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The Occurrence of Somatic Complaints in German Resident Physicians
Compared to the General Population and Their Associations with
Psychosocial Working Conditions and Working Time Characteristics

Dissertation

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Zusammenfassung

Somatoforme Körperbeschwerden (SC) sind in der berufstätigen Bevölkerung weit verbreitet und verursachen nicht nur Leiden, sondern auch eine erhebliche Inanspruchnahme des Gesundheitssystems. Widrige psychosoziale Arbeitsbedingungen, wie im Job Demand-Control-Support Modell (J-DCS) beschrieben, und ungünstige arbeitszeitbezogene Faktoren (WTC), wie eine hohe wöchentliche Arbeitszeit oder die Ausführung von Schichtdienst, stellen potentielle Risikofaktoren dar. Beides tritt in besonderem Maße bei Krankenhausärzten während der Facharztweiterbildung auf. Die vorliegende Arbeit untersucht das Auftreten von SC bei Krankenhausärzten in Deutschland im Vergleich zur Gesamtbevölkerung, geschlechtsspezifische Unterschiede sowie den Zusammenhang mit JDC-S und WTC.

Im Rahmen einer Querschnittsstudie wurden im Jahr 2007 405 Assistenzärzte am Ende ihrer Facharztweiterbildung im Großraum München befragt. Zur Ermittlung der SC wurde der Gießener Beschwerdebogen (GBB-24, Bereiche Erschöpfung, Magenbeschwerden, Gliederschmerzen, Herzbeschwerden sowie ein Gesamtbeschwerdedruck) eingesetzt. Daten zu Arbeitsbedingungen wurden durch einen standardisierten Fragebogen (TAA-KH-S), der die Dimensionen Arbeitsanforderungen, -autonomie und soziale Unterstützung abbildet, erhoben sowie durch Fragen zu WTC. Zur Auswertung wurden deskriptive Statistiken, ein zweiseitiger Zwei-Stichproben-T-Test für den Vergleich der Mittelwerte sowie eine multiple schrittweise Regressionsanalyse durchgeführt.

Im Ergebnis berichtete die Ärztekohorte in allen Kategorien außer Herzbeschwerden höhere Werte als die altersentsprechende Allgemeinbevölkerung. Unsere Ergebnisse sind dabei geschlechtsunabhängig, jedoch stärker ausgeprägt bei den Ärztinnen. Im Geschlechtervergleich innerhalb der Gruppe der Ärzte berichten Ärztinnen signifikant höhere Werte für den Gesamtbeschwerdedruck, für Erschöpfung und für Gliederschmerzen. Die Dimension Arbeitsanforderung hatte die stärkste Verbindung mit SC, mit Ausnahme der Kategorie Magenbeschwerden. Die Dimension Arbeitsautonomie zeigte keine signifikanten Ergebnisse. Eine hohe soziale Unterstützung war verknüpft mit niedrigeren SC. Eine große Anzahl freier Wochenenden war mit niedrigeren SC verknüpft, mit Ausnahme der Kategorie Erschöpfung. Die Ausführung von Schichtarbeit war verbunden mit höheren SC bezüglich des Gesamtbeschwerdedrucks und der Kategorie Gliederschmerzen. Die wöchentliche Arbeitszeit hatte keinen Einfluss auf SC.

Die hohe Prävalenz von SC bei Assistenzärzten im Krankenhaus und ihr Zusammenhang mit ungünstigen JDC-S und WTC haben möglicherweise einen ernstzunehmenden Einfluss auf die langfristige Gesundheit der Ärzte und die Qualität der Versorgung im Gesundheitswesen. Eine Bestätigung der Ergebnisse durch zukünftige Längsschnittstudien erlaubt Rückschlüsse auf einen kausalen Zusammenhang zwischen JDC-S, WTC und SC, und gäbe mögliche Hinweise für die Prävention von SC bei Ärzten während der Facharztweiterbildung.

Summary

Somatic complaints (SC) are highly prevalent in working populations and cause suffering and extensive health-care utilization. Adverse psychosocial working conditions as conceptualized in the Job Demand-Control-Support Model (JDC-S) and adverse working time characteristics (WTC) are potential risk factors. This combination is particularly common in hospital physicians. This thesis examines the occurrence of SC in German resident physicians compared to the age-adjusted general population, gender differences and their associations with JDC-S and WTC separately and combined.

In 2007, a cross-sectional study was conducted among 405 resident physicians in the Munich area at the end of their residency training. SC were measured using the Giessen Subjective Complaints List (GBB-24) containing the total score and the sub-categories exhaustion, gastrointestinal, musculoskeletal, and cardiovascular complaints. Data on working conditions were collected by a self-report method for work analysis in hospitals (TAA-KH-S) and by questions on WTC (i.e., working hours). Descriptive statistics, two-sample two-tailed t-tests for mean comparison and multivariable stepwise regression analyses were conducted.

Resident physicians reported higher somatic complaints than the reference sample in all sub-categories except cardiovascular complaints and independent from gender, however, taken shape in a stronger way regarding women. In the direct comparison between women and men within the study population, female resident physicians generally reported higher somatic complaints applying for all sub-categories except gastrointestinal and cardiovascular complaints. Workload showed the most pronounced relationship with all sub-categories of SC except gastrointestinal complaints. Job autonomy was not significantly related to any SC sub-category. Social support at work was inversely associated with all SC sub-categories except for cardiovascular complaints. Free weekends were associated with reduced SC except for exhaustion. Shift work was related to an increased SC total score and musculoskeletal complaints. Weekly working hours showed no association with SC.

The high prevalence of somatic complaints in resident physicians and their relationship with adverse psychosocial working conditions and adverse working time characteristics may have a serious impact on long-term health of physicians and the quality of care in the health service. If confirmed in longitudinal studies, these insights may inform the development of preventive measures to improve the health of this professional group. Prospective studies are needed though to corroborate our findings.

List of abbreviations

4-DSQ	Four-Dimensional Symptom Questionnaire
BAuA	<i>Bundesanstalt für Arbeitsschutz und Arbeitsmedizin</i> (The Federal Institute for Occupational Safety and Health)
DSM	Diagnostic and Statistical Manual of Mental Disorders
FSS	Functional somatic syndromes
GBB	<i>Gießener Beschwerdebogen</i> (Giessen Subjective Complaints List)
ICD	International Statistical Classification of Diseases & Related Health Problems
JDC-S	Job demand, control and support (presenting psychosocial working conditions)
OECD	The Organisation for Economic Co-operation and Development
PHQ-15	Patient Health Questionnaire 15-item Somatic Symptom Severity Scale
SAD-triad	Triad of somatization, anxiety, depression
SC	Somatic complaints
SCL-90	Symptom Checklist 90
SD	Somatoform disorders
SHC	Subjective Health Complaints Inventory
SOMS	<i>Screening für somatoforme Störungen</i> (Screening for somatoform disorders)
SSEQ	Somatic Symptoms Experiences Questionnaire
TAA-KH-S	<i>Tätigkeits- und Analyseverfahren für das Krankenhaus</i> (a self-report method for work analysis in hospitals)
US\$	US-Dollar
WTC	Working time characteristics

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1 Introduction

1.1 Background

Physicians belong to an occupational group that is well known to be exposed to an exceptional combination of both adverse psychosocial working conditions as well as adverse working time characteristics (2). This unique occupational situation involves primarily high job demands such as occupational stress (3) and also a high number of working hours per week or shift work. A sub-group of this occupational group that is experiencing an even intensified situation are German resident physicians who are undergoing specialty training in hospitals for acquiring the 'specialist' qualifications. This phase of the medical career is directly associated with a particular level of psychosocial work stress (4) and a higher frequency of shift work (5).

Several work stress models exist to describe psychosocial working conditions. One of the most extensively applied during the last thirty years is the Job Demand-Control-Support Model developed by Karasek, et al. (6, 7). Three dimensions are determined representing psychosocial working conditions: 'job demand', 'job control' and 'support'. Considerable research has presented empirical evidence for the relationship between adverse psychosocial working conditions determined through high demands, low control and low support and not only physical health impairments like cardiovascular diseases (8, 9) but also mental health impairments (10) comprising depression (11, 12) and burnout (13, 14). These occur in several occupational groups, amongst them physicians (15), resident physicians (16) or nurses (17, 18). Adverse working time characteristics as an additional straining factor resident physicians are exposed to can amongst others be itemized in a high number of working hours per week, frequent working on weekends or the participation in shift work. It is well researched and described widely that adverse working time characteristics are related to several health outcomes, again including physical and mental impairments such as cardiovascular diseases (19, 20) or depression (21, 22). This applies as well for several occupational groups (23, 24) including physicians (25, 26).

Accordingly, many health outcomes have been examined in these contexts. However, there is one health outcome that is not yet part of the growing body of research and far less studied in the context of adverse psychosocial working conditions and working time characteristics: somatic complaints. They are highly prevalent in the working population and have considerable impact on several fields: not only do they affect the general quality of life of persons afflicted but also their performance and presence at work as well as the use of the health care system. However, research on somatic complaints is complicated by the lack of a consistent terminology, definition, model of etiology and delimitation to related clinical pictures.

Existing definitions describe somatic complaints as types of physical symptoms that range from pain in different body regions to impairments related to specific organs (e.g. cardiovascular, gastrointestinal, disturbances of the musculoskeletal system or concerning the

sensorium) as well as symptoms related to fatigue and exhaustion (27), others consider somatic complaints simply as a synonym to pain, yet others delimit pain intentionally from further bodily sensations or fatigue and exhaustion.

Adding to the complication in definition is the fact that single somatic complaints or a set of them may already represent clinical pictures or are considered to lead to them (28, 29), comprising functional somatic syndromes (FSS) or somatoform disorders (SD) as specified in ICD-10 and DSM-V. These clinical pictures are overlapping substantially regarding their definition, describing physical or bodily symptoms with an unclear etiology (30). They are also presenting a high lifetime prevalence of 4 to 10% among the general population, and, likewise, they have a major socioeconomic impact by causing a high number of physician visits, medical examinations and treatments (31). Likewise, these clinical pictures are above all related to psychic disorders such as depression and anxiety disorder (32-34), being well known for an intense utilization of the health system (35, 36).

Regarding the etiology, it is not fully understood how somatic complaints do emerge, however, several approaches exist (29, 37). In the context of a multifactorial etiology there may be factors that trigger somatic complaints like critical life events such as the loss of a close family member or stressful conditions in general like the birth of an impaired child. These may lead to a physical alteration in the body causing complaints, along with a changed perception of these as well as a deceptively biased evaluation of physical symptoms also caused by a higher attention for them (38). As the workplace setting represents a substantial source of potential distress in adult life, being the place of socialization, where most of the daytime is spent and where the adult socioeconomic status is determined (39), adverse occupational conditions may contribute to the emergence of somatic complaints. According to longitudinal research based on workplace observation instead of self-report measures, stressors at work are described to have a prolonged effect on resultant somatic complaints (40).

However, and beyond these challenges regarding a lacking term and definition or a consolidated understanding of the etiology, the prevalence for somatic complaints is considerable: a survey in the U.K. revealed prevalence of more than 30% for fatigue, more than 25% for back pain and 23% for joint pain, measured for a two-week period prior to the time of the measurement. These were reported by a working population without otherwise chronic diseases. Participants reported that a major proportion of these somatic complaints are experienced as severe and interfering with daily activities (41). In Germany, similar research declared a 12-months-prevalence of 30-50% for pain in different body regions and fatigue or exhaustion experienced on working days with a severity from mild and transient to severe and chronic (42). The high prevalence consequently impacts the utilization of the health care system, with somatic complaints presumably leading to a burden of the health economic system in several ways. They may generate considerable diagnostic examinations and therapeutic treatments (27, 31), and lead to increased sickness absence (43, 44) and a reduced job performance (45) when perceived as severe and interfering with daily activities. Beyond

economic aspects, somatic complaints regularly involve a considerable burden to the patients e.g. comprising a difficult relationship to physicians (46, 47) or experiences of stigmatization (48, 49).

The current body of research in regard of the relationship between the general occurrence or higher reported levels of somatic complaints, adverse psychosocial working conditions and adverse working time characteristics is fragmentary and focuses on certain aspects of its complexity. Well examined seems to be the interaction between job stress as conceptualized by the Job Demand-Control-Support Model and somatic complaints in general (17). More precisely, these studies were able to confirm the assumed connection between the JDC-S dimension ‘demand’ (in this thesis referred to as ‘workload’) and ‘support’ (‘social support at work’) with somatic complaints (50-53). It was not always possible, however, to show a consistent association between the buffering aspect of the dimension ‘control’ (‘job autonomy’) and somatic complaints (54). Regarding single complaints, e.g. complaints related to muscles, tendons and joints, it was possible to show an interaction with psychosocial working conditions. The evidence is, however, not as strong as for cardiovascular diseases or mental disorders (55-57).

Contrary to the satisfying research situation regarding the before described relationship, research concerning the interaction of working time characteristics and somatic complaints in general (58, 59) or specific complaints such as musculoskeletal complaints (60) is also limited, and remarkably little is known about it. Furthermore, concerning the overall and combined influence of psychosocial working conditions and working time characteristics on somatic complaints, the body of research is very sparse (61, 62), especially when regarding a full range of somatic complaints instead of single aspects (44, 63). Beyond this, no study is published to the best of our knowledge, researching young and in other respects healthy resident physicians working in hospitals.

Therefore, this thesis examines the occurrence of somatic complaints in young and healthy resident physicians in German hospitals compared to the general population as well as gender differences and the interaction of adverse psychosocial working conditions, adverse working time characteristics and reported somatic complaints basing on cross-sectional research.

1.2 Aims of the thesis and research questions

Physicians (2, 3), especially resident physicians (4, 5) during their specialty training in hospitals, are well known to be working under adverse working conditions. These include psychosocial working conditions (JDC-S) as well as working time characteristics (WTC). Adverse working conditions regularly lead to physical and mental health impairment according to the Job Demand-Control-Support Model. Moreover, the prevalence of common psychic diseases like depression (64, 65), burnout (66, 67) or substance use disorder (68) as well as suicidal incidences (69, 70) is also substantially higher in physicians compared to the general population. Regarding physical impairment, there are some observations that indicate that the occurrence of cardiovascular diseases is higher (71). Therefore, it seems reasonable

to assume that the prevalence of somatic complaints in resident physicians is increased compared to the general population and to investigate it. The objectives this thesis pursues arise from the three fields that are likely to be affected by the consequences of somatic complaints in resident physicians and comprise health economics, health care policies and occupational medicine.

1.2.1 Relevance in terms of health economics

Physicians with somatic complaints possibly turning into clinical pictures like somatoform disorders or functional somatic syndromes affect health economics in several ways. Patients with somatic complaints or their exacerbation are costly to the health care system (72) in terms of multiple physician visits, extended medical examinations and sickness absence (27, 31, 43, 44). It is unlikely that this may be different in physicians being a patient at the same time. Due to their own health-behavior one may in fact assume that physicians might suffer from exacerbated levels of somatic complaints: physicians are known to consult medical colleagues rather hesitantly and to tend to self-medication (73, 74). Furthermore, there may be a reduced quality in the physicians' work due to possible erroneous treatments that may even result in an insufficient patient security, as research has shown that especially in resident physicians' mental health impairment, e.g. burnout, depression, is related to lower levels of patient care quality (75, 76).

1.2.2 Relevance in terms of health care policies

The world is facing a current and future lack of physicians, especially in the rural areas (USA (77), Germany (78, 79), Finland (80), Australia (81) and other OECD countries (82)). The causes are manifold (83). Firstly, the number of currently active physicians is decreasing (5) due to seniority (84) and early retirement (85). In addition, the number of physicians entering the workforce is decreasing due to a reduced number of graduates, e.g. due to restricted intake rates to medical schools (82, 86). Moreover, physicians' intention to leave the curative field is rising (78, 83). This intention is associated to higher rates of depression, anxiety, burnout and psychosocial stress (87-89). Secondly, the population pyramid predicts older and therefore more potentially multimorbid patients (90), which consequently leads to a relatively reduced physician-patient-ratio (78). Thirdly, the number of women entering the medical profession was rising over the last decades – a trend that does not seem to end in the near future (91). Very often, women fulfill several roles in the social structure of family and work, which regularly leads to part-time work (92).

The assumed higher prevalence of somatic complaints in physicians is therefore relevant in terms of health care policies, as physicians affected by somatic complaints may not at all or not to a full extent be available for the medical care of patients and by this intensify the current and future lack of physicians by leading to a high sickness absence (43, 44) and to the above mentioned intention to leave.

1.2.3 Relevance in terms of occupational medicine

A major field of activity of occupational medicine represents the preventive medicine field regarding illness, injury or impairment related to the workplace (93). The idea and relevance of prevention gets emphasized by the current Act to Strengthen Health Promotion and Preventive Health Care (Preventive Health Care Act) that entered into force on 25th July 2015 in Germany. It aims at preventing diseases prior to their manifestation (94). Prevention measures may decrease the prevalence of somatic complaints in physicians and their consequences by improving working conditions. To identify appropriate measures, it is necessary to examine the relation between adverse working conditions, psychosocially and in terms of working time characteristics, and higher reported somatic complaints. This thesis pursues to expand the current knowledge and the body of research about this relationship to contribute to the improvement of health and working conditions of resident physicians.

1.2.4 Research questions

The research questions of this thesis and the attached corresponding article (1) are:

- 1) Do otherwise healthy resident physicians report higher somatic complaints, such as
 - a. exhaustion,
 - b. musculoskeletal complaints,
 - c. cardiovascular complaints,
 - d. and gastrointestinal complaintscompared to the age-adjusted general population?
- 2) Are there gender specific differences concerning the reported somatic complaints within the resident physicians' cohort?
- 3) Are psychosocial working conditions, such as
 - a. 'workload' (indicating job demands),
 - b. 'job autonomy' (job control),
 - c. and 'social support at work' (support)associated with somatic complaints among resident physicians?
- 4) Do working time characteristics, such as
 - a. average weekly working time,
 - b. the number of free weekends per month,
 - c. and shift work schedulehave an association with somatic complaints among resident physicians, individually and beyond psychosocial working conditions as listed in research question 3)?

Our findings regarding research questions 3) and 4) are subject of the above mentioned published and attached article which is part of this thesis. The findings regarding research questions 1) and 2) are additional results in excess to the article.

1.3 Theoretical approach

1.3.1 Somatic complaints

When talking about somatic complaints, we are facing several challenges. Firstly, an unclear number of synonyms exist for the term ‘somatic complaints’ also lacking a consistent definition. Secondly, it is not fully understood how somatic complaints do emerge. Thirdly, there is no consistent comprehension of if and how somatic complaints can lead to several disease patterns such as functional somatic syndromes that for their part are known for several synonyms or closely related diseases with an unclear differentiation among each other. All this makes a structured approach and a comparability of existing research and results difficult. By discussing these challenges, a common understanding for this thesis and our findings will be generated. A section will follow, describing prevalence, comorbidities, impact to the patient and the health care system and measurement instruments of somatic complaints or related clinical pictures.

1.3.1.1 Plethora of terminology and definition of the term ‘somatic complaints’

Numerous synonyms exist describing what we call somatic complaints, these comprise ‘medically unexplained (physical) symptoms’, ‘body-related’ or ‘multisomatoform complaints’, ‘non-specific’ or ‘somatoform (bodily) complaints’ or ‘symptoms’, ‘functional somatic symptoms’, ‘physical complaints’ or ‘symptoms’, ‘psychosomatic complaints’ or ‘unexplained clinical conditions’, etc. In 2007, Henningsen et al. concluded that “currently, no term or classification is fully satisfactory when dealing with the clinical phenomenon of patients reporting persistent bodily complaints for which no clear organic reason can be found” (37). Following up their findings in 2018, no substantial change regarding the plethora of terminology and definition of the term somatic complaints can be reported: “there is no generally accepted overarching term” (29). In a mini research regarding the number of hits in google scholar (scholar.google.de, 03/2015), we found that the term somatic complaints had 56,000 hits, with only physical symptoms having more (155,000). We decided, however, to use the term ‘somatic’ because we find it appropriate in regard of further classifications and comorbidities and ‘complaints’ due to the burden it usually means to the patient.

The agreement on a term – at least regarding this thesis – still leaves the meaning of it undefined. No consistent concept exists, whether somatic complaints can be seen as a synonym to pain in different body regions or if they comprise further bodily sensations, e.g. vegetative. In 1998, Kroenke defined ‘physical symptoms’ as “any physical symptom reported by a patient, including both symptoms that have an adequate physical explanation as well as those that are unexplained (i.e., somatoform)” and ‘somatoform symptoms’ as “a physical symptom that lacks an adequate physical explanation” (95). In 2003, he further points out that “the terms ‘physical’ and ‘somatic’ are interchangeable”, with the term ‘physical’ most commonly used by physicians “who care predominantly for medical disorders, and ‘somatic’ by psychiatrists and psychologists in the context of mental disorders”. It is also important to

mention that both terms do not mean that these are “medically unexplained” (96). In the S3 guidelines from 2012, ‘non-specific, functional and somatoform bodily complaints’ are defined as “pain in various locations, impaired organ dysfunction [...], including autonomic complaints, and exhaustion/fatigue” (27). Henningsen (97) differentiates when postulating that people suffering from pain do often additionally experience further, often referred to as functional somatic complaints such as dizziness, cardiovascular or gastrointestinal complaints, or, as a fourth complaint type, exhaustion. In 2012, the BAuA (42), however, questioned participants for complaints including pain in clearly defined body locations. The same does SCAN, a semi-structured psychic interview schedule for clinical assessment in neuropsychiatry, the physical health chapter of the WHO including 76 physical symptoms. The current version of the International Statistical Classification of Diseases and Related Health Problems, ICD-10, however, differentiates in chapter F45 ‘somatoform disorder’ between pain and somatic symptoms by defining miscellaneous entities such as somatization disorder, hypochondriac disorder, and persistent somatoform pain disorder separately. Moreover, the single subject-specific clinical pictures such as fibromyalgia, irritable bowel syndrome, etc. are described in entirely different chapters, the same applies for single physical symptoms like back pain or tinnitus (98). Regarding the DSM, the Diagnostic and Statistical Manual of Mental Disorders, a substantial change happened from DSM-IV (1994) to DSM-V (2013): whereas in DSM-IV the superordinate diagnosis named ‘somatoform disorder’ comprised sub-diagnoses such as somatization disorder, hypochondriasis, body dysmorphic disorder, conversion disorder and pain disorder separately, in DSM-V the same was renamed to ‘somatic symptom and related disorders’ with predominant pain being one of the diagnosing criteria, representing the former sub-diagnose pain disorder (99, 100). Regarding DSM and ICD however, physicians were amongst others questioned concerning the applied terms. More than 90% reported that there is no clear delimitation between the terms in use. Moreover, “over 30% of the physicians considered the diagnostic guidelines for pain disorder and somatoform disorder not otherwise specified as ‘unclear’” (101).

In summary, these numerous different definitions and fundamental approaches make it difficult to find an appropriate definition, and to compare the results of the current research in a reasonable and meaningful way. Regarding a definition of the term however, we decided to rely on the approach of the Giessen Subjective Complaints List, where somatic complaints are assessed via 24 items in four sub-categories including autonomic sensations (e.g. heavy, rapid or irregular heart-throbbing) and pain (e.g. pains in joints or limbs, pains in neck or shoulder, headaches) (102).

1.3.1.2 About the emergence of somatic complaints

It still does not seem to be fully understood, and no consistent concept exists of how somatic complaints as a very common and relevant health problem emerge. Different models exist in literature, often assuming a multifactorial emergence consisting of specific biological,

psychological, interpersonal, and social shares, the latter being subdivided into factors of predisposing, triggering and maintaining character (29, 37) as presented in Figure 1.

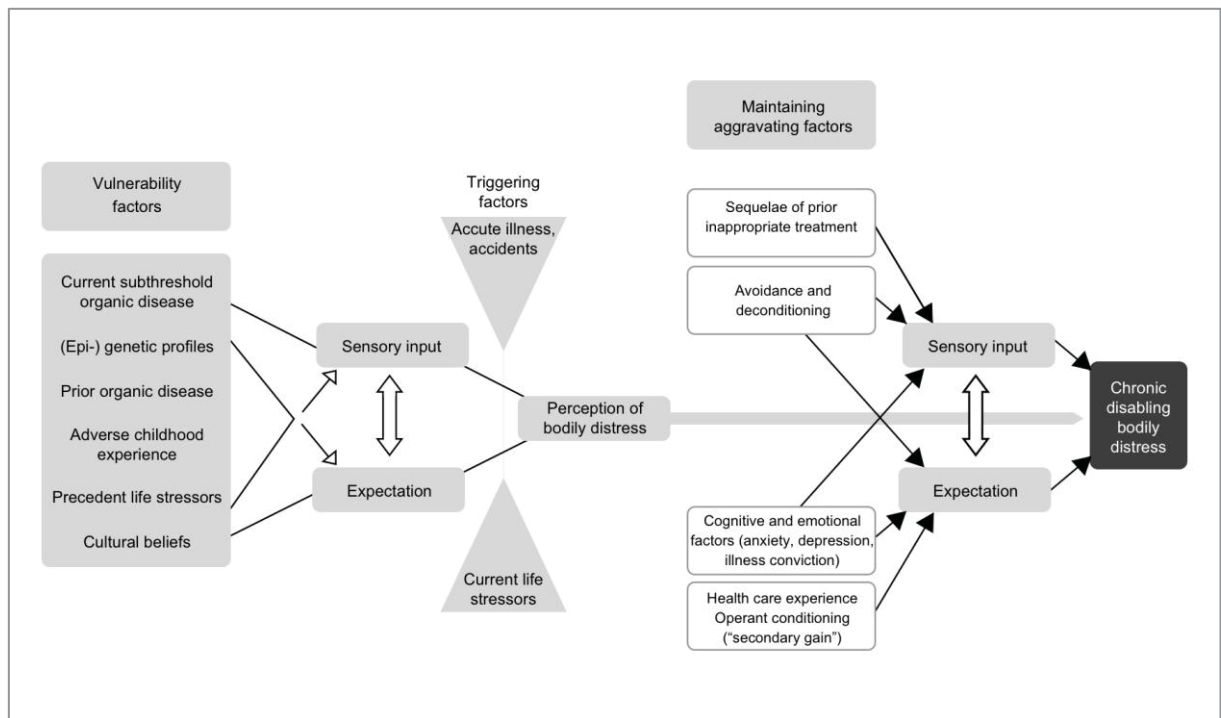


Fig. 1: Schematic model of the etiology of bodily distress. Adapted from Henningsen, P., et al., 2018 (29).

Possible factors triggering somatic complaints may in this context be critical life events such as the loss of a close family member or stressful conditions in general like the birth of an impaired child. Resulting in a physical alteration in the body, this may cause complaints coming along with a changed perception of bodily sensations as well as a deceptively biased evaluation of these as a result of a higher attention for them (38).

In a detailed description of 2014, Henningsen, et al. (97) postulated that the former separation of researchers into two groups representing either the biological or psychosocial explanatory model has been widely replaced by a combined bio-psycho-social model. In Henningsen's opinion, the biological group was formerly taking the view that only a detectable organic pathology was relevant in terms of somatic complaints and – when absent – that these patients were suffering from a dysfunction of the mental state at the most. However, the other group found psychic causes like emotional pressure and conflicts for somatic complaints not being explainable by physical correlates. Later, in the bio-psycho-social model combining both positions, the basic assumption describes that the experience of pain and complaints is always subjective and consequently depends on the current psychic state of a person being defined by mood, mind and attentiveness (97). This assumption is thereby independent from the question, whether a physio-pathological correlate can be identified or not, e.g. a muscle fiber rupture in patients with muscle pain. This explains the paradigm shift from DSM IV to DSM V, where the explainability of somatic complaints through organic correlates becomes far less important in the criteria for somatic symptom disorders. However, in both cases and thanks to modern neuro-imaging systems, anatomical correlates of somatic complaints can be

found today in the brain representing the dysfunction of the processing of stimuli. All these described correlations seem to be understood rather well nowadays, whereas it still seems to be unclear, how psychic strains and psychosocial conditions can contribute in an altered production and processing of stimuli, e.g. in a psycho-immunologic and/or psycho-endocrine way, which therefore need further research. Regarding a possible explanatory model, Henningsen further explains that the differentiation between trigger and maintaining factors is of utmost importance: organic trigger factors, e.g. a herniated disk in patients with back pain, clearly explain the cause of the pain in these patients, whereas an ongoing pain, especially after having curative surgery, cannot be explained. Here, psychosocial factors like fear of pain, the intensified mental focusing on the physical symptom and an increased, inward-looking attention seem to be maintaining factors. A failure of this differentiation may then lead to a prolonged course of the aetiopathology and a possible exacerbation with its consequences for the patient and the health care system.

1.3.1.3 From somatic complaints to functional somatic syndromes

To the best of our knowledge, no clear consistent concept exists to describe the association between one or multiple somatic complaints, including pain, and diverse clinical disease patterns or syndromes. Also, a number of terms exist for these syndromes, such as somatoform disorders (SD) or functional somatic syndromes (FSS). According to ICD-10, a SD is “present when insufficiently explained bodily complaints persist for at least six months, leading to a significant impairment of the ability to function in everyday life. If any physical disorders are present, they do not explain the nature and extent of the symptoms or the distress and preoccupation of the patient” (98). FSS are “characterized by patterns of persistent bodily complaints for which adequate examination does not reveal sufficiently explanatory structural or other specified pathology. We differentiate three main types of bodily complaints in FSS: pain of different location (back, head, muscles or joints, abdomen, chest, etc.); functional disturbance in different organ systems (e.g., palpitation, dizziness, constipation or diarrhea, movement, sensation); and complaints centering around fatigue and exhaustion” (37). It is, however, unclear whether a single or multiple somatic complaints can lead to SD or FSS and to which extent (i.e. number of complaints) or of which severity. Furthermore, there is no consistent list of complaints nor defined cut-off points for the clinical diseases named above. As a further challenge, different medical specialties have introduced terms of frequent clinical pictures with specific somatic complaints that can be clearly defined, and, most of them, located to specific body regions such as irritable bowel syndrome or non-ulcer dyspepsia in gastroenterology, fibromyalgia in rheumatology, chronic (postviral) fatigue syndrome regarding infectious diseases or atypical/non-cardiac chest pain in cardiology. It is unclear and difficult to determine how these clinical pictures can be related to somatic complaints on the one hand and syndromes like FSS or SD on the other hand. Although there seems to be a substantial overlap concerning these specific symptoms and syndromes in general, a clear delimitation is difficult (103). We assume, however, and as a basis for this thesis, that there is

a connection between the occurrence of somatic complaints and the diagnosis of the miscellaneous clinical pictures or syndromes mentioned above. We suppose that a certain extent, severity and/or duration of somatic complaints that are not fully explainable from a medical perspective can lead to SD or FSS (28, 29, 104), i.e. as a kind of exacerbation or development when untreated. This assumption is again relevant in terms of consequences for the patient as well as the health care system.

1.3.1.4 Prevalence

Data regarding the prevalence of somatic complaints vary substantially (105). Regarding the reported prevalence data as well as their interpretation and comparison, several aspects should be considered. Firstly, literature differentiates between prevalence, life-time prevalence and incidence (see section 7 Glossary). Moreover, and very often, the reported prevalence was assessed in conjunction with certain medical specializations, e.g. general practitioners, psychotherapists, internal specialists, or to a certain type of patient care, e. g. in-patient or out-patient, psychiatric patients, psychosomatic patients, etc. Furthermore, data depend on the measuring instrument applied (see section 1.3.1.7 Measurement instruments) and the diagnostic criteria (ICD-10, DSM-V) (106). Lastly, due to a missing definition of the term ‘somatic complaints’ and a missing delimitation regarding clinical pictures like SD or FSS the reported values should be considered with care.

Between 1979 and 1983, in a cohort study concerning the epidemiology of psychogenic diseases, Franz, et al. examined the prevalence of somatic complaints in a cohort of 600 probands in a psychosomatic outpatient clinic. The most common ones were headaches (38.7%), epigastric complaints (31.7%), musculoskeletal complaints (19.7%), cardiac pain (17.8%), underbelly pain (16.2%) and palpitations of the heart (107). In 2006, Hiller, et al. questioned 2.552 German inhabitants nationwide with a minimum age of 14 by applying the Screening for Somatoform Symptoms (SOMS). The participants were asked to report the appearance of one of the 53 somatic complaints of the SOMS within the past seven days as well as their associated impairment ranging from mild to very severe. The results revealed that at least 81.6% of the participants experienced at least one of the symptoms with an at least mild impairment. Moreover, 22.1 % reported at least one symptom with a severe impairment. On average, every participant reported 6.6 symptoms causing at least mild impairment, the most common ones being pain in various locations such as back, head, joints or extremities (108). Also in 2006, Ajdacic-Gross, et al. (109) examined somatic complaints in the Swiss population such as sleep disorders, backache, headache, stomach or bowels complaints. These were assessed during interviews at six different inquiries between 1979 and 1999 by applying the SCL-90 questionnaire. They found that 80% of the participants reported two or more complaints at every of these times of inquiry. A similar survey of the UK in 2007/2008 investigated the prevalence of somatic complaints two weeks prior in a UK-wide survey of participants aged 18 to 60 years. The questionnaire applied consisted of 25 physical and psychological symptoms. For the investigated timeframe, the working population without

otherwise chronic diseases reported prevalence of more than 30% for fatigue, more than 25% for back pain and 23% for joint pain. A major proportion of these were experienced as severe and interfering with daily activities (41). A German survey of 2011 assessing medically unexplained symptoms in a cohort of 308 probands by applying the PHQ-15 identified a prevalence of at least one reported medically unexplained symptom of almost 65%. Hereby, “the most frequently mentioned were back pain (54.9%), joint pain (45.5%), fatigue (37.3%), sleep problems (36.4%), and muscle pain (26.9%)” (110). In another German survey of 2012 questioning 20.036 employed participants with a minimum age of 15 and a minimum weekly working time of 10 hours a 12-months-prevalence of 30 to 50% for pain in miscellaneous parts of the body (lower back, neck and shoulders, extremities, head, cardiac pain) and fatigue or exhaustion was quantified (42).

Although the presented results should be considered with care and although a comparison is difficult, it is obvious that the prevalence for somatic complaints has to be considered as high or even as an everyday phenomenon that should be taken seriously by examining origins and effects as well as comorbidities.

1.3.1.5 Comorbidities

The association between somatic complaints, depression and anxiety disorder has been examined, observed and described in depth. Although the relationship itself does not seem to be doubted, it is still controversially debated (111) as nature and direction between the variables do not seem to be fully explored and understood (112).

In 2003, Kroenke, et al. found a strong association between somatic complaints and depression and anxiety disorder. He does, however, not distinguish between “unexplained or multiple somatic symptoms” but found, as further predictors of psychic comorbidity, not only a higher somatic symptom severity but also recent stress amongst others (96). Moreover, in 2010 in a systematic review, Kroenke, et al. even spoke of a well-established ‘SAD-triad’ describing the comorbidity of somatic, anxiety and depression symptoms (33). Henningsen in his meta-analytic review in 2003 was able to confirm that certain functional somatic syndromes like irritable bowel syndrome, non-ulcer dyspepsia, fibromyalgia and chronic fatigue syndrome showed a relation to depression and anxiety. However, for medically unexplained physical symptoms he only found limited evidence regarding the same kind of relation (113). In 2010, Haftgoli, et al. also found an association but described this in a vice versa direction when observing that mental disorders like depression and anxiety were “frequently associated with physical complaints” with remarkable rates of 20.0% respectively 15.5%. Like Kroenke, he also observed an increased prevalence for these psychic disorders associated to a higher subjectively perceived intensity exposure. Likewise, he found psychosocial stressors as assessed through the twelfth question of the Patient Health Questionnaire to be significantly related to mental disorders. He was also able to observe a substantial overlap in the prevalence

of depression, anxiety and somatoform disorders in patients with physical complaints (see Figure 2) (32).

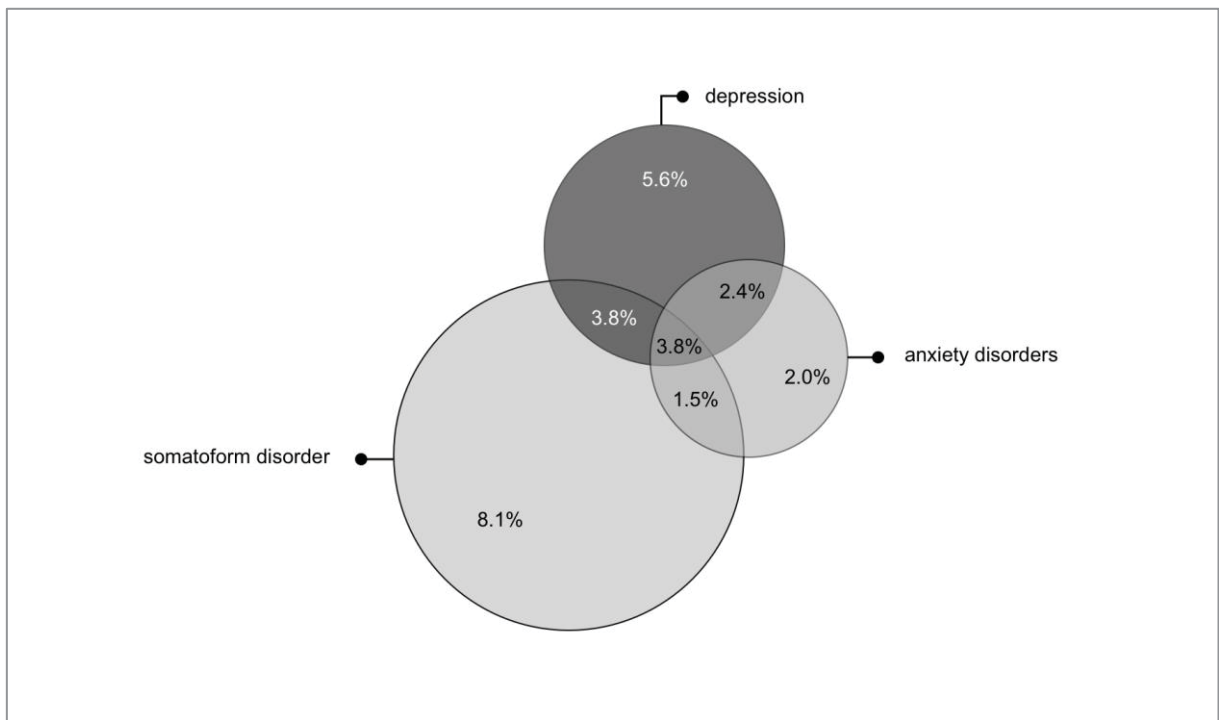


Fig. 2: Overlapping of depression, anxiety, and somatoform disorder for patient with a physical complaint in primary care. Adapted from Haftgoli, N., et al., 2010 (32).

Hörlein also came to very similar results in her doctoral thesis in 2013 (see Figure 3) (34).

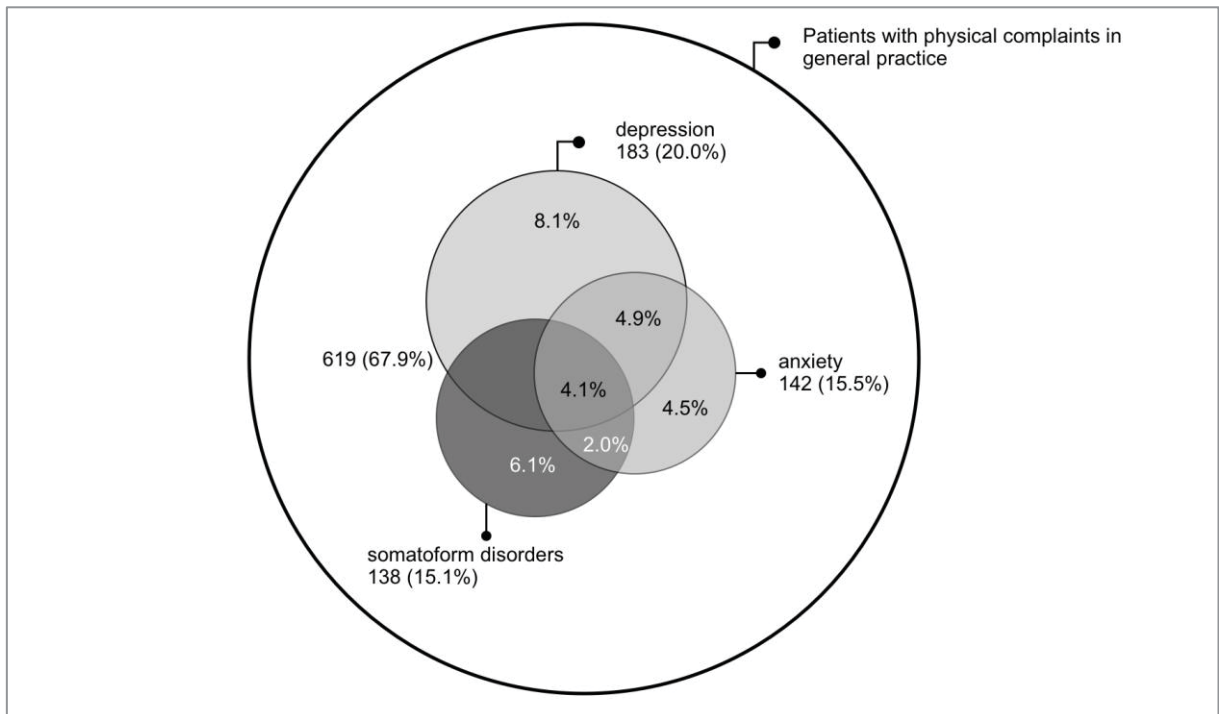


Fig. 3: Overlapping in mental disorders (Überlappungen psychischer Störungen). Adapted from Hörlein, 2013 (34).

Even though somatic complaints and somatoform disorders cannot be equalized, these findings still show that there is some kind of overlapping in somatic complaints as well as

depression and anxiety. Furthermore, and despite the limitations mentioned above, it seems that there is a kind of an at least descriptive relation between somatic complaints and mental disorders like depression and anxiety disorder. The perceived severity of the somatic complaints does also seem to play a role here. This underlines the seriousness of somatic complaints, their consequences as well as their possible prevention.

1.3.1.6 Impact to the patient and the health care system

Due to their high prevalence as well as their characteristic nature, somatic complaints have major implications not only concerning the single patient but also regarding the health care system. This impact depends on several factors: how often is a patient bothered by these complaints, what is the number, specificity and severity of the complaints, does the patient feel limited in his/her daily activities, does he or she feel limited in his or her working ability. The answers to these questions are experienced subjectively and depend on parameters like personality type (114), the history of someone regarding physical and psychic health (97), resilience (115) and the social environment as well as coping strategies (27).

Economically, the health care system is affected to a notably high amount, as somatic complaints regularly lead to a considerable use of it through:

- direct costs (see 7 Glossary)
 - repeated, partly inappropriate or unnecessary und mostly costly diagnostic and therapeutic procedures and/or interventions (31, 116)
 - multiple physician consultations, no matter if general practitioners or specialists, inpatient or outpatient ('physician (s)hopping') (31)
- indirect costs (see 7 Glossary)
 - a considerable amount of sickness absence days (43, 44)
 - a reduced job performance (45)

In their systematic review of 2012, Konnopka, et al. (72) found that the cost of illness (see 7 Glossary) of somatic complaints, there referred to as medically unexplained symptoms, are related to annual excess costs (see 7 Glossary) ranging from 432 to 5.353 US\$ per patient (prices of 2006). They are therefore comparable with excess costs for mental diseases like depression with up to 5.871 US\$ and anxiety disorders with up to 3.042 US\$ per patient. The numbering of the direct and indirect costs, however, does not seem to be that simple. Two tendencies regarding direct costs were elaborated: excess costs for inpatient treatment of 68% to 74% and for diagnostic procedures of about 40%. However, due to a lack of measuring, no clear statement regarding indirect costs can be reported except that they were three times higher than direct costs (72). Sickness absence days as a major part creating indirect costs seem furthermore to be associated to the total number of somatic complaints in a patient (44).

In line with these findings, both Reid and Barsky found that compared to patients with medically explained symptoms, patients with medically unexplained symptoms generate a higher use of the health care system in terms of the application of medical investigations as

well as the use of the outpatient and inpatient medical care. The latter is hereby independent from any psychic comorbidities such as depression or anxiety disorder (31, 117). The consequences for the patient himself/herself are also manifold and affect the patients' well-being and quality of life (118, 119), his/her ability to work (45) especially in terms of sickness absence (43, 44).

Beside financial aspects, patients with somatic complaints, especially when the complaints are multiple and when no physiological correlate can be found, are not rarely suffering from a considerable burden. Their relationship to physicians is described widely as difficult (46, 47). This might be attributed on the one hand to the already described uncertainty of especially young physicians leading to an over-investigation or – even worse – avoidance of patient contact (120). Another reason might be their concerns of losing sight of physical causes for the patients' complaints, again connected to repeated diagnostic and therapeutic procedures that are unnecessary or even create iatrogenic harm (117), not only through maintaining somatic complaints (121). Furthermore, physicians are described to often experience these patients as difficult to help (122). From the patients' perspective, they very often feel not listened to adequately or satisfyingly and therefore highly misunderstood (123). Furthermore, they feel a lack of empathy and often feel offended (123) and stigmatized (48, 49) when shifted into the psychic field, regardless whether reasonable or not. A comorbidity with depression and anxiety disorder further challenging patient and physician has already been discussed, whereat the direction of the relationship with somatic complaints is not clarified yet (see section 1.3.1.5 Comorbidities). Also, possible clinical exacerbations of somatic complaints like somatoform disorders are often diagnosed late (124), endangering patients to suffer from chronic manifestation (125).

In summary, the patients' quality of life is reduced (118, 119) by feelings of an impaired every-day life and role-functioning (45) while life expectancy in general is described to be normal (126).

1.3.1.7 Measurement instruments

In literature, several instruments exist to measure somatic complaints respectively the probable clinical pictures or syndromes somatic complaints can lead to or are associated with.

The Giessen Subjective Complaints List (GBB) is a self-assessment measure for subjective psychosomatic health complaints (102). It was developed in 1983 and represents an often and internationally applied instrument with a high construct validity and a satisfactory internal consistency. It was developed for the field of psychosomatic medicine and has been tested on several hundred of clinical samples with a mostly high number of patients as a systematic test with little expenditure of assessment time. It can also be applied for the assessment of change or development of complaints.

For detailed information, especially concerning items and sub-categories see section 3 Method and material. Further measuring instruments are:

- The screening for somatoform symptoms (SOMS, Screening für somatoforme Störungen) was developed in 1997 by Rief, et al. Through 68 items, it measures somatic complaints that cannot be explained by organic diseases, classifies patients with somatoform disorders, and thereby considers ICD-10 and DSM IV criteria. It can also be applied for process documentation (127).
- In 1999, Eriksen, Ihlebaek and Ursin enhanced the Ursin Health Inventory from 1988 to the Subjective Health Complaints Inventory (SHC) consisting of 29 items. The inventory inquires the prevalence and intensity of somatic and psychological complaints that have occurred in the past 30 days (128).
- The Patient Health Questionnaire 15-item Somatic Symptom Severity Scale (PHQ-15) as a short form of the Patient Health Questionnaire was published in 2002 by Kroenke, et al. and assesses somatic symptoms or symptom clusters including the most prevalent somatic symptoms according to DSM IV. It was initially tested on 6.000 patients (general practitioner, obstetrics-gynecology) with a high internal reliability and a “strong association between PHQ-15 scores and functional status, disability days, and symptom-related difficulty”. It is an instrument commonly and internationally applied in diverse areas of the health care system (129).
- In 2006, in the Four Dimensional Symptom Questionnaire (4-DSQ), Terluin, et al. describe four symptom dimensions (general distress, and psychic symptoms such as depression, anxiety, and somatization) to distinguish between stress-related symptoms and psychic illness in the general working population (130).
- A further instrument is the Symptom Checklist 90 (SCL-90) in its revised version of 2010. It measures the subjectively experienced impairment by physical or psychic symptoms during the last seven days (131) whereat the number of somatic complaints seems to be relatively limited.
- The Somatic Symptoms Experiences Questionnaire (SSEQ) is a self-assessment questionnaire, and was developed in 2013 by Herzog, et al. to give consideration to the strong emphasis DSM-V puts on the psychic characteristics of somatoform disorders and that the instrument therefore assesses. It consists of four factors with 13 items. In a first test on 453 patients of the department for psychosomatic medicine und psychotherapy in Hamburg-Eppendorf it showed a satisfactory reliability and validity (132).

1.3.2 Job stress and health – work stress models

In our society, a person's employment is of utmost importance in his or her life. Not only does it provide for an income (manifest function), it is also responsible for activity, the structure and routine of the day as well as the social position and integration (latent functions) (133). Furthermore, employment fulfills important psychic needs e.g. for social affiliation, a positive sense of self-worth or self-efficacy (134). Beside the positive effects of employment, work respectively adverse working conditions perceived as job stress may lead to negative consequences, particularly with regards to well-being and health (8, 12, 13, 23, 24). Health is hereby defined by the WHO as "not merely the absence of disease or infirmity" but a positive "state of complete physical, mental and social well-being" (135). Job stress, or work-related stress, occupational stress, is defined by the WHO as "the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope" (136).

The general association between occupational demands or work stress as its consequence and health is complex: occupational demands are determined by both physical and psychosocial demands as well as working time characteristics. Likewise, the health outcomes can be itemized in physical or psychiatric subcategories. The findings about these complex relationships also differ strongly. The major share of studies investigating the association between physical demands (e.g. work intensity, disadvantageous posture) on diverse somatic complaints (e.g. musculoskeletal complaints) is often concentrating on certain occupational groups (137, 138). This association is well studied and accepted. Likewise, there is a correlation between working time characteristics and physical as well as psychic health, e.g. in matters of long working hours or shift and night work (20, 22). However, research regarding the interaction with somatic complaints in general (58, 59) or specific complaints such as musculoskeletal complaints (60) is scarce. The relation between psychosocial working conditions, however, in terms of established work stress models, on both physical (e.g. cardiovascular diseases (8, 9)) and psychic diseases (e.g. depression (11, 12), burnout (13, 14)) have been examined and documented extensively in several different occupational groups (15-18). The relationship between psychosocial working conditions and somatic complaints in general also seems to be researched very well, confirming particularly the impact of the dimensions 'demand' and 'support' on the occurrence of somatic complaints (50-53). Similar results were found for single somatic complaints (55-57, 139). Moreover, and only most recently, Herr, et al. indicated that the interaction between adverse psychosocial working conditions and somatic complaints may have a longitudinal character (140).

Work stress models examine and measure miscellaneous factors and their interaction to identify relationships that lead to work stress and quantify these. They also measure and describe the interaction with diverse outcomes, especially health outcomes. Several theoretical models exist to describe the relationship between job stress and its implications for health, e.g. Rohmert's & Rutenfranz' model of stress and strain from 1975 (141, 142), the concept of

organizational injustice from 1982 (143, 144) or Siegrist's Effort-Reward-Imbalance Model from 1996 (39, 145).

The Job Demand-Control Model as applied here is a very established and widely utilized model. It was developed in 1979 by the US-American sociologist Karasek for the evaluation of factors that lead to strains and demands in the working population (6). Together with the Swedish socio-epidemiologist Theorell he empirically tested and reviewed it in 1990 (7). The model concentrates on certain aspects of the working organization and the job profile that defines the experience with its two dimensions 'demand' and 'control' and its interaction as the origin of chronic stress. It conceptualizes that job stress is characterized by two aspects: job demand representing psychological and non-physical demands, e.g. the time available for the completion or the difficulty of a task, and job control or decision latitude being defined "as the combination of job decision-making authority and use of skills on the job" (146) (see Figure 4 below).

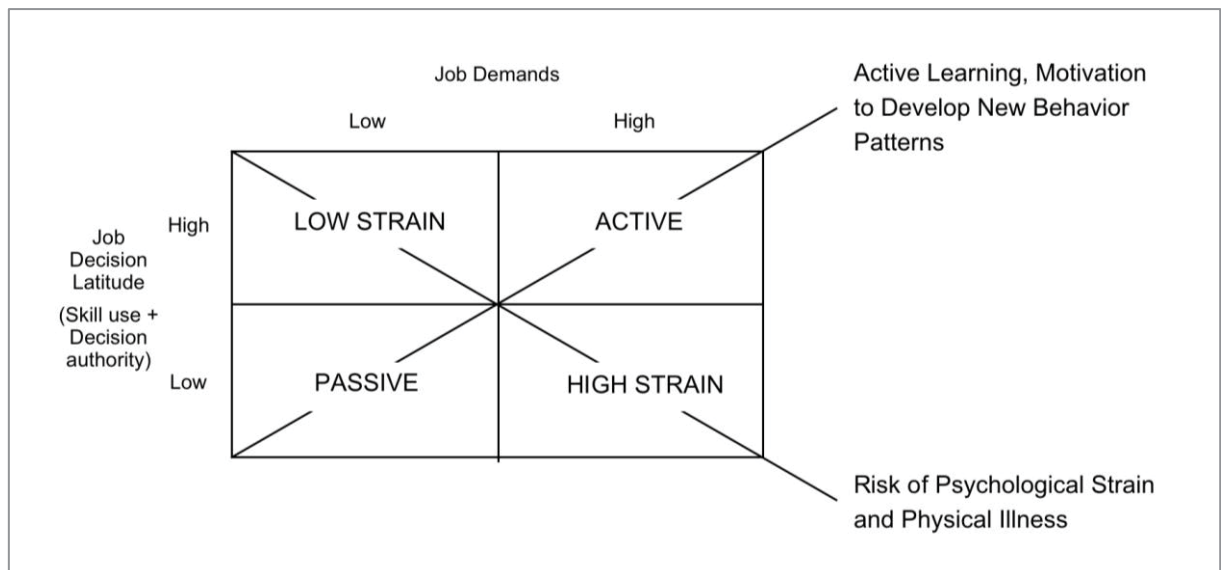


Fig. 4: The Job Demand-Control-Support Model. Adapted from Schnall, P.L., et al. (146).

The combination that leads to the strongest job strain thereby is a situation with high demands and low control, a constellation that is said to be a hazard to people's health who are exposed to this combination in an exceeding way. On the contrary, situations with high demand and high control are discussed to be those with the highest potential for motivation, learning and growth.

In detail, four possible constellations exist of these two dimensions (7). Low strain jobs distinguish themselves by low demands and high control. These jobs are described by Karasek and Theorell as "almost too good to be true" and therefore represent the most favourable constellation of the two dimensions with low health risks but also limited learning possibilities. They refer to natural scientists or self-employed architects as the main representatives of this constellation. It has, however, to be considered that this reference originates from 1979 and may not be valid for these professions today. High strain jobs, however, are characterized by high demands and low control. People being exposed to this

constellation exceedingly experience a high risk of psychological overstraining and physical illness with only a moderate level of learning at the same time. Assembly-line workers are named to be the typical affected stereotype. These two presented types belong to the strain hypothesis.

Two more types can be described, basing on the learning hypothesis: passive and active jobs. Passive jobs are exposed to low demands and low control, a combination that leads to low levels of learning with a clear lack of motivation to extend his or her skills set on the one hand, and a moderate stress level on the other, due to the unchallenging job and a lack of promotion and demands. Jobs of these constellations are often found in the security profession with mostly monotone and little diversified tasks. Active jobs on the contrary feature a combination with high demands and high control, leading to high levels of learning and moderate levels of strain. They motivate people to acquire further skills, and are not expected to induce serious health implications. Karasek and Theorell refer to physicians and managers in this context.

In 1988, Johnson and Hall extended the model by a further dimension 'support' representing a protective factor which worsens the situation when absent. Through inaugurating this third dimension, a further stereotype was defined termed iso-strain (combining isolation and job strain). This constellation, where high demands and low control are combined with low support, represents the most adverse possible job situation with an outstanding risk for health implications (147).

As already discussed, the Job Demand-Control-Support Model has been applied in many empirical investigations and has been discussed to be appropriate for examinations on job stress and different health outcomes. The most criticized aspect is the missing of an intrinsic component defined in the model such as personal character trait or coping styles (145).

2 Published original article

Due to copyright issues, the published original article will not be displayed here.

3 Method and material

The basic information regarding method and material can be taken from the respective section in the underlying article (1). Single detailed information is added here.

3.1 Study design and participants

The data collection was carried out within the framework of the Münchener Ärztstudie, a cohort study with to date four times of inquiry in 2004 (T1), 2005 (T2), 2007 (T3) and 2014 (T4). An overview over the return rates can be taken from Figure 5.

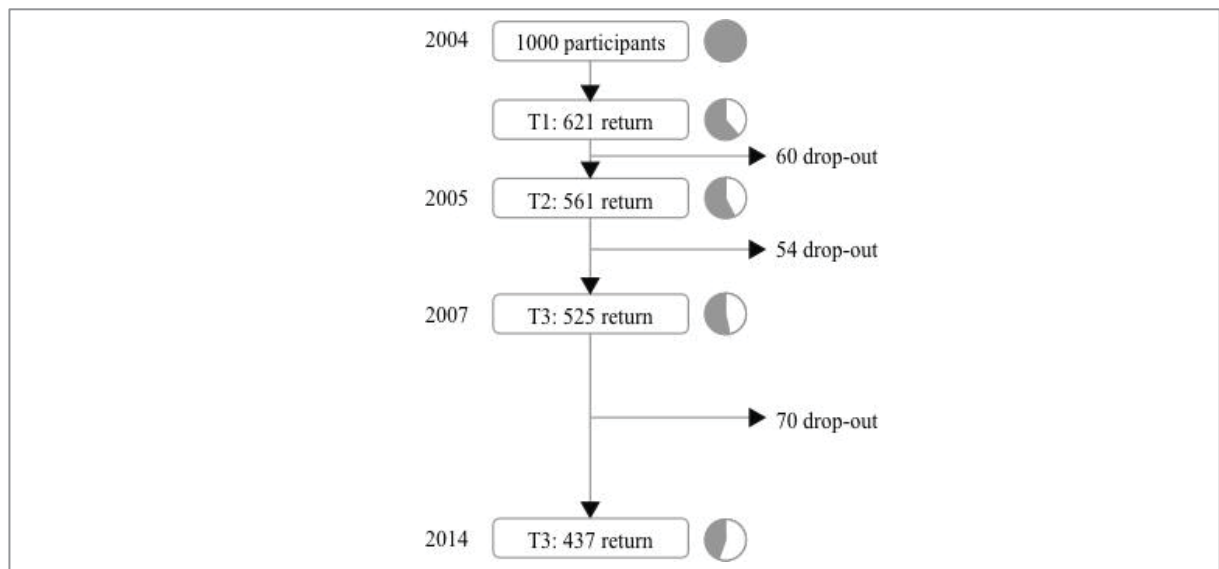


Fig. 5: Overview over the return rates of the Münchener Ärztstudie.

Between T1 and T2, there was a time-lag of 14 months (planned twelve months plus extension), and a 19-month lag (planned 18 months plus extension) between T2 and T3 (33 months between T1 and T3). These time-lags were chosen for strategic reasons of a follow-up study regarding depressive symptoms in resident physicians (64). The return rates were more than satisfying and the gender distribution remained stable throughout the different time points. Initially in T1, 1000 physicians with 482 women and 518 men were contacted, of which 621 returned usable questionnaires with a distribution of 318 women and 303 men. In T2, 561 of the 621 contacted physicians replied with completed questionnaires (90.3%) with a gender distribution of 289 women and 272 men. At the assessment of T3, 33 months after T1, 525 responded (response rate 84.5%) with a gender distribution of 268 women, 257 men. Up to T3, 507 resident physicians participated in all three surveys repeatedly (260 women, 247 men). In T4, seven years later, 450 of the contacted 621 physicians responded with a gender distribution of 236 women and 214 men. Before starting the investigation, approval from The Committee on Ethics of Human Research of the Medical Faculty, Ludwig-Maximilians-University Munich (No. 016/04) as well as written informed consent from all study participants were requested and received.

3.2 Questionnaire

The applied questionnaire was developed initially for the first time of inquiry (T1) in 2004 and was adapted partly for the subsequent follow up surveys (T2 to T4) in accordance with strategic inquiry focus. The structure of the questionnaire was always similar and consisted of a self-developed set of variables concerning socio-demographic values (e.g. gender, family status) as well as concerning the specific job situation (e.g. status of the practical training, functional direction, position, working hours, etc.) or health issues (BMI, acute or chronic diseases, smoking/drinking habits, physical training, etc.). The second part consisted of a set of standardized, established, and validated measurement instruments with diverse scope i.e. on working conditions, work stress, psychological well-being and mental health. The complete questionnaire of 2007 (T3) is added in the appendix (due to copyright issues, this applies only for the printed version of this thesis).

3.3 Study measures

3.3.1 Predictor variables

Psychosocial working conditions (JDC-S):

Basic information regarding the assessment can be taken from Fischer, et al. (1). Additionally, the full questionnaire with all items to assess the three dimensions ‘workload’ (‘job demands’), ‘job autonomy’ (‘job control’) and ‘social support at work’ (‘support’) equivalently to the job content questionnaire and taken from the TAA-KH-S, the *Tätigkeits- und Analyseverfahren für das Krankenhaus* (148), is listed below.

‘Workload’ refers to the amount of work and the time being available for its completion. It was measured by four items:

- “Even in a constant hurry, the amount of work is frequently too high to complete.”
- “Frequently, there is too much work at once.”
- “Short-term deadlines given by the supervisor frequently require working under pressure.”
- “Short-term deadlines given by other departments frequently require working under pressure.”

‘Job autonomy’ describes the decision latitude and degree of freedom at work and comprised seven items:

- “This work permits making own decisions on task goals.”
- “This work offers latitudes to decide which tasks to pursue.”
- “This work allows using one’s own ideas.”
- “This work permits being creative in achieving work goals.”
- “This work offers discretion in processing and scheduling.”
- “It is possible to make own decisions on how to carry out the work.”
- “This work involves choices regarding what methods and tools to use.”

‘Social support’ at work mirrors the relationship to colleagues, superiors and further instances in the hospital. It was represented by five items:

- “In this department, there is a trusting relationship between colleagues.”
- “In this department, there is a trusting relationship with supervisors.”
- “In this department, there is a trusting relationship with the hospital management.”
- “In this department, there is a trusting relationship with the colleagues of other divisions (e.g. other departments or the administration).”
- “In this department, there is a trusting relationship with other persons (employees of other hospitals or other institutes or companies).”

Working time characteristics (WTC):

The basic information regarding the assessment of these variables can be taken from Fischer, et al. (1).

3.3.2 Outcome variable

Somatic complaints (SC):

The basic information regarding the assessment of SC can be taken from Fischer, et al. (1). The 24 single items of the GBB-24 (102) are:

“I feel bothered through the following complaints:

1. Physical weakness
2. Heavy, rapid or irregular heart-throbbing
3. Pressure or heaviness in the stomach
4. Excessive need for sleep
5. Pains in joints or limbs
6. Dizziness
7. Backache
8. Pains in neck or shoulders
9. Vomiting
10. Nausea
11. Sensation of tightness, choking or lumpiness in the throat
12. Belching
13. Heartburn
14. Headaches
15. Tendency to rapid exhaustion
16. Tiredness
17. Feeling numb or benumbed
18. Heaviness or tiredness in the legs
19. Weariness
20. Twinges, pains or aching in the chest
21. Stomach aches
22. Attacks of breathlessness
23. Head pressure
24. Sudden bouts of heart-trouble”

The questionnaire is applicable for participants aged 18 years and older. The time needed for the completion of the GBB-24 questionnaire amounts to five to ten minutes. The reference sample used for the comparison with the resident physicians' cohort is the actual normed reference sample for the applied GBB-24. The data were collected in 2001 through face-to-face interviews of a representative sample of the population aged between 18 and 95 years ($M=49.16$, $SD\ 16.90$) in Germany by the University of Leipzig. Sample size amounted to $N = 1.941$ (1059 women, 920 men). The selection of households happened in random-route-procedure. The response rate constituted 65%. The age cohort of 31 to 40 years was the largest with 19.3% (102).

3.4 Statistical analysis

3.4.1 Approach

405 records were included in the cross-sectional analysis (see Figure 6).

Descriptive statistics were computed to describe the sample. Statistical analysis was conducted in four steps according to the research questions (see section 1.2.4 Research questions):

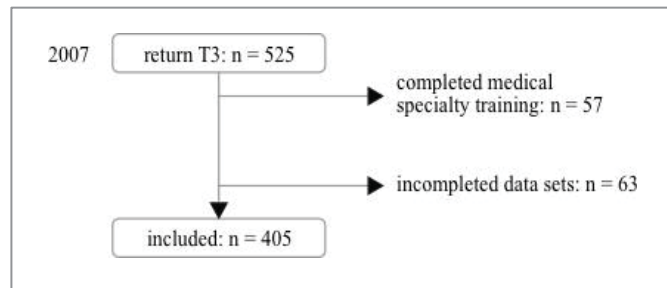


Fig. 6: Overview over the drop-outs of T3 of the Münchener Ärztstudie.

Regarding research question 1), we compared the reported somatic complaints of the resident physicians' cohort with those of Brähler's age-matched normed reference sample (102) to find out whether the physicians report higher values. This was done in two steps.

Firstly, we opposed the percentaged numbers of the given answers related to every single subcategory separately for women and men:

- Percentage comparison SC: resident physicians' cohort vs. reference sample

Secondly, we applied a two-sample two-tailed t-test. This was done separately for women and men as well as for the different sub-categories. Thus, there are two analyses:

- Mean comparison SC resident physicians' cohort vs. reference sample – women, all sub-categories (adjusted for age)
- Mean comparison SC resident physicians' cohort vs. reference sample – men, all sub-categories (adjusted for age)

Regarding research question 2), another two-sample two-tailed t-test was conducted to identify gender differences within the resident physicians' cohort:

- Mean comparison SC resident physicians' cohort – women vs. men: all sub-categories (adjusted for age)

The processing of research questions 3) and 4) is subject of the published article this thesis bases on and is described there in detail (1).

3.4.2 General annotation

For all analyses, a type 1 error probability (alpha) of less than 5% was considered to constitute statistical significance.

All regression analyses were computed after logarithmizing the GBB-24 total score and sub-categories to account for non-normal distribution (see section 3.4.3 Normal distribution).

All statistical analyses were performed with Stata 12 and Microsoft Excel 2016.

3.4.3 Normal distribution

As the collected data concerning the somatic complaints (GBB-24) were not normally distributed, we logarithmized the sub-categories to approach a normal distribution. The table of the logarithmized sub-categories below shows that also after logarithmizing the data were not perfectly normally distributed, but approximated it (see Table 1).

	Skewness	Kurtosis	Shapiro-Wilks		Francia	
			W	Prob>z	W'	Prob>z
total score	0.000	0.669	0.984	0.000	0.987	0.000
exhaustion	0.367	0.239	0.994	0.049	0.999	0.971
musculoskeletal complaints	0.000	0.205	0.958	0.000	0.978	0.000
gastrointestinal complaints	0.272	0.001	0.991	0.004	0.999	0.926
cardiovascular complaints	0.000	0.000	0.928	0.000	0.958	0.000

Table 1: Overview over the normal distribution of the GBB total score and sub-categories after logarithmizing.

4 Results

The descriptive analysis as well as the results regarding research questions 3) and 4) are subject of the underlying article (1). All additional results can be found here.

4.1 Characteristics of the study sample

Details of this chapter can be taken from the respective section of Fischer, et al. (1)

4.2 Percentage comparison SC: resident physicians' cohort vs. reference sample

We opposed the percentaged numbers of the given answers of the participants of both samples concerning every single sub-category item. The results can be found in Figures 7 to 14.

Women, sub-category exhaustion

Female resident physicians reported higher somatic complaints concerning the sub-category exhaustion (see Figure 7). Far more female resident physicians tended to report higher values regarding the items 'excessive need for sleep' (24.80% vs. 3.00% reporting 'considerably') and 'tiredness' (18.70% vs. 4.00% reporting 'considerably') compared to the reference sample. Some resident physicians also stated higher values regarding the items 'weariness', 'physical weakness' and 'tendency to rapid exhaustion'. No substantial difference can be reported for the item 'feeling numb or benumbed'.

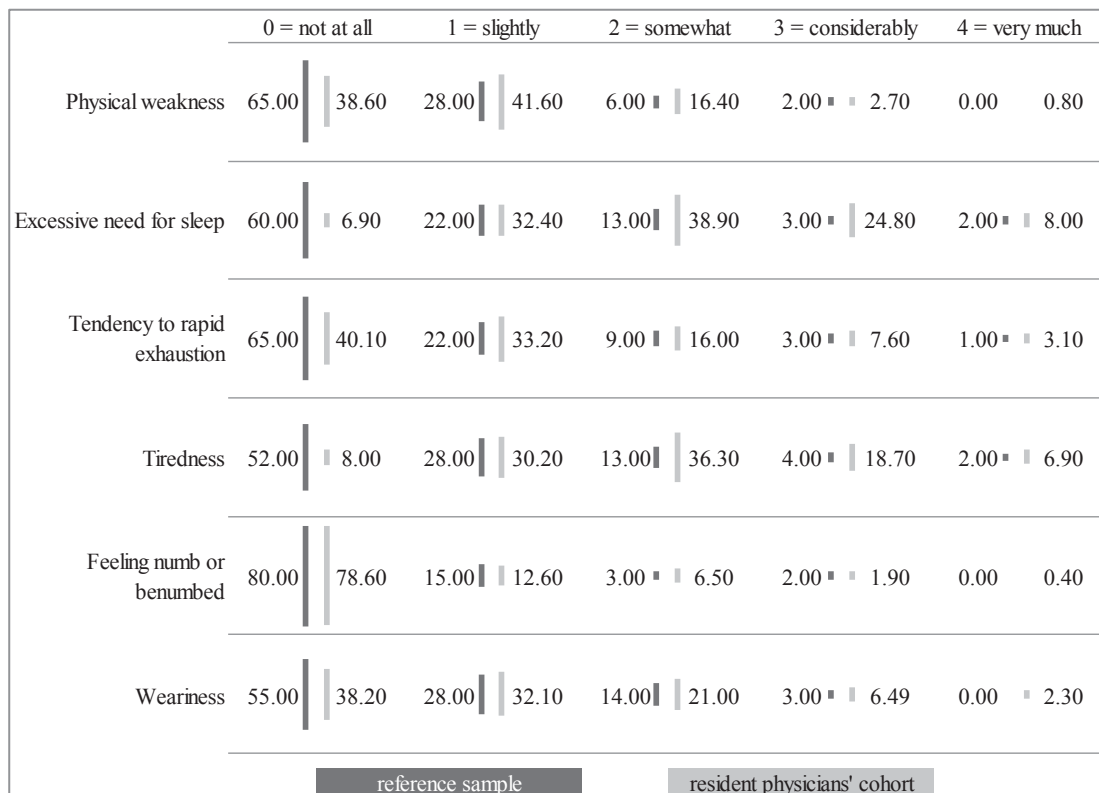


Fig. 7: Percent numbers of the given answers of both samples on item-level – women, sub-category exhaustion.

Women, sub-category gastrointestinal complaints

Concerning gastrointestinal complaints (see Figure 8), there seem to be no substantial differences between the reported complaints of the female resident physicians in comparison to the reference sample except the item ‘pressure or heaviness in the stomach’ (22.10% vs. 6.00% reporting ‘somewhat’).

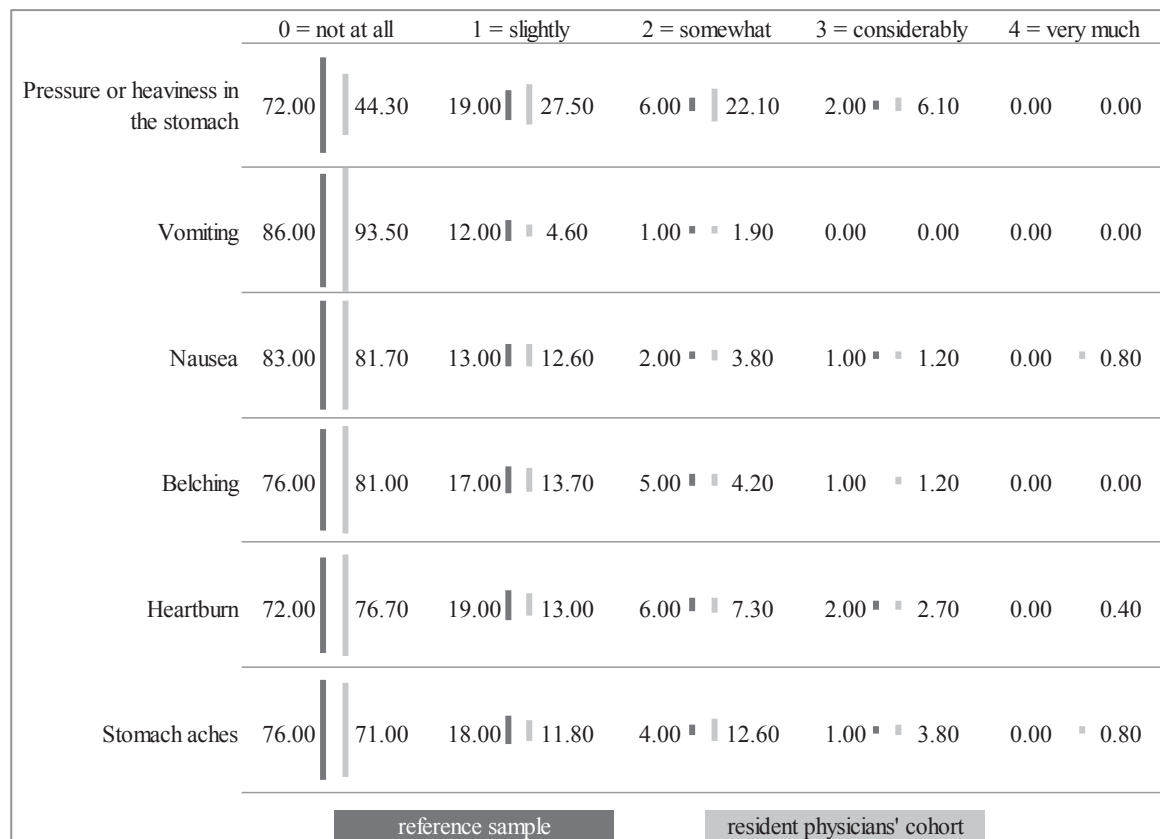


Fig. 8: Percent numbers of the given answers of both samples on item-level – women, sub-category gastrointestinal complaints.

Women, sub-category musculoskeletal complaints

Concerning musculoskeletal complaints (see Figure 9) and other than in men, the female resident physicians generally report higher complaints compared to the women of the reference sample. This applies especially for the items ‘pains in neck or shoulder’ (14.90% vs. 6.00% reporting ‘considerably’) and ‘backache’ (11.10% vs. 6.00% reporting ‘considerably’).

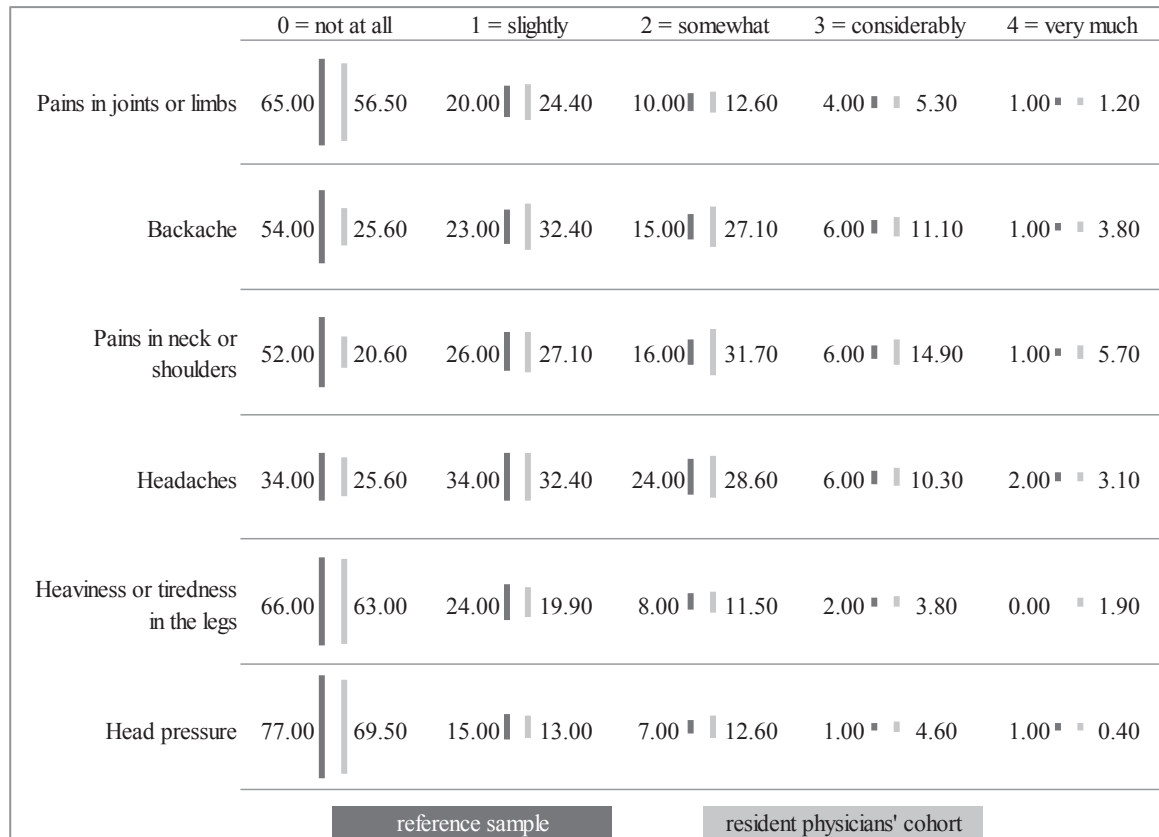


Fig. 9: Percent numbers of the given answers of both samples on item-level – women, sub-category musculoskeletal complaints.

Women, sub-category cardiovascular complaints

No substantial differences can be stated concerning the reported complaints regarding the single items of the sub-category cardiovascular complaints (see Figure 10) between the study sample and the reference population. Like in men, it can be stated that more female resident physicians reported no complaints ('not at all') regarding the subscales 'sensation of tightness, choking or lumpiness in the throat', 'twinges, pains or aching in the chest', 'attacks of breathlessness' and 'sudden bouts of heart-trouble'.

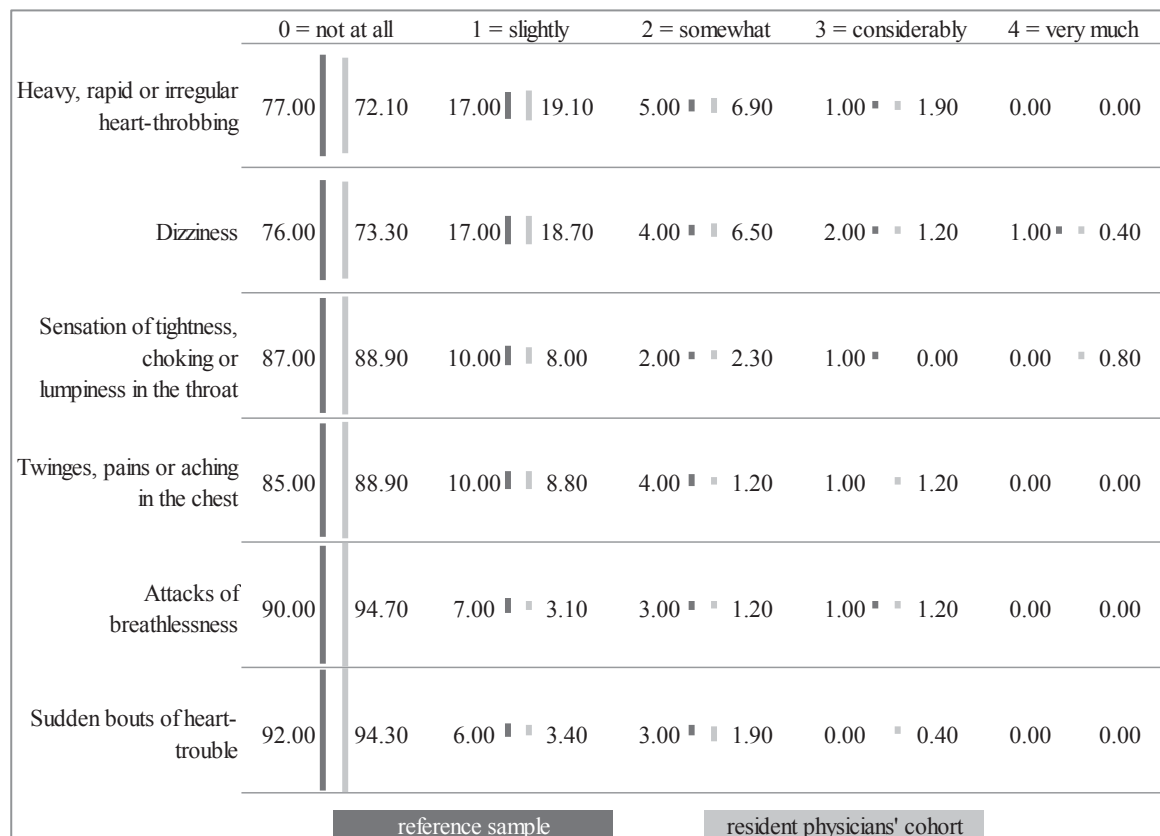


Fig. 10: Percent numbers of the given answers of both samples on item-level – women, sub-category cardiovascular complaints.

Men, sub-category exhaustion

Figure 11 shows that concerning the sub-category exhaustion, more male resident physicians tended to report higher values regarding the items ‘excessive need for sleep’ (18.40% vs. 5.00% reporting ‘considerably’) and ‘tiredness’ (15.60% vs. 4.00% reporting ‘considerably’) compared to the reference sample. Some resident physicians also stated higher values regarding the items ‘weariness’, ‘physical weakness and ‘tendency to rapid exhaustion’. No substantial difference can be reported for the item ‘feeling numb or benumbed’.

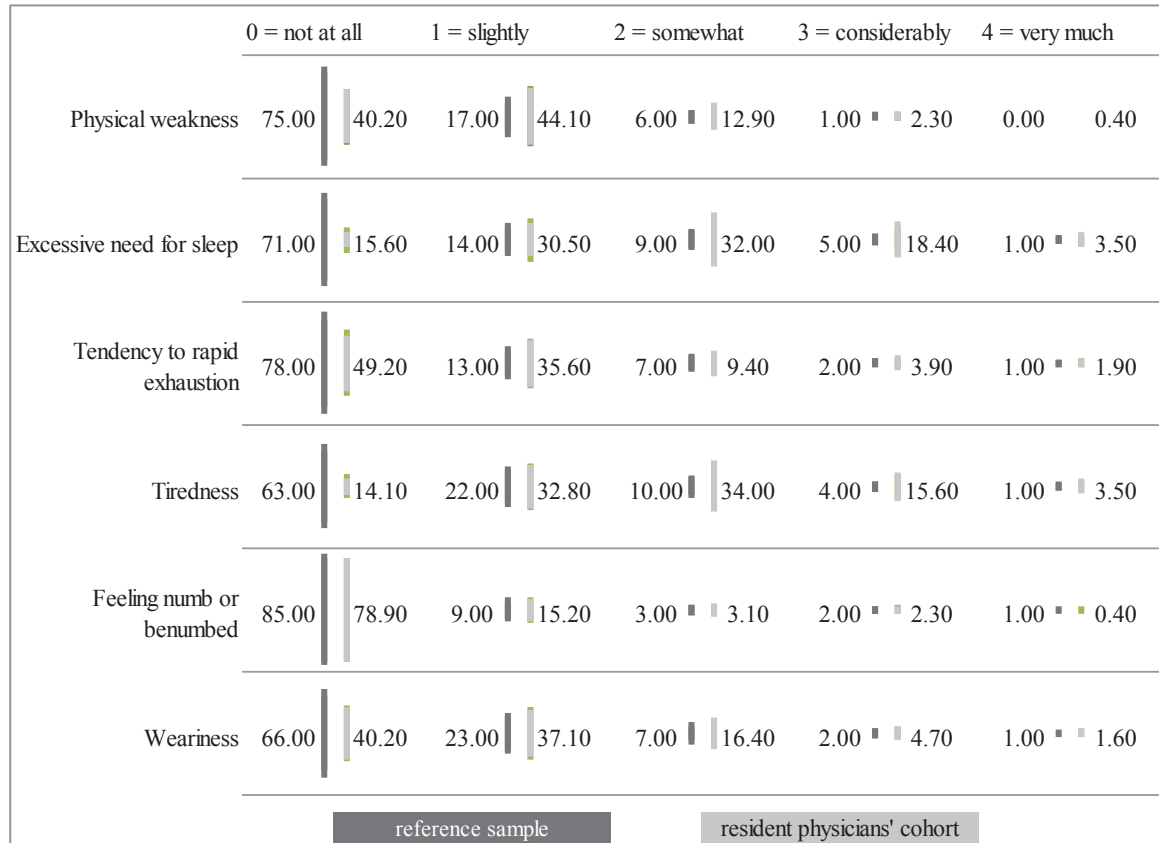


Fig. 11: Percent numbers of the given answers of both samples on item-level – men, sub-category exhaustion.

Men, sub-category gastrointestinal complaints

The results for the comparison of reported gastrointestinal complaints (see Figure 12) in men between the study population and the reference sample reflects the results of the female subgroup: no substantial differences can be assessed between the reported complaints of the male resident physicians in comparison to the reference group except the item ‘pressure or heaviness in the stomach’ (34.00% vs. 15.00% reporting ‘slightly’ and 13.70% vs. 7.00% reporting ‘somewhat’).

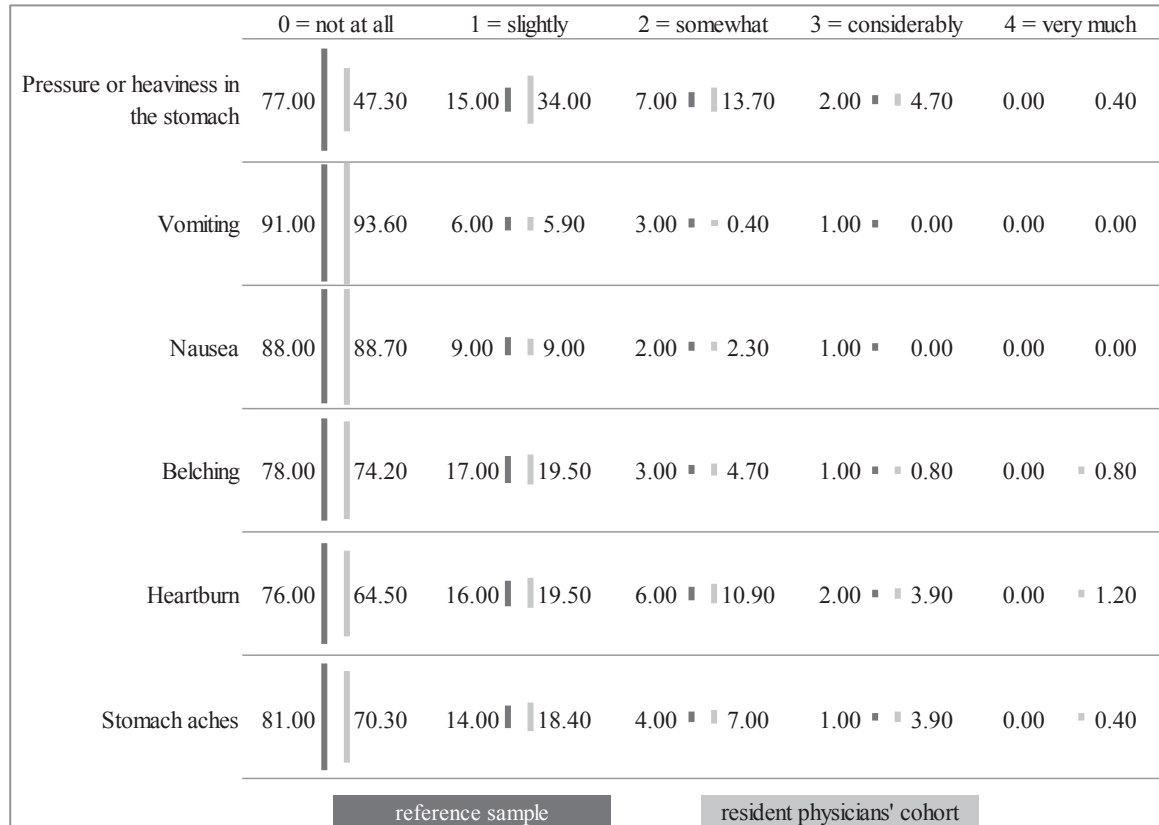


Fig. 12: Percent numbers of the given answers of both samples on item-level – men, sub-category gastrointestinal complaints.

Men, sub-category musculoskeletal complaints

No substantial differences can be described concerning the reported complaints of the sub-category musculoskeletal complaints (see Figure 13) between the study sample and the reference population. The highest deviation can be detected for the item ‘backache’ where about twice as much physicians reported considerable complaints (9.80% vs. 5.00%) and the item ‘pains in neck or shoulders’ where about threefold as much physicians reported considerable complaints (8.60% vs. 3.00%).

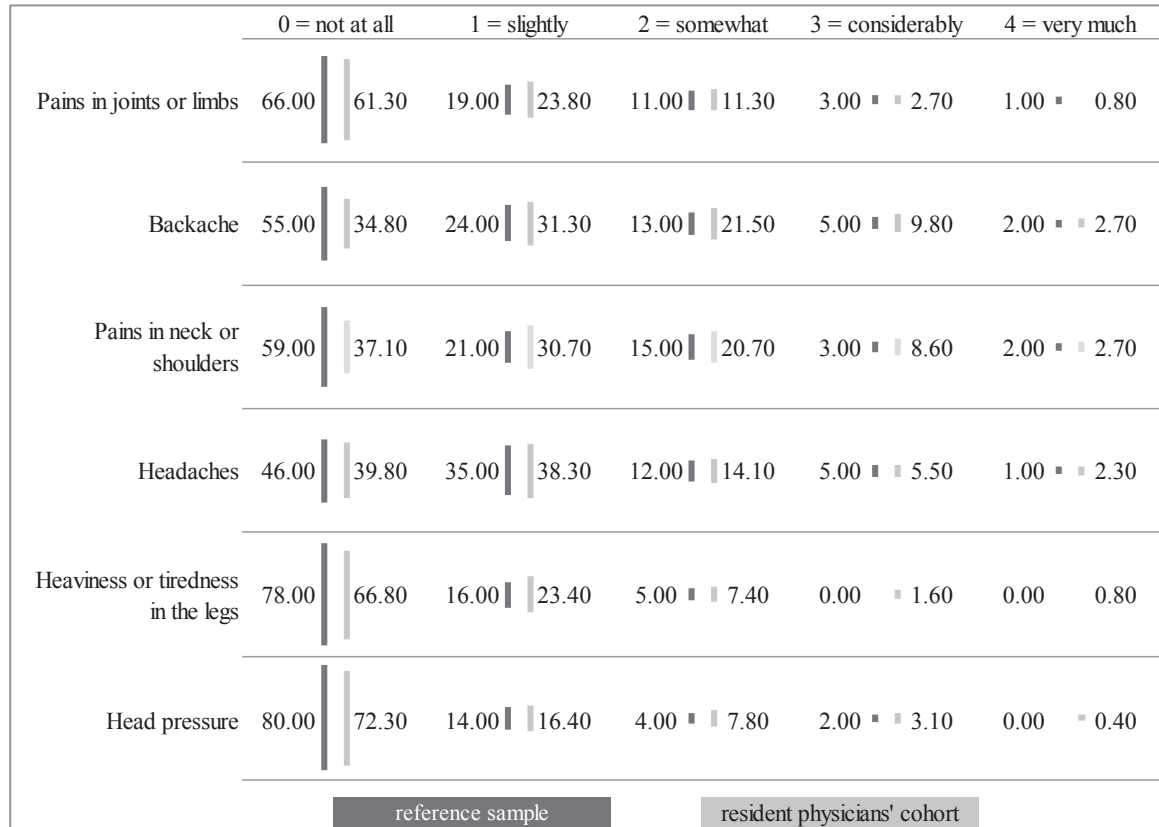


Fig. 13: Percent numbers of the given answers of both samples on item-level – men, sub-category musculoskeletal complaints.

Men, sub-category cardiovascular complaints

No substantial differences can be stated concerning the reported complaints regarding the single items of the sub-category cardiovascular complaints (see Figure 14) between the study sample and the reference population. It can even be described that in comparison to the reference sample, more male resident physicians reported ‘not at all’ regarding the sub-categories ‘twinges, pains or aching in the chest’, ‘attacks of breathlessness’ and ‘sudden bouts of heart-trouble’.

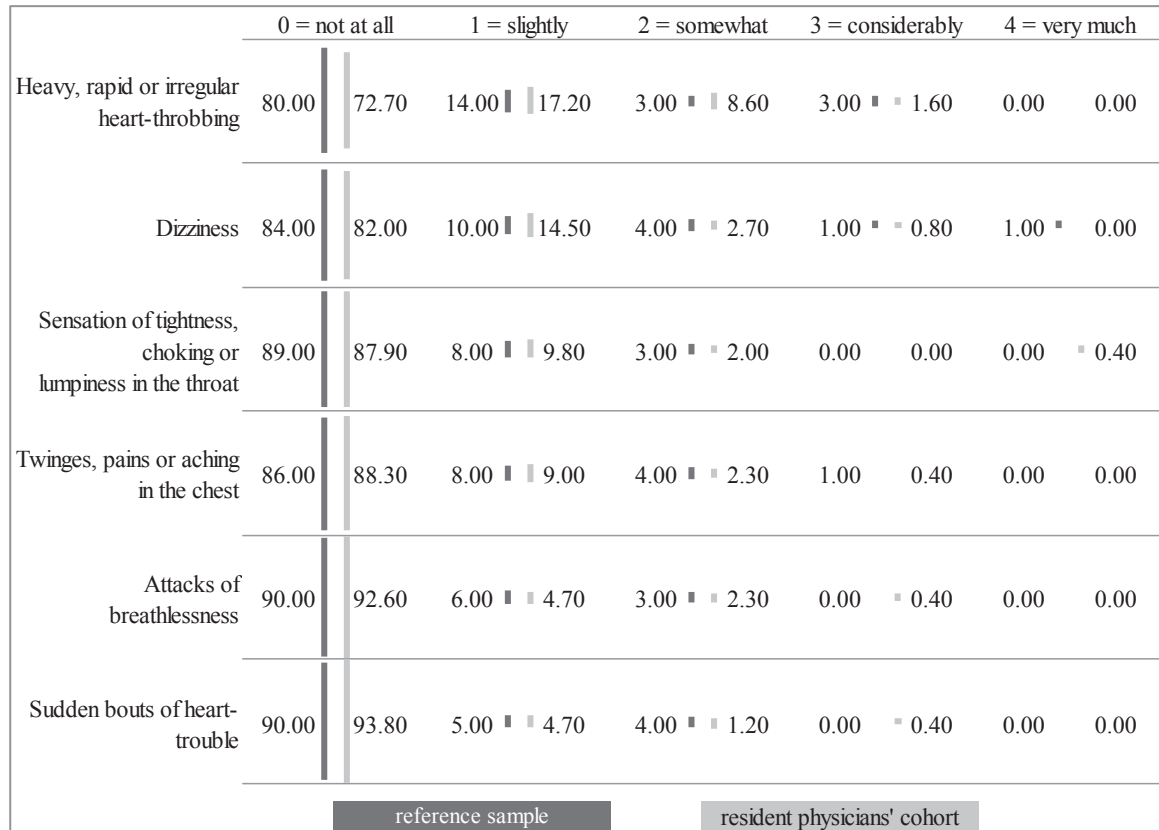


Fig. 14: Percent numbers of the given answers of both samples on item-level – men, sub-category cardiovascular complaints.

4.3 Mean comparison SC resident physicians' cohort and reference sample

The GBB-24 scoring concept comprises the determination of mean values, this allows for a respective comparison between the resident physicians' cohort and the reference sample. We applied a two-sample two-tailed t-test, separately for women and men as well as for the different sub-categories. The results for the reported means of somatic complaints of the resident physicians' cohort and their comparison to the reference sample, calculated separately according to gender, are shown in Tables 2 to 4. A graphic presentation is shown in Figures 15 to 17.

4.3.1 Resident physicians' cohort vs. reference sample – women

The mean comparison of somatic complaints in women between the resident physicians' cohort and the reference sample can be found in Table 2 and Figure 15.

GBB sub-category	women (< 40 years)						
	resident physicians' cohort (n=262)		reference sample (n=381)		Δ mean	p-value	SL
	mean	SD	mean	SD			
Total score	16.87	9.98	10.38	11.10	6.49	<0.001	***
Exhaustion	7.13	4.47	3.32	3.80	3.81	<0.001	***
Gastrointestinal complaints	2.39	2.86	1.76	2.80	0.63	0.006	**
Musculoskeletal complaints	6.11	3.93	4.00	3.90	2.11	<0.001	***
Cardiovascular complaints	1.23	1.88	1.30	2.40	-0.07	0.679	ns

SD = standard deviation, SL = significance level (ns = $p > 0.05$; * = $p < 0.05$, ** = $p < 0.01$; *** = $p < 0.001$)

Table 2: Mean comparison SC resident physicians' cohort and reference sample – women, all sub-categories, adjusted for age, including significance level.

In general, female resident physicians reported higher somatic complaints compared to the reference sample. Regarding the total score, a higher mean value of complaints was detected (mean=16.87, SD=9.98) compared to the female reference sample (mean=10.83, SD=11.10). The detected difference (Δ mean=6.49) was highly significant ($p < 0.001$).

The women in the resident physicians' cohort stated higher mean values for exhaustion (mean=7.13, SD=4.47) than the women of the reference sample (mean=3.32, SD=3.80). This remarkable difference (Δ mean=3.81) was highly significant ($p < 0.001$).

A higher level of complaints regarding gastrointestinal complaints was detected in the female resident physicians (mean=2.39, SD=2.86) compared to the female reference sample (mean=1., SD=2.80). This difference (Δ mean=0.63), was significant ($p = 0.006$).

Female resident physicians reported a higher degree of musculoskeletal complaints (mean=6.11, SD=3.93) in comparison to the reference sample (mean=4.00, SD=3.90). This difference ($\Delta\text{mean}=2.11$) was again highly significant ($p<0.001$).

The results for the mean differences concerning cardiovascular complaints ($\Delta\text{mean}=-0.07$) were not significant.

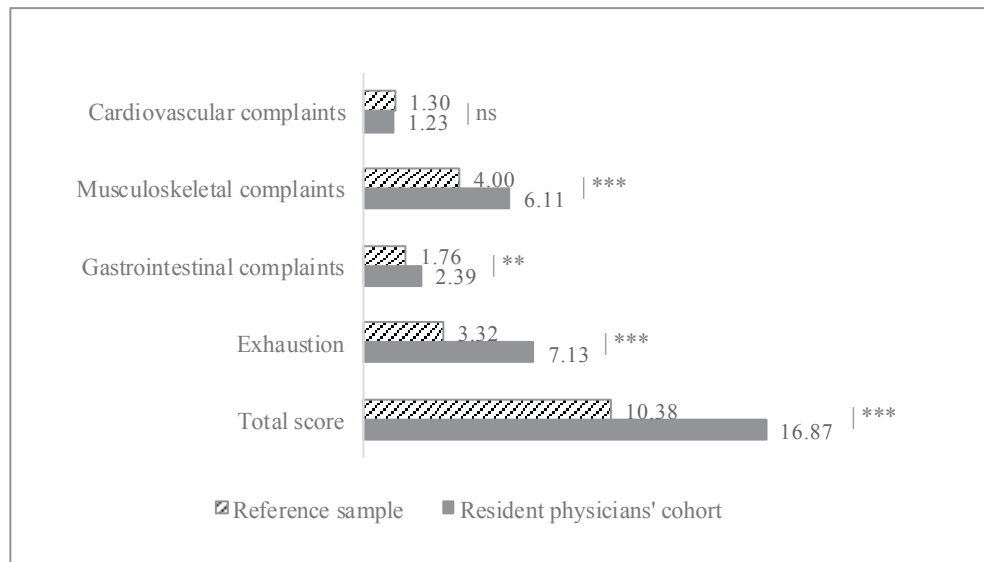


Fig. 15: Graphic presentation mean comparison SC resident physicians' cohort and reference sample – women, all sub-categories, adjusted for age, including significance level.

4.3.2 Resident physicians' cohort vs. reference sample – men

The mean comparison of somatic complaints in men between the resident physicians' cohort and the reference sample can be found in Table 3 and Figure 16.

GBB sub-category	men (< 40 years)						
	resident physicians' cohort (n=256)		reference sample (n=316)		Δ mean	p-value	SL
	mean	SD	mean	SD			
Total score	14.06	9.71	8.53	11.10	5.53	<0.001	***
Exhaustion	5.98	4.15	2.52	3.80	3.46	<0.001	***
Gastrointestinal complaints	2.35	2.80	1.52	2.60	0.83	<0.001	***
Musculoskeletal complaints	4.63	3.73	3.31	3.80	1.32	<0.001	***
Cardiovascular complaints	1.10	1.79	1.19	2.70	-0.09	0.633	ns

SD = standard deviation, SL = significance level (ns = $p>0.05$; * = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$)

Table 3: Mean comparison SC resident physicians' cohort and reference sample – men, all sub-categories, adjusted for age, including significance level.

In general, male resident physicians reported higher somatic complaints compared to the reference sample. Regarding the total score, a higher mean value of complaints was detected

(mean=14.06, SD=9.71) compared to the male reference population (mean=8.53, SD=11.10). The detected difference (Δ mean=5.53) was highly significant ($p<0.001$).

On average, male resident physicians experienced a higher degree of exhaustion (mean=5.98, SD=4.15) compared to the male reference sample (mean=2.52, SD=3.80). This difference (Δ mean=3.46) was again highly significant ($p<0.001$).

Concerning gastrointestinal complaints, male resident physicians reported on average a higher level (mean=2.35, SD=2.80) compared to the male reference sample (mean=1.52, SD=2.60). This difference (Δ mean=0.83) was highly significant ($p<0.001$).

Male resident physicians also stated a higher degree of musculoskeletal complaints (mean=4.63, SD=3.73) compared to the male reference sample (mean=3.31, SD=3.80). This difference (Δ mean=1.32) was also highly significant ($p<0.001$).

As for women, the results for the mean differences concerning cardiovascular complaints (Δ mean=-0.09) were not significant.

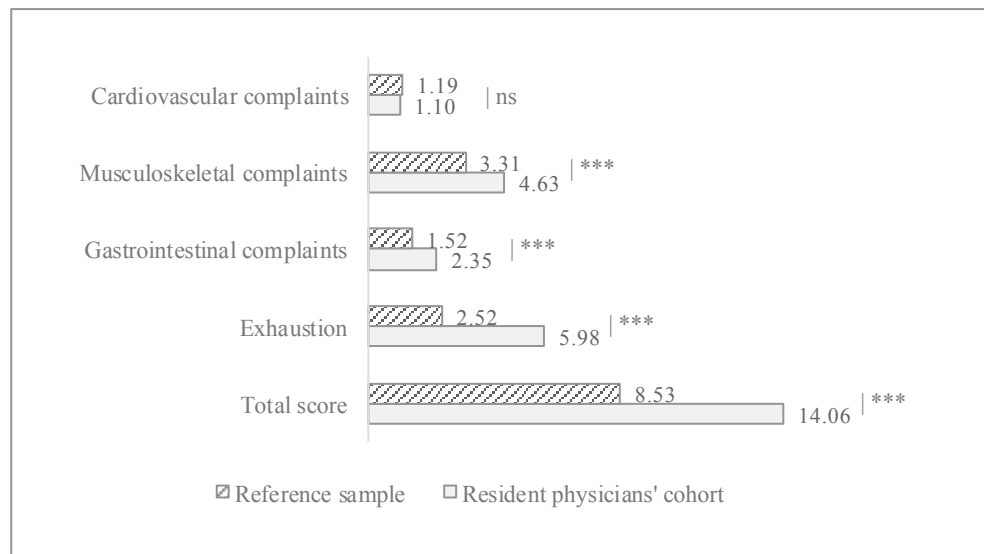


Fig. 16: Graphic presentation mean comparison SC resident physicians' cohort and reference sample – men, all sub-categories, adjusted for age, including significance level

4.3.3 Resident physicians' cohort – women vs. men

The gender differences in the means of reported somatic complaints of the resident physicians' cohort can be found in Table 4 and Figure 17.

GBB sub-category	resident physicians (< 40 years)								Δ mean	p-value	SL
	men		women								
	(n=256)		(n=262)								
	mean	SD	mean	SD							
Total score	14.06	9.71	16.87	9.98	-2.81	0.001	**				
Exhaustion	5.98	4.15	7.13	4.47	-1.15	0.003	**				
Gastrointestinal complaints	2.35	2.80	2.39	2.86	-0.04	0.867	ns				
Musculoskeletal complaints	4.63	3.73	6.11	3.93	-1.48	<0.001	***				
Cardiovascular complaints	1.10	1.79	1.23	1.88	-0.13	0.444	ns				

SD = standard deviation, SL = significance level (ns = $p > 0.05$; * = $p < 0.05$, ** = $p < 0.01$; *** = $p < 0.001$)

Table 4: Mean comparison SC resident physicians' cohort – women vs. men, all sub-categories, adjusted for age including significance level.

In the direct comparison between men and women within the resident physicians' cohort, women generally report higher somatic complaints compared to men. Regarding the total score, a higher mean value of complaints was detected (mean=16.87, SD=9.98) compared to the male study population (mean=14.06, SD=9.71). The detected difference (Δ mean=2.81) was significant ($p=0.001$).

Female resident physicians reported a higher exhaustion (mean=7.13, SD=4.47) compared to men (mean=5.98, SD=4.15). This result (Δ mean=1.15) was significant ($p=0.003$).

In regard of musculoskeletal complaints, women referred to higher complaints (mean=6.11, SD=3.93) compared to men (mean=4.63, SD=3.73). This difference (Δ mean=1.48) showed a high level of significance ($p < 0.001$).

The results for the mean differences concerning gastrointestinal (Δ mean=0.04) and cardiovascular complaints (Δ mean=0.13) were not significant.

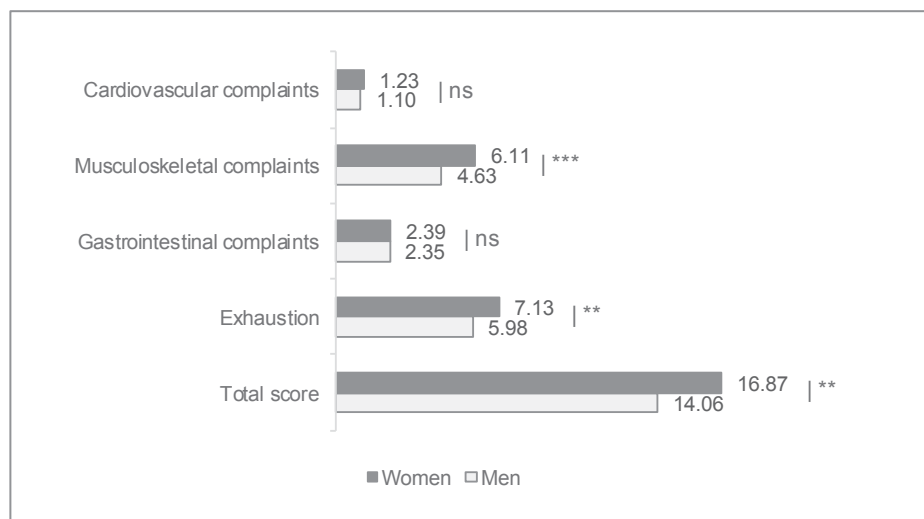


Fig. 17: Graphic presentation mean comparison SC resident physicians' cohort – women vs. men, all sub-categories, adjusted for age including significance level.

5 Discussion and perspective

This thesis comprised the examination of the occurrence of somatic complaints in German resident physicians in comparison to the German general population and the within group comparison between genders. The second part of the examination is engaged with the association of psychosocial working conditions and working time characteristics with somatic complaints in resident physicians. This is presented in detail in the publication which is part of this thesis (1). The discussion of this second part is summarized briefly in the following sections.

5.1 General discussion

5.1.1 Research question 1

1) Do otherwise healthy resident physicians report higher somatic complaints, such as

- *exhaustion,*
- *musculoskeletal complaints,*
- *cardiovascular complaints,*
- *and gastrointestinal complaints*

compared to the age-adjusted general population?

Our results revealed that, in general, resident physicians reported higher somatic complaints than the reference sample. This result applies for both women and men for all sub-categories except cardiovascular complaints. Regarding the single items, female and male resident physicians reported higher values regarding ‘excessive need for sleep’ and ‘tiredness’ (sub-category ‘exhaustion’), ‘pressure or heaviness in the stomach’ (sub-category ‘gastrointestinal complaints’) and ‘backache’ (sub-category ‘musculoskeletal complaints’). Female resident physicians additionally reported higher complaints regarding the item ‘pains in neck or shoulders’ in the sub-category ‘musculoskeletal complaints’.

Our results of resident physicians generally reporting higher somatic complaints compared to the general population reflects our expectation and is in line with earlier findings (149). Several explanations may apply. Resident physicians are exposed to a high level of work stress (2, 4, 5) being well examined to lead to physical and mental impairment such as cardiovascular diseases (8, 9, 20), depression (11, 12, 22), or burnout (13, 14). It is also acknowledged that somatic complaints and their possible exacerbated clinical pictures like functional somatic syndromes, etc. are closely related to depression (32-34) which is known to be highly prevalent in physicians (64, 65). We also found that physicians tend to avoid the consultation of colleagues (73, 150), a phenomenon that may lead to higher reported somatic complaints. On the other hand, physicians also have a habit of self-medicating (74), possibly leading to rather lower reported somatic complaints by masquerading them. This finding – independent from gender – applies for all sub-categories except ‘cardiovascular complaints’ but particularly for ‘exhaustion’ and ‘musculoskeletal complaints’.

The sub-category ‘exhaustion’ takes the strongest position here. Exhaustion plays a major role in the origin and existence of burnout (151). It is therefore not surprising that physicians report high levels of it and are highly prevalent for burnout at the same time (66, 67). Regarding the single items, our results reveal that ‘excessive need for sleep’ and ‘tiredness’ represent a major proportion of it. Both items suggest a relationship to adverse working time characteristics – e.g. excessive weekly working hours, shift work, etc. – that are common in resident physicians (2, 3). However, our own findings of the second part of the examination cannot confirm this suggestion, for surprisingly no relation was found between ‘exhaustion’ and working time characteristics. Regarding weekly working hours, this could be caused by the fact that works’ quality in terms of psychosocial working conditions could outweigh working time characteristics that may be compensated for more easily when experienced as adverse (1).

Our findings that resident physicians report higher musculoskeletal complaints is supported by the current body of research. In general, in studies examining the prevalence of somatic complaints it has been found that musculoskeletal complaints are amongst the most frequently named (41, 110). Furthermore, it was ascertained in a systematic review from 2011 that there is a high prevalence for musculoskeletal complaints in hospital physicians and that these may be work-related, identifying risk factors like non-ergonomic and long-lasting positions during diagnostic and therapeutic interventions such as operations and laparoscopy or long walking distances (152). In an additional systematic review from 2017 about the prevalence in surgeons performing minimally invasive surgery, risk factors like “static body posture, repetitive upper extremity movements, and force exertion from adverse positions” were identified (153). Another origin could be long standing during ward round. Magnavita, et al. additionally identified a relationship between musculoskeletal complaints and ultrasound works (154). These studies also confirm that the items ‘backache’ and – in women – ‘pain in neck or shoulder’ take an exceptional position in the highly reported musculoskeletal complaints (60, 152). However, a different study from 2011 assessing somatic complaints through the GBB-24 amongst physicians/psychologists, nursing staff and the remaining employees including technical and administrative jobs showed that the age-adjusted group of physicians/psychologists reported less musculoskeletal complaints compared to the group of the remaining employees, hereby contradicting our results. One has to bear in mind, however, that this result may arise from the integration of physicians and psychologists in one group with psychologists experiencing different somatic complaints (149). A direct comparison may therefore be difficult.

Resident physicians also reported higher gastrointestinal complaints compared to the general population. This result is corroborated by the finding of the already mentioned study of Hiemisch, et al. (149). In this survey, the group of physicians/psychologists clearly reported higher levels of gastrointestinal complaints compared to the group of technical and administrative employees. Furthermore, Ihlebaek, et al. (155) support our results when comparing the occurrence of somatic complaints in health service workers to the occurrence in service workers including office and/or administrative jobs in 2003. It was found that “health service workers had significantly higher prevalence than service workers”. The high

results for gastrointestinal complaints can be attributed mainly to the item ‘pressure or heaviness in the stomach’. No literature was found to best of our knowledge regarding this particular item. Yildiz and Esin, however, were able to describe that Turkish nurses – as an occupational group closely related to physicians – being questioned about gastrointestinal and cardiovascular symptoms named the symptom ‘bloating/flatulence’ as the most common gastrointestinal complaint together with ‘upset stomach’ (156).

5.1.2 Research question 2

2) Are there gender specific differences concerning the reported somatic complaints within the resident physicians’ cohort?

In the direct comparison between women and men within the resident physicians’ cohort, female resident physicians generally reported higher somatic complaints applying for all sub-categories except gastrointestinal and cardiovascular complaints, where insignificant results were found. These findings are in line with previous findings and therefore correspond to our expectation (52, 102). E.g., in a systematic review from 2017, Alleblas identified five studies specifically naming gender a risk factor by showing that women performing minimally invasive surgery were more likely to present higher levels of musculoskeletal complaints, thereby supporting our findings (153). Barsky et al. summarized possible explanations for the gender differences and named biological differences such as a different central processing of sensory information, differences in the awareness, attentiveness, and evaluation of sensation, differences in socialization and social roles, different occurrence of abusive and traumatic experiences, higher prevalence for depression and anxiety disorders as well as generalized psychological distress, and lastly a possible gender bias in research and clinical practice (157).

5.1.3 Research questions 3 and 4

3) Are psychosocial working conditions, such as

- ‘workload’ (indicating job demands),
- ‘job autonomy’ (job control)
- and ‘social support at work’ (support)

associated with somatic complaints among resident physicians?

4) Do working time characteristics, such as

- average weekly working time,
- the number of free weekends per month
- and shift work schedule

have an association with somatic complaints among resident physicians, individually and beyond psychosocial working conditions as listed in research question 3)?

As presented in the underlying article (1), our findings show that high workload and shift work are related to higher reported somatic complaints. This applies especially for the relation between high workload and the sub-categories exhaustion, cardiovascular and musculoskeletal complaints. High levels of social support as well as a higher number of free weekends per month are connected to lower reported somatic complaints.

Both, the basic model investigating the relation between psychosocial working conditions and somatic complaints as well as the extended model including working time characteristics, reveal that our findings support earlier examinations particularly regarding the connection between psychosocial working conditions and self-reported health (17). Hereby, mainly the dimensions 'workload' and 'social support at work' were confirmed, thereby meeting our expectations. Moreover, previous research can confirm our finding that the dimension 'workload' is generally the dimension with the strongest impacts on health outcomes (51, 52). As well, the strong and inverse effect of social support on somatic complaints is in keeping with previous findings indicating that support represents a strong buffer for both psychological well-being (50) and self-rated health (53). In line with the assumptions of the Job Demand-Control-Support Model, we expected the dimension 'job autonomy' – when experienced as high – to lead to lower reported somatic complaints in terms of a further protecting factor like social support. Our results, however, could not confirm this theory, which was already found in earlier observations (158). For this, several possible explanations may apply. It may firstly be conceivable that resident physicians at the beginning of their clinical career experience the unlimited job autonomy that they are often exposed to in terms of e.g. the prioritization of tasks or how to handle them rather as stressful and challenging than as helpful. This theory could be confirmed by the findings of Jones et al (159). A further explanation may be that the immense workload being characteristic for resident physicians at the beginning of their clinical career simply overlies the protecting effects job autonomy usually involves. Lastly, we found further studies where not all dimensions of the Job Demand-Control-Support Model and their theorized effects were confirmed. By way of example, a meta-analysis of 1999 reported that only 9 of 19 studies were identified where the expected buffering effect of job autonomy on psychological well-being could be approved (54). Also in line is the finding of another meta-analysis where only 50% of the examined studies could find the expected effects of all three dimension of the model regarding psychological well-being and only 28% reported complete support of the model (10). This all is underlined by the results of our additional analyses of the interactions between workload and job autonomy with somatic complaints that turned out to be insignificant.

Relating to the combined model of psychosocial working conditions and working time characteristics with somatic complaints, our results may be interpreted in that psychosocial working conditions outweigh working time characteristics in explaining somatic complaints. Beyond this, working time characteristics have an additional and independent explanatory value. This applies for several aspects of both models, the basic model (psychosocial working conditions and somatic complaints) as well as the combined model (psychosocial working conditions/working time characteristics and somatic complaints). For example, in both models

a significant relationship was found between shift work and somatic complaints which is in line with earlier observations (160). Only marginally significant in the combined model was the inverse association between free weekends per month and somatic complaints, however, still representing the important need for recovery during free weekends being in accordance with previous findings (161). For the relation between the average weekly working time and somatic complaints, no significance was found thereby contradicting our expectations and earlier findings (61, 162).

Concerning the full model, the joint association of psychosocial working conditions and working time characteristics on somatic complaints, we also examined the individual GBB-24 sub-categories. In terms of exhaustion, surprisingly and contrary to our assumptions no relation was found interacting with working time characteristics. Our results concerning this matter do also disagree with earlier findings for the average weekly working time (163) and for shift work (164).

Regarding the sub-category musculoskeletal complaints, our findings were in line with our results regarding the pattern of relationships with the somatic complaints total score. In this context, meaningful associations were found for workload, social support at work, free weekends and shift work. Our results were as well in line with previous observations (55) excepting shift work, where varying outcomes were found (165).

In terms of the sub-category cardiovascular complaints, positive associations were found regarding workload, and negative associations were found for free weekends. Palpitations and chest tightness are items representing this sub-category. We found studies showing that both can be related to psychosocial stress or stressful working conditions. E.g., Barsky, et al. showed that palpitations of the heart or further arrhythmias are experienced in a stronger way or can even be provoked by psychosocial stress (166). Moreover, several studies have shown an association between stressful working conditions and chest tightness as a possible but not distinct indicator for ischemic heart disease (167, 168). However, two aspects should be kept in mind in this context. Firstly, somatic complaints cannot be equated with cardiovascular diseases such as ischemic heart disease. Secondly, ischemic heart disease is very improbable and rare in young and presumably healthy resident physicians.

‘Social support at work’ is known to be an important protective factor against symptoms related to depression and anxiety disorder (169). It may therefore be conceivable that this dimension of the Job Demand-Control-Support Model also represents a protecting factor against somatic complaints in the presence of high workload. Social-neuroscientific research confirms our findings: it is known that the strength of our social contacts strongly influences our physical health. In this context, negative social experiences interact in a profound way with emotional well-being. Moreover, brain networks responsible for processing physical pain are activated when experiencing social rejection, a phenomenon what has been termed ‘social pain’ (170).

Furthermore, a stability was observed regarding the main results of the basic model after inclusion of working time characteristics. Relating to this result, we assume that for resident

physicians it is easier to compensate successfully for the possible harmful impact of adverse working time characteristics such as long working hours, etc. in comparison to the detrimental influence of a high workload representing one major component of psychosocial working conditions. A possible explanation for this finding may be that workload comprises more than simply working hard and quickly but also represents adverse conditions such as deadlines, time pressure or a high number of tasks needed to be handled simultaneously and therefore possibly being perceived as one major factor of psychosocial working conditions. On the contrary, a high number of weekly working hours alone – as a dominant factor of adverse working time characteristics – does not explain the quality of these working hours. Therefore, long working hours do not necessarily need to be experienced as stressful whilst perceived as qualitatively high. This perception may as well be moderated by individual preferences (171). In this context, a possible overlap between our measures for workload and for the average weekly working time is conceivable and should be considered. To rule this out, however, we investigated the variance inflation factor (VIF) which showed that this is not applicable with mean VIF of 1.18 and lower.

No profound association was found between the average weekly working time and somatic complaints, more precisely between the average weekly working time and exhaustion. This finding did not meet our expectation, but as already discussed above, it may be conceivable that psychosocial working conditions may outweigh working time characteristics. This assumption is supported by Richter, et al.'s (2014) findings that showed that working time constraints within the framework of the European Working Time Directive did not lead to reduced stress and burnout in physicians (172). Our findings are also in line with findings where the average weekly working time was not associated with somatic complaints (155). The majority of studies, however, investigating this or similar relationships, i.e. between somatic complaints and all-cause mortality, depression and more health outcomes, could document this well. Therefore, our findings need to be confirmed by future research especially regarding the combined influence of psychosocial working conditions and working time characteristics on somatic complaints as well as the experienced quality of working conditions in relation to somatic complaints.

We found that musculoskeletal complaints generally behave like the somatic complaints total score. This result may suggest that musculoskeletal complaints represent a major part of the variance of the total score. It is therefore conceivable that musculoskeletal complaints may be the most prominent and frequent complaints in resident physicians in general. Our own findings of the first part of this study may support this assumption as musculoskeletal complaints represented the second most common complaint in resident physicians. Moreover, and beside the neuroscientific approach discussed above, musculoskeletal complaints could be regarded as an example for a better understanding of how psychosocial stress may induce somatic complaints in general. Previous research found that psychosocial stressors lead to physiological somatic responses, e.g. by a change of the muscle tensions degree (56). On the long term, this may trigger a changed perception of bodily sensations, an intensified inward attention (38) and may lead to an increased necessity and will to report somatic complaints.

5.2 Limitations and further research

Many limitations regarding our research have been presented in the underlying article (1) and will be summarized here briefly.

Firstly, and as a main limitation, this investigation was conducted as a cross-sectional design. Therefore, no conclusion is possible regarding the direction of the relationship between psychosocial working conditions, working time characteristics and somatic complaints. Longitudinal research is therefore necessary to confirm our findings.

Secondly, there are further variables that are relevant in terms of the detection of somatic complaints such as sickness absence, number of physician consultations, frequency of the reported somatic complaints, chronic illness, medication intake, etc. Although an assessment of these variables would have been useful, especially to identify possible exacerbated clinical pictures like functional somatic syndromes or somatoform disorders, the GBB-24 does not allow for this. It is, however, an often and internationally applied instrument to detect somatic complaints (173).

As a third limitation, one has to keep in mind that coping strategies and personal character traits play an important role in the association of adverse working conditions like workload with health outcomes like somatic complaints (174). These, however, have also not been assessed within this examination as a possible moderator variable as this was not the focus of the underlying study.

Lastly, one may speculate that there is a relevant bias due to the potential tendency of resident physicians to present themselves as overworked, leading to a systematic over-reporting of both adverse working conditions in terms of psychosocial working conditions and working time characteristics as well as adverse health outcomes like somatic complaints (175, 176).

There are further limitations additionally to those described in the underlying article (1) arising from the supplementary analyses and results presented in this thesis.

First of all, for the extended descriptive analysis regarding the comparison of given answers on single-item level between the resident physicians' cohort and the reference sample separately for women and men only the percentage values could be examined and presented as the original data (i.e. numeric values) of the reference sample were not available. Therefore, no rank sum test was performable. This analysis should thus be considered with a limited explanatory power regarding a quantitative comparison.

Secondly, the somatic complaints data assessed via GBB-24 were not perfectly normally distributed even after logarithmizing the data (see section 3.4.3 Normal distribution). However, the same applied for the GBB-24 reference sample data (102). The results of the applied two-sample two-tailed t-test should therefore be interpreted with care.

5.3 Conclusion

The findings of this thesis and the underlying article may take effect on several fields comprising health economics, health care policies and the preventive medicine field.

Further, especially longitudinal research is necessary to investigate possible causal interaction between the variables we examined. Moreover, our observations, when confirmed in longitudinal research, may have influence on the development of future guidelines and interventions regarding a change of resident physicians' working conditions in German hospitals. In terms of health economics, these interventions may help to reduce the direct and indirect costs that somatic complaints and their consequences are generating to the health care system through excessive use of it, through sickness absence and through a reduced health care quality. There may as well be consequences regarding patient care quality and patient security due to possible erroneous treatments by physicians with somatic complaints. Relating to health care policies, these guidelines may at least help to not aggravate the current and future lack of physicians. Lastly and concerning occupational medicine, our findings may support the development of future prevention measures by expanding the current body of research to contribute to the improvement of physicians' health and therefore, ultimately, for the benefit of every patient.

6 References

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7 Glossary

- **Cost-of-illness study (COI):**
“In a COI, one estimates the direct costs and/or indirect costs associated with a disease or disease group (e.g. costs of depression, costs of anxiety disorders) or a risk factor (e.g. costs of smoking).” (72)
- **Direct costs:**
“Monetarily valued resource use resulting from the treatment of a disease. Occur as medical costs (e.g. for hospital use, physician use, pharmaceuticals) and nonmedical costs (e.g. administration costs, travel costs, research costs). Normally direct costs are calculated by multiplying utilization data with costs per unit used.” (72)
- **Excess costs:**
“Costs that can be attributed to a specific disease of interest in addition (excess) to costs that result from other diseases. Can be estimated e.g. by comparing the cost of patients with the disease of interest with ‘representative’ or matched patients without the disease of interest.” (72)
- **Incidence:**
describes how many people fall ill newly.
- **Indirect costs:**
“The monetarily valued loss of productivity associated with a disease. Occur primarily as reduced productivity at work, sickness absence, early retirement or premature mortality. Normally indirect costs are calculated by multiplying loss of productivity time with wages.” (72)
- **Life-time prevalence:**
the frequency of the occurrence of a disease during a period of time from birth to the time of the data inquiry.
- **Prevalence:**
in the epidemiologic terminology usually in terms of the point prevalence meaning the frequency of the occurrence of a state, usually a disease, at a certain point of time.

8 Appendix

- Complete questionnaire of 2007 (T3)
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