified maladjustment disorder. These persons were invited through an information letter to participate in the study. All 8 accepted, and received verbal information before they were included in the study. All had been on sick leave more than 3 months from their employment as white-collar workers. They also met the criteria of high burnout score (≥ 4.75, graded 1-7) on the Shirom - Melamed Burnout Questionnaire, SMBQ, (Kushnir & Melamed, 1992; Melamed et al., 1992). The sample size was large enough to achieve a variation of experiences and small enough to permit a deep analysis of the data (Streubert & Carpenter, 1995).

The burnout group in study II was recruited from the registers of an insurance company serving white-collar workers and included if: 1) they had a high burnout score (≥ 4.75, on a scale of 1-7) on the SMBQ, based on clinical data from the stress clinic (Perski et al., 2002), 2) they were on sick leave (fulltime) since at least three months, 3) their complaints involved work related burnout. Lacking a formal ICD diagnosis for burnout, stress related exhaustion (Z73.0 – ICD 10, WHO, 1992) was used as an important additional inclusion criterion. A control group of white-collar workers was recruited through internal advertisement from the same insurance company or through personal contacts, and were included if they 1) were full-time white-collar workers 2) scored < 2.75 on the SMBQ scale.

In order to assess psychiatric co-morbidity, all participants were assessed by a clinical psychiatrist, using the Structured Clinical Interview for DSM-IV, (SCID) (First et al., 1997a).
Before the interview, participants completed questionnaires to assess previous life events (Deykin et al., 2001) and the screening questionnaire for personality disorders (SCID-scan) (First et al., 1997b). This was done to exclude Axis II diagnoses as defined by the DSM-IV (APA, 2000). 65% of the patients had a diagnosis of depression at the beginning of the illness episode, but individuals with ongoing major depression and other Primary Axis I disorders were also excluded from the study.

The burnout group and controls were medically examined before the study and participants with infections or a medical history of Chronic Fatigue Syndrome (CFS), fibromyalgia, autoimmune diseases, Cushing’s syndrome, or other chronic diseases that might possibly explain fatigue were excluded from the study. Other exclusion criteria were: heavy snoring, sleep apnea (as evidenced in self-reports and oxygen desaturation measurements) and use of antidepressant medication, hypnotics, beta-receptor blockers and other medication known to interfere with sleep.

128 individuals on sick leave were contacted, 48 did not respond and 22 declined. Among the 58 volunteers 26 were not included since they fulfilled criteria for an Axis II diagnosis or ongoing major depression, 18 were not included since they were treated with Selective Serotonin Reuptake Inhibitors (SSRI), hypnotics or other medication interfering with sleep, one decline after inclusion because of extensive fatigue, and one left the study for family reasons. The 12 remaining were included in the burnout group. On the basis of the psychiatric evaluation work related problems was the precipitating factor in all cases, 7 also reported family stress.

Out of 45 control volunteers 14 scored above 2.75 on SMBQ scale, 8 were not included because of snoring or sleep apnea and 11 did not match the patients on gender and/or age. The remaining 12 individuals who met the inclusion criteria described above were included as controls. None of the control volunteers used hypnotics or antidepressants, and none fulfilled criteria for Axis I or Axis II diagnosis.

### Table 3: Overview over the inclusion/exclusions of participants in study II and III

<table>
<thead>
<tr>
<th>Study II</th>
<th>Study III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnout group</td>
<td>Control group</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>invited 128</td>
<td>45</td>
</tr>
<tr>
<td>No excluded</td>
<td>No excluded</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>-48 nonresponders</td>
<td>-11 non matchers</td>
</tr>
<tr>
<td>-22 declined</td>
<td>-8 snoring/sleep apnea</td>
</tr>
<tr>
<td>-26 Axis II diagnosis</td>
<td>-14 SMBQ &gt;2.75</td>
</tr>
<tr>
<td>-18 SSRI medicated</td>
<td></td>
</tr>
<tr>
<td>-2 other reasons</td>
<td></td>
</tr>
<tr>
<td>participants =12</td>
<td>=12</td>
</tr>
</tbody>
</table>

In study III – IV the participants were selected from a computerized questionnaire distributed to all employees at the company. 414 employees (out of 676) completed the questionnaires concerning stress at work, health, sleep and life style. This included the Shirom - Melamed Burnout Questionnaire (SMBQ) (Kushnir & Melamed, 1992; Melamed et al., 1992) modified.
from the original range 1-7 to a 4-graded scale, with 4 being almost always. The respondents were allocated to a high, and low, burnout group based on their total scores on the modified SMBQ. Inclusion criteria for the high burnout group was set to >=2.75 (linear transformation equaled 4.5 on the original version). Twelve employees scoring above the upper cutoff level of SMBQ (based on clinical data from the stress clinic) (Perski et al., 2002) were randomly selected, of which all agreed to participate in the study. Twelve control subjects were thereafter selected with burnout scores below the lower cut off level (<1.5), meeting the matching criteria: sex, age and experience in the company. If more than one individual in the low burnout group met the matching criteria, selection between these individuals was made randomly. Two selected subjects in the control group declined participation and were replaced by two others, selected from the low burnout group as described above.

**Ethical issues and approval.**

After recruitment the participants were informed that the participation was voluntary and that confidentiality would be preserved. They were given verbal information about the procedures (II & III), and all subjects gave written informed consent to participate. In the interview situation (I) special care was taken to show an open attitude and to show sensitivity to the participant’s vulnerability in re-living difficult experiences. The ethical committee of the Karolinska Institutet approved all studies.

**General procedure**

In study I data was collected using audio-taped interviews following phenomenological methods developed by Giorgi (1985, 1997) and Dahlberg (2001). The author conducted all the interviews in a quiet room at the stress clinic, and they lasted 45 to 90 minutes. The interviews were tape-recorded and transcribed verbatim. The interviews were in dialogue form and the participants were encouraged to describe in their own words concrete lived experiences from their whole life situation during the months preceding the acute phase of burnout. Follow up questions in order to elucidate the experiences as richly as possible, were for example: 1) Can you give an example of this? 2) What did you feel? 3) Please tell me more about that?

In study II the participants were subjected to a polysomnographical recording in their home (after habituation). Karolinska Sleep Diary (KSD) was filled out every day upon awakening and a daytime diary, including sleepiness (Karolinska Sleepiness Scale, KSS), and mental fatigue was completed at bedtime. Additionally, questionnaires raising questions on their habitual sleep pattern (Karolinska Sleep Questionnaire, KSQ), mood (Beck Depression and Anxiety Inventory, BDI, BAI), work characteristics, recovery and health were used at the beginning of the study.
The participants in study III and IV were subjected to a two-week protocol with sleep diary ratings completed upon awakening. Daytime ratings included acute sleepiness (KSS) every two hours from awakening to bedtime. The diary also included questions about work performance, health and stress symptoms. Two ambulatory polysomnographic (PSG) recordings were carried out in their home; one night before a workday and one night before a day off in a balanced design. Repeated saliva samples were collected during the day after the PSG-recordings following a schedule described in the methods section. The morning after the workday PSG, a fasting blood sample was collected between 8 and 9 AM. This was done by the same nurse at the participants’ work place (IV).

After the blood sample a recording of ambulatory blood pressure (ABP) was started and data were collected during 24 h (only morning sampling reported on here). In conjunction with the physiological assessment the participants completed a questionnaire to assess the current sleep pattern (KSQ), health status, mood (Hospital Anxiety and Depression scale, HAD), medications, work situation and performance (III, IV).

Measures

In table 1 (p. 28) an overview of the measurements used in the different studies are presented.

Polysomnography

Study II-IV included polysomnographically recorded sleep using portable "Embla” recorders (Flaga HF®). Ag/AgCl electrodes were used with two electroencephalographic (EEG) derivations C3 – A2 and C4 – A1, one chin electromyographic (EMG) derivation and two oblique electro-oculogram derivations (EOG). The frequency response for the Embla is between 0.5 and 100 Hz. The filter settings were 0.5 Hz for high pass filters and 75 Hz for low pass filters.

The electrodes for the polysomnographic measurement were attached in the laboratory between 4 and 6 AM in study II whereas the electrodes were attached in the participants home approximately two hours before bedtime in study III and IV.

Sleep stages were scored visually in 30-second epochs according to Rechtschaffen and Kales (1968). Sleep scoring was blind to group membership. Arousals were scored using the American Sleep Disorders Association criteria (ASDA, 1992). An arousal was defined as an EEG shift to at least alpha activity from stages 2-4 or Rapid Eye Movement (REM) sleep, preceded by at least 10 seconds of uninterrupted sleep (stages 2-4 or REM). During REM sleep an increase in EMG-activity was required. For an arousal to be scored it had to last for more than 3 seconds and for less than 15 sec. Sleep onset latency was scored as time from ‘eyes closed’ to the first epoch of at least three consecutive sleep epochs (Stage 1 or other sleep stages).
Computer-aided methods - spectral analysis

Also spectral analysis (Fast Fourier Transform, FFT) of the EEG was carried out (study II). The EEG was sampled at a frequency of 100 Hz using conventional filter settings (band pass filter set to 0.5 - 32 Hz). The FFT analysis was based on four-second epochs, and after visual artifact detection the entire 4-second "sub-epoch" was removed from analysis, and substituted by the mean of the immediately adjacent epochs. Values were then integrated across each band and averaged across 1-min intervals of sleep. The bands used were: 0.5-4.5 Hz (delta), 4.51-7.5 Hz (theta), 7.51–12.5 Hz (alpha), 12.51-16.50 (sigma) and 16.51-32.5 Hz (beta).

Physiological measures

Measures of the physiological stress response included different neuroendocrine markers reflecting the activity within the SAM-system and the HPA-axis respectively (Cox, 1985; King & Hegadoren, 2003; Seeman et al., 2001). It is known that concomitant with a long-drawn-out activity in the HPA-axis the energy mobilization of glucose and lipids is increased, with a risk of insulin resistance and other aspects of the metabolic syndrome as well as CVD (Björntorp, 2002; Peters et al., 2004). Since the metabolic and cardiovascular risk factors are associated with work stress (Schnall et al., 1998; Theorell & Karasek, 1996) as well as disturbed sleep (Nilsson et al., 2001; Nilsson et al., 2004) the physiological markers in study IV were chosen based on those findings. The variables used are briefly presented below.

Blood pressure and heart rate. The acute neural stress response from the Central Nervous System (CNS) reflected in catecholamine (e.g. norepinephrine and epinephrine) release into the blood are short-lived and difficult to measure, but the cardiovascular changes with a rise in blood pressure and heart rate have been used as markers of the intensity of stress related arousal in several studies (Chrousos, 1998a, 1998b; Folkow, 1997). For the ABP, an Ultralite™ monitor (90217, Spacelabs medical®) was used. The cuff was attached to the nondominant arm, and the recorder was programmed to operate every hour during waking hours and every second hour during nighttime sleep (between 12PM and 5AM).

Cortisol is one of the most commonly used biological markers of stress in bio-psycho-social research, showed to be involved in the final common pathway of the stress response (Wust et al., 2000). The cortisol response is an integral part of the HPA- activity and receptors are found in all major organs and bodily tissues (Folkow, 1997). Cortisol release facilitates energy mobilization but also alters the responsiveness of the immune system. Cortisol was measured in plasma and in saliva and those measures are normally highly intercorrelated (King & Hegadoren, 2003). The morning sampling of salivary cortisol followed a schedule used in previous studies (Pruessner et al., 1997): immediately after awakening, and 15, 30, and 60 minutes thereafter. This was followed by five additional samples: at 11AM, 3PM, 7PM, 9PM, and at bedtime. For statistical analysis, the awakening value (at 7AM ±1 hour) was used, as well as the mean values of all four morning samples.

Lipids. In response to acute stress and during prolonged periods of stress, the activation of the neuroendocrine systems and the subsequent secretion of hormones contribute to the mobilization of free fatty acids in the circulating blood. The free fatty acids in turn, stimulate
the production and release of lipoprotein including cholesterol and triglycerides (Brindley et al., 1993; Stoney & Finney, 2000).

**Triglycerides** are produced in the liver and in adipose tissue and are used as energy by the body. Disturbances in protein synthesis or elimination may lead to increased levels of triglycerides and subsequently may result in metabolic disturbances, insulin resistance (Brunner et al., 1997), and increased risk for heart diseases (Carlson & Åberg, 1985). Elevated levels have been associated with psychosocial arousal (Dimsdale & Herd, 1982) overload and burnout (Shirom et al., 1997).

**Cholesterol** is transported in plasma by lipoproteins that consist of proteins, triglycerides and phospholipids. The main types are the High Density Lipoprotein-Cholesterol, HDL-C, and the Low Density Lipoprotein-Cholesterol, LDL-C. Low levels of HDL-C with concomitant elevated levels of LDL-C constitute a risk factor for cardiovascular diseases. Psychosocial factors have been shown to decrease the HDL-C levels and increase the LDL-C levels and total cholesterol (Brindley et al., 1993).

**Glucose** is the main energy source, and the brain is almost exclusively dependent on the metabolization of glucose. Sleep plays an important role in energy balance and modulates leptin and carbohydrate regulation (Spiegel et al.), while increased cortisol release in response to stress stimulates glucose mobilization and lipolysis (Rosmond, 2005).

**Insulin** (and leptin) are involved in the stimulatory feedback signals in CNS and the LHPA-system involved in the brain’s prioritization of its own ATP concentration and the allocation of energy recourses for the rest of the body (Peters et al., 2004). A dysregulation of insulin in response to stress is one factor involved in the metabolic and cardiovascular diseases (Høieegen et al., 1998; Kissebah & Krakower, 1994).

**Antropometric measures.** The Waist to Hip circumference Ratio (WHR) has in a number of studies been observed as a powerful predictor of CVD, stroke, non-insulin dependent diabetes (Björntorp, 1993). The Body Mass Index (BMI) is a more generalized measure of body mass and is often assessed in combination with the WHR. It is hypothesized that increased WHR is a symptom of chronic hypothalamic arousal as a defeat reaction to exposure to psychosocial stress (Björntorp, 1991). Taken together, accumulation of visceral fat cells will generate high levels of free fatty acids, which subsequently may lead to CVD and a state of insulin resistance and the metabolic syndrome (Björntorp, 1991, 2002; Ottoson et al., 1994). Waist circumference was measured at the narrowest part around the waistline. Hip circumference was measured at the widest point between umbilicus and thighs. All measurements were taken to the nearest 0.5 cm. BMI was calculated as weight (kg) / height (m²) and WHR was calculated as waist (cm) / hip (cm) (Alberti & Zimmet, 1998).

**Laboratory analysis**

Serum was separated and frozen within two hours. All blood samples from each participant were analyzed in the same assay. This sample was analyzed for levels of serum glucose, total cholesterol, and triglycerides by solid-phase chemistry (Vitros, Johnsson & Johnsson). The
average total coefficient of variation was less than 6% for plasma glucose and 4.7% for cholesterol and triglycerides. LDL-C and HDL-C were measured by colorimetry (Hitachi 911, Roche) with a total coefficient of variation of less than 6%. Serum insulin and cortisol were measured by immunofluorescence (Auto Delfia, Wallac), with a limit of sensitivity of 20 pmol/l and a total coefficient of variation of 15% for insulin and 3.5% for cortisol.

Cortisol in saliva samples (using Salivette®, Sarstedt; Rommelsdorf, Germany) was determined through radioimmunoassay (Orion Diagnostica, Finland). The lower limit of sensitivity was 20 nmol/L in plasma and 1 nmol/L in saliva and the average inter- and intra-assay coefficient of variation never exceeded 10%.

**Sleep diary**

Subjective sleep quality was measured in study II to IV using the Karolinska Sleep Diary, KSD (Åkerstedt *et al.*, 1994; Åkerstedt *et al.*, 1997). The KSD was filled in every day upon awakening (Appendix II). It contained questions about “bed times”, “rise times”, “sleep latency”, “sleep quality”, “ease of falling asleep”, “calm sleep”, “sleep throughout the allotted time”, “number of awakenings”, “ease awakening”, “sufficient sleep” and “well rested”. A *Sleep Quality Index* (SQI) was used consisting of the following items: “sleep quality?” “ease falling asleep”, “calmness of sleep” and “sleep throughout”. The response alternatives ranged from 1 (great problems/very poor) to 5 (no problems at all/very good). Also questions about activation at bedtime and “sleep anticipation” was used, range 1=very relaxed to 9=very activated/very good (III) (see Appendix II).

**Wake diary**

Daytime ratings included sleepiness (II and III) and mental fatigue (II) and were carried out at awakening (around 7AM) and approximately at 10AM, 2PM, 8PM and at bedtime. Sleepiness was rated on the Karolinska Sleepiness Scale (KSS) (Åkerstedt & Gillberg, 1990) ranging from 1 to 9 (very alert-extremely sleepy, fighting sleep, an effort to remain awake). It has been validated against electrophysiological indices of sleepiness (Åkerstedt & Gillberg, 1990). Mental fatigue was rated on a 9-point scale ranging from 1=very fresh to 9= totally exhausted, with “5” meaning neither fresh, nor exhausted (see Appendix III-IV).

A second part of the wake diary included items describing “time pressure”, “sufficient rest”, “thoughts about work during leisure”, “mood” and “global health” (III). (Appendix III-IV)

**Questionnaires and indices**

**Burnout**

Burnout was measured in all studies using the Shirom – Melamed Burnout Questionnaire, SMBQ (Melamed *et al.*, 1992; Shirom, 1989). It consists of a list of 22 symptom sentences that measure different aspects of energetic exhaustion. Each item was scored on a seven-point...
scale graded from 1=almost never to 7=almost always (see Appendix V). The main subscale: emotional exhaustion and physical fatigue was formed from 8 items, the tension and listlessness subscales consisted of 4 item each and the cognitive weariness subscale of 6 items. A total index with the four subscales was calculated for each participant with a reliability coefficient (Cronbach’s alpha) of 0.90. This index correlates highly with the emotional exhaustion subscale of Maslach’s Burnout Inventory, MBI (Maslach et al., 1996) and with Pines Burnout measure (Pines et al., 1981) in a recent study of burnout women (Grossi et al., 2003).

In addition, the general version of MBI- General Survey, MBI-GS (Maslach et al., 1996) was used in study II. The MBI-GS assesses the same three general aspects as the original measure (emotional exhaustion, depersonalization and reduced personal accomplishment), using slightly revised items, and the suitable labels are; emotional exhaustion, cynicism (an alienated attitude towards one’s job) and professional efficacy (Maslach et al., 1996, p.20-21). The subscales are different from the original version in that they are generic, without emphasis on emotions and without direct reference to service recipients. The inventory consists of 16 items scored on a 7-point scale from 0=never to 6=always.

Sleep

Habitual sleep quality was assessed with the Karolinska Sleep Questionnaire (KSQ) (Åkerstedt et al., 2002). From this was derived the Sleep Quality Index (SQI) which includes: initiation and maintenance of sleep, with the items; “sleep quality”, “calmness of sleep”, “ease of falling asleep” and “sleep throughout the allotted time”. The response alternatives were 6= always/almost every day, 5=very often/≥ 4 days per week, 4=mostly/several days per week, 3=sometimes/several times per month, 2=seldom/a few times per year and 1=never in study II and varied from 1 never to 5 always, in study III (see Appendix I). The SQI has been validated against polysomnography and show good correlations with objective sleep parameters (Kecklund & Åkerstedt, 1997). A Sleep Sufficiency Index (SSI = sleep time/habitual sleep need x 100) was calculated from the habitual sleep need.

Depression and anxiety

The Beck Depression Inventory (BDI) (Beck et al., 1961), and the Beck Anxiety Inventory (BAI) (Beck et al., 1988) were used to assess depression and anxiety in study II. Those inventories are developed to discriminate groups with anxiety and depression in clinical research in psychiatric populations.

The Hospital Anxiety (HAD-A) and Depression scale (HAD-D) (Zigmond & Snaith, 1983) was used in study III. HAD has been tested and evaluated in different groups as a useful instrument because of its brevity, simplicity and lack of effect of somatic conditions (Hopwood et al., 1991; Zigmond & Snaith, 1983). It shows strong correlations with the BDI and Spielberger’s state Trait Anxiety Inventory in a Swedish sample (Lisspers et al., 1997).
Health and mood

The health and mood assessment (IV) consisted of 22 items, used in the clinical work at the stress clinic. The checklist is similar to the Symptom Checklist-90 (Derogatis, 1977) and the General Health Questionnaire (Goldberg & Hillier, 1979) and concern to what extent complaints like, irritability, pain, worries etcetera had occurred during the last three months. The response alternatives varied from 1 = never to 5 = always/almost every day. The 22 items were factor analyzed (n=414, varimax rotation) for purposes of data reduction (unpublished). The orthogonal factor solution yielded five factors with an eigenvalue above one: “cognitive symptoms” (5 item), “ache/pain” (4 item), “tension” (3 item), “passivity” (3 item) and “fatigue” (3 item). The remaining four items had a factor loading below 0.4 and were not accepted. The indices: “tension” and “ache/pain” were used in study IV. The remaining indices overlap with SMBQ and were not suitable for inclusion in the analysis. The tension index consisted of “irritability”, “anger” and “tension/restlessness” (Cronbach’s α =0.85), and the ache/pain index included the items: “pain from neck and shoulders”, “upper back pain”, “lower back pain”, and “aching hands and joints” (Cronbach’s α =0.88) see appendix I.

Occupational fatigue

To differentiate specific dimensions of fatigue related to work in burnout (study II) we selected the Swedish Occupational Fatigue Inventory (SOFI), which has been used and validated in different occupational settings (Åhsberg, 2000). SOFI consists of 25 expressions with a response scale ranging from 0 to 6, verbally defined at the endpoints: 0 = not at all and 6 = to a very high degree. The 25 items form five dimensions: “lack of energy”, which indicates a general character, “physical exertion”, “physical discomfort”, “lack of motivation” and “sleepiness”, consisting of four item each.

Work stress

Work characteristics were assessed in the questionnaire and consisted of psychosocial work factors, inspired by the two dominating models concerning job stress over recent years: the demand-control-support model (Karasek, 1979; Toomingas et al., 1997) and the effort-reward model (Siegrist, 1996). The original demand-control-support model deals primarily with work content that can be changed by means of organizational redesign. The effort reward imbalance model deals with the framework around the job situation, such as the balance between effort and reward (money, esteem, job security). The items varied partly between studies to suit different conditions. The questionnaire was generally shorter in study II since the participants suffered from difficulties to concentrate on paperwork. In study II two indices were formed; demands at work (4 items, Cronbach’s α = 0.85) and decision latitude (3 items, Cronbach’s α = 0.76) (see Appendix I). The participants were asked to remember the work conditions six months before sick leave. The response alternatives were: 1 = totally disagree to 4 = totally agree. Psychosocial work factors in study III and IV derives from a factor analysis of the whole sample (n=414) (unpublished), and included job demands (10 items, Cronbach’s α =0.85), control (i.e. decision latitude, 3 items, Cronbach’s α =0.88), support from managers (4 items, Cronbach’s α =0.86), support from colleagues (5 items, Cronbach’s α =0.83). Also an index concerning thoughts about work during leisure time (3 items, Cronbach’s α =0.82), and single items like: “work interferes with leisure time”, “working hours per week”, “time
pressure”, and frequency of “bringing work home” were used to various extent in study III-IV. The response alternatives were; 1 (totally disagree) to 4 (totally agree), except for “bringing work home”, the scale of which ranged from 1 = never to 5 = always/almost every day (see appendix I).

Statistics and analysis

Phenomenological analysis - study I

A phenomenological life world approach based on Husserl’s (1998) phenomenology was used in study I to describe the lived experiences of time preceding burnout. The phenomenological method implies a rigorous, step-by-step analysis of concrete life descriptions. In order to stay faithful to data and avoid being biased during the analysis the researcher has to set aside any pre-understanding or taken for granted assumptions of the phenomenon: bracketing (Giorgi, 1997).

The analysis has four steps:

1. Naive reading in order to grasp a sense of the whole.
2. Discrimination of meaning units within the chosen perspective, focusing on the phenomenon under study.
3. Every meaning unit was reflected on with free imaginative variation and transformed into a statement expressing its most invariant meaning - a careful transformation of each meaning unit into everyday language in an attempt to shed light on, and better understand the participants’ lived experience of the phenomenon.
4. When all meaning units had been transformed and in reflecting on the variations of meanings, the analysis brought out an essence of the phenomenon and the core that did not vary between the individual’s unique meanings emerged (Dahlberg et al., 2001; Giorgi, 1985, 1997).

The insights reached were synthesized and integrated into a descriptive structure containing eight closely interrelated constituents. The general structures emerging from the analysis illuminates the essential meaning of the phenomenon “the lived experiences during the time preceding burnout”.

Statistics – study II-IV

Differences between groups were analyzed using t tests or χ2 tests (II-IV). For measures within groups and for analysis between groups for several days or across days an Analysis of Variance (ANOVA) for repeated-measures was applied. The latter included correction for violation of the assumptions of equal variances and covariances (Winer, 1971). The between group factor used in the analysis was group (burnout patients/high burnout group and healthy controls/low burnout group) and the within group factors were: time of day (awakening to bedtime) and day (weekday/workday and weekends/days off) (II, III). When appropriate, and after a significant main effect, pairwise t-tests were carried out to investigate the simple
effects. (II, III). Background variables were included as covariates to rule out their influence on the dependent variables.

Correlations (Pearson’s $r$) were calculated to describe the magnitude and direction of a relationship between variables (II-IV) and also to assess the stability of different measures (i.e. cortisol in blood and saliva in study IV, between MBQ and SMBQ study II or test–retest reliability of the SMBQ in study III). A set of stepwise regression analyses were carried out in order to understand the relation between disturbed sleep and the physiological parameters, and also to find the best predictor of high frequency of arousal (IV) (Winer, 1971).

Variables with a skewness $\geq 2.0$ were log transformed (IV). The internal consistency of the indices used in the analysis (II-IV) was tested by computing the alpha coefficient (Cronbach, 1951). An alpha level of 0.05 was considered to be of statistical significance. All values in the analyses are expressed as mean $\pm$ SE. All calculations were carried out using Statview software (version 5.0.1; SAS Institute Inc, Cary, NC) and SPSS 10.0 (11.0 in study II) for Macintosh (SPSS Inc., Chicago, Ill.).
Summary of studies

In the following the major findings from each study are presented briefly.

Lived experiences of the time preceding burnout (study I)

This study aimed to elucidate lived experiences of the time preceding burnout and identify early signs of burnout in the development of burnout. The study has a phenomenological life world approach and the analysis followed methods developed by Giorgi and Dahlberg (Dahlberg et al., 2001; Giorgi, 1997).

The essential meaning of the time preceding the manifestation of burnout was experienced as being trapped in an ambiguous struggle to live up to the never-ending demands within and outside working life on the one hand and to the stimulating challenges as a self-nourishing drive on the other. By gradually cutting off everything that interfered with their focus on the “struggle”, like personal needs of regular meals, physical training, social activities and time for sleep and rest, a variety of bodily and psychological manifestations emerged. Symptoms like pain, frequent infections, emotional instability, sleep disturbances, cognitive impairment appeared, with an overwhelming fatigue as a common feature. The leisure time became either consumed by illness and fatigue, or by an inability to unwind that made it hard to sleep and recuperate.

In focusing even harder the “cutting off” became a barrier that prevented help from others and they became alienated from their own feelings and from others. The physiological and psychological manifestations progressed and the participants described how a terrifying feeling emerged of being trapped in a vicious circle without means to struggle against it. In that stage they were too drained of energy to be able to change the situation.

The description of the time preceding burnout shows that the participants came to critical points and events that were crucial for the outcome. Acceptance of, and reconciliation with the situation, was what could stop the struggle and that marked the turn of the tide. From there a new reconstruction of life could emerge.

The essential meaning of the time preceding burnout was illuminated by eight constituents; “inner incentive”, “feeling responsible”, “threatened self-image”, “cutting off”, “bodily manifestations”, “psychological manifestations”, “fatigue” and “reaching the bottom line” (see fig 3).
The results show that there is a need for better understanding of the early signs in order to prevent the damaging effects of burnout at an early stage. Furthermore, the study suggests that a better understanding of how to reach behind the defense of “cutting off” is an essential skill for nurses, healthcare professionals and others encountering the burnout sufferers.

**Sleep, sleepiness and fatigue in burnout patients (study II)**

This study recorded polysomnography in white-collar workers with a high level of burnout. Sleep and the time of day pattern of sleepiness and mental fatigue on weekdays and weekend were described, and precipitating factors and different dimensions of occupational fatigue were also measured. 12 patients on long-term sick leave (> 90 days) because of occupational burnout, and a control group with 12 healthy fulltime white-collar workers participated.

The PSG findings showed that sleep was impaired in burnout patients compared to controls for: sleep efficiency (lower), SWS (lower), stage 1-sleep (higher), arousals (higher), and sleep fragmentation index (# arousals + # awakenings to stage 0 and stage1) was higher in the burnout group. But also REM sleep (lower), Wake time After Sleep Onset, WASO (higher) and SWA (lower) showed that sleep was affected, compared with healthy controls. TST, bedtime and rise time, sleep latency, SWS latency, REM sleep latency, number of awakenings and stage 2-sleep did not differ between groups.

This subjective perception of sleep was characterized by significantly more awakenings, lower sleep quality, and less sufficient sleep in the burnout group. The groups did not differ on TST, bed times or rise times. Most variables showed a clear weekend effect – later sleep hours being associated with longer and more sufficient sleep. Sleep quality and number of awakenings were not affected, however. No interactions were seen.

Results from the 2-way ANOVA for repeated measures showed a significant main effect for sleepiness with respect to group, day and time of day. The burnout group was sleepier than
the controls and there was a U-shaped diurnal pattern with the nadir at midday. Several interaction effects were seen, indicating that the difference between the groups was larger during the weekend and the diurnal pattern was shallower in the burnout group. Post-hoc comparisons between groups showed higher sleepiness for the burnout groups for each point in time, both weekdays and weekends, except for the workweek afternoon when the controls were as sleepy as the burnout group (fig 4).

The main finding from the within group ANOVAs on the different days in each group showed that the burnout group was as sleepy on weekends as on weekdays, while the healthy controls perceived more alertness during days off compared to weekdays.

The same analysis for mental fatigue (fig 4) showed a significant main effect of group, with higher levels of mental fatigue at virtually all points in time (except for weekday evenings) in the burnout group compared to controls. The u-shaped time of day pattern in both groups indicated higher levels of mental fatigue in the mornings and evenings but the diurnal pattern was shallower in the burnout group. The within group ANOVAs showed no significant effects except for time of day, suggesting a consistent level of higher mental fatigue across weekdays in both groups.

The total SMBQ-score for the whole sample was positively correlated with the total MBI-GI score showing that the selection criteria are consistent with the burnout measure most used in research. Among the burnout patients 7 (58%) met the criteria for insomnia according to DSM-IV. The BDI and BAI-scores confirmed that the burnout group contained elements of depression and anxiety even though patients with an ongoing major depression were not included in the study.
The work situation for burnout patients before sick leave was characterized by higher work stress and more interference with leisure time. The burnout group also had more difficulties unwinding after work. The five dimensions of fatigue measures on the SOFI, were all markedly elevated in the burnout group compared with the controls indicating a general lack of energy without any particular type of fatigue dominating.

This study clearly showed that burnout patients were characterized by impaired sleep and alertness.

**Sleep and sleepiness in young individuals with high and low burnout scores (study III)**

This study sought to investigate PSG measured sleep in persons at risk of developing burnout that is, with high burnout scores but still successfully working. The aim was also to study the diurnal pattern of sleepiness, as well as self-rated work stress and mood in groups with different burnout scores. Sleep was measured in the participants own home one night before work and one night before a day off. Diary ratings of sleep, sleepiness and work performance were carried out during two weeks.

The main result from the PSG measures in the high vs low burnout group was a significant main effects of group with respect to the total number of arousals and number of arousals per hour, which both were higher for the high burnout group. Sleep efficiency tended to be poorer in the high burnout group, but did not reach statistical significance. Significant effects of day were found for bedtime, rise time, total sleep time, stage 2 sleep and REM-sleep, which showed that both groups went to bed later before the day off, rose earlier and slept shorter before the workday. Both groups showed more stage 2 and REM-sleep before the day off. No significant interaction effects were found.

The sleep diary ratings for the two PSG nights showed a significant difference between groups in: sleepiness (KSS) at rise time, impaired awakening, and sufficient sleep, with poorer values in the high burnout group. There was an interaction effect in KSS at rise time and impaired awakening, indicating that the high burnout group did not feel as refreshed after sleep as the low burnout group on days off. The diary ratings showed that perceived sleep quality, wake time after sleep onset and number of awakenings did not differ between groups, or between weekday/day off.

The main findings from the diurnal pattern of sleepiness on the workday and on the day off in high vs low burnout groups was a significant interaction effect (day x group) indicating that the groups were equally sleepy during workdays, but differed during the days off, with higher sleepiness in the high-burnout group in the morning and afternoon.

Questionnaire data showed that the groups did not differ in perceived support from managers or co-workers, decision latitude or working hours. But those with high burnout scores felt
higher demands at work, worked more at weekends and during leisure time, and described more frequently that they brought work home than did the low burnout scorers. The work characteristics were confirmed in the diary ratings. The high burnout group had more thoughts about work during leisure time than the low-burnout group and felt less satisfaction with work performance, even though the groups did not differ in time pressure, work pace, work load or working hours.

This study shows a moderate sleep fragmentation and impaired recovery on days off in individuals with high burnout scores. Possibly this could be an early sign of risk for developing burnout.

**Arousals from sleep and physiological correlates (study IV)**

This study sought to investigate if the burnout and sleep parameters, mainly arousals would be correlated to physiological markers that in the long run could have adverse effects on health. Also the correlation between fragmentation and work stress, real life stress and mood was tested.

A stepwise regression analysis using the main sleep parameters (frequency of arousals, TST and sleep efficiency) and burnout groups as predictors brought out number of arousals as the best predictor of morning cortisol (serum & saliva), heart rate, systolic and diastolic blood pressure, total cholesterol, HDL-, LDL-Cholesterol and LDL/HDL-ratio. In addition to the number of arousals, TST was positively related to the LDL/HDL-ratio and negatively to cortisol in saliva. For the latter also the burnout group entered the regression (higher cortisol in burnout subjects). Sleep efficiency was negatively related to heart rate.

Burnout group and gender were tested in the same analysis and gender was the only predictor of WHR (higher in women) and was accompanied by burnout group and sleep efficiency as significant predictor of higher HDL-C. No relations were found between fragmentation and any of the other predictors and triglycerides, P-glucose, or the insulin/glucose ratio.

Work related stress (“bringing work home”) and tension index was the best predictor of arousals among the subjective stress variables tested. Those variables were closely correlated to each other and to burnout. Neither of the control variables tested – ache/pain index, snoring, having small children, anxiety, or depression - entered any of the stepwise multiple regression analyses.

In summary, this study demonstrated that a subtle sleep fragmentation in otherwise normal sleep was related to physiological changes that in the long run may affect health. Also “unclear boundaries between work and leisure time” and “tension/irritability” were associated with the sleep fragmentation, suggesting that inability to unwind the stress system may be a mediating factor.
Discussion

Introduction

Before discussing the results a summary of the main findings is presented below. Then the discussion will concern sleep in burnout, which was the main objective of the investigation. Thereafter the findings on stress physiology, sleepiness and fatigue are discussed, and the process of burning out will be discussed from a life world perspective. After methodological considerations and a tentative integration of the results, implications for further research will be discussed.

The main findings of this thesis are:

In individuals on sickleave for burnout/stress related exhaustion:
- Experiences of time preceding burnout were described as being trapped in a pitfall where the stimulating challenges had become a self-nourishing drive to protect a threatened self-image and balancing never-ending demands. “Cutting off” recovery led to increasing amounts of physiological, cognitive and emotional symptoms. Acceptance of, and reconciliation with, the situation, was the turning point.
- Sleep was impaired on all essential sleep variables in the burnout group, indicating an impaired recuperation. The subjective ratings of sleep were in agreement with the PSG recordings.
- The diurnal pattern of sleepiness was different in weekends and weekdays in burnout group and controls. The compensatory restorative effect of prolonged sleep during days off had an impact on alertness in controls but not in the burnout group.
- Work stress was clearly pronounced in the burnout group, supporting its key role in the development of burnout.
- The fatigue was generalized and of an unspecific character and extended across physical and mental dimensions.

In persons at risk for developing burnout:
- PSG recorded sleep in young individuals, were characterized by a higher frequency of arousals compared to those with low burnout scores.
- The sleep fragmentation, rather than burnout scores, was associated with elevated levels of cortisol, blood pressure, heart rate and lipids, suggesting a link between disturbed sleep and metabolic and cardiovascular risk indicators.
- Arousals from sleep were related to workload and stress/tension.
- The sustained sleepiness pattern on workdays and weekend suggests an early sign of impaired recovery from sleep during days off.
- Working more at weekends and during leisure time, bringing work home more frequently, combined with more thoughts about work at leisure, indicate a prolonged work load and wind-up stress system in the high burnout group.
In order to avoid confusion about the study groups, the individuals at sick leave for burnout/stress related exhaustion in study II are referred to as burnout patients, and the young group scoring high on burnout in study III and IV is referred to as pre-burnouts. When the groups are discussed together they will be labeled burnout groups. And the healthy controls (II) and low burnout group (III) will be labeled control groups when they are discussed together.

Sleep

Burnout and sleep

Sleep problems was a common theme in the descriptions of the time preceding burnout and sleep was voluntary curtailed in order to cope with work demands (I). It was also obvious in the sleep diaries of the burnout groups in both sleep studies (II, III) as well as in the questionnaires, similar to other questionnaire observations by Melamed (1999), Grossi (2003) and coworkers.

The two sleep studies in this thesis provide support for the subjective complaints of disturbed sleep in burnout. The polysomnographical findings showed that sleep in young individuals at risk of developing burnout (III) were characterized by a higher frequency of arousals compared to colleagues with low burnout scores. The level was higher than the cutoff point used for diagnosing sleep apnea (Guilleminault et al., 1993), which suggests that the effects are not marginal. Since a higher frequency of arousals was significant for both recordings (one night in-between two workdays and one night at the end of the working week – after a workday and before a day off) the result seems relatively robust.

The burnout patients (II) showed an even stronger sleep impairment. Thus, beyond arousals, they also showed fragmentation in terms of real awakenings, as well as more stage 1 sleep and wake time after sleep onset. Sleep in the group of burnout individuals on sickleave also contained a lower sleep efficiency, less SWS and REM sleep and a lower delta power density than in controls (II). There are no other PSG studies on burnout available to compare with but the polysomnography is at least as impaired (with less SWS, REM and reduced SWA) as in insomnia, even though the subjective perception was similar (AASM, 2001; Morin et al., 1993).

Vital Exhaustion (VE) may be a state similar to burnout and in the only sleep study available it was demonstrated a reduction in SWS similar to that in the present burnout group (van Diest & Appels, 1994). Patients with Chronic Fatigue Syndrome (CFS) appear to exhibit reduced sleep efficiency, comparable to what was found in the burnout group, but those patients tended to extend their sleep (Sharpley et al., 1997). Taken together the two studies suggest that burnout is associated with impaired sleep.
Sleep and stress

The two sleep studies are descriptive and do not provide any clear explanation of the reason for the sleep disturbances. However, long-term stress seems to be the most likely cause. Thus, the burnout groups reported increased levels of work stress in the questionnaires (II, III), mainly as high work demands, as well as reports of not being able to avoid thinking of work. Furthermore, in the interview study the participants described how they began to more or less voluntary shorten their sleep due to work demands. To this was added frequent awakenings at night or in the early morning (I). The process also involved alternating states of sleepiness/fatigue and of difficulties sleeping.

The notion of stress as a cause of disturbed sleep in the pre-burnout group is also supported by study IV, which showed that a high frequency of arousals was related to higher subjective tension/irritability, which is a common correlate of stress (Chrousos & Gold, 1992), as well as a predictor of disturbed sleep (Healey et al., 1981; Rosa & Bonnet, 2000). Thus, one might hypothesize that a reduced capacity to relax mentally because of stress or tension might be a contributor to the sleep disturbances seen in this thesis since “persistent thoughts” and an inability to unwind were found in both burnout groups (II, III). This is consistent with findings of a stronger tendency to experience stress-related intrusive thoughts being associated with greater sleep complaints (Hall et al., 2000).

Incidentally, also the diagnosis Primary Insomnia is closely linked to long term exposure to stress (Freudenberger, 1983; Hauri, 2000; Morin, 1993) and the established etiology is clearly stress (Healey et al., 1981; Morin et al., 2003). Primary Insomnia is also associated with physiological and CSN mediated hyper arousal (Adam et al., 1986; Bonnet & Arand, 1998; Perlis et al., 2001b; Vgontzas et al., 2001), and impaired daytime functioning and fatigue are part of the diagnostic criteria of insomnia (AASM, 2001; APA, 2000). In the study on burnout patients (II) it was estimated that about 60% fulfilled the criteria for insomnia according to DSM-IV (APA, 2000) and the ICSD (AASM, 2001). This raises the question of the relation between burnout and Primary Insomnia.

Stress physiology and sleep

The study on the groups with high and low burnout scores (IV) brought out arousals from sleep as the best predictor of a number of cardiovascular and metabolic risk factors. The arousals were associated with increased heart rate and blood pressure (i.e. increased CNS activation), as well as increased levels of cortisol, and lipids (IV). This indicates a link to the HPA-axis and the metabolic system. The findings are consistent with studies showing that sleep fragmentation is associated with an increased metabolic rate, and cortisol (and catecholamines) is usually increased by arousals from sleep (Spiegel et al., 1999; Späth-Schwalbe et al., 1991).

As already mentioned, the link with stress was brought out in the prediction of arousals by tension index (IV). This may be interpreted as an indication of not feeling well. Possibly, this indicates a “pre-phase” of burnout related to what was reported in the interview study that “something feels very wrong” (I), which was experienced before any consciousness of illness.
appeared. Thus, illness seemed to be experienced at a *prereflective level* before any explicit manifestation of measurable biological facts (Husserl, 1970; Merleau-Ponty, 1995). This is in concordance with a cluster of illness with subjective health complaints (Ursin & Eriksen, 2001), and emphasizes the role of *emotions* as a possible link in the chain between psychosocial stress and diseases (Bullington, 1999). This is highly speculative though and need to be investigated further.

Although the transient disruptions of sleep (IV) observed in the present studies could be harmless, they signify an elevated physiological arousal, and it is possible that over time they could interfere with the normal anabolic dominance in sleep. It is possible that the metabolic and hemodynamic changes might be linked to subsequent pathology since it has been demonstrated that disturbed sleep predicts cardiovascular disease (Nilsson *et al*., 2001), and diabetes type II (Nilsson *et al*., 2002). Other studies have suggested extreme fatigue and sleep loss as precursors of early heart events (Appels & Mulder, 1988; van Diest & Appels, 1994). In addition, diabetics (Vgontzas & Chrousos, 2002) and patients with CVD often suffer from sleep loss, fatigue and stress (Edél-Gustafsson & Hetta, 2001). However, the physiological pathways between stress, sleep and burnout or other diseases are largely unknown.

It should be emphasized that in the present work high morning cortisol in blood and saliva, as well as the metabolic and hemodynamic variables were predicted by arousal from sleep rather than burnout (IV). It is not clear what this means other than the metabolic and related effects may “need” an acute load of tension/anxiety in order to show a link to burnout. Rosa *et al* (2000) put forward similar suggestions with regard to Primary Insomnia, that is, sleep fragmentation and other impairment appeared in insomniacs only under acute stages of tension/anxiety. Otherwise sleep was relatively normal. It might be the case that the duration of the exposure to stress needs to be longer for a clear effect to be seen.

Thus, even though no conclusions about causality can be drawn from the present results (I-IV) it seems reasonable to believe that a prolonged period of overload and stress could be a significant contributor to disease, especially since *sleep*, assumed to repair the wear and tear was impaired. This is a conclusion that Selye made already in the early 20th (Selye, 1936, 1946).

And according to the model of allostatic load (McEwen & Stellar, 1993; McEwen, 2004; Seeman *et al*., 2001), extended stress or tension may result in an up-regulation in the HPA-axis and SAM systems resulting in a more or less permanent hyperarousal, mediating frequent microdisturbances of sleep (III). Evidence for sleep interfering with the same physiological systems (Moldofsky, 1997; Vgontzas & Chrousos, 2002; Weitzman, 1975) imply that a regular return to a pre-stressor level is necessary to avoid the physiological *state of balance* to be pathologically displaced (McEwen, 1998, 2004). Further studies are needed however, but some studies show alteration in the above-mentioned systems in insomnia (Adam *et al*., 1986; Bonnet & Arand, 1995a; Bonnet & Arand, 1998) and Vgontzas (2001) reported significant association between the degree of nocturnal hypersecretion of cortisol and sleep disturbances, which supports this suggestion. Some recent research (Alderling *et al*., 2005) shows a decreased cortisol levels in patients with clinical depression, insomnia and anxiety, suggesting a “blunted” HPA-axis response due to long-term stress exposure.
Sleepiness

Sleepiness was included as a variable in the sleep studies because it is a natural complement to sleep. Even though excessive fatigue and complaints of sleep disturbances are common in burnout, the daily and weekly pattern of sleepiness has never been investigated before.

The diurnal pattern of sleepiness was quite pronounced in both studies (II, III). Sleepiness was high in the morning and in the late evening, with high levels during the midday hours. The pre-burnout group (III) showed higher levels of sleepiness at the time of rising than their colleagues. Still the sleepiness levels throughout the work day were comparable in the two groups. However, during the weekend the low burnout group showed a clear drop in sleepiness (and increased alertness) that must be interpreted as recovery. This effect was not present in the pre-burnout group (III). This, again, suggests a lack of recovery through weekend rest, which seems a pervasive phenomenon in burnout (Freudenberger, 1974; Maslach & Jackson, 1981a). The same pattern of non-recuperation was seen in the burnout patients (II) and the levels were considerably higher than what was seen in the pre-burnout group.

Figure 5. Mean for rated sleepiness at different points of day and weekend, in the burnout groups (study II filled black circles study III filled grey circles) and controls (open circles). To compare with sleepiness in shift workers on night shift (triangles) (Axelsson et al., 2004), train drivers on early morning shifts (open squares), day shift (filled squares) and a day off (open squares with broken lines) (Söderström et al., 2001).
The levels of sleepiness were comparable with what is seen in, for example shift workers during a night shift (Kecklund et al., 1997) or after early rising (Ingre et al., 2004; Söderström et al., 2001) (See fig 5). Thus the levels of sleepiness in burnout must be considered far above normal levels.

Sleepiness and performance in relation to disturbed sleep

The disturbed sleep in the burnout groups is a problem in its own right. However, it is an interesting question whether the observed sleep disturbances, as discussed above (II, III) could contribute to the observed sleepiness/fatigue and cognitive weariness. The cross-sectional nature of the present study does not permit any conclusions in this regard, but there are other data that may strengthen the argument.

Thus, even if field studies on arousals are scarce and most of them have been made in relation to respiratory obstruction, several studies show clear associations between sleep fragmentation and high sleepiness levels, as well as impaired daytime functioning (Carskadon et al., 1982; Guilleminault et al., 1991; Stepanski et al., 1984). Furthermore, experimental sleep fragmentation clearly impairs alertness (Bonnet, 1986; Bonnet & Arand, 2003), performance and cognitive functioning (Gosselin et al., 2005; Vgontzas et al., 2004).

Interestingly the sleep fragmentation in the pre-burnout group (III) was not accompanied by any concomitant reduction of total sleep time. Even though some studies suggest that daytime alertness is impaired as a function of sleep continuity rather than total sleep time in both “normal” sleepers and in sleep disorders (Carskadon et al., 1982; Rosenthal et al., 1984; Stepanski et al., 1984), no studies have been able to successfully separate sleep fragmentation per se from sleep loss or reduction in specific sleep stages. However, it seems reasonable to assume that a repeated sleep fragmentation might reduce the recuperative value of sleep and lead to reduced alertness and impaired performance (III).

In the burnout patients (II) the higher level of stage 1 sleep might have contributed further to the accumulation of fatigue and cognitive impairment, since it has been shown in a metaanalysis that the relation between fragmentation and sleepiness increases if also increases in stage 1 are included (Wesensten et al., 1999).

Additionally, it may be of importance that sleep duration in the burnout patients (II), was considerably less than 7 hours. In the light of recent observations of 7 hours of sleep as a level below which fatigue/sleepiness starts to accumulate (Belenky et al., 2003; Van Dongen et al., 2004) it seems a distinct possibility that individuals with burnout get insufficient amounts of sleep to maintain alertness. Furthermore, the Sleep Sufficiency Index (SSI) was clearly below 80% during weekdays (II), indicating a persistent, insufficient sleep (Broman et al., 1996). It is plausible to believe that simply too little time for sleep, due to work-related reasons, might have started the sleep insufficiency, like what has been seen in a Swedish population study (Broman et al., 1996).
Voluntary sleep reduction during the workweek in, for example, shift workers is generally compensated by extended recovery sleep in weekends (Åkerstedt et al., 2000), and normally, recovery sleep is suggested to compensate for the SWS reduction and impairment due to sleep loss (Carskadon & Dement, 1985; Dijk et al., 1991; Dijk & Beersma, 1989). But even though sleep was extended during days off in all participants (II, III) the compensatory restorative effect had an impact on alertness only in the control groups. The SSI remained on a low level during the weekend (86%) in burnout patients (II), and it seems conceivable that the effect of the fragmented and insufficient amounts of sleep in burnout causes a sleep deficit to accumulate across time. It is not clear whether the effects are due to fragmentation, sleep length or content of specific stages, however.

### Sleepiness and SWS

One argument for the importance of SWS is that it is a sensitive measure of the restorative function and an increased delta power or SWS is normally seen after experimentally shortened sleep (Borbély et al., 1981; Webb & Agnew, 1971). Notably, the amount of SWS was lower in both high and low burnout groups in study III than what is seen in “normal” sleepers in this age group (Williams et al., 1974) (table 4) and the reason for this is unclear. One might speculate that these study groups of IT professionals were subjected to a high work pressure, which might have suppressed the SWS, although the low burnout group did not complain of tension or intrusive thoughts about work (Hall et al., 2000; Kecklund & Åkerstedt, 2004).

One might also consider the significance of the reduced amount of SWS and SWA in the burnout patients (II). Both have been considered restorative although there are no data on whether SWS adds any restorative value above that of, for example sleep continuity (Bonnet & Arand, 2003). The reason for the reduced SWS/SWA in the present study may be the sleep fragmentation in burnout. Both fragmentation and stress/tension may reduce SWS (Kecklund & Åkerstedt, 2004). However, the present design does not permit any conclusion on causes.

As outlined in the background, SWS is viewed as the most restorative sleep stage and perhaps most important for brain repair (Horne, 1978). Growing evidence suggests that the prefrontal cortex is particularly vulnerable to both stress (Lupien et al., 1998) and sleep deprivation (Harrison & Horne, 2000; Jones & Harrison, 2001) and sleep is necessary for procedural memory and executive functioning (Gais & Born, 2004; Maquet, 2000; Nilsson et al., 2005). Thus, the self-reported dissatisfaction with work in the pre-burnout group (III) might be a combined effect of the high stress and impaired sleep. It might also be hypothesized that the decreased cognitive function reported in burnout in the present studies (I, II) might be associated with a reduction of SWS, sleep efficiency and delta power density in this group. No studies on executive functioning and sleep in burnout are available however, to confirm this suggestion.
Table 4. Means (SD), from PSG measured sleep in study II and III and from *comparison groups of the same age (Williams, 1974)

<table>
<thead>
<tr>
<th></th>
<th>Study II</th>
<th></th>
<th>Study III</th>
<th></th>
<th>Study III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Burnout group</td>
<td>Control group</td>
<td>40-49 old women*</td>
<td>High BO n=12</td>
<td>Low BO n=12</td>
</tr>
<tr>
<td></td>
<td>n=12</td>
<td>n=12</td>
<td>n=11</td>
<td>n=12</td>
<td>n=12</td>
</tr>
<tr>
<td>SPT (min)</td>
<td>455 (23)</td>
<td>453 (62)</td>
<td>432 (24)</td>
<td>463 (41)</td>
<td>418 (26)</td>
</tr>
<tr>
<td>TST (min)</td>
<td>373 (73)</td>
<td>408 (53)</td>
<td>425 (23)a</td>
<td>401 (48)</td>
<td>377 (27)</td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>85 (0.06)</td>
<td>91 (0.02)</td>
<td>96 (0.02)a</td>
<td>87 (7.0)</td>
<td>90 (4.1)</td>
</tr>
<tr>
<td>Awakenings stage 0 (#)</td>
<td>16 (4.3)</td>
<td>13 (4.1)</td>
<td>3.1 (2.1)</td>
<td>6.9(4.2)</td>
<td>6.3(3.5)</td>
</tr>
<tr>
<td>Arousals/h (#)</td>
<td>20 (9)</td>
<td>12 (4)</td>
<td>-</td>
<td>12(6)</td>
<td>8 (4)</td>
</tr>
<tr>
<td>WASO (% of SPT)</td>
<td>13.4 (7.6)</td>
<td>6.9 (2.5)</td>
<td>1.6 (1.3)b</td>
<td>9.6 (7.1)</td>
<td>8.8 (8.1)</td>
</tr>
<tr>
<td>Stage 1 (%)</td>
<td>5.4 (3.0)</td>
<td>3.2 (1.4)</td>
<td>5.6 (2.1)</td>
<td>3.6 (3.3)</td>
<td>4.2 (2.5)</td>
</tr>
<tr>
<td>Stage 2 (%)</td>
<td>43 (11)</td>
<td>43 (3)</td>
<td>54.0 (8.6)</td>
<td>50.7(6.5)</td>
<td>56.0(8.3)</td>
</tr>
<tr>
<td>SWS (%)</td>
<td>10 (4)</td>
<td>15 (5)</td>
<td>12.0 (8.3)</td>
<td>7.8 (6.4)</td>
<td>8.0 (8.5)</td>
</tr>
<tr>
<td>REM (%)</td>
<td>19 (6)</td>
<td>14 (3)</td>
<td>26.7(4.1)a</td>
<td>24.4(5.8)</td>
<td>21.4(6.7)</td>
</tr>
<tr>
<td>Sleep onset latency (min)</td>
<td>21 (22)</td>
<td>10 (6)</td>
<td>7.8(6.0)</td>
<td>19.3(24)</td>
<td>15.8(8.0)</td>
</tr>
<tr>
<td>Latency stage 2 (min)</td>
<td>5.3 (9)</td>
<td>3.1 (4)</td>
<td>7.6(6.1)</td>
<td>4.7 (5.4)</td>
<td>3.0 (1.5)</td>
</tr>
<tr>
<td>SWS latency (min)</td>
<td>18 (10)</td>
<td>14 (6)</td>
<td>35.0 (18.3)</td>
<td>29 (18)</td>
<td>27 (18)</td>
</tr>
<tr>
<td>Stage 1 to REM latency (min)</td>
<td>78 (35)</td>
<td>65 (16)</td>
<td>82.3 (34)</td>
<td>80 (34)</td>
<td>74 (24)</td>
</tr>
</tbody>
</table>

a=significantly higher and b=lower levels compared to men in the same age group.
WASO=Wake Time after Sleep Onset, REM= Rapid Eye Movement sleep, SWA= Slow Wave Activity, NREM=non REM (stage 2+3+4)

A possible alternative interpretation of the increased sleepiness is the presence of a reduced sleep debt (or weakened drive for sleep) (Borbély, 1982; Gillberg & Åkerstedt, 1994) due to inactivity and distress in the patient group. Thus a similar lack of SWS and assumed lower sleep drive (process S) has been suggested to be present in depression (Staner et al., 2003), representing an impaired “ability” to accumulate effects of sleep loss (Borbély, 1982; Borbély & Achermann, 2000). Staner (2003) has contrasted this to a hypothesized increase in a wake promoting drive (process W), which would cause a lower increase in SWA in insomniacs, while the homeostatic drive (accumulation of sleep debt) is intact. This is rather speculative, however.

**Fatigue**

Excessive fatigue is the core dimension of burnout (Maslach & Jackson, 1981b; Shirom, 1989) and since the burnout scale used to select participants essentially was a fatigue scale the findings of high levels of fatigue or burnout using such or similar scales (II, III) are trivial, but may counter an impression of validity and reliability. However, the repeated ratings of mental fatigue during the week (II) showed sustained differences between the burnout groups and the controls during workdays and weekend. Thus fatigue was not reduced during the time...
for recovery presumably provided by the weekend rest and sleep. This suggests an established long term fatigue level that is more than a temporary state.

As discussed above, the disturbed sleep may at least partly be responsible for the severe fatigue/exhaustion in burnout (I, II). Thus it was of interest to examine whether there was any diurnal variation of fatigue throughout the day. Such a diurnal pattern of mental fatigue (II), with lower levels in the middle of the day was shown, although the pattern was shallower than in sleepiness. There are no other studies to compare with, so the implications of this diurnal pattern are not clear. However, they may simply reflect the circadian rhythm in temperature metabolism (Buysse et al., 2004; Van Cauter et al., 1997) that is also seen in sleepiness, as discussed above.

The differences in temporal pattern of fatigue and sleepiness emphasizes that the two represent different states. Sleepiness has been defined as a drive towards sleep, due to lack of sleep (Dement & Carskadon, 1982; Dinges, 1989), whereas fatigue is more a disinclination towards activity, usually because of excessive exposure to that activity and/or frustration at having to do it (Grandjean, 1970). At a moderate level of sleep debt (or an adaptation to sleep deprivation), the individual often fails to recognize the subjective indication of being sleepy (Dement et al., 2003), and since the lay person’s use of the terms often are blurred, it might be that at low and intermediate levels both scales reflect the same phenomenon. Therefore it is an interesting question whether the persistent pattern of severe sleepiness in the burnout groups is due to sleepiness per se or to an misinterpretation of mental fatigue as sleepiness.

In the present case (II) it seems plausible that if sleep for a long period of time does not provide adequate recovery, an accumulation of sleepiness may lead to permanently high fatigue levels. In addition, the high engagement (I) and tension (III) might have masked the sleepiness and interfered with recovery for a long time, thus leading to the chronic state of fatigue (Cameron, 1973). This should be followed up in experimental studies.

**Fatigue and mood**

A complementary and more traditional view of the causation of fatigue is that extreme fatigue emerges as an emotional and psychological response to a stressful situation where all efforts to get rid of the “threat” in a traditional manner (i.e working harder), have failed. The experience of fatigue is also closely related to decreased motivation, feelings of uneasiness, anxiety and distress (Cahill, 1999; Cameron, 1973), and is in line with most theories of stress where a depressive behavior is one way to adapt and manage a fearful situation (Lazarus & Folkman, 1984; Selye, 1946; Ursin & Eriksen, 2004).

In study I fatigue was described as being paralyzing, and feelings of numbness like living in a vacuum or in a state of non-existence were reported (I). Such feelings of emptiness and loss of meaning, deteriorated mood and decreased performance found in this thesis (I-III) are shared with features of major depression as well (APA, 2000). Even though patients with an ongoing major depression were excluded from study II, 58% (7 persons) exceeded the clinical limit (≥22) for depression on the BDI. This is in line with the overlap with depression found in other studies on burnout (Hallsten, 1993; Åsberg et al., 2002). Although burnout and
depression share several features such as feelings of worthlessness, concentration difficulty and fatigue (Lloyd et al., 1994; Martin et al., 1997), they are considered to be distinguished concepts (Glass et al., 1993; Leiter & Durup, 1994; McKnight & Glass, 1995). But since sleep disturbances is a common complaint in both depression and burnout (Borbély & Wirtz-Justice, 1982; Ohayon & Roth, 2003), and fatigue is a feature of insomnia (AASM, 2001; APA, 2000), it is a plausible to believe that the excessive fatigue in burnout is linked to disturbed sleep and depressive mood as well. However this is an issue for further research, and the direction of the relationship is not understood.

The concept of fatigue

The fatigue in burnout, as indicated in the introduction, is a poorly defined concept and in the every-day meaning its use is broad and blurry. The one-dimensional scale; mental fatigue was used (II) to assess the state that occurs as a result of prolonged mental strain; a feeling of inadequacy and inability to think. The interviews added a dimension through its description of fatigue as a “dense fog” that enveloped them (I) and was described to accumulated as the process of burnout progressed.

The complex nature of fatigue, with impact on both physical and mental functioning, was not extensively explored in this work. When the occupational fatigue inventory (SOFI) was applied in diverse job context different profiles of fatigue emerged (Åhsberg, 2000). Thus, firemen in action had a peak in physical fatigue, train drivers in sleepiness etcetera. However, in the burnout patients (II), fatigue was significantly increased on all five dimensions, even if the F-ratio was largest (most significant) for “lack of energy”. This indicates that the fatigue in burnout is more general than specific, with a severity of fatigue that exceeds the fatigue that normally is experienced after a day’s work (Åhsberg, 2000). It might also be that the SOFI measure is insufficient to discriminate different aspects of fatigue in conditions of ill health since it was developed for use in a healthy population and the fatigue dimensions correlated more than expected when it was applied in a patient group (Åhsberg & Furst, 2001). The fatigue in cancer patients during radiotherapy was generalized and unspecific like in the present study (II), although on a lower level.

Possibly, fatigue is experienced differently in illness and in health (Cella et al., 2002; Ream & Richardson, 1996). This suggestion is for example supported by studies where the meaning of fatigue in women with fibromyalgia (FM), was a quite different experience from the tiredness narrated by healthy women (Söderberg et al., 2002). In that study the descriptions of “trötthet” in healthy women signified tiredness, described as a temporary feeling relieved by rest, while the FM women communicated “trötthet” as the heavy burden of something always present that was hard to relieve. In the interview study (I) the participants distinguished their experiences of fatigue from that of most people at the end of the day, and reported that they were “dead tired” and had “gone beyond all tiredness” (I p. 64). Further they expressed their feelings of fatigue as being “not sleepy-tired” (I), which represents a fatigue that does not withraw with rest or sleep, in agreement with definitions of burnout (Maslach & Leiter, 2005) and observed in chronic diseases (Cella et al., 2002; Olson et al., 2002; Söderberg et al., 2002). This suggests that the fatigue has characteristics distinguished from tiredness or
The same confusion exists about the concepts “tiredness” and “sleepiness” as mentioned earlier, and it has been suggested that tiredness is a sub-optimal state of sleepiness (Dement, 2003; Dement et al., 2003) while others claims that both are qualitatively distinguished from each other (Horne, 2003).

Taken together, the descriptions of the experienced tiredness/fatigue represent specific and separate sides of the phenomenon throughout the process of burning out, and suggest that there is a distinction between sleepiness, tiredness, fatigue and exhaustion. This hypothesis needs to be further evaluated and confirmed in qualitative studies however, to provide a new understanding about those concepts in relation to burnout. If tiredness is a precursor of fatigue, and fatigue a precursor of exhaustion, the transition from one state to another is the prime target for health care providers (Olson, in press). Tiredness might be alleviated through providing sufficient sleep, while fatigue might require other interventions. A careful listening to the descriptions of the unusual sensations (Toombs, 1992, p.70), might imply specific interventions in different stages of the process, and this has also to be further understood.

Another question that needs further qualitative studies to understand, is if there is a specific “sickness-fatigue” that is non-comparable with any other description of fatigue, and if this fatigue has the same features in different diseases. Since fatigue is the most common symptom of illness (Aaronson et al., 1999) these research questions are crucial for recognizing and preventing not only burnout but also other illnesses and diseases.

The process of burning out

One aim of this thesis was to elucidate how the process of burning out was experienced in order to reach a better understanding of how to prevent and alleviate burnout in today’s working life. From the descriptions of lived experiences a general structure of the person’s transition throughout the burnout process emerged (figure 3). This will be discussed below.

Responsibilities towards work and real life

In most conceptualizations, burnout is considered as a result of prolonged occupational stress. Self-reports of a sustained mental strain, never-ending demands and ‘bringing work home’ (II-IV) indicated an untenable work situation. Furthermore the psychiatric assessment in study II revealed that work related problems were a precipitating factor in burnout, in line with the mainstream of theories of burnout (Shirom, 1989), and with the growing body of research in the area (Bakker et al., 2000; Demerouti et al., 2000; Kalimo, 1999; McVicar, 2003; Stordeur et al., 2001). On the other hand, the participants described how they were absorbed not only by responsibilities towards work, but also responsibilities towards the family and/or other commitments in their life world (I). Even though there is a lack of
research on “real life stress” and burnout, a few studies suggesting that stress outside work promotes or exacerbates burnout (Etzion, 1984; Kushnir & Melamed, 1992) support these findings.

Another interesting question is to what extent the “fuzzy borders” between work and leisure time indicated in these studies (I-III) may contribute to the sleep disturbances, and to the dissatisfaction and disengagement from work. Connections between organizational stress and job satisfaction (Adams et al., 1998; Upenieks, 2002), and between high work stress and emotional exhaustion (Demerouti et al., 2000; Koustelios, 2001; Stordeur et al., 2001) are supported in several studies. Moreover, job dissatisfaction and disengagement are both related to burnout (Demerouti et al., 2000; Kalliath & Morris, 2002; Pines et al., 1981). On the other hand, sleep disturbances have been connected to job dissatisfaction and a need for recovery, suggesting a link to sleep (Axelsson et al., 2003; Axelsson et al., 2004).

However burnout is commonly considered an individual matter, a result of ineffective coping with prolonged stress (Maslach et al., 2001). A positive attitude has been viewed as an effective buffer against disease (Antonovsky, 1979; Thoresen et al., 2003). By working “excessive overtime”, “bringing work home” and “working during leisure time” (I-IV), the burnout group made an active choice of action to solve the work demands, instead of a passive withdrawal (Jones, 1993; Lee & Ashforth, 1996). But in contrast with other studies (Maslach et al., 2001), active and confronting coping did not seem to be enough to buffer against burnout (Demerouti et al., 2001; Thoresen et al., 2003). This illustrates that there is a certain limit above which more efforts are impossible and it emphasizes a fundamental need for recovery (Grandjean, 1970).

The inner incentive in the interview study (I) corresponds to recent development of engagement as the positive antithesis of burnout (Maslach & Leiter, 2005; Maslach et al., 2001). A high degree of commitment and initial engagement has been suggested to be a characteristic that distinguishes burnout from depression, job stress or other overlapping concepts (Hallsten, 1993; Hallsten et al., 2002; Maslach et al., 2001). To succeed with a difficult task or to create something new might be a creative and “self-nourishing” drive as long as “a sense of harmony” (Asp, 2002, p. 200) with respect to other responsibilities in life is maintained. But being constrained by time and being trapped between different responsibilities created a sense of guilt or “disharmony in feelings, actions and motivation” (Asp, 2002, p.200) and the participants found themselves like “trapped in a pitfall” (I). According to CATS (Ursin & Eriksen, 2004) hopelessness emerges when efforts and recourses available does not change the situation and this feeling is associated with guilt and depression.

Maslach and Leiter (Maslach & Leiter, 1997) rephrased burnout as “an erosion of engagement” and Hallsten (1993, 2002) hypothesized that the “absorbing engagement” turns into “frustration”, which involves a negative attitude and decreased motivation when the goals are not reached. The descriptions of how the all-absorbing focus on work, piece by piece, deflated the rest of their lives to the extent that the leisure time was not sufficient to restore their strength (I), illustrate their difficulty to maintain a balance in life. Interestingly, intervention programs usually focus on teaching the individual how to manage stress, often with poor results (Maslach et al., 2001), while little attention has been paid to how to recover and balance life.
To conclude, the findings in this thesis (I-IV) of high work pressure and excessive overtime, is in line with the mainstream of research on burnout (Adams et al., 1998; Brown & Pranger, 1992; Jenkins & Elliott, 2004; Maslach et al., 2001; Stordeur et al., 2001). But the findings also showed that they were squeezed between different responsibilities in life (I) supporting the notion of “real life stress” as an important condition for the burnout development (Etzion, 1984; Kushnir & Melamed, 1992).

This is in line with the life-world perspective implying a circularity between the person and his/her milieu (Merleau-Ponty, 1995), meaning that what happens in the work organization for example and in the interrelationship with others affects the individual and vice versa (Dahlberg et al., 2001). Thus the causality is rather circular than linear (Merleau-Ponty, 1995) implying responsibilities in relation to others, irrespective of whether it is at work or “in real life”, understood as affecting the person.

“Cutting off” - and neglect of essential needs

In the descriptions in study I it was found that the reason for focusing even harder on fulfilling responsibilities, even when strength began to dissipate, was a struggle to shelter the threatened self-image as skilled and competent professionals (I). This reflects that a person’s existential significance often is rooted in “doing”, instead of “being” (Cherniss, 1980; Heidegger, 1962; Pines, 1993). One’s self-image is greatly influenced by self-esteem (Lyttkens, 1989) and self-esteem primarily built on accomplishment and “doing” has been called performance based self-esteem (Hallsten et al., 2002; Hallsten et al., 2005), which recently has been recognized as a plausible predictor of burnout (Hallsten et al., 2005). This thesis did not intend to provide for any causal conclusions of relations to personality or whether self-esteem is an antecedent or consequence of burnout but further studies are needed.

The self-defense of “cutting off” served to bottle up emotions and everything that interfered with their focus to fulfill their responsibility towards work (I). The emerging fatigue and emotional exhaustion was a suffering that became a threat against the person’s self, or his/her sense of identity (Lindholm & Eriksson, 1993; Norberg et al., 2001).

In suffering, different “façades” are often constructed for two purposes: to keep the person’s suffering concealed from others, as well as from her/himself (Fredriksson & Lindström, 2002). But even though the “cutting off” sheltered the self-image and protected from suffering to a certain degree, it was also part of the suffering. The “cutting off” included neglect of essential needs such as: regular meals, sleep, physical training, and time for recovery and rest (I-IV). The façade of “cutting off” also implied withdrawal from deep relations with others and feelings of alienation and “non-existence” emerged (I). Self-care, is the basis for health and all human life (Eriksson, 1987; Halldorsdottir, 1999), but the “cutting off” was a hindrance for self-care and created a barrier that disabled them from accepting care from others (I) that may have promoted the gradual development of physical and mental illness.
The turning point

It is debated whether burnout is a process or a state (Schaufeli & Enzmann, 1998) and in this thesis the results are commensurate with the idea that burnout is both (Hallsten et al., 2002): an ongoing development of emerging symptoms (I-IV) but also critical points throughout the process. Such a point was described when the participants reached the bottom-line and in acceptance gave up their strong protection of self (I). Their façade of cutting off cracked in different ways, but the act of acceptance became the turning point from where a new reconstruction of life could be created (I). Acceptance is a way “to expand oneself” (Marcel, 1979, p 116-29), to get reconciled with one’s vulnerability and aware of the interdependence in relation to others (Lindseth et al., 1993). This is in line with findings of how sufferers’ facades were abandoned in other studies (Fredriksson & Lindström, 2002).

Hallsten (2002) also discusses that critical events seem to be crucial for whether the frustration over an unsolvable situation turns into reorganization or if the process turns into depression or burnout. Thus, to reach behind the façade of cutting of seems to be crucial for bringing the burnout development into a turning point and thus avoid that the process progresses into the state of burning-out (see fig. 3).

In this study (I) the “cutting off” was characterized by withdrawal and non-presence, which made the participants “blind and deaf to warning signals from their own body and from others” (I p.63). This became a hindrance to communicate their needs (Marcel, 1967), which complicates the possibilities for managers or others to intervene at an early stage. How to respond to this unspoken ethical demand, without insulting the integrity of the person, is an ethical dilemma. Lögstrup (1971) argues that the responsibility of the provider of care never is to take over the responsibility of “the other”. Thus the ethical demand cannot be met until the sufferer opens up and invites “the other” (Lögstrup, 1971).

Being met in the suffering has opened up in other crisis situations (Rasmussen, 2000; Sundin & Jansson, 2003; Talseth et al., 2001; Talseth et al., 2003). But this implies openness, availability, presence (Norberg et al., 2001; Younger, 1995) and an intensive attentiveness to understand the most constructive way to meet “the other”, in a nonjudgmental way (Buber, 1954; Pettigrew, 1990).

Although the experiences of the time preceding burnout took place outside the health care system, the interviewees (I) were in need of care, in order to reduce the risk for burnout. Those who first recognized the burnout symptoms were: family, colleagues, managers, human resource personnel or company health service. This study emphasizes the importance of the organizational culture, climate and ethics, and calls for further studies addressing leadership training and organizational healthiness (Cox et al., 1993; Karasek & Theorell, 1990; Winnubst, 1993). In reality this means openness and shared responsibility between managers and employees to communicate organizational incongruities and fuzziness that might be embedded in the culture of the workplace. This study is limited to the process of “burning out” and does not provide data for the reconstruction of a balance in life. Thus, further research is needed to describe the recovery process as well, important for wellbeing and rehabilitation of burnout personnel.
Methodological considerations

In this thesis focus has been on how the development of burnout is experienced (I), subjective and objective measures of sleep (II, III), diurnal and weekly pattern of sleepiness (II, III) and fatigue (II), and how the impaired sleep may relate to physiological measures of health (IV). The phenomena under investigation affect the person—from the cellular biological level to the mental, emotional and cognitive level, and contains the persons history, actual life situation, purposes and expectations. Both quantitative and qualitative approaches have been applied. The quantitative and qualitative paradigms are complementary to each other and in combining those methods a deeper understanding of burnout has been attained. Thus, the aims of the studies have determined the choice of method (Clark, 1998; Sandelowski & Barroso, 2002), and a fruitful approach has been to use the hypothetic-deductive methods to measure the psycho-physiological responses, like EEG, hormones and blood pressure, and the established measures of burnout and sleep, whereas the phenomenological life world approach was appropriate to grasp the meaning of the lived experiences of burnout.

Qualitative methods have large components of subjectivity and context dependence. On the other hand, all human research deals with the dilemma of subjectivity irrespective of methodological approach, since the subjective influence of the scientist is always there whether it is traditional empirical science or not. Qualitative studies emphasize the understanding of lived human experiences, and aim to describe a deeper underlying meaning of data. The researcher’s contribution in the process of data collection and analysis belongs to the data as well (Dahlberg et al., 2001). With a qualitative approach validity and reliability are an ongoing process throughout the whole study. In striving for objectivity and validity of data in study I the necessity of self-awareness, the ability to affect one’s pre-understanding and being conscious about the limits of self-awareness (Dahlberg et al., 2001), were crucial. Self-reflection was used to put the researcher’s presumptions and pre-understanding into light. The interviewer made diary notes on feelings, reactions and assumptions throughout the whole process, in order to distance one-self and set aside any pre-understanding or taken for granted assumptions of the phenomenon (Giorgi, 1997). The co-author analyzed the transcripts independently and there was also a dialectic encounter between the two during the research process. Co-assessment of other professionals in seminaries was another way the results were validated.

In the quantitative studies (II-IV) awareness of subjective influences (i.e. hypothesis and background knowledge) of the scientist were needed in the reflections upon the meaning of statistical data, and the qualitative understanding and interpretation to translate numbers into words (Föllesdal et al., 1984; Streubert & Carpenter, 1995). Efforts were made to restrain the preunderstanding and to detach the researchers from the interpretation of data to the greatest extent possible. The questionnaires and many of the subjective variables used in study II-IV have been validated, and in our hands diaries seem to provide reliable data (Åkerstedt et al., 1997). Compliance in diary ratings was high, partly due to close and frequent interaction between the experimenter and participant. No data loss occurred other than as exceptions.

All studies were suffering from small sample sizes which one has to bear in mind when interpreting the results. However, looking at the results it does not seem likely that study II
and III would have yielded much different conclusions with larger sample sizes. However, larger samples would have made subgroup analyses possible, for example with respect to gender. According to Giorgi, (1985, 1997) and Dahlberg (2001) the sample size in qualitative research should be large enough to achieve a variation of experiences and small enough to permit deep analysis of the data. It is also important to choose information-rich participants with a variety of backgrounds such that the phenomenon of interest might be covered (Streubert & Carpenter, 1995). In study I the participants were both men and women with a wide age range and in different marital status. They also came from different work places. Since the interviews provided rich information the researchers determined that the number of participants was adequate.

In the sleep studies (II, III) it was important to describe sleep as realistically as possible. Thus, it was of particular importance to obtain measures of sleep in the home environment. On the other hand, field studies suffer from influences of numerous confounding variables not easy to control. Example of such variables in the sleep environment is temperature, light exposure, presence of small children or a snoring partner etcetera. Other variables like age, sex, social responsibilities, may vary considerably between individuals and confound the results. In study IV possible control factors: “self-reported snoring”, “having small children” (< 7 yrs) and ache/pain were tested in the stepwise regression analysis. Furthermore the comparison groups (study II and III) were selected with respect to age, sex, educational level and occupation in order to grasp at least some of those confounders. The groups did not differ on most background variables, like number of children, marital status, lifestyle, BMI, or medication.

Sleeping with the EEG equipment might have disturbed the sleep even if the sleep environment was familiar. Although the first night effect is most investigated in laboratory settings (Agnew et al., 1966; Dement et al., 1965), some studies have found such effects even in home environment (Walsh & Sugerman, 1986; Wauquier et al., 1991). On the other hand other studies did not find any first night effect, especially with ambulatory equipment (Coates et al., 1981; Kader & Griffin, 1983). However, one night of habituation was performed to get the participants familiar with the method and the electrodes (II). The problems of changes across time were handled through a balanced design in study III.

The selection procedure may have had confounding effects in all studies and care must be exercised when generalizing. Possibly, for example, another pre-burnout group than the IT-company employees might have presented another picture of sleep, sleepiness and stress. On the other hand, questionnaire studies of larger groups seem to show conclusively that at least sleep and stress problems are universal. Study II had a broader population from which the participants were sampled, but still mainly represents burnout in white collar workers. In study IV data represent a secondary analysis carried out on a sample of young individuals scoring high and low on burnout. The variable “burnout group” was tried in all the stepwise multiple regression analyses but did not enter any of them, suggesting that the selection procedure may not have had any confounding effects.

Possibly, the large number of analyses carried out in groups with a small sample size may have inflated the risk of type 1 errors, yielding too many significant results. On the other hand the results in study II-IV formed a coherent pattern, which suggests that the results are relatively robust.
A main purpose of scientific work is to generalize the findings to other settings. In the present studies the **cross-sectional designs** and **correlative approaches** limit the conclusions that can be drawn about causality. Prospective studies, with a longitudinal approach would give better information about possible pathways between sleep, fatigue and burnout. However, despite those limitations the findings give descriptions of how sleep, fatigue and physiological markers may be linked to each other and they generate new questions, to be followed up in further studies.

**Generalization** is limited in study I since qualitative research in general is understood as very context dependent. Phenomenological research is contextual and never understood as universal. The goal is to illuminate and raise the understanding of the phenomenon. The general structure or essence that emerged means that the result is raised above the concrete level, but still it is within the chosen context: the participants on sick-leave from their white-collar employment for burnout. Dahlberg et. al (2001) argue that the possibility to transfer and apply the results in other similar contexts depend on: 1) whether a new understanding has emerged 2) the quality of data, (i.e if data are rich of naïve descriptions of lived experiences devoid from interpretation, construction or explanation), 3) the degree to which the researcher has been aware of and able to hold the pre-understanding. The scientific value of a lifeworld research study depends on the **thoroughness** in reasoning, labeled a **coherence criterion** (Kvale, 1997). The coherence criterion involves a research result that presents an inner logic, that is, it should be possible to follow the research process throughout the study. Further, the reasoning should be visible throughout, without contradictions, if the study is to be judged as valid (Dahlberg et al., 2001; Sandelowski & Barroso, 2002). Since the aim of study I was to describe lived experiences of time preceding burnout, healthy white-collar workers was not included in the study. However, it would have been interesting to investigate why colleagues with similar work conditions did NOT develop burnout. Those informants possibly would have added understanding on how a balance between different responsibilities in life can be created and this is an issue for further studies.

One problem that has been discussed elsewhere in this thesis is the presence of **co-morbidity**. This is particularly complicated with respect to depression (persons with chronic fatigue were excluded). Fatigue is a key characteristic of both depression and burnout. Even if ongoing major depression was a criterion for exclusion sub clinical levels were clearly present among those on sickleave due to burnout. However, this thesis was not focused on differentiating burnout from other states but future research will have to deal with this problem of co-morbidity.

**Tentative integration and some hypotheses**

The main findings in this thesis suggest that impaired sleep and recovery is involved in the burnout process and might be a link to the excessive fatigue that characterizes burnout. This adds a physiological dimension to the main stream of research, which has focused on psychosocial processes, and the erosion of energy (Maslach, 2005).
Figure 6 illustrates a working hypothesis on the process of burning out based on the findings in this thesis. The process describes the dynamics within the physiological, emotional and cognitive systems (the spiral in the figure), and the interaction between the person and his/her situation. The process might move back and forth and might vary between individuals dependent on the situation.

Without drawing any conclusions about causality one might speculate on a “vicious circle” where high work demands and other commitments in life lead to a restricted time for recovery, and to begin with, a voluntary shortening of sleep to cope with the responsibilities. This is a common situation in today’s society (Bonnet & Arand, 1995b), and recovery sleep (during weekends or leisure) normally compensates and restore the balance. Even if sleep is not shortened, “thoughts of work” and tension to perform well might elevate the physiological arousal and transient microarousals might disturb sleep and result in impaired recovery. A third possibility is that high work demands (stress) cause an increased need for sleep, which most individuals ignores. An “inner incentive” might be the “drive” that compensates for the moderate sleep debt and makes possible a further increase of effort, if needed (the first loop in the process).

If the situation persists and becomes chronic the fatigue starts to accumulate since the energy drain is higher than the restitution. The engagement and tension still masques the fatigue and “bringing work home”, and “work at weekends” might be a way to cope with the work pressure. Thus essential needs for recovery and repair are “cut off” and feelings of dissatisfaction with the situation emerge. Impaired cognitive functioning promotes anxiety and fear of failing and even more effort may be needed to keep up the same standard at work. At this stage there is clearly a need to be attentive to the accumulation of energy drain / lack of recovery and to take steps that breaks the “vicious circle”. Managers or health care providers are those who in the first line would observe the complaints of fatigue and sense of illness that occur before any biological measures of ill health appear (second loop).

If the process continues the physiological arousal might interfere with the restorative function of sleep resulting in the severe fragmented sleep with disturbed restorative quality as was seen in the patients. In this state, disturbed sleep has become chronic and may be regarded as stress-related insomnia. The overwhelming fatigue makes it difficult to fulfill the demands and feelings of guilt and worthlessness add more energy drain to the process. Alienation from everything that interferes with work implies that also activities that generate energy are withdrawn. Thus actions, thoughts and emotions are closely intertwined with the physiological systems and the vicious circle of ill health, fatigue, alienation and distress becomes self-nourishing, and may be difficult to turn around (third loop). At this stage professional treatment is needed in particular to return to normal good quality sleep.

This hypothetical reasoning on burnout development, emphasizes the personal appraisal of the situation and the total load on the individual. Clearly work stress might be the major contributor, but lack of recovery (where sleep is essential) might be equally important. However, this is a working hypothesis that integrates bodily and psychological processes with the individual’s life world but needs to be confirmed in further research. Also studies on how the vicious circle can be stopped at different stages in the process are needed.
Practical implications and further research

The findings of the present thesis have several implications for practice and for further research. The most important finding is that burnout was associated with disturbed sleep, even at an early stage, and that the disruption seems to be a part of the fatigue/sleepiness in burnout, independent of sleep length. These observations emphasize the need for effective treatment of disturbed sleep in order to prevent or alleviate burnout. For example, psychological/behavioral treatment of sleep (Morin et al., 1999) but also pharmacological intervention might provide relief. Similarly, information/interventions for improved sleep should be part of preventive work on company and population level. Inferences can also be made to the context of nursing care, in inspiring to innovative thinking to implement effective routines that promote good sleep in hospital wards, and in public health care.

There is also a need for clinical intervention studies of different types of treatment for sleep disorders to establish whether this could be part of evidence based medical treatment. Such studies are presently under way. The observed sleep disturbances also raise the question of
whether burnout and insomnia are overlapping states. As discussed previously the level of disturbed sleep, the fatigue, and the etiology are similar. This issue needs to be studied in large studies specifically designed for this purpose.

However, there is also a need for other lines of research. One should be focused on following large risk groups before burnout appears to obtain better information on risk indicators and physiological and psychological mechanisms. If sleep turns out to be important in burnout development it would also be of interest to study the possible role of sleep apnea, Primary Insomnia, restless legs, etcetera, in the development of burnout. As was discussed previously, one could perhaps cause burnout without any increase in stress, but instead through lack of recovery.

The findings also emphasize that experiments are needed. In particular, the effects of partial sleep loss on the endocrine and immune system may give clues as to the mechanism of burnout. This would need to focus on partial sleep loss across considerable periods of time since this is the way sleep loss normally occurs (rather than periods of total sleep loss).

Further research where individual differences are evaluated on an individual level is needed to give a deeper and more nuanced view of the phenomenon. This requires use of new statistical tools such as, for example, mixed models analysis (cf. Ingre et al., 2004). Such research is important for example to clarify if some individuals are more vulnerable to developing burnout than others.

This thesis also emphasizes that there is a need for a deeper understanding of the nature of fatigue – as a symptom of disturbed or insufficient sleep and the core dimensions of burnout have to be distinguished and evaluated. Future studies should focus on the “illness-fatigue” observed in the present studies - to understand what fatigue is, if fatigue is experienced differently in health and illness, how and to what extent sleep disturbances are involved. Furthermore, we need information on how fatigue affects the perception of health, wellbeing and illness, and how illness and diseases affect fatigue. Since fatigue primarily is a subjective experience affecting emotions, motivation, performance and wellbeing, qualitative studies are needed to provide such understanding.

Finally, the findings in this thesis also illustrate how illness might be experienced through subtle bodily sensations before any explicit manifestation of measurable biological facts. This enlightens the need of further research on how knowledge on a prereflective level is communicated. It is still not known how acute or chronic stressful experiences, or the failure to cope with them, contribute to the onset of a disease or illness (Ader, 1980). Thus, also multidimensional approaches would be valuable in order to bridge experiences to physio-psychological processes and bring science a step forward in this regard. But such thinking challenges traditional methods and calls for new perspectives, where the natural science methodology and qualitative studies are integrated and used simultaneously.
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Abstract

Burnout and Sleep
The overall aim of this thesis was to describe the physiological characteristics of sleep in persons with burnout and the relation between sleep and a number of physiological stress markers. The aim was also to evaluate the diurnal pattern of subjective sleepiness and fatigue across workday and weekend, and to describe the experiences of time preceding burnout from a life world perspective.

This thesis focuses on burnout in white-collar workers; one group on sick-leave (I, II) and one with high burnout scores (pre-burnout) but still at work (III, IV). The Shirom- Melamed Burnout Questionnaire (SMBQ) was used for selection of participants with a mean of ≥4.75 on the total score (range 1-7) as upper limit and <2.5 as cut off for the two control groups.

A combination of methods was used – interviews, sleep and wake diaries, questionnaires, blood and saliva samples, and polysomnographic (EEG, EOG, EMG) measures of sleep. The analyses included; t tests, χ2, analysis of variance, ANOVA, and covariance, ANCOVA, correlations, Pearson’s r, stepwise regression analyses (study II-IV), and phenomenological analysis (study I).

Study I describes the complex interaction between the person and his/her life world during the process of burning out. Study II evaluated whether subjective sleep complaints in burnout individuals on sick leave was related to disturbed sleep architecture and impaired homeostatic processes. Physiological and subjective aspects of sleep before a workday and a day off were investigated in study III. The diurnal pattern of sleepiness on workday and weekend was evaluated in study II and III, and the diurnal pattern of mental fatigue was evaluated in study II as well as occupational fatigue. Additionally, the burnout groups (II III) were described with respect to work stress, mood, recovery and burnout related variables. Study IV was a correlation study where the relation between sleep fragmentation and a number of physiological stress parameters, as well as possible predictors in daily life was evaluated.

The most important finding is that sleep was impaired on all essential sleep variables in the burnout group on sick-leave (II). In the pre-burnout group (III) the main findings was an increased frequency of arousals, and the relatively moderate sleep fragmentation was related to a number of risk factors for CVD and the metabolic syndrome (IV). Also unclear boundaries between work and leisure time and tension/irritability were associated with the sleep fragmentation. The burnout group on sick leave was sleepier than the controls for most point in time, with levels comparable to night or early morning shifts, and mental fatigue was equally elevated (except for weekday evenings). The pattern of sleepiness and mental fatigue was consistent across days. The high and low burnout groups were equally sleepy during workdays but differed during days off, indicating impaired recovery in the high burnout group. The time preceding burnout (I) was experienced as being trapped between never-ending demands on the one hand and stimulating challenges on the other. “Cutting off” important areas of life enhanced the strong focus on responsibilities, protected their ‘self-images’ and impeded sleep and recovery. Acceptance of the situation was the turning point from where a new reconstruction of life could emerge.

These findings suggest that sleep disruptions and impaired recovery seem to be characteristics of burnout, resulting in fatigue, and that inability to unwind the stress system may be a mediating factor. With this knowledge interventions for sleep improvement on company or population level seems important, and effective treatment of sleep disorders in order to prevent or relieve burnout is needed, as is a deeper understanding of how fatigue is experienced in health and illness.
List of original papers

This thesis is based on following papers, which will be referred to in the text by their Roman numerals.

I
Ekstedt, M., Fagerberg, I.
Lived experiences of time preceding burnout.
*Journal of Advanced Nursing*, 2005 (49), 59-67

II
Ekstedt, M., Söderström, M., Åkerstedt, T., Nilsson, J., Søndergaard, H-P., Perski, A.
Disturbed sleep in occupational burnout. (Submitted)

III
Söderström, M., Ekstedt, M., Åkerstedt, T., Nilsson, J., Axelsson, J.
Sleep and sleepiness in young individuals with high burnout scores
*Sleep*, 2004 (17), 1369-1377

IV
Ekstedt, M., Åkerstedt, T., Södeström, M.
Microarousals during sleep are associated with increased levels of lipids, cortisol and blood pressure.
*Psychosomatic Medicine*, 2004 (66), 925-931

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### List of Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABP</td>
<td>Ambulatory Blood Pressure</td>
</tr>
<tr>
<td>ACTH</td>
<td>Adrenocorticotropin</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
</tr>
<tr>
<td>BAI</td>
<td>Beck Anxiety Inventory</td>
</tr>
<tr>
<td>BDI</td>
<td>Beck Depression Inventory</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>CATS</td>
<td>Cognitive Activation Theory of Stress</td>
</tr>
<tr>
<td>CFS</td>
<td>Chronic Fatigue Syndrome</td>
</tr>
<tr>
<td>CNS</td>
<td>Central Nervous System</td>
</tr>
<tr>
<td>CRH</td>
<td>Cortico-Releasing-Hormone</td>
</tr>
<tr>
<td>CVD</td>
<td>Cardiovascular diseases</td>
</tr>
<tr>
<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual of Mental Disorders 4th ed.</td>
</tr>
<tr>
<td>EEG</td>
<td>Electroencephalography</td>
</tr>
<tr>
<td>EMG</td>
<td>Electromyography</td>
</tr>
<tr>
<td>EOG</td>
<td>Electrooculography</td>
</tr>
<tr>
<td>FFT</td>
<td>Fast Fourier Transformation</td>
</tr>
<tr>
<td>HAD</td>
<td>Hospital Anxiety and Depression scale</td>
</tr>
<tr>
<td>HDL-C</td>
<td>High Density Lipoprotein-Cholesterol</td>
</tr>
<tr>
<td>HPA</td>
<td>Hypothalamo-Pituitary-Adrenal</td>
</tr>
<tr>
<td>ICSD</td>
<td>International Classification of Sleep Disorders</td>
</tr>
<tr>
<td>KSD</td>
<td>Karolinska Sleep Diary</td>
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<tr>
<td>KSS</td>
<td>Karolinska Sleepiness Scale</td>
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<tr>
<td>KSQ</td>
<td>Karolinska Sleep Questionnaire</td>
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<tr>
<td>LDL-C</td>
<td>Low Density Lipoprotein-Cholesterol</td>
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<tr>
<td>MBI</td>
<td>Maslach Burnout Inventory</td>
</tr>
<tr>
<td>NREM</td>
<td>Non-Rapid Eye Movement</td>
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<tr>
<td>ICD-10</td>
<td>International Classification Diseases</td>
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<tr>
<td>LHPA</td>
<td>Limbic-Hypothalamo-Pituitary-Adrenocortical</td>
</tr>
<tr>
<td>MSLT</td>
<td>Multiple Sleep Latency Test</td>
</tr>
<tr>
<td>PSG</td>
<td>Polysomniographic</td>
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<tr>
<td>RAS</td>
<td>Reticular Activating System</td>
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<tr>
<td>REM</td>
<td>Rapid Eye Movement</td>
</tr>
<tr>
<td>SAM</td>
<td>Symphato-Adrenal-Medullary</td>
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<tr>
<td>SCID</td>
<td>Structured Clinical Interview for DSM-IV</td>
</tr>
<tr>
<td>SCN</td>
<td>Suprachiasmatic nuclei</td>
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<tr>
<td>SMBQ</td>
<td>Shirom-Melamed Burnout Questionnaire</td>
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<tr>
<td>SOFI</td>
<td>Swedish Occupational Fatigue Inventory</td>
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<tr>
<td>SSI</td>
<td>Sleep Sufficiency Index</td>
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<tr>
<td>SSS</td>
<td>Stanford Sleepiness Scale</td>
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<tr>
<td>SWA</td>
<td>Slow Wave Activity</td>
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<tr>
<td>SWS</td>
<td>Slow Wave Sleep</td>
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<tr>
<td>SQI</td>
<td>Sleep Quality Index</td>
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<tr>
<td>TIB</td>
<td>Time In Bed</td>
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<tr>
<td>TST</td>
<td>Total Sleep Time</td>
</tr>
<tr>
<td>VE</td>
<td>Vital Exhaustion</td>
</tr>
<tr>
<td>W</td>
<td>Wake</td>
</tr>
<tr>
<td>WASO</td>
<td>Wake Time After Sleep Onset</td>
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<tr>
<td>WHR</td>
<td>Waist to Hip circumference Ratio</td>
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