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**Patient and Occupational Safety Culture and Working
Conditions in Hospitals - Perspectives of Nurses and
Physicians**

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vorgelegt von

Wagner, Anke Barbara

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Dekan: Professor Dr. B. Pichler
1. Berichterstatter: Professorin Dr. M. Rieger
2. Berichterstatter: Professor Dr. R. Ziegler

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Table of content

List of tables	5
Abbreviations.....	6
1 Introduction	7
1.1 Relevance of Patient and Occupational Safety Culture and Working Conditions in Hospitals.....	7
1.2 Overall Concept of the Dissertation.....	10
1.3 Safety Culture in Hospitals.....	13
1.3.1 Definition of Terms	13
1.3.2 State of Research.....	17
1.4 Working Conditions in Hospitals	22
1.4.1 Description of Terms within Working Conditions	22
1.4.2 State of Research.....	24
1.5 Research Questions.....	31
2 Results.....	34
2.1 Publication 1	34
2.2 Publication 2	54
2.3 Publication 3	73
2.4 Publication 4	92
3 Discussion	115
3.1 Patient Safety Culture in University Hospitals: Assessment and Predictors.....	115
3.2 Occupational Safety Culture in University Hospitals: Assessment, Predictors and Determinants.....	121
3.3 Patient and Occupational Safety Culture in University Hospitals: Shared Predictors	125
3.4 Working Conditions in University Hospitals: Assessment and Comparison.....	126
3.5 Strengths and Limitations.....	132
3.6 Conclusion	134

Table of content

4	Summary	136
4.1	English summary.....	136
4.2	German summary	139
5	References	142
6	Declaration of own contribution.....	163
7	Publications in connection with the doctoral project.....	168
7.1	Peer reviewed articles.....	168
7.2	Congress papers.....	168
7.3	Final report of the research project "WorkSafeMed"	169
	Acknowledgments	170

List of tables

Table 1: Contribution to Publication 1..... 164
Table 2: Contribution to Publication 2..... 165
Table 3: Contribution to Publication 3..... 166
Table 4: Contribution to Publication 4..... 167

Abbreviations

ABSK	Arbeitsbedingungen und Sicherheitskultur (=Working Conditions and Safety Culture)
AHRQ	Agency for Healthcare Research and Quality
ArbiK	Arbeitsbedingungen im Krankenhaus (=Working Conditions in hospital)
COPSOQ	Copenhagen Psychosocial Questionnaire
DRG	Diagnosis Related Groups
EUNetPaS	European Network for Patient Safety
EU-OSHA	European Agency for Safety and Health at Work
GDA	Joint German Occupational Safety and Health Strategy
Health PROMeTHEUS study	Health Professional Mobility in the European Union study
IOM	Institute of Medicine
MDS	Medical Service of the German National Asso- ciation of Health Insurance Funds
NEXT study	Nurses' Early Exit Study
PSC	Psychosocial Safety Climate
RN4CAST study	Registered Nurse Forecasting study
WHO	World Health Organization
WorkSafeMed	Working Conditions, Safety Culture and Pa- tient Safety in Hospitals - What predicts the Safety of the Medication Process?

1 Introduction

1.1 Relevance of Patient and Occupational Safety Culture and Working Conditions in Hospitals

In healthcare, an important milestone for the discussion of safety culture was the release of the report "To err is human" in 1999 by the Institute of Medicine (IOM) [1]. In the IOM report, the researcher pointed out that nearly 98,000 patients in America died each year as a result of medication errors [1]. The researcher tried to raise awareness for this problem and proposed several strategies for an improved safety culture, especially for patients [1]. This report and his recommendations were discussed across national borders. Almost at the same time, the report "An organization with a memory" was published in the UK [2]. This report also focused on serious failures in the health system and explored how to learn from these failures, as well as from the expertise of other high-risk industries [2].

In Germany, the Advisory Council on the Assessment of Developments in the Health Care Sector ("Sachverständigenrat zur Begutachtung der Entwicklung im Gesundheitswesen") demanded the establishment of a safety culture in the German healthcare sector in its expert reports from 2003 and 2007 [3, 4]. Other pivotal developments for patient safety were the founding of the German Coalition for Patient Safety in 2005 ("Aktionsbündnis Patientensicherheit"), and the establishment and promotion of the Institute for Patient Safety in Bonn in 2009. Furthermore, the Federal Ministry of Health has launched various laws and other initiatives to strengthen patient safety in Germany [5]. These include the Patients' Rights Act in 2013, and the Hospital Structure Act in 2016 [5]. Other activities comprised for example the use of surgical checklists, an action plan to improve drug therapy safety, and measures to prevent antibiotic resistance and nosocomial infections (e.g., the German campaign "Aktion Saubere Hände") [5].

For the year 2019, the annual report by the Medical Service of the German National Association of Health Insurance Funds ("Medizinischer Dienst des Spitzenverbandes Bund der Krankenkassen (MDS)") together with the expert commissions and arbitration boards of the medical profession found 14,553 cases of sus-

pected treatment errors, whereby 25.3% (3,688 cases) were confirmed as treatment errors [6]. The German Medical Association (“Bundesärztekammer”) received 11,565 complaints for the year 2019, of which 1,871 cases were classified as treatment errors [7]. For years, the cases have remained at a similar level and demonstrate that continued efforts are needed to reduce treatment errors and establish a good safety culture for patients in healthcare.

At the same time, nurses and physicians in hospitals are exposed to high risks for work-related injuries, diseases, or psychological stress and strain [8–10]. Wicker et al., for example, stated in 2008 that annually over 500,000 needlestick injuries happened among healthcare workers in Germany [8]. Physicians have the highest risk for needlestick injuries with possible consequences of bloodborne infections like hepatitis B, hepatitis C, or HIV [8, 10]. The BKK Health Atlas 2017 revealed alarming figures for nursing staff in hospitals and inpatient care in Germany: compared to non-medical professions, nurses were confronted with higher psychological stress and strain, as well as a higher risk of musculoskeletal disorders [9]. The high psychological stress and strain manifests itself in the sickness patterns of employees - nursing staff have an above-average number of days of absence compared to non-medical employees, and also give worse evaluations of their own work ability [9]. According to results from a recent survey of the Marburger Bund, the trade union of salaried physicians and medical students [11], physicians also reported how high psychological stress and strain have an impact on their own health [12]. In summary, the promotion of occupational health and safety and the maintenance of employees’ work ability should be considered a high priority in healthcare. In the previous study project “Stop Needle-Stick Injuries: Safety through Training, Organisation and Product Selection”, the authors assumed that nurses and physicians often neglect their own health and safety in favor of patient safety [13].

Thus, in addition to a patient safety culture, an occupational safety culture is also needed to promote the overall health and safety of healthcare workers. Unlike other workplace sectors, safety culture in the hospital sector plays a special role. The safety culture in hospitals is characterized by employees being responsible not only for their own safety and health, but also for the safety and health of often

vulnerable patient groups. Several, mainly international, studies to date demonstrated that patient and occupational safety culture are closely linked with working conditions, and that working conditions have a relevant impact on safety outcomes for employees [14, 15] and patients [14, 16–18]. However, to the best of my knowledge, the impact of working conditions on patient and occupational safety culture in German hospitals has yet to be investigated.

The importance of good working conditions for hospital staff is, particularly in Germany, a subject of intense discussions between different disciplines and policy makers. At the policy level, profound (financial) decisions have been made in recent years affecting the working conditions of nurses and physicians to a great extent.

In 2004, the DRG (Diagnosis Related Groups) system was introduced as an obligatory system for hospital financing in Germany [19]. The classification into a DRG is made in particular according to the type of illness (diagnosis), the severity of the illness, as well as the provided medical services (operations and procedures) [19]. This enables the payment of a defined illness and its treatment (excluding the costs for nursing care) to be calculated within a certain length of stay [19]. According to the Federal Ministry of Health, the introduction of DRGs in Germany has led to an improvement in transparency and cost-effectiveness of general hospital care and also to a reduction in the length of hospital stays (for example, 6.6 days on average for 2018) [19]. With the Nursing Staff Strengthening Act (Pflegepersonal-Stärkungsgesetz), which came into force on 1 January 2019, it was decided to refund nursing staff costs for direct patient care independently of the DRGs in future [19]. Since 2020, hospital financing has been based on a combination of DRGs and nursing staff costs (nursing budgets) [19].

The expansion to a nursing budget was a reaction to the increasing criticism of the DRG system. A recent study by the Hans Böckler Foundation analyzed the DRG system and found that it led to a significant deterioration of working conditions for hospital employees, especially for nursing and service staff [20]. The introduction of DRGs was accompanied by massive job reductions, especially in the nursing and service sectors [20]. The budget cuts in nursing staff led to a

reduction of 33,000 full-time staff between 2002 and 2006 [20]. Since 2009, an attempt has been made to create new nursing positions through a nursing support program, but with little success [20]. According to the German Economic Institute, there were a total of 376,128 open positions in the outpatient and inpatient nursing sectors for the year 2020 [21]. For the year 2035, demographic developments and other factors will result in a total additional personnel requirement of 493,603 persons for the inpatient and outpatient nursing sector [21]. However, long-standing chronic understaffing and high workloads have led to a situation whereby it is becoming increasingly difficult to find qualified nursing staff at all [20].

In comparison, the medical sector has become more important due to the introduction of DRGs and received an increase in number of jobs [20]. One explanation is that services that were paid for by DRGs were mainly dependent on medical diagnosis and medical activities [20]. However, in recent years the workload for physicians has also risen continuously due to more patients, demographic change, and more extensive administrative work [20]. Furthermore, a qualitative study by Wehkamp et al. (2017) revealed that physicians felt increasingly stressed and brought into ethical conflict situations when they had to coordinate economic interests of the hospital and patient treatment [22]. In summary, the study by the Hans Böckler Foundation assumed that the DRG system had an increased negative impact on the quality of care and patient safety due to chronic understaffing of nursing staff and interference in medical services in favor of economic interests [20].

1.2 Overall Concept of the Dissertation

The developments in recent years highlight that great attention should be paid to an occupational safety culture for nurses and physicians, and its associations with working conditions in hospitals, in addition to and alongside patient safety culture.

Therefore, this dissertation aims to gain a deeper understanding of both kinds of safety culture and their associations with working conditions considering the perspective of nurses and physicians in two university hospitals in Germany. The

dissertation is based on the previously conducted ABSK study (“Arbeitsbedingungen und Sicherheitskultur” = Working Conditions and Safety Culture) [23] and WorkSafeMed study (“Working conditions, safety culture and patient safety in hospitals: what predicts the safety of the medication process?”) [24].

The feasibility ABSK study pursued the objective of depicting associations between working conditions and safety culture [23]. The ABSK study was conducted between 2010 and 2013 in cooperation of the Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, and the Institute of Patient Safety, University Hospital of Bonn. Within the study, a questionnaire was developed for nursing staff and physicians, which captures both the perceived patient and occupational safety climate. This questionnaire was applied and tested in a survey between December 2011 and April 2012 at a large university hospital in Southern Germany. The ABSK study demonstrated that *“the comparative investigation of patient and occupational safety in a large hospital is a promising approach and can be recommended for further studies.”* [23]

The WorkSafeMed study was based on the previous insights gained from the ABSK study and was performed by the same institutes together with the Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tübingen. Funded by the Federal Ministry of Education and Research, the WorkSafeMed study investigated associations between working conditions, job satisfaction, patient and occupational safety culture, as well as the quality of documentation in the medication process (as a proxy for patient safety) [24]. The WorkSafeMed study was conducted from 2014 to 2017. The research methods included a standardized paper-based cross-sectional survey with nurses and physicians in 2015, as well as a retrospective chart review conducted in 2016 and the additional analysis of routine data [24–26]. I joined the study team in 2015 at the beginning of the cross-sectional survey.

The dissertation comprises the following three parts:

First, the theoretical background and the current state of research of patient and occupational safety culture, as well as working conditions of nurses and physicians are presented (see chapter 1.3 and 1.4). Then, the research questions related to patient and occupational safety culture and working conditions are derived (see chapter 1.5).

Second, four publications are presented (see chapter 2):

- **Publication 1** (*“Healthcare professionals' perspectives on working conditions, leadership, and safety climate: a cross-sectional study”*) assesses working conditions, leadership, and safety climate among nurses and physicians in two university hospitals aiming to detect differences between the two occupational groups [27]. The study was published in the journal BMC Health Services Research (Impact Factor 2018: 1,932).
- **Publication 2** (*“Do Occupational and Patient Safety Culture in Hospitals Share Predictors in the Field of Psychosocial Working Conditions? Findings from a Cross-Sectional Study in German University Hospitals”*) identifies predictors in the field of working conditions which have an influence on the perceived patient and occupational safety culture of nurses and physicians in two university hospitals [28]. This study was published in the International Journal of Environmental Research and Public Health (Impact Factor 2017: 2,145).
- **Publication 3** (*“Comparing perceived psychosocial working conditions of nurses and physicians in two university hospitals in Germany with other German professionals - feasibility of scale conversion between two versions of the German Copenhagen Psychosocial Questionnaire (COPSOQ)”*) focuses on perceived working conditions. Data were gathered during the survey in the WorkSafeMed study, and compared respective scales with corresponding reference data from the German COPSOQ database (2012 - 2017) [29]. Implications for improving working conditions of nurses and physicians in German university hospitals were derived from this comparison. The study was published in the Journal of Occupational Medicine and Toxicology (Impact Factor 2019: 2,592).

- **Publication 4** (*“Determinants of occupational safety culture in hospitals and other workplaces - results from an integrative literature review”*) builds a link between occupational safety culture in different workplaces (hospital workplaces and workplaces in construction, manufacturing, and other sectors of industry) and represents an overview of determinants used in previous studies [30]. The fourth publication was published in the International Journal of Environmental Research and Public Health (Impact Factor 2019: 2,849).

Third, the dissertation includes a comprehensive discussion summarizing the main results of the four publications regarding the topics patient and occupational safety culture and working conditions (see chapter 3).

1.3 Safety Culture in Hospitals

1.3.1 Definition of Terms

Safety Culture

There are currently many definitions of safety culture [31, 32]. A review by Vu et al. (2014) identified a total of 51 original definitions of safety culture published between 1991 and 2013 [31].

The term “safety culture” was first mentioned in 1986 in response to the Chernobyl disaster [33]. The most cited definition of safety culture to date comes from the Health and Safety Commission (HSC) [34] and was adapted to the healthcare sector by Nieva and Sorra in 2003 [35]: *“The safety culture of an organisation is the product of individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization’s health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.”* [34]

A recent definition which applies to the healthcare sector was developed by the American Nurses Association (ANA) in 2016 [36]. According to ANA, safety culture is defined *“as one in which a health care organization’s leaders, managers and workers are committed to core values and behaviors that emphasize safety*

over competing goals. Other signs of a safety-focused culture include openness and mutual respect when discussing safety concerns and solutions without shifting to individual blame; a learning environment; transparency and accountability; and reliable teams.” [36]

Safety Culture versus Safety Climate

The terms safety culture and safety climate were often used synonymously due to their close relationship [33]. However, there is still discourse and disagreement among researchers as to whether both terms should be considered equal or not [32, 37, 38]. Halligan et al. (2011) captured and summarized different definitions, theories, and concepts of safety culture in their review [39]. According to Halligan et al. (2011), there is still disagreement regarding the definition of safety culture, and whether safety climate is a distinct construct or not [39]. The term safety climate was greatly influenced by the research work of Zohar [40]. Zohar defines safety climate as follows: *“Safety climate reflects employees’ perceptions about the relative importance of safe conduct in their occupational behaviour. It can vary from highly positive to a neutral level, and its average level reflects the safety climate in a given company.” [40]* According to Wiegmann et al. (2002), safety climate *“(…) is the temporal state measure of safety culture, subject to commonalities among individual perceptions of the organization. It is therefore situationally based, refers to the perceived state of safety at a particular place at a particular time, is relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions.” [37].*

At this point, a main difference between the two terms becomes apparent. Safety climate is considered as *“a temporal phenomenon, a “snapshot” of safety culture, relatively unstable and subject to change (…)” [37, 38]*, whereas safety culture is regarded as *“relatively enduring, stable and resistant to change.” [37, 38]* Safety climate is understood as a manifestation of safety culture and is, unlike safety culture, more and easily tangible and measurable [31]. According to Cox and Flin (1998), safety culture can be understood as an *“organization’s personality”* with stable systems, procedures, and behaviors, whereas *“[safety] climate represents a more transient mood state, sensitive to external pressures.” [41]*

In his work, Guldenmund (2010) mentions three approaches for regarding and understanding safety culture and safety climate from different angles: the academic (anthropological), the analytical (psychological), and the pragmatic (experience-based) approach [42]. The **academic approach** refers to qualitative methodologies and research methods like document analysis, observations, focus groups, interviews etc. [42]. This qualitative approach is therefore suitable for reflecting the underlying safety culture of an organization [42]. The **analytical approach** is the most frequently used [33]. Within this approach, standardized questionnaires are applied for the quantitative measurement of safety climate [42]. In the last years, most of the studies published have applied the analytical approach, for example, using surveys in cross-sectional studies, thus demonstrating a snapshot of the current safety climate in an organisation [33]. The **pragmatic approach** is based mainly on experience and theoretical expert opinions to gain a more advanced maturity level of safety culture [42]. According to Guldenmund (2010), “(...) *the academic and analytical approaches together cover the full range of scientific research (...). The academic approach focuses more on the cultural core and on understanding its meaning by looking at its past, whereas the analytical approach is directed more at a description of present cultural manifestations, like various types of behaviour and how these are perceived by existing groups.*” [42]

Psychosocial safety climate (PSC)

The novel construct "psychosocial safety climate" (PSC) has also been introduced in recent years [43, 44]. PSC refers to the “*policies, practices, and procedures for the protection of worker psychological health and safety*”. [43, 44] PSC pursues the aim of combining two different research directions: research on safety climate and work stress research [43]. According to Dollard et al. (2010), recent safety climate research focuses on workplace climate, environment, and physical health outcomes, while research on work-related stress concentrates on psychosocial risk factors and psychological health outcomes [43]. Within PSC, both research directions and their related topics are combined.

Patient Safety Culture

In health services research, safety culture is closely connected to patient safety culture. Patient safety culture refers to the following: *“An integrated pattern of individual and organisational behaviour, based upon shared beliefs and values that continuously seeks to minimise patient harm, which may result from the processes of care delivery.”* [45] According to the World Health Organization (WHO), patient safety *“(…) is a framework of organized activities that creates cultures, processes, procedures, behaviours, technologies, and environments in health care that consistently and sustainably: lower risks, reduce the occurrence of avoidable harm, make error less likely and reduce its impact when it does occur.”* [46]

Occupational Safety Culture

Occupational safety culture refers to occupational safety in the workplace and addresses the shared perceptions of working group members in relation to policy, procedures and practices relating to occupational safety and health in an organization [47]. The European Agency for Safety and Health at Work (EU-OSHA) defines occupational safety culture as *“(…) how an organisation’s informal aspects influence occupational safety and health in a positive or negative way.”* [33] Lin et al. (2017) preferred the following definition of occupational safety culture for healthcare providers: *“(…) the overall shared perception that a work environment in a healthcare organisation is free from harm or danger under usual conditions. It consists of the explicit characteristic of safety culture in a healthcare organisation influencing employee practices and attitudes towards work safety, and it thus influences occupational safety and the quality of patient care.”* [48]

In summary, the concept of safety culture is complex, since there is an ongoing debate regarding different definitions and it is investigated in various research disciplines (e.g. engineers, psychologists, sociologists, healthcare researchers) [49]. Within this dissertation, safety culture (differentiated into patient and occupational safety culture) and the related concepts of safety climate are examined and discussed from the perspective of health services research focusing on the hospital setting. Following Guldenmund’s three approaches, the terms “patient safety climate” and “occupational safety climate” are used explicitly when findings

of cross-sectional studies are described. Otherwise, the superior terms “patient safety culture” or “occupational safety culture” are used.

1.3.2 State of Research

Studies on Patient Safety Climate in the Hospital Setting

Studies on patient safety climate in the hospital setting can be categorized into five different areas of emphasis.

One focus of studies on patient safety climate is the ***illustration of methodological aspects***. Pumar-Méndez et al. (2014) undertook a thematic review and found the following three methodological areas addressed in recent studies on patient safety climate: research approaches, survey tools, and level of data aggregation [50]. According to Pumar-Méndez, safety climate is less-studied in qualitative approaches or in studies with a mixed-method design [50]. Common research approaches are quantitative assessments of safety climate [50]. Frequently used survey tools were identified and revealed different psychometric properties [50]. The level of data aggregation “*refers to the level at which survey data is summarised for analysis (...)*” [50]. Individual personal characteristics (individual level) are not suitable for drawing conclusions about a social and group phenomenon (group level) such as safety culture [50]. Most studies still examine patient safety climate at the individual level, although certain authors insist that safety climate as a socially formed product can only be explored at the group level [50]. To date, methodological aspects, such as the adequacy of psychometric properties, have mainly been investigated in quantitative studies [51–53]. One study reviewed methodological aspects of existing qualitative studies, and revealed the lack of theoretical frameworks as a foundation [54]. Nevertheless, these studies show a different perspective on safety culture that should be explicitly adopted in the future [54].

The majority of previous studies focused on the ***assessment of patient safety climate in hospitals***. There are studies that were carried out in different departments or units in the hospital, for example in intensive care units [55], hospital emergency departments [56, 57], inpatient mental health units [58, 59], maternity units [60], or in operating rooms [61]. The aim of most of the mentioned studies

was to capture attitudes of health workers towards patient safety climate [56, 62–65]. One literature review indicated that physicians in emergency departments rated safety climate more positively than nurses [56], while another literature review in other hospital departments and units showed that physicians evaluated safety climate more critically than nurses or allied health professionals [65]. A recent systematic review and meta-analysis by Okuyama et al. (2018) summarized studies worldwide that captured patient safety climate with the dimensions of the Hospital Survey of Patient Safety Culture (HSPSC) [64]. The dimensions “teamwork within units” and “organizational learning and continuous improvement” of the instrument were rated most positively with over 70% [64]. “staffing” and “nonpunitive response to errors” received the lowest ranking [64]. The authors concluded that reporting errors should be encouraged through effective communication, feedback, leadership, and the willingness to learn from mistakes [64]. One study focused additionally on healthcare professionals’ knowledge and skills related to patient safety, and identified the need for improvements among clinic staff [66]. In summary, the majority of existing studies include the perspective of healthcare professionals, and only few studies have considered the perspective of patients [67]. A literature review demonstrated that patients are also in a position to report on patient safety climate and can address safety concerns [67].

Another focus of recent research lies in the derivation of ***promoting or impeding factors for patient safety climate*** [54, 68–70]. Promoting factors for patient safety climate are for example establishing a blame-free culture, improving communication and leadership capacity, learning from errors, and including further patient perspectives in safety initiatives [68]. According to another study, staffing, communication, non-human resources, organizational factors, and patient-related factors can be seen as both a supporting but also, if not well implemented, as a hindering factor for good patient safety climate [54]. Other impeding factors were identified in patient safety incident reporting, for example fear or shame about reporting, reporting focused on only more severe incidents, lack of knowledge about reporting, and lack of time to report [69]. Work overload and

lack of time also contributed to less patient safety incident reporting [69]. Recommendations to improve patient safety incident reporting included avoiding a punitive climate, encouraging reporting, and investing in training to raise awareness about this topic [69].

Several studies in recent years addressed possible **associations and relationships of patient safety climate, and other factors**. Garcia et al. (2019) investigated the relationship between burnout and patient safety among healthcare professionals, and identified an association between burnout among staff and decrease in patient safety [71]. Another study by Hickam et al. (2003) showed an effect of working conditions on patient safety [72]. According to the authors, in particular workforce staffing and workflow design have the greatest impact on patient safety [72]. Recent studies have tried to demonstrate associations between patient safety climate, patient safety, and quality of care outcomes [73], or between patient safety climate and patient outcomes [74–76]. The Health Foundation study (2011) summarized to what extent patient safety climate is associated with hospital readmission rates, length of stay, mortality, complications such as pressure ulcers or falls, general composite adverse events, and medication errors [76]. The study found associations between patient safety climate and adverse events, medication errors, readmission, and length of stay [76]. No results or mixed results were achieved for mortality, complications, or composite adverse events [76]. In a meta-analysis, Groves (2014) examined the relationship between safety climate and pressure ulcers, falls, medication errors, nurse-sensitive outcomes, as well as post-operative outcomes, and found no significant relationships [74]. According to the author, possible explanations for this surprising result are measurement issues and the current lack of theoretical underpinning of the construct patient safety climate [74].

Another focus in recent studies is the development of **strategies for improving patient safety climate**. However, there are studies that present overarching strategies [77, 78], while certain studies also examine specific elements, such as speaking-up behavior for patient safety [79], the implementation of specific training (classroom-based Crew Resource Management training) [80], or the use of handover tools to improve the handover process from intensive care to general

units [81]. Overarching strategies for the improvement of patient safety climate seem to be leadership or front line safety walk rounds, promotion of incorporate team training, and the support of team communication [77, 78]. However, further studies are needed to evaluate specific interventions in terms of their benefits for patient safety climate.

Studies on Occupational Safety Climate in the Hospital Setting

Subsequently, studies related to occupational safety climate or specific aspects of occupational safety climate in hospitals are described. A review by Lin et al. (2017) analyzed the construct safety climate in relation to the perspective of healthcare providers and identified the following elements which seem to be important for an occupational safety climate: (1) creation of a safe working environment by senior management in healthcare organizations; (2) shared perception of healthcare providers about safety of their work environment; and (3) the effective dissemination of safety information [48]. Aburumman et al. (2019) examined the effectiveness of workplace interventions in improving occupational safety climate [82]. In this review, the authors also considered other workplace settings besides healthcare [82]. According to the authors, the most successful types of interventions were those that focused on the importance of safety, leadership style, and behavioral monitoring [82]. However, the authors criticized the poor quality of the studies included [82].

Most of the studies published in the last years describe **associations between aspects of occupational safety climate and safety outcomes** (e.g. work-related injuries, exposure incidents) [83–92] using mainly cross-sectional studies. According to studies by Mullen et al. (2009) and Vredenburg et al. (2002), safety-specific transformational leadership training as well as specific proactive management practices seemed to have positive effects on safety outcomes [93, 94]. Eliseo et al. (2012) investigated perceptions of safety climate and adherence to safety rules among 196 emergency medical services (EMS) providers [95]. According to the results, a high perceived safety climate was associated with more adherence to safety rules and safe work practices [95]. Gershon et al. (2000) conducted a survey with 789 hospital employees to capture the relationship between hospital safety climate and employee compliance with safe work

practices and incidents of workplace exposure to blood and other body fluids [85]. According to the results, the frequency of exposure incidents was significantly lower when management support was rated high and when employees received safety feedback and training [85].

Further studies show the **relevance of workplace characteristics** for occupational safety climate [96–98]. Turner et al. (2012) for example demonstrated the link between certain aspects of work characteristics (job demands, job control, social support), and safety behavior among 280 healthcare staff from seven hospitals in the UK [98]. McCaughey et al. (2013) identified associations between safety climate perceptions and further employee outcomes (e.g. job stress, turnover intention, and job satisfaction) among a sample of 218 healthcare providers [89].

Other studies addressed the **newly developed concept of PSC** and its relevance in the hospital setting [99–101]. McLinton et al. (2018) for example identified factors that play a crucial role in forming a PSC using a mixed-method design [99]. The authors conducted semi-structured interviews with 27 hospital staff [99]. Leadership style, management involvement, and communication were identified as central themes of PSC [99].

Summary

Overall, previous studies in the hospital setting focused primarily on patient safety climate and patient outcomes, and the implications derived for improving overall patient safety culture. However, current studies illustrate that central promoting factors of patient safety climate are also important for occupational safety climate. Compared with studies on patient safety climate, there are fewer studies covering different aspects of occupational safety climate in hospitals from the perspective of healthcare workers [48]. Promoting occupational safety culture among employees in hospitals has received less attention in studies so far, and most studies were not conducted in the German healthcare system. The concept of occupational safety climate has been explored more often in other work areas in the past (see for example [102–106]).

To date, only few studies have considered both patient and occupational safety climate (for a comprehensive overview, please see the introduction section in Publication 2), although in 2005, Yassi et al. proposed recommendations for a comprehensive approach to patient and occupational safety climate [107]. For the hospital sector, therefore, there are separate studies that jointly consider different aspects of patient and occupational safety climate. Hence, at the start of the WorkSafeMed study in the year 2014, there was a lack of studies considering patient and occupational safety climate together on a broader perspective and in the sense of an overarching safety culture. Looking at both types of safety culture can provide additional insights and contribute to the further development and strengthening of an overarching safety culture in the hospital setting.

1.4 Working Conditions in Hospitals

Patient and occupational safety culture are closely related to working conditions. In the following, the theoretical background of working conditions with special consideration of psychosocial factors at work is addressed, including the description and definition of terms like “stress factors”, “resources”, and “strain” within the general stress-strain model (see 1.4.1). A brief summary is also given on the state of research on working conditions for nurses and physicians in hospitals (see 1.4.2).

1.4.1 Description of Terms within Working Conditions

Working conditions have changed considerably over the last few years, and psychosocial factors at work are becoming more and more important [108]. Meanwhile, the following demands are placed on employees in the context of working conditions: (1) receiving and processing information (perceiving, thinking, memory skills), (2) experiencing and showing emotions, and (3) the ability to design and implement plans of action, decision-making [108]. With the increased complexity of work and the changed working conditions, the demands and stress factors on employees have also changed, e.g. in terms of flexibility and work pressure/intensity [108].

Various theories and models have been developed to describe psychosocial stress factors within working conditions. Well-known theories and models are the

job demand-control model [109], the job demand-control-support-model [110], the effort-reward-imbalance-model [111, 112], the concept of organizational justice [113], and the job demands-resources (JD-R) model [114]. The stress-strain model originally developed by Rohmert and Rutenfranz (1975) [115] is widely used in occupational science. The model distinguishes between stress and strain, as well as the consequences of strain [116]. It is criticized as a strongly mechanistic concept, but is the current basis for DIN EN ISO 10075 “Ergonomic principles related to mental workload” [117].

The Joint German Occupational Safety and Health Strategy (“Gemeinsame Deutsche Arbeitsschutzstrategie (GDA)”) relies on previous theoretical models to describe different **stress factors** at work and their influence on health [108]. Stress factors are “*the entirety of measurable external influences*” [118]. In occupational science, the term “stress” is intended to be neutral and can therefore have positive as well as negative attributes [119]. The GDA categorizes stress factors at work with regard to mental workload and health into the following five areas [108, 119]:

- **Work content and task:** e.g., completeness of the task, freedom of action, variability, information/supply of information, responsibility, qualification, emotional demands [119]
- **Organization of work:** e.g., work time, work process, communication/cooperation [119]
- **Social relations:** e.g., with colleagues or managers [119]
- **Working environment:** e.g., physicochemical factors, physical factors, workplace and information structure, work equipment [119]
- **New forms of work:** e.g., mobility, atypical employment relationships, time flexibility [108]

The different kind of stress factors vary in terms of duration, severity, and progression [120]. In addition to the occupational stress factors, other personal stress factors may also appear [120], which can result in an overall perceived high burden. The recent German stress reports (2013 and 2020) by the Federal Institute for Occupational Safety and Health revealed that employees are confronted with a high level of stress factors at work [121, 122].

Individual conditions and resources: The above-mentioned stress factors affect individuals who differ from each other in certain conditions and resources [120]. Each individual is different in terms of psychological preconditions (e.g., skills, abilities, experience, knowledge, motivation, attitudes, coping strategies...) and also in terms of other conditions (e.g., health, age, gender, physical constitution, nutrition, general condition, current condition...) [120]. Due to their individual conditions and resources, individuals are able to cope with stress factors in different ways [120].

Strain: The impact on the individual person caused by stress factors is called strain [120]. Strain comprises the *“effects of the stress on employee depending on his/her individual conditions (...)”* [108, 118].

Consequences of strain: Depending on the individual conditions, stress factors can lead to positive or negative consequences of strain for the individual [120]. Positive consequences are to be expected if the level of stress corresponds to the general preconditions [120]. Positive consequences of stress factors can contribute, for example, to exercise, further development of both physical and mental skills, well-being, and maintenance of health [120]. In the case of strong discrepancies (a stress factor that is either too high or too low), negative consequences are expected [120]. Negative consequences can result, for example, in general psychosomatic disorders and illnesses (including digestive problems, heart problems, headaches), burnout, absenteeism, fluctuation, and early retirement [120]. Negative consequences of stress can be reduced by adjusting the stress factors or by strengthening personal resources (e.g. promotion of social support by colleagues) [120].

1.4.2 State of Research

In this chapter, selected studies are presented which focus on working conditions of nurses or demonstrate associations between working conditions and safety outcomes of patients or nurses in hospitals. Then, studies are presented which depict working conditions of physicians in hospitals.

Working conditions of nurses in the hospital setting

In Germany, the *nursing thermometer* (“Pflegethermometer”) is an annual survey providing a representative overview of the specific situation regarding nursing care. Thereby, the situation of nursing staff in hospitals was frequently the center of interest. The nursing thermometers from 2007 [123], 2009 [124], 2012 [125], and 2014 [126] highlighted various aspects of nursing care in German hospitals. Two studies focused on the assessment and situation of nurse staffing [123, 124], while the other two studies referred to the specific situation in intensive care [125] or to that of patients with dementia in hospitals [126]. The nursing thermometer from 2007 already drew attention to the reduction of nursing staff in Germany and recommended the development of further strategies for the improvement of working conditions of nurses [123]. In addition, based on an additional analysis of data from the DGB-Index “Gute Arbeit” from 2012 to 2017, the *Nurse Report 2019* documented the following stress and strain factors for nurses in Germany: high work intensity, no use of breaks and little recovery due to little time, reductions in the quality of care, high emotional stress (e.g., dealing with serious illness, suffering, and dying), high physical demands, regular night and shift work, perceived lack of recognition and financial reward [127].

In recent years, the RN4CAST study (Registered Nurse Forecasting) has highlighted the relationship between *working conditions of nurses and patients or quality of care outcomes* [16, 17, 128–131]. The RN4Cast study involved twelve European countries (Belgium, England, Finland, Germany, Greece, Ireland, Norway, Poland, Spain, Sweden, Switzerland, and Netherlands), and focused on general acute hospitals [128]. In several studies within the RN4CAST study, associations between nurses’ working conditions and multiple factors were investigated. Within the RN4Cast study, Aiken et al. (2012) demonstrated the link between working conditions (improved nurse staffing, better nurse work environment) and patient outcomes (satisfaction overall and with nursing care, willingness to recommend hospitals), as well as nurse outcomes (hospital staffing, work environments, burnout, dissatisfaction, intention to leave job in the next year, patient safety, quality of care) [16]. In their study, they proved a close association between improved working conditions with reduced ratios of patients to nurses

and increased patient satisfaction, as well as increased quality of care using data from nurses (488 in 12 European countries; 617 in the United States) and patients (210 European hospitals and 430 US hospitals) [16]. The authors revealed that with 13.0, Germany has the highest average ratio of patients to nurses compared with other countries (for example US 5.3, Switzerland 7.9, Norway 5.4, or England 8.6) [16]. In a further retrospective observational study relating data from 422,730 patients to data from 26,516 nurses from nine RN4CAST countries, Aiken et al. (2014) revealed associations between nursing staffing, nurses' educational qualification, and hospital mortality after common surgical procedures [17]. The results demonstrated that improved nurse staffing and a higher educational background of nurses could prevent hospital deaths [17]. The authors therefore concluded that specific investments in nurses (improved patient-to-nurse-ratio and better educational qualification of nurses) are probably associated with a reduction of hospital deaths [17]. Based on the same data, Ball et al. (2018) investigated associations between nurse staffing, missed nursing care, and hospital mortality [131]. The authors identified missed nursing care as a mediator between the relationship of nurse staffing with the risk of hospital mortality [131]. German data were not included in either analyses. However, it can be assumed that the results from Aiken et al. [17] and Ball et al. [131] are applicable to the situation in German hospitals.

Other studies worldwide also investigated the ***relationship between working conditions of nurses and patient outcomes*** [18, 132–136]. One study confirmed the effects of nurse staffing, work environments, and education on patient mortality for South Korea [132]. McHugh et al. (2016) revealed that increased patient-to-nurse-ratio was associated with a worse patient outcome and a lower likelihood of surviving in 75 hospitals in the USA [133]. Stone et al. (2007) demonstrated that higher nurse staffing was linked with lower incidence of central line associated bloodstream infections, ventilator-associated pneumonia, 30-day mortality, and decubiti [134]. Ramanujam et al. (2008) surveyed 430 nurses at two US hospitals and identified a close negative relationship between job demands and patient safety [135]. From the nurses' point of view, patient safety decreases the more job demands become apparent [135]. Van Bogaert et al.

(2014) also identified associations between nurse practice environment factors, nurse work characteristics, nurse and patient outcomes using a sample of 1,108 nurses [18]. A further study proved a connection between missed nursing care and heart failure readmissions using surveys, patient discharge data from three states, and routine data from 160,930 patients with heart failure in 419 acute care hospitals in the USA. This study demonstrated that missed nursing care can lead to increased readmissions of patients, and also showed that the relationship is attenuated when adjusted for the quality of work environment of nurses [136].

Further studies explored the relationship between **working conditions and specific outcomes of nurses**. Leigh et al. (2015) showed a strict nurse-to-patient ratio was associated with fewer occupational injuries and illness rates among nurses [15]. Other studies also investigated associations between working conditions and the occurrence of injuries and illness rates or healthcare-associated infections, and found that favorable working conditions can reduce injuries, illness rates, and infections of nurses [137–142]. Further studies also described associations between poor working conditions for nurses and an increased incidence of low back pain [143], shoulder pain [144], and musculoskeletal injuries [145].

Several studies demonstrated a relationship between **working conditions and burnout** of nurses [146–150]. Gershon et al. (2007), for example, conducted a review and summarized previous research investigating the association between a subconstruct of working conditions (organizational climate) and specific occupational health outcomes (e.g., blood and body fluid exposure, musculoskeletal injuries, and burnout) of nurses [146]. All included studies revealed a negative impact of organizational climate on nurses health [146]. However, the authors emphasized that the data were mainly based on cross-sectional studies and that further studies are needed [146]. Other studies found associations between nurses' burnout with intention to leave the profession [149], patient safety indicators [150], work overload, and a lack of supervisor support [151].

Further studies focused on the **early exit of nurses from the profession** or on **the assessment of intention to leave** among nurses. The NEXT study (nurses' early exit study) addressed the work situation for nurses and the reasons for an

early exit from the profession [152]. The NEXT study was conducted in ten European countries (Belgium, Germany, Finland, France, United Kingdom, Italy, Netherlands, Norway, Poland, and Slovakia) and the baseline data collection comprised a sample of 39,898 nurses [152]. In a subgroup analysis of 28,561 hospital nurses, the intention to leave the profession was higher than 15% among nurses in Italy, Finland, France, Germany, and the United Kingdom [153]. Poorer working conditions for nurses were discussed as one cause for prematurely leaving the profession in the respective countries [153]. In particular, the following factors seemed to have an influence on the decision to leave the profession: quality of teamwork, interpersonal relationships, possibilities of development, uncertainty regarding treatment, and influence at work [153]. Other factors that can contribute to premature departure from the profession were work-family-conflict, dissatisfaction with pay, and burnout [153]. The authors from the NEXT study group therefore recommended to improve work processes through more collaboration and teamwork, as well as to integrate nurses' expertise [153]. Further studies from the NEXT study group identified decreased work ability [154], higher age [155], low health [155], and an imbalance between high effort and low reward [156] as contributing factors for the intention to leave the nursing profession.

Based on ***data sources of the RN4CAST study and the Health PROMeTHEUS study*** (Health Professional Mobility in the European Union study), Zander et al. (2013) conducted an additional analysis comparing working conditions of 27,451 nurses in five destination countries (United Kingdom, the Netherlands, Sweden, Norway, Switzerland) and three source countries (Poland, Greece, and South Africa) with working conditions in Germany [157]. The authors identified poor working conditions as the most relevant push factor for nurses migrating from Germany [157]. Insufficient nursing staff, low decision-making power, low recognition, and a lack of collaboration with other occupational groups, were also rated as worse in Germany compared with the five destination countries [157]. Based on their results, the authors recommended investing in better working conditions as a way to retain nurses and also to attract nurses from other countries [157].

Working conditions of physicians in the hospital setting

There are also several studies exploring working conditions of physicians. In the following, only selected studies are presented which focused on the assessment of psychosocial stress or strain factors within working conditions or on associations of working conditions with outcomes regarding patients or physicians.

Several studies focused on the **assessment of psychosocial stress or strain factors within working conditions** among physicians. Laubach et al. (2007) examined job satisfaction and work situation of physicians employed in a German University Hospital [158]. The results imply that working conditions, superiors, hierarchy, transparency, and participation in decisions were important variables for job satisfaction [158]. Bauer and Groneberg (2013) examined perceived work-related stress and found that 55.5% of the physicians experienced high work-related stress [159]. Past survey data from recent years also revealed that physicians in Germany rated their working conditions poorly. In 2017, 6,172 physicians and members of the Marburger Bund (trade union of salaried physicians and medical students) in Germany participated in an online-questionnaire, and reported a worsening of working conditions with accompanying higher workloads, staff shortages, and growing bureaucratic tasks [160]. Wehkamp et al. (2017) interviewed physicians and hospital chief executive officers (CEOs) between 2013 and 2016 to depict whether physicians and CEOs perceive any economic influence on physicians' actions and medical care [22]. They found differing perspectives, with physicians perceiving increasing pressure to consider economic interests of the hospital when making decisions about patient care [22]. As a consequence, physicians addressed inadequate treatments for patients (overtreatment, undertreatment, and incorrect treatment) and increasing ethical conflicts, stressful situations, and personal frustration [22]. Keller et al. (2010) identified work-related stressors like high work intensity due to documentation and administrative tasks, teaching duties and lectures, understaffing, delaying and cancelling breaks, and time pressure [161]. Other stressors were background/on-call duties, weekend duties (in the clinic), working overtime, work assignments in dif-

ferent workplaces/clinics, difficulties in planning work in advance, and unclear responsibilities [161]. Colleague support and opportunities for qualification were regarded as a key resource [161].

Some studies investigated **associations between working conditions and outcomes for physicians**. Consequences of poor working conditions for physicians or junior physicians were more depressive symptoms [162, 163], risk for burnout [164], and the intention to leave the profession [165]. Further studies reported that high demands in working conditions lead to a higher perceived work-family-conflict [166, 167]. Wallace et al. (2009) performed a systematic review addressing factors, barriers, and consequences of work stress of physicians [14]. Work-related stressors are workload, work hours, fatigue, emotional interactions, cognitive demands, restricted autonomy, and structural and organizational changes to practice [14]. Work-related stressors can lead to physician outcomes (stress, burnout, depression, relationship troubles, substance abuse, as well as risk of suicide) and patient outcomes (e.g., retention issues, suboptimum quality of patient care, reduced patient adherence and satisfaction, and increased risk of medical errors) [14].

As already indicated by Wallace et al. (2009) [14], several studies have demonstrated that **working conditions of physicians interact with the quality of care outcomes for patients** [168–172]. According to patients, specific quality of care outcomes comprise a perceived lack of support [168], worse recovery, and lower satisfaction with medical care [169]. Klein et al. (2011) found that high levels of perceived work stress lead to an increased level of suboptimal quality of care [170]. Krämer et al. (2016) performed a longitudinal study with 95 physicians in two hospitals analyzing associations between job demands, work-related strain, and perceived quality of care [171]. The authors identified high social stressors and time pressure on physicians as relevant factors for decreased quality of care [171]. Loerbroks et al. (2016) conducted a cross-sectional study comprising 416 German physicians [172]. The study revealed that high work-related efforts and low reward lead to reports of poorer quality of care for patients [172].

Summary

There are many studies that examine working conditions of nurses and physicians separately. It is evident that, apart from the nursing thermometer series of studies and the nursing report, there are few studies in Germany that examine working conditions and perceived work stress of nurses in detail. Most of the studies were conducted in other countries, but in some cases, data from German hospitals were included (RN4CAST study, NEXT study, PROMeTHEUS study). To date, only few studies have surveyed working conditions of both nursing staff and physicians in Germany [173–175]. Bartholomeyczik et al. (2008) conducted an assessment of working conditions of nurses and physicians within the ArbiK study (“Arbeitsbedingungen im Krankenhaus“) [173]. The study also successfully included the bottom-up development of an organizational intervention which addressed nurses and physicians as a team to improve the collaboration in single hospital units and within the hospital [173]. Previous studies agreed that working conditions for nurses and physicians in German hospitals have deteriorated in recent years. In the Hospital Report of 2014, Bräutigam et al. (2014) demonstrated that nurses and physicians rated their working conditions in hospitals negatively [175]. Poor working conditions, low payment, and lack of appreciation were particularly criticized by the nursing staff, and they stated that their working conditions prevented them from providing good care for patients [175]. The relationship and impact of working conditions on the quality of patient care and nursing staff outcomes have been predominantly examined in international studies. Nevertheless, the results of these studies are certainly applicable to the situation in German hospitals. At the time of the WorkSafeMed study, the impact of working conditions on patient and occupational safety culture from the perspective of nurses and physicians had not yet been investigated in German hospitals. Thus, the WorkSafeMed study, and the dissertation within, followed previous international studies and addressed open research questions particularly for German hospitals.

1.5 Research Questions

This dissertation focuses on the issues of patient safety culture, occupational safety culture, as well as psychosocial factors within working conditions in four

publications. Three publications used a cross-sectional design and survey data from the WorkSafeMed study [27–29]. One publication was conducted using an integrative literature review [30].

The dissertation addresses the following topics and research questions:

1. Patient Safety Culture in University Hospitals: Assessment and Predictors

- How do nurses and physicians in the WorkSafeMed study assess patient safety climate, and are there any differences between the two occupational groups? [27]
- From the perspective of nurses and physicians in the WorkSafeMed study, which predictors have an influence on perceived patient safety culture? [28]

2. Occupational Safety Culture in University Hospitals: Assessment, Predictors and Determinants

- How do nurses and physicians in the WorkSafeMed study assess occupational safety climate, and are there any differences between the two occupational groups? [27]
- From the perspective of nurses and physicians in the WorkSafeMed study, which predictors have an influence on perceived occupational safety culture? [28]
- Which determinants for occupational safety culture are generally described in different workplaces (hospital, construction, manufacturing, and other industry sectors), and what implications can be derived for hospital workplaces? [30]

3. Patient and Occupational Safety Culture in University Hospitals: Shared Predictors

- Which shared predictors can be found for both kinds of safety culture considering the perspective of nurses and physicians in the WorkSafeMed study? [28]

4. Working Conditions in University Hospitals: Assessment and Comparison

- How do nurses and physicians in the WorkSafeMed study assess psychosocial factors within their working conditions, and are there any differences between the two occupational groups? [27]
- How do nurses and physicians in the WorkSafeMed study assess psychosocial factors within their working conditions compared with corresponding reference data from the German COPSQ database? [29]

Based on the findings of the four publications, recommendations for further research regarding the issues of patient and occupational safety culture and working conditions in university hospitals are derived.

2 Results

2.1 Publication 1

Objective: Assessment of patient safety climate, occupational safety climate, and working conditions of nurses and physicians in the WorkSafeMed study, and identification of differences between the occupational groups

Authors: Anke Wagner, Monika A. Rieger, Tanja Manser, Heidrun Sturm, Juliane Hardt, Peter Martus, Constanze Lessing, Antje Hammer

Title: Healthcare professionals' perspectives on working conditions, leadership, and safety climate: a cross-sectional study

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RESEARCH ARTICLE

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Healthcare professionals' perspectives on working conditions, leadership, and safety climate: a cross-sectional study

Anke Wagner^{1*} , Monika A. Rieger¹, Tanja Manser², Heidrun Sturm¹, Juliane Hardt^{3,4,5}, Peter Martus³, Constanze Lessing⁷, Antje Hammer⁶ and on behalf of the WorkSafeMed Consortium

Abstract

Background: Promoting patient and occupational safety are two key challenges for hospitals. When aiming to improve these two outcomes synergistically, psychosocial working conditions, leadership by hospital management and supervisors, and perceptions of patient and occupational safety climate have to be considered. Recent studies have shown that these key topics are interrelated and form a critical foundation for promoting patient and occupational safety in hospitals. So far, these topics have mainly been studied independently from each other. The present study investigated hospital staffs' perceptions of four different topics: (1) psychosocial working conditions, (2) leadership, (3) patient safety climate, and (4) occupational safety climate. We present results from a survey in two German university hospitals aiming to detect differences between nurses and physicians.

Methods: We performed a cross-sectional study using a standardized paper-based questionnaire. The survey was conducted with nurses and physicians to assess the four topics. The instruments mainly consisted of scales of the German version of the COPSOQ (Copenhagen Psychosocial Questionnaire), one scale of the Copenhagen Burnout Inventory (CBI), scales to assess leadership and transformational leadership, scales to assess patient safety climate using the Hospital Survey on Patient Safety Culture (HSPSC), and analogous items to assess occupational safety climate.

Results: A total of 995 completed questionnaires out of 2512 distributed questionnaires were returned anonymously. The overall response rate was 39.6%. The sample consisted of 381 physicians and 567 nurses. We found various differences with regard to the four topics. In most of the COPSOQ and the HSPSC-scales, physicians rated psychosocial working conditions and patient safety climate more positively than nurses. With regard to occupational safety, nurses indicated higher occupational risks than physicians.

Conclusions: The WorkSafeMed study combined the assessment of the four topics psychosocial working conditions, leadership, patient safety climate, and occupational safety climate in hospitals. Looking at the four topics provides an overview of where improvements in hospitals may be needed for nurses and physicians. Based on these results, improvements in working conditions, patient safety climate, and occupational safety climate are required for health care professionals in German university hospitals – especially for nurses.

Keywords: Patient safety climate, Occupational safety climate, Hospital, Working conditions, Leadership, Transformational leadership

* Correspondence: anke.wagner@med.uni-tuebingen.de

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, Wilhelmstraße 27, 72074 Tübingen, Germany
Full list of author information is available at the end of the article



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Background

Promoting patient and occupational safety are two key challenges for hospitals. To effectively manage these challenges, healthcare organizations are recommended to develop a culture of safety [1]. An organization's safety culture refers to "the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of an organization's health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures" [1]. In summary, an organization's safety culture reflects how safety is viewed and treated in organizations [2], guiding employees and hospital managers in fulfilling their tasks and in dealing with safety issues [3]. Patient safety can be therefore defined as "the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare" [4]. Occupational safety and occupational safety climate relates to workplace health and safety and deals with workgroup members' shared perceptions of policy, procedures, and practice in relation to occupational health and safety in the organization [5].

Given the dynamic nature of modern hospitals, healthcare professionals are confronted with major changes in psychosocial working conditions characterized by skills shortage or imbalance, increasing workload and task complexity [6–10]. In addition, demographic changes are making hospital-based patient care increasingly demanding, as chronic diseases and multimorbidity are becoming more predominant [6, 10–12]. To support adaptation to the dynamically evolving nature of work in hospitals, leadership by hospital management and direct supervisors takes on a central role [13, 14]. A transformational leadership style has been shown to contribute particularly well to high performance in the face of organizational change [15–21]. Especially in safety-critical working environments, transformational leadership is positively associated with employees' safety performance and behaviour [21, 22]. It has been shown to increase employees' level of awareness regarding organizational learning processes and the importance of accomplishments and to support their commitment towards common missions [23, 24].

In recent years, several studies on working conditions [6, 25–32], on (transformational) leadership [17–20, 33], and on patient safety climate in hospitals [34–36] have been published. While there are a great number of studies investigating the association between working conditions and safety climate in hospitals [37–41], there are only few studies focusing explicitly on occupational safety climate in hospitals [42, 43], or investigating the association between patient and occupational safety climate [44–46]. As

a common result, studies have shown that these four key topics - (1) psychosocial working conditions, (2) leadership, (3) patient safety climate, and (4) occupational safety climate - are interrelated and form a critical foundation for promoting patient and occupational safety in hospitals. However, relevant studies mentioned above clearly show that these topics have mainly been studied independently of each other and in most cases solely focus on one professional group, either nurses or physicians.

Previous studies showed that physicians and nurses perceptions on psychosocial working conditions and safety culture vary, although they work in the same setting [36, 47]. Recently conducted studies also identified close relationships between working environments for hospital staff and safety culture [48, 49]. Thus, it can be assumed that improving working conditions for healthcare professionals also leads to improved safety culture.

Moreover, when aiming to improve both patient and occupational safety in hospitals, psychosocial working conditions, leadership by hospital management and supervisors, and perceptions of occupational and patient safety climate have to be considered. Consequently, studies aiming to assess and potentially improve occupational as well as patient safety climate should take into account the views of nurses and physicians. Likewise, it is important to assess and evaluate perceptions and attitudes of the closely cooperating frontline healthcare workers to these four topics in order to develop comprehensive improvement measures for patient and occupational safety culture in hospitals.

The present study investigated hospital staffs' perception of these four topics for the first time from the perspectives of both nurses and physicians. We present descriptive findings on the current state in two German university hospitals and investigate perceptions and attitudes of nurses and physicians related to these four topics aiming to detect possible differences.

Methods

Study design and questionnaire

Between 2014 and 2017 we conducted a cross-sectional, multicenter, mixed-methods project *Working conditions, safety culture and patient safety in hospitals – what predicts the safety of the medication process* (WorkSafeMed). Part of the WorkSafeMed project was a staff survey using a standardized paper-based questionnaire. An overview of all scales and items used in this paper is provided in Table 1.

The questionnaire used common and validated instruments to measure four study topics:

- (1) *Psychosocial working conditions*: To measure staffs' perceptions of psychosocial working conditions and the according strain (job satisfaction and burnout),

Table 1 Overview of the scales and items presented in this paper

Assessment Instruments	Psychosocial working conditions	Leadership	Patient safety climate	Occupational safety climate
Overall number of scales and items	Copenhagen Psychosocial Questionnaire (COPSOQ) and adaptation of Copenhagen Burnout Inventory (CBI) 17 scales	Transformational Leadership Inventory (TLI short) and Copenhagen Psychosocial Questionnaire (COPSOQ) 2 scales	Hospital Survey on Patient Safety Culture (HSFSC-D) and Twins Patient Safety 13 scales and 9 single items	TWINS Occupational Safety and self constructed indices 1 scale, 3 indices, 7 single items
Scales, indices and items	COPSOQ -Quantitative demands (scale, 4 items) -Emotional demands (scale, 3 items) -Work-privacy-conflict (scale, 5 items) -Influence at work (scale, 4 items) -Degree of freedom at work (scale, 4 items) -Possibilities for development (scale, 4 items) -Meaning of work (scale, 3 items) -Workplace commitment (scale, 4 items) -Predictability (scale, 2 items) -Role clarity (scale, 2 items) -Social conflicts (scale, 4 items) -Feedback (scale, 2 items) -Social support (scale, 4 items) -Sense of community (scale, 3 items) Outcome scale - COPSOQ -Job satisfaction (scale, 7 items) Outcome scale - CBI (adapted client-related burnout) -Patient-related burnout (scale, 6 items)	TLI short -Transformational leadership (scale, 6 items) COPSOQ -Quality of leadership (scale, 4 items)	HSFSC-D -Teamwork within units (scale, 4 items) -Staffing (scale, 4 items) -Organizational learning (scale, 3 items) -Nonpunitive response to error (scale, 3 items) -Supervisor/ manager expectations (scale, 4 items) -Feedback & communication about error (scale, 3 items) -Communication openness (scale, 3 items) -Management support for patient safety (scale, 3 items) -Teamwork across units (scale, 4 items) -Handoffs & transitions (scale, 4 items) -Frequency of event reported (scale, 3 items) -Overall perceptions of patient safety (scale, 4 items) -Patient safety grade (single item) -Safety grade in the medication process (single item) TWINS Patient Safety -Supervisor support for patient safety (scale, 3 items) -My direct supervisor openly addresses problems concerning patient safety in our hospital (single item) -My direct supervisor focuses more on patient safety than a year ago (single item) -It is important to my direct supervisor that our hospital pays great attention to patient safety (single item) -Hospital management openly addresses problems concerning patient safety in our hospital (single item) -Hospital management focuses more on patient safety than a year ago (single item) -It is important to the hospital management that our hospital pays great attention to patient safety (single item) -Do you have an individual influence on how well patient safety is implemented at the workplace (single item)	TWINS Occupational Safety -Supervisor support for occupational safety (scale, 3 items) -My direct supervisor openly addresses problems concerning occupational safety in our hospital (single item) -My direct supervisor focuses more on occupational safety than a year ago (single item) -It is important to my direct supervisor that our hospital pays great attention to occupational safety (single item) -Hospital management openly addresses problems concerning occupational safety in our hospital (single item) -Hospital management focuses more on occupational safety than a year ago (single item) -It is important to the hospital management that our hospital pays great attention to occupational safety (single item) -Do you have an individual influence on how well occupational safety is implemented at the workplace (single item) Outcome scales - self constructed indices -Subjective assessment of specific protective measures (behaviour & regulations) related to infectious diseases (index, 7 items) -Subjective assessment of occupational safety measures initiated by the employer, related to own safety (index, 6 items) -Personal perception of the frequency of occupational risks (index, 4 items)

we used 16 scales, each with a number of items ranging between three to seven, from the German version of the Copenhagen Psychosocial Questionnaire (COPSOQ) [50–52]. The COPSOQ comprises concepts from several traditional theories of psychosocial working conditions, e. g. the job demand-control model by Karasek [53] with the established scales “influence at work” and “degree of freedom at work”. Single items were rated on a 4-point and 5-point Likert scale. We also adapted one scale from the Copenhagen Burnout Inventory (client-related burnout) to measure patient-related burnout [54]. Before calculating scale scores for each dimension and in accordance with the recommended COPSOQ transformation [52], scales were transformed into scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”). Negatively worded items were not recoded in the process of documentation. However, depending on the wording of items within each scale, maximum values can be positive (high = positive) or negative (high = negative). For example: A high value for “influence at work” is considered positive while a high value for “quantitative demands” is considered negative.

- (2). *Leadership*: To measure leadership, and especially transformational leadership, we focused on the leadership quality scale from the COPSOQ-questionnaire [50, 51] and the short scale on Transformational Leadership (TLI-short) [19]. The latter is a shortened measure derived from a German adaption of the Transformational Leadership Inventory (TLI) [55, 56]. Each of the six TLI-short items matched one of the six transformational behaviours in the original inventory by reflecting the item with the highest factor loading within the German TLI [19]. The items of the TLI short scale were answered on a 5-point Likert scale of frequency (from “1 = never” to “5 = always”), where high values imply a high perception on transformational leadership. The items on the leadership quality scale from the COPSOQ-questionnaire were rated on a 5-point Likert scale. As above, answer scales were transformed into scale scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”). Due to the wording of the scale items, maximum values are positive (high = positive).
- (3). *Patient safety climate*: The multi-dimensional construct of safety culture is usually quantitatively measured by safety climate, which can be defined as the shared perceptions of employees about safety-relevant aspects of their work environment [57, 58]. To assess patient safety climate, we used the German version of the *Hospital Survey on Patient*

Safety Culture (HSPSC-D) [59]. The instrument used in this study consisted of 43 items, measuring ten patient safety culture scales, two outcome scales; one single-item outcome on *patient safety grade*, and one single-item outcome on the *overall safety grade in the medication process*. Scale-items were rated on a 5-point Likert scale, either of agreement (from “1 = strongly disagree” to “5 = strongly agree”) or frequency (from “1 = never” to “5 = always”). Scale scores were calculated after reverse coding of negatively worded items. High values on scales imply a high perception on patient safety climate. The two single-item outcomes were answered on a 5-point Likert frequency scale ranging from “1 = excellent” to “5 = failing”, where high values imply a rather low perception of these two outcomes. Based on findings from a former study [60], self-developed items of the HSPSC-D measuring aspects of supervisor and management support regarding patient safety was used to capture the interaction of supervisors and management from the participants’ perspective. Hereby, the original HSPSC-D scale “management support for patient safety” was worded analogously to cover the specific aspects with regard to the supervisor’s support (new scale “supervisor’s support for patient safety” – the original scale was omitted) and a set of items covering both the role of supervisors and the management were developed. In a second step, this set of items was also verbalized with regard to occupational safety climate (see below) and both sets of items were named as “twins” (TWINS Patient Safety). Each item of the TWINS Patient Safety was rated on a 5-point Likert scale of agreement (from “1 = strongly disagree” to “5 = strongly agree”) or frequency (from “1 = never” to “5 = always”). Maximum values are positive except for one item (*Individual influence on patient safety at the workplace*), where high values imply a rather low perception of one’s own influence.- (4). *Occupational safety climate*: As described above for the patient safety climate, we employed an identical item set to capture aspects of supervisor and management support regarding occupational safety as important aspect of the occupational safety climate (TWINS Occupational Safety). Each item here was rated on a 5-point Likert scale of agreement (from “1 = strongly disagree” to “5 = strongly agree”) or frequency (from “1 = never” to “5 = always”). Maximum values are positive except for one item (*Individual influence on occupational safety at the workplace*), where high values imply a rather low perception of one’s own influence. To assess occupational safety climate outcomes, we used three self-constructed indices (good Cronbach’s alpha from .76 to .82), which

measure perceived occupational safety: (1) subjective assessment of specific protective measures (behaviour & regulations) related to work-related infectious diseases (e.g. protective gloves), (2) subjective assessment of occupational safety measures initiated by the employer, related to own safety (e.g. regulations on how to act in the case of fire or other emergency) and (3) personal perception of the frequency of occupational risks (e.g. do you feel exposed to risks of infection?). Items were answered on a 5-point Likert scale of agreement (from "1 = strongly agree" to "5 = strongly disagree") or frequency (from "1 = never" to "5 = always"). Low values on scales and single items imply a high perception of occupational safety climate.

Prior to data collection, the final survey underwent a pre-test with 4 physicians and 8 nurses using cognitive think aloud interviews.

Setting and sample

We conducted the staff survey with healthcare professionals at two German university hospitals. Hospital selection was based on a convenient sample to have an appropriate sample size large enough to perform multivariate analyses and keep organizational characteristics as comparable as possible. We included all inpatient units, which treat at least 500 patients per year and excluded intensive care and psychiatric units.

Data collection

Prior to data collection, the consent of the executive board of directors, the workers council, and the medical directors of the clinics/departments participating in the study was obtained in both university clinics. After a hospital-wide information by the executive medical directors of the two participating university clinics, the study was presented in department meetings of physicians or during regular team meetings of nurses in the units. The questionnaire then was distributed to a total of 2512 physicians and nurses (including nursing aids and nurses in vocational training). In total, we collected data from 37 departments including 73 units. The data collection took place between April 2015 and July 2015. After approximately two to four weeks, at least one written and, if necessary, oral reminder was carried out on the level of departments (physicians) or units (nurses).

Statistical analysis

Prior to data analyses, we imputed missing values in the survey data (excluding sociodemographic items). For this, scale items from the four different topics (psychosocial working conditions, leadership, patient safety climate, occupational safety climate) were grouped into four separate

imputation groups. Within each imputation group, respondents with missing values of > 30% for scale items were excluded because of the limited data quality (Respondents with missing values: Imputation group 1 (psychological working conditions): $n = 4$ (0,4%), imputation group 2 (leadership): $n = 42$ (4,2%), imputation group 3 (patient safety climate): $n = 21$ (2,1%), imputation group 4 (occupational safety climate): $n = 22$ (2,2%)). Then data for each group were imputed with NORM 2.03 software using the Expectation-Maximization-algorithm [61, 62]. After the necessary reverse coding of negatively worded items, mean scale values were computed for all scales of the four topics. Descriptive analyses included mean values and standard deviations (mean \pm SD) of continuous variables and scale-scores, and absolute and percentage frequencies of categorical variables. T-tests for independent samples were used to determine differences in mean values between nurses and physicians. P -values $\leq .05$ were considered statistically significant. As this is an explorative study, significance testing was conducted to discover tendencies and not for confirmatory purposes, thus no adjustment for multiple testing was applied. We calculated and categorized the effect size according to Cohen's suggestions: mean/SD $< .30$ = small effect/difference, $< .50$ = medium effect/difference and $\geq .50$ = large effect/difference [63]. Data were analysed using IBM Statistics SPSS (Version 23) for Windows. We found some statistically significant differences between the two hospitals: Overall, psychosocial working conditions at the first hospital were indicated more positively than at the second hospital. Patient safety culture also received more positive ratings at this hospital. However, the differences in most of the scales represent only small effects (for more information see Additional file 1) and are not relevant for answering our research question. Therefore, all descriptive results are presented for both hospitals together.

Ethics and confidentiality issues

Ethics approval was obtained from the ethical committees at the two participating university hospitals. Informed consent was sought from participants, who were informed that the study was voluntary and that they could withdraw at any time. The data were analysed anonymously.

Results

Response rate and sample characteristics

A total of 995 out of 2512 distributed questionnaires were completed and returned. Thus, the overall response rate was 39.6%. The sample consisted of 381 physicians and 567 nurses (including nursing aids and nurses in vocational training). The response rates were 39.4% for nurses and 35.5% for physicians. In addition, 47 persons participated who either belonged to another professional

group (19 persons) or gave no information on their professional status (28 persons). The characteristics of the sample are summarized in Table 2.

Descriptive results including differences for nurses and physicians in scale scores and items are presented on Table 3.

Psychosocial working conditions

Psychosocial working conditions

When analysing demands, we found high values for both professional groups. *Quantitative demands* were rated higher than *emotional demands*. The mean score of the *work-privacy-conflict* scale was also high in both professional groups. When comparing the two professional groups, we found that physicians experienced significantly greater *quantitative demands* (71.9 ± 13.9) than nurses (66.5 ± 13.5). However, there were no significant differences in *emotional demands*. Furthermore, although high in both professional groups, physicians reported a significantly greater *work-privacy-conflict* (68.7 ± 25.1) than nurses (61.3 ± 24.4). Both differences represented medium effects (*quantitative demands*: $d = .40$; *work-privacy-conflict*: $d = .30$).

There were medium value ranges given for *influence at work*, *degree of freedom at work*, and *workplace commitment*, while high (positive) value ranges were reported for *possibilities for development* and *meaning of work*. All in all, physicians made more positive

indications in this domain than the nurses (see Table 3). Differences of the three scales *degree of freedom at work* ($d = .58$), *possibilities for development* ($d = .53$), and *workplace commitment* ($d = .68$) presented a large effect, while the other two scales (*influence at work*: $d = .13$ and *meaning of work*: $d = .32$) represented small to medium effects.

The results for interpersonal relations showed medium or high value ranges. Overall, we found fewer differences between physicians and nurses. There were no statistically significant differences between the two professional groups in the four scales *predictability*, *role clarity*, *feedback*, and *sense of community*. We identified significant differences with small or medium effects in three scales (*social support*: $d = -.15$, *role conflicts*: $d = -.31$, and *social relations*: $d = .40$). Nurses experienced more role conflicts (50.6 ± 17.2) than did the physicians (45.1 ± 18.4) in our sample. Concurrently, the results also indicate that nurses experienced more *social support* (66.7 ± 17.0) compared to physicians (64.2 ± 17.0). Physicians rated items on the scale *social relations* more positively (51.5 ± 15.1) than the nurses (45.0 ± 17.0).

Outcome scales

The average mean on the scale *job satisfaction* was high in both professional groups, while the results of the scale *patient-related burnout* were low. However, physicians had significantly higher values for *job satisfaction* (73.4 ± 12.0) than the nurses (67.5 ± 10.2). Similarly, physicians reported significantly fewer symptoms for *patient-related burnout* (28.0 ± 16.5) compared to nurses (36.5 ± 17.6). The differences between the professional groups with regard to *job satisfaction* and *patient-related burnout* represented a large effect size (*job satisfaction*: $d = .54$ and *patient-related burnout*: $d = -.50$).

Leadership

Values for employees' views on transformational leadership were relatively high for both physicians (3.2 ± 0.8) and nurses (3.1 ± 0.8). There was no significant difference in rating transformational leadership. Nurses rated the quality of leadership more positively (53.8 ± 22.7) than physicians (49.2 ± 22.9). This difference was significant but represented a small effect size ($d = -.20$).

Patient safety climate

Patient safety climate

We observed statistically significant differences between nurses and physicians in six out of ten patient safety culture scales. Physicians gave significantly higher ratings for the four scales *staffing* (2.8 ± 0.8), *nonpunitive response to error* (3.5 ± 0.8), *management support for patient safety* (3.0 ± 0.8), and *teamwork across units* (3.1 ± 0.7) than

Table 2 Demographic characteristics of the study respondents

Characteristic of the study respondents	N	%
Profession		
Nurse	567	57.0%
Physician	381	38.3%
Others	19	1.9%
Missing	28	2.8%
Gender		
Male	291	29.2%
Female	656	65.9%
Missing	48	4.8%
Supervisor function		
Yes	195	19.6%
No	759	76.3%
Missing	41	4.1%
	Mean (SD)	Range in years
Age	37,7 (10,7)	19 to 65
Average work experience	13,5 (10,9)	0 to 44
Average work experience in the hospital	10,7 (9,5)	0 to 43
Average work experience in the current department	8,5 (8,2)	0 to 40

Table 3 Descriptive statistics, results of the student's t test and effect size comparing answers by nurses and physicians

Psychosocial working conditions	Interpretation (0 = minimum value, 100 = maximum value)	Mean (SD) (nurses = 564)	Mean (SD) (physicians = 380)	(df) t-value ¹	d _{Cohen}
Copenhagen Psychosocial Questionnaire (COPSOQ)					
Quantitative demands	high = negative	66.5 (13.5)	71.9 (13.9)	(942) -5.974*	0.40
Emotional demands	high = negative	64.4 (18.3)	64.6 (16.5)	(942) -2.202	0.01
Work-privacy-conflict	high = negative	61.3 (24.4)	68.7 (25.1)	(942) -4.497*	0.30
Influence at work	high = positive	36.3 (17.3)	38.8 (20.8)	(710) -2.006*	0.13
Degree of freedom at work	high = positive	36.0 (15.9)	46.2 (20.0)	(687) -8.373*	0.58
Possibilities for development	high = positive	71.6 (15.7)	79.6 (14.2)	(942) -8.032*	0.53
Meaning of work	high = positive	77.7 (16.6)	82.9 (16.1)	(942) -4.753*	0.32
Workplace commitment	high = positive	48.4 (18.8)	61.3 (19.2)	(942) -10.220*	0.68
Predictability	high = positive	53.3 (16.4)	52.5 (19.3)	(720) 0.710	-0.05
Role clarity	high = positive	73.5 (14.5)	72.5 (16.5)	(740) 1.027	-0.07
Role conflicts	high = negative	50.6 (17.2)	45.1 (18.4)	(942) 4.611*	-0.31
Feedback	high = positive	41.9 (21.0)	41.0 (21.5)	(942) 0.632	-0.04
Social support	high = positive	66.7 (17.0)	64.2 (17.0)	(942) 2.169*	-0.15
Social relations	high = positive	45.0 (17.0)	51.5 (15.1)	(874) -6.194*	0.40
Sense of community	high = positive	77.8 (15.2)	76.7 (15.1)	(942) 1.096	-0.07
Outcome scale – Copenhagen Psychosocial Questionnaire (COPSOQ)					
Job satisfaction	high = positive	67.5 (10.2)	73.4 (12.0)	(942) -8.135*	0.54
Outcome scale – Copenhagen Burnout Inventory (CBI, adapted client-related burnout)					
Patient related burnout	high = negative	36.5 (17.6)	28.0 (16.5)	(942) 7.464*	-0.50
Leadership					
Interpretation (0/1 = minimum value, 100/5 = maximum value)		Mean (SD) (nurses = 543)	Mean (SD) (physicians = 369)	(df) t-value ¹	d _{Cohen}
Transformational Leadership Inventory (TLI short)					
Transformational leadership	5 = positive	3.1 (0.8)	3.2 (0.8)	(910) -1.605	0.13
Copenhagen Psychosocial Questionnaire (COPSOQ)					
Quality of leadership	high = positive	53.8 (22.7)	49.2 (22.9)	(910) 3.031*	-0.20
Patient safety climate					
Interpretation (1 = minimum value, 5 = maximum value)		Mean (SD) (nurses = 558)	Mean (SD) (physicians = 373)	(df) t-value ¹	d _{Cohen}
Hospital Survey on Patient Safety Culture (HSPSC-D)					
Staffing	5 = positive	2.4 (0.8)	2.8 (0.8)	(929) -7.721*	0.50
Organizational learning	5 = positive	3.0 (0.7)	3.1 (0.7)	(762) -1.366	0.14
Communication openness	5 = positive	3.7 (0.6)	3.4 (0.7)	(758) 6.010*	-0.47
Feedback & communication about error	5 = positive	3.4 (0.8)	3.3 (0.9)	(929) 1.519	-0.12
Nonpunitive response to error	5 = positive	3.3 (0.8)	3.5 (0.8)	(929) -3.746*	0.25
Teamwork within units	5 = positive	3.3 (0.6)	3.4 (0.6)	(929) 1.326	0.17
Teamwork across units	5 = positive	3.0 (0.6)	3.1 (0.7)	(698) -3.316*	0.16
Handoffs & transitions	5 = positive	3.2 (0.6)	2.9 (0.7)	(713) 5.702*	-0.47
Supervisor/manager expectations	5 = positive	3.4 (0.7)	3.3 (0.7)	(929) 1.020	-0.14

Table 3 Descriptive statistics, results of the student's t test and effect size comparing answers by nurses and physicians (Continued)

Management support for patient safety	5 = positive	2.6 (0.8)	3.0 (0.8)	(929) -5.797*	0.50
Outcome scales – Hospital Survey on Patient Safety Culture (HSPSC-D)					
Frequency of event reported	5 = positive	3.0 (1.1)	2.9 (0.9)	(874) 1.053	-0.10
Overall perceptions of patient safety	5 = positive	2.9 (0.7)	3.3 (0.8)	(929) -7.782*	0.54
Patient safety grade	1 = positive	2.9 (0.8)	2.6 (0.7)	(929) 7.456*	-0.39
Safety grade in the medication process	1 = positive	3.0 (0.8)	2.8 (0.7)	(831) 5.065*	-0.26
Patient safety climate	Interpretation (1 = minimum value, 5 = maximum value)	Mean (SD) (nurses = 543)	Mean (SD) (physicians = 369)	(df) t-value ¹	d _{Cohen}
TWINS Patient Safety					
Supervisor support for patient safety	5 = positive	3.4 (0.8)	3.5 (0.7)	(910) -1.996*	0.13
My direct supervisor openly addresses problems concerning patient safety in our hospital	5 = positive	3.3 (0.9)	3.3 (1.0)	(729) -0.865	0.00
My direct supervisor focuses more on patient safety than a year ago	5 = positive	2.8 (0.9)	2.8 (1.0)	(735) -0.27	0.00
It is important to my direct supervisor that our hospital pays great attention to patient safety	5 = positive	3.4 (0.9)	3.5 (0.9)	(910) -1.509	0.11
Hospital management openly addresses problems concerning patient safety in our hospital	5 = positive	2.8 (0.8)	3.0 (0.9)	(910) -4.188*	0.36
Hospital management focuses more on patient safety than a year ago	5 = positive	2.7 (0.9)	2.8 (0.9)	(910) -2.758*	0.12
It is important to the Hospital management that our hospital pays great attention to patient safety	5 = positive	3.0 (1.0)	3.2 (1.0)	(784) -3.698*	0.20
Do you have an individual influence on how well patient safety is implemented at the workplace	1 = positive	3.2 (0.9)	2.9 (1.0)	(910) 4.558*	-0.32
Occupational safety climate	Interpretation (1 = minimum value, 5 = maximum value)	Mean (SD) (nurses = 543)	Mean (SD) (physicians = 369)	(df) t-value ¹	d _{Cohen}
TWINS Occupational Safety					
Supervisor support for occupational safety	5 = positive	3.5 (0.8)	3.4 (0.8)	(910) 1.050	-0.13
My direct supervisor openly addresses problems concerning occupational safety in our hospital	5 = positive	3.3 (0.9)	3.2 (0.9)	(910) 0.869	0.00
My direct supervisor focuses more on occupational safety than a year ago	5 = positive	2.8 (0.9)	2.7 (0.9)	(910) 0.628	-0.11
It is important to my direct supervisor that our hospital pays great attention to occupational safety	5 = positive	3.3 (0.9)	3.2 (1.0)	(910) 2.299*	-0.11
Hospital management openly addresses problems concerning occupational safety in our hospital	5 = positive	2.9 (0.9)	3.1 (0.9)	(910) -3.337*	0.22

Table 3 Descriptive statistics, results of the student's t test and effect size comparing answers by nurses and physicians (*Continued*)

Hospital management focuses more on occupational safety than a year ago	5 = positive	2.7 (0.9)	2.8 (0.9)	(910) -1.936	0.11
It is important to the Hospital management that our hospital pays great attention to occupational safety	5 = positive	2.9 (0.9)	3.1 (1.0)	(766) -2.720*	0.21
Do you have an individual influence on how well occupational safety is implemented at the workplace	1 = positive	3.3 (0.9)	3.3 (1.0)	(910) .893	0.00
Occupational safety climate	Interpretation (1 = minimum value, 5 = maximum value)	Mean (SD) (nurses = 560)	Mean (SD) (physicians = 372)	(df) t-value ¹	d _{Cohen}
Outcome scales – self constructed indices					
Subjective assessment of specific protective measures (behaviour & regulations) related to infectious diseases	1 = positive	1.8 (0.6)	1.8 (0.6)	(930) -1.132	0.00
Subjective assessment of occupational safety measures initiated by the employer, related to own safety	1 = positive	1.7 (0.6)	2.0 (0.6)	(930) -8.328*	0.50
Personal perception of the frequency of occupational risks	5 = positive	3.2 (0.8)	3.5 (0.7)	(853) -5.608*	0.39

Notes: ¹p-value* ≤ 0.05

nurses (*staffing*: 2.4 ± 0.8 ; *nonpunitive response to error*: 3.3 ± 0.8 ; *management support for patient safety*: 2.6 ± 0.8 ; *teamwork across units*: 3.0 ± 0.6). By contrast, nurses gave significantly higher ratings for the two scales *communication openness* (3.7 ± 0.6) and *handoffs and transitions* (3.2 ± 0.6) than the physicians (*communication openness*: 3.4 ± 0.7 ; *handoffs and transitions*: 2.9 ± 0.7). All of these differences represented a medium to rather large effect size, with exception of the scales *teamwork across units* and *nonpunitive response to error*. We observed no significant differences between the two professional groups in the remaining four scales (*teamwork within the units*, *organizational learning*, *supervisor/manager expectations*, and *feedback and communication about error*).

TWINS patient safety

We also identified significant differences for the twin items regarding patient safety climate. Physicians rated the three scales focusing on management and the scale addressing individual influence on patient safety at the workplace more positively than nurses. These differences represented a small to medium effect size. We found no significant differences between the two professional groups in the other four scales.

Outcome scales and items

The single items *patient safety grade* and *safety grade in the medication process* were rated significantly less safe by the nurses (*patient safety grade*: 2.9 ± 0.8 ; *safety grade in the medication process*: 3.0 ± 0.8) than by physicians

(*patient safety grade*: 2.6 ± 0.7 ; *safety grade in the medication process*: 2.8 ± 0.7). In addition, physicians rated the *overall perceptions of patient safety* as significantly safer (3.3 ± 0.8) than the nurses (2.9 ± 0.7). These differences represented a medium to large effect. We found no significant difference in frequency of reported events.

Occupational safety climate

TWINS occupational safety

We identified significant differences for the twin items covering occupational safety climate. Physicians rated two of the three scales focusing on management more positively than the nurses (see Table 3). These differences represented a small effect. We found no significant differences between the two professional groups in the other six scales. Overall, the two professional groups rated *individual influence on occupational safety* less positively than *individual influence on patient safety*.

Outcome scales – Perceived occupational safety climate

Two significant differences between the two professional groups were found in the outcome scales. Nurses rated *occupational safety measures initiated by the employer* more positively than physicians. This difference represented a large effect ($d = .50$). They also indicated higher occupational risks (3.2 ± 0.8) than physicians (3.5 ± 0.7). This difference was significant and it also represents a medium effect ($d = .39$). Both professional groups also stated that specific protective measures related to infectious diseases were important.

Discussion

This paper analysed data from a staff survey conducted at two German university hospitals. The applied standardized questionnaire was used to assess psychosocial working conditions, job satisfaction, patient safety climate, and occupational safety climate. We report results of descriptive and inferential statistics aiming to detect differences between the two professional groups.

Psychosocial working conditions

Overall, there are few studies which use the COPSOQ instrument to jointly question physicians and nursing staff on their psychosocial working conditions and to compare the results. Ilic et al. questioned nurses and physicians on their working conditions and found some differences between the two professional groups [64]. The physicians in the study indicated, for example, higher demands, more influence at work, and more possibilities for development than the nurses. However, the study population of Ilic et al. consisted of nurses and physicians in emergency medicine.

Our study found significant differences between the two professional groups in 12 out of 17 scales. Nine scales (*influence at work, degree of freedom at work, possibilities for development, meaning of work, workplace commitment, role conflicts, social relations, job satisfaction*, and the additional scale *patient-related burnout*) were significantly more positively assessed by physicians than the nursing staff. This may be due to the fact that some of the differences also lie in the work characteristics of the two occupational groups. A physician usually has more influence at work than a nurse. Nursing staff assessed a total of three scales addressing the concept of psychosocial working conditions (*quantitative demands, work-privacy conflict*, and *social support*) significantly more positively than physicians. The results imply that, on the whole, the surveyed physicians in our study evaluated their psychosocial working conditions more positively than nursing staff. That nurses critically assess their working conditions was also demonstrated in other studies. For example in the RN4Cast study, in nine out of 12 European countries more than half of the surveyed nurses reported that the work environment at their hospital was poor or fair, as opposed to good or excellent [65]. Germany was one of the countries where working conditions of nurses were criticized [65]. This is not surprising, considering how, in recent years, the nursing profession in Germany has been particularly characterized by skills shortages and a shortage of freshly graduated nurses [6–10]. Due to demographic changes and an increase in patients with chronic diseases and multimorbidities, the care demands on nurses have also been steadily increasing [6, 10–12]. A previously conducted study comparing nurse emigration in Germany to nurse emigration in other countries

identified poor working conditions as one of the main causes, and suggested Germany should invest in better working conditions for nurses [66]. Based on our results, measures to improve psychosocial working conditions for healthcare professionals in hospitals are necessary – with a special emphasis on improvements for nurses. The following implications to improve psychosocial working conditions for healthcare professionals in university hospitals seem to be necessary: reduction of high quantitative demands and role conflicts, and improvement of the perceived work-privacy conflict. Also, existing resources, such as social support, possibilities for development, meaning of work, sense of community should be further supported. Especially for nurses, workplace commitment and the degree of freedom at work should be improved.

Leadership

In the concept leadership, the values for *transformational leadership* and *leadership quality* were situated in the moderate range and comparable for recently conducted studies in hospital settings [17, 19, 30, 67]. On the whole, nurses assessed the quality of leadership more positively than physicians. We presume, therefore, that the nurses were more satisfied with their direct supervisors than the physicians. The different assessment may also be due to the fact, that different work structures of physicians and nurses affect how leadership is perceived [68]. Nurses work with a direct supervisor on the ward while physicians may work in several units [68] and thus may experience less direct support by their supervisors than nurses. In Germany, it is common practice for nurses' direct supervisors to work on site and act as a contact person. Physicians in Germany do not always have contact with their direct supervisors and may therefore assess the quality of leadership more critically. There were no significant differences in how transformational leadership was rated. However, we found only small differences between the two professional groups for both scales. According to the results, the quality of leadership can be further enhanced.

Patient safety climate

We found significant differences between the occupational groups for patient safety climate in nine out of 14 scales. Similar to the assessment of the psychosocial working conditions, patient safety climate was also assessed more positively by physicians than by nursing staff. Seven scales (*staffing, nonpunitive response to error, teamwork across units, management support for patient safety, overall perceptions of patient safety, patient safety grade*, and *safety grade in the medication process*) were rated more positively by physicians than nurses. In contrast, nursing staff rated the scales *communication openness* and *handoffs and transitions* more positively than

physicians. Our results correspond to other studies which questioned both physicians and nursing staff about patient safety and reported apparent differences between occupational groups [69–71], and that patient safety climate scales were also rated more positively by physicians than by nursing staff [71, 72]. Singer and colleagues considered whether nurses perceive safety deficiencies in organizational structures more often than physicians [71]. Another explanation is that the perceived worsening of working conditions for nurses also affects the perception of patient safety. A recently conducted study identified relationships between working environments for nurses (nurse staffing) and patient safety (increased survival of in-hospital cardiac arrest patients) [48]. The RN4Cast study investigated associations between nurse staffing, education and hospital mortality in nine European countries [49]. As a major result an increase in nurses' workload by one patient increased the likelihood of an inpatient dying within 30 days of admission [49]. We therefore assume that improving working conditions and staffing also leads to improved patient safety.

There were also significant differences between the occupational groups for the TWINS Patient Safety, especially for the items regarding support from management. With a specific focus on patient safety, physicians rated the items regarding *hospital management* and *supervisor support for patient safety* significantly more positively than the nurses. This result is consistent with results of other studies [65, 69, 72]. In another study, nurses reported that management does not listen and answer to employee concerns, so nurses indicated that patient safety is not a management priority [65]. In the current study, nurses assessed management support for patient safety much worse compared to physicians [69, 72]. A possible explanation for this finding may be that nurses in our sample have little contact with hospital management and may therefore assume that managing staff is not interested in patient safety issues in their unit. Other authors assume that physicians work more closely with management and therefore perceive more support [72]. But in another study, physicians also indicated that the higher management does not listen and can jeopardize patient safety [73]. Overall, in our study it seems necessary for hospital management to become more visible especially to nurses and for communication between hospital management and nursing staff to be improved.

Occupational safety climate

The TWINS Occupational Safety found significant differences between the occupational groups with a small effect in three scales. Here, similar to patient safety climate, physicians assessed the individual items related to management more positively than the nurses. On the

other hand, the nurses rated the item regarding the direct supervisor more positively than the physicians. In this case, it also seems plausible that nurses are more critical of the hospital management than of their direct supervisors, since they usually have little contact with the managing staff. This result is in line with another study. Among other things, Eklöf et al. confirmed the critical evaluation of hospital management in terms of safety. A direct implication here is also to improve communication between hospital management and nursing staff in order to promote the perceived occupational safety climate.

For two out of three indices, we also found significant group differences with a medium to large effect. Occupational safety measures initiated by the employer were considered more important by nurses than by physicians. Here it can be assumed that the questioned nurses desire more regulations with regard to occupational safety on the part of the employer. Additionally, in our sample, nurses indicated occupational risks more often than physicians. This result has not been described previously and is surprising, since within their profession physicians have more invasive activities than nurses. Studies also show that physicians, for example, are more affected by needlestick injuries than nurses [74, 75]. Therefore, we cannot explain why nurses in our sample indicated occupational risks more often than physicians.

Strengths and limitations

In our study, we assessed psychosocial working conditions, leadership, patient safety climate, and occupational safety climate in one standardized questionnaire. The identified results in the different four topics can help to identify where improvements for either professional group or a specific emphasis on certain topics are necessary. Based on the results, we can derive further implications to finally improve working conditions, leadership, patient safety climate, and occupational safety climate in hospitals for nurses and physicians. Our results show for example that high quantitative demands should be reduced and also that adequate staffing may contribute to improved patient safety. In addition, it seems necessary for hospital management to become more visible by actively supporting measures for improved patient and occupational safety climate.

This study also has some limitations. First, the results from the cross-sectional study only refer to one point of time. The survey was conducted at only two university hospitals in Germany, and we had an overall response rate of 39.6%. We excluded units with specific treatment in patient care, such as intensive care and psychiatric units. Therefore, presented results are limited with regard to generalizability, but should at least be applicable to other university hospitals in Germany. Second, the

questionnaire covered only self-reports by physicians and nurses. We did not include the perspectives from hospital management. To comprehensively measure patient and occupational safety climate, a combination of different methods, such as survey and observation, should be used. In addition, the perspective from other professional groups and from patients could be valuable to evaluate these four topics and to develop improvements in these areas.

Conclusions

The WorkSafeMed study combined the assessment of four topics: *Psychosocial working conditions, leadership, patient safety climate, and occupational safety climate* in hospitals. Considering nurses' and physician's perceptions of these four perspectives provides an integrative overview of where improvements may be needed in hospitals. There were, in part, great differences in the evaluation of these four topics by the two professional groups included in this study. For example, psychosocial working conditions and patient safety climate were assessed more positively by physicians than by nurses. These results may help to refine how different professional groups are addressed when aiming for improvements that are meaningful based on their most pressing needs.

Additional file

Additional file 1: Descriptive statistics, results of the student's t test and effect size comparing answers by study participants of the two university hospitals. (DOCX 38 kb)

Abbreviations

CBI: Copenhagen Burnout Inventory; COPSOQ: Copenhagen Psychosocial Questionnaire; HSPSC: Hospital Survey on Patient Safety Culture; TLI: Transformational Leadership Inventory

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Availability of data and materials

Because of data security aspects, data from the WorkSafeMed study will not be made available in the public domain. However, data will be used by students of both project partners for their theses. Data will be stored in accordance with national and regional data security standards.

Authors' contributions

AW, AH, and TM drafted the manuscript. MAR, JH, HS, CL, and PM gave valuable modifications to the text. MAR, CL, and PM developed the study design, AH, HS, TM, PM, and MAR developed the questionnaire including the pretest. AH, HS, TM, and MAR planned the data collection, wrote the study protocol, and performed the survey. AW performed the statistical analysis and received valuable advice from PM and JH. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The WorkSafeMed study with all its components was approved by the responsible ethics committees of the medical faculties of the project partners in Bonn (#350/14) and Tuebingen (#547/2014B01). Each partner complied with confidentiality requirements according to German law. Informed verbal consent was sought from participants, who were informed that the study was voluntary and that they could withdraw at any time. The need for written consent is deemed unnecessary according to national regulations. The method of acquiring the consent was approved by the ethics committees.

Consent for publication

Informed verbal consent was sought from participants. All participants consented to have the results published as part of the informed consent process. The participants were assured of their confidentiality. The need for written consent is deemed unnecessary according to national regulations. The method of acquiring the consent was approved by the ethics committees.

Competing interests

The authors declare that they have no competing interests.

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Author details

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tuebingen, Wilhelmstraße 27, 72074 Tuebingen, Germany. ²University of Applied Sciences and Arts Northwestern Switzerland, FHNW School of Applied Psychology, Riggenbachstrasse 16, 4600 Olten, Switzerland. ³Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tuebingen, Silcherstraße 5, 72076 Tuebingen, Germany. ⁴Berlin Institute of Health (BIH), Clinical Research Unit (CRU), Anna-Louisa-Karsch-Str. 2, 10178 Berlin, Germany. ⁵Institute of Biometry and Clinical Epidemiology, Charité – Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin, Germany. ⁶Institute for Patient Safety, University Hospital of Bonn, Sigmund-Freud-Str. 25, 53127 Bonn, Germany. ⁷Independent consultant, Berlin, Germany.

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CORRECTION

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Correction to: Healthcare professionals' perspectives on working conditions, leadership, and safety climate: a cross-sectional study



Anke Wagner^{1*}, Monika A. Rieger¹, Tanja Manser², Heidrun Sturm¹, Juliane Hardt^{3,4,5}, Peter Martus³, Constanze Lessing⁷, Antje Hammer⁶ and on behalf of the WorkSafeMed Consortium

Correction to: BMC Health Serv Res

<https://doi.org/10.1186/s12913-018-3862-7>

In the original publication of this article [1], the authors missed that reverse coding was necessary for the item “Do you work separate from your colleagues?” before calculating the scale ‘social relations’. So they corrected the analysis accordingly. The results with the revised scale show that there are no longer any significant differences between nurses and physicians with regard to this scale.

This error (scale social relations) affects the following parts of our manuscript:

‘Methods’ section:

Old version: We also adapted one scale from the Copenhagen Burnout Inventory (client-related burnout) to measure patient-related burnout [54]. Before calculating scale scores for each dimension and in ac-

cordance with the recommended COPSOQ transformation [52], scales were transformed into scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”).

Correction: We also adapted one scale from the Copenhagen Burnout Inventory (client-related burnout) to measure patient-related burnout [54]. Before scale calculation, reverse coding was carried out for one item (“Do you work separate from your colleagues?”). Scale calculation was done in accordance with the recommended COPSOQ transformation [52], scales were transformed into scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”).

The original article can be found online at <https://doi.org/10.1186/s12913-018-3862-7>

* Correspondence: anke.wagner@med.uni-tuebingen.de

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, Wilhelmstraße 27, 72074 Tübingen, Germany
Full list of author information is available at the end of the article



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‘Result’ section:

Old version: There were no statistically significant differences between the two professional groups in the four scales predictability, role clarity, feedback, and sense of community.

Correction: There were no statistically significant differences between the two professional groups in the five scales predictability, role clarity, feedback, social relations, and sense of community.

Old version: We identified significant differences with small or medium effects in three scales (social support: $d = -.15$, role conflicts: $d = -.31$, and social relations: $d = .40$).

Correction: We identified significant differences with small or medium effects in two scales (social support: $d = -.15$, and role conflicts: $d = -.31$).

Old version: Physicians rated items on the scale social relations more positively (51.5 ± 15.1) than the nurses (45.0 ± 17.0).

Correction: Values for the scale social relations were relatively high for both physicians (54.8 ± 20.7) and nurses (55.5 ± 20.2). There was no significant difference between the two professional groups in rating the scale social relations.

‘Discussion’ section:

Old version: Our study found significant differences between the two professional groups in 12 out of 17 scales. Nine scales (influence at work, degree of

freedom at work, possibilities for development, meaning of work, workplace commitment, role conflicts, social relations, job satisfaction, and the additional scale patient-related burnout) were significantly more positively assessed by physicians than the nursing staff),

Corrected version: Our study found significant differences between the two professional groups in 11 out of 17 scales. Eight scales (influence at work, degree of freedom at work, possibilities for development, meaning of work, workplace commitment, role conflicts, job satisfaction, and the additional scale patient-related burnout) were significantly more positively assessed by physicians than the nursing staff.

Revised Table 3

We corrected the values for the scale “Social relations”. We also detected some minor errors with no consequences and corrected them too (for the following scales or single items: “Emotional demands”, “Teamwork within units”, “My direct supervisor focuses more on patient safety than a year ago”, “Hospital management openly addresses problems concerning patient safety in our hospital”, “Hospital management focuses more on patient safety than a year ago” and “My direct supervisor openly addresses problems concerning occupational safety in our hospital”).

Table 3 with the corrected values is shown below:

Table 3 Descriptive statistics, results of the student’s t test and effect size comparing answers by nurses and physicians

Psychosocial working conditions	Interpretation (0=minimum value, 100=maximum value)	Mean (SD) (nurses=564)	Mean (SD) (physicians=380)	(df) t-value ¹	d _{Cohen}
Copenhagen Psychosocial Questionnaire (COPSOQ)					
Quantitative demands	high=negative	66.5 (13.5)	71.9 (13.9)	(942) -5.974*	0.40
Emotional demands	high=negative	64.4 (18.3)	64.6 (16.5)	(866) -0.206	0.01
Work-privacy-conflict	high=negative	61.3 (24.4)	68.7 (25.1)	(942) -4.497*	0.30
Influence at work	high=positive	36.3 (17.3)	38.8 (20.8)	(710) -2.006*	0.13
Degree of freedom at work	high=positive	36.0 (15.9)	46.2 (20.0)	(687) -8.373*	0.58
Possibilities for development	high=positive	71.6 (15.7)	79.6 (14.2)	(942) -8.032*	0.53
Meaning of work	high=positive	77.7 (16.6)	82.9 (16.1)	(942) -4.753*	0.32
Workplace commitment	high=positive	48.4 (18.8)	61.3 (19.2)	(942) -10.220*	0.68
Predictability	high=positive	53.3 (16.4)	52.5 (19.3)	(720) 0.710	-0.05
Role clarity	high=positive	73.5 (14.5)	72.5 (16.5)	(740) 1.027	-0.07
Role conflicts	high=negative	50.6 (17.2)	45.1 (18.4)	(942) 4.611*	-0.31
Feedback	high=positive	41.9 (21.0)	41.0 (21.5)	(942) 0.632	-0.04
Social support	high=positive	66.7 (17.0)	64.2 (17.0)	(942) 2.169*	-0.15
Social relations	high=positive	55.5 (20.2)	54.8 (20.7)	(942) 0.512	-0.03
Sense of community	high=positive	77.8 (15.2)	76.7 (15.1)	(942) 1.096	-0.07
Outcome scale – Copenhagen Psychosocial Questionnaire (COPSOQ)					
Job satisfaction	high=positive	67.5 (10.2)	73.4 (12.0)	(942) -8.135*	0.54

Table 3 Descriptive statistics, results of the student's t test and effect size comparing answers by nurses and physicians (Continued)

Outcome scale – Copenhagen Burnout Inventory (CBI, adapted client-related burnout)					
Patient related burnout	high=negative	36.5 (17.6)	28.0 (16.5)	(942) 7.464*	-0.50
Leadership	Interpretation (0/1=minimum value, 100/5=maximum value)	Mean (SD) (nurses=543)	Mean (SD) (physicians=369)	(df) t-value ¹	d _{Cohen}
Transformational Leadership Inventory (TLI short)					
Transformational leadership	5=positive	3.1 (0.8)	3.2 (0.8)	(910) -1.605	0.13
Copenhagen Psychosocial Questionnaire (COPSOQ)					
Quality of leadership	high=positive	53.8 (22.7)	49.2 (22.9)	(910) 3.031*	-0.20
Patient safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (nurses=558)	Mean (SD) (physicians=373)	(df) t-value ¹	d _{Cohen}
Hospital Survey on Patient Safety Culture (HSPSC-D)					
Staffing	5=positive	2.4 (0.8)	2.8 (0.8)	(929) -7.721*	0.50
Organizational learning	5=positive	3.0 (0.7)	3.1 (0.7)	(762) -1.366	0.14
Communication openness	5=positive	3.7 (0.6)	3.4 (0.7)	(758) 6.010*	-0.47
Feedback & communication about error	5=positive	3.4 (0.8)	3.3 (0.9)	(929) 1.519	-0.12
Nonpunitive response to error	5=positive	3.3 (0.8)	3.5 (0.8)	(929) -3.746*	0.25
Teamwork within units	5=positive	3.3 (0.6)	3.4 (0.6)	(929) -1.326	0.17
Teamwork across units	5=positive	3.0 (0.6)	3.1 (0.7)	(698) -3.316*	0.16
Handoffs & transitions	5=positive	3.2 (0.6)	2.9 (0.7)	(713) 5.702*	-0.47
Supervisor/ manager expectations	5=positive	3.4 (0.7)	3.3 (0.7)	(929) 1.020	-0.14
Management support for patient safety	5=positive	2.6 (0.8)	3.0 (0.8)	(929) -5.797*	0.50
Outcome scales – Hospital Survey on Patient Safety Culture (HSPSC-D)					
Frequency of event reported	5=positive	3.0 (1.1)	2.9 (0.9)	(874) 1.053	-0.10
Overall perceptions of patient safety	5=positive	2.9 (0.7)	3.3 (0.8)	(929) -7.782*	0.54
Patient safety grade	1=positive	2.9 (0.8)	2.6 (0.7)	(929) 7.456*	-0.39
Safety grade in the medication process	1=positive	3.0 (0.8)	2.8 (0.7)	(831) 5.065*	-0.26
Patient safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (nurses=543)	Mean (SD) (physicians=369)	(df) t-value ¹	d _{Cohen}
TWINS Patient Safety					
Supervisor support for patient safety	5=positive	3.4 (0.8)	3.5 (0.7)	(910) -1.996*	0.13
My direct supervisor openly addresses problems concerning patient safety in our hospital	5=positive	3.3 (0.9)	3.3 (1.0)	(729) -0.865	0.00
My direct supervisor focuses more on patient safety than a year ago	5=positive	2.8 (0.9)	2.8 (1.0)	(735) -0.027	0.00
It is important to my direct supervisor that our hospital pays great attention to patient safety	5=positive	3.4 (0.9)	3.5 (0.9)	(910) -1.509	0.11
Hospital management openly addresses problems concerning patient safety in our hospital	5=positive	2.7 (0.8)	3.0 (0.9)	(910) -4.188*	0.36
Hospital management focuses more on patient safety than a year ago	5=positive	2.7 (0.9)	2.8 (0.9)	(910) -2.758*	0.11
It is important to the Hospital management that our hospital pays great attention to patient safety	5=positive	3.0 (1.0)	3.2 (1.0)	(784) -3.698*	0.20
Do you have an individual influence on how well patient safety is implemented at the workplace	1=positive	3.2 (0.9)	2.9 (1.0)	(910) 4.558*	-0.32
Occupational safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (nurses=543)	Mean (SD) (physicians=369)	(df) t-value ¹	d _{Cohen}

Table 3 Descriptive statistics, results of the student's t test and effect size comparing answers by nurses and physicians (Continued)

TWINS Occupational Safety					
Supervisor support for occupational safety	5=positive	3.5 (0.8)	3.4 (0.8)	(910) 1.050	-0.13
My direct supervisor openly addresses problems concerning occupational safety in our hospital	5=positive	3.2 (0.9)	3.2 (0.9)	(910) 0.869	0.00
My direct supervisor focuses more on occupational safety than a year ago	5=positive	2.8 (0.9)	2.7 (0.9)	(910) 0.628	-0.11
It is important to my direct supervisor that our hospital pays great attention to occupational safety	5=positive	3.3 (0.9)	3.2 (1.0)	(910) 2.299*	-0.11
Hospital management openly addresses problems concerning occupational safety in our hospital	5=positive	2.9 (0.9)	3.1 (0.9)	(910) -3.337*	0.22
Hospital management focuses more on occupational safety than a year ago	5=positive	2.7 (0.9)	2.8 (0.9)	(910) -1.936	0.11
It is important to the Hospital management that our hospital pays great attention to occupational safety	5=positive	2.9 (0.9)	3.1 (1.0)	(766) -2.720*	0.21
Do you have an individual influence on how well occupational safety is implemented at the workplace	1=positive	3.3 (0.9)	3.3 (1.0)	(910) 0.893	0.00
Occupational safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (nurses=560)	Mean (SD) (physicians=372)	(df) t-value ¹	d _{Cohen}
Outcome scales – self constructed indices					
Subjective assessment of specific protective measures (behaviour & regulations) related to infectious diseases	1=positive	1.8 (0.6)	1.8 (0.6)	(930) -1.132	0.00
Subjective assessment of occupational safety measures initiated by the employer, related to own safety	1=positive	1.7 (0.6)	2.0 (0.6)	(930) -8.328*	0.50
Personal perception of the frequency of occupational risks	5=positive	3.2 (0.8)	3.5 (0.7)	(853) -5.608*	0.39

Notes: ¹p-value* ≤.05

‘Additional file 1’: Revised version

We corrected the values for the scale “Social relations”. We also discovered another minor error (concerning the scale influence at work) and corrected the value too. The table with the corrected values is shown below:

Psychosocial working conditions	Interpretation (0=minimum value, 100=maximum value)	Mean (SD) (hospital 1 = 573)	Mean (SD) (hospital 2 = 418)	(df) t-value ¹	d _{Cohen}
<i>Copenhagen Psychosocial Questionnaire (COPSOQ)</i>					
Quantitative demands	high=negative	68.4 (13.7)	68.9 (14.5)	(989) -0.568	0.04
Emotional demands	high=negative	65.1 (17.7)	63.1 (17.8)	(989) 1.742	-0.11
Work-privacy-conflict	high=negative	62.2 (25.5)	66.0 (24.8)	(989) -2.332*	0.15
Influence at work	high=positive	36.1 (19.1)	38.9 (18.5)	(989) -2.295*	0.15
Degree of freedom at work	high=positive	39.8 (18.5)	40.9 (18.4)	(989) -0.926	0.06
Possibilities for development	high=positive	75.2 (16.2)	74.3 (15.5)	(989) 0.896	-0.06
Meaning of work	high=positive	80.6 (16.0)	78.5 (17.7)	(989) 1.918	-0.13
Workplace commitment	high=positive	55.0 (18.8)	51.8 (21.7)	(820) 2.447*	-0.16
Predictability	high=positive	54.7 (17.0)	50.7 (18.5)	(989) 3.452*	-0.23
Role clarity	high=positive	74.3 (15.3)	71.6 (15.9)	(989) 2.746*	-0.17
Role conflicts	high=negative	47.3 (17.3)	49.9 (18.9)	(989) -2.267*	0.15

(Continued)

Feedback	high=positive	40.1 (20.7)	43.5 (22.0)	(866) -2.418*	0.16
Social support	high=positive	66.0 (16.4)	65.4 (17.7)	(858) 0.587	-0.04
Social relations	high=positive	55.4 (20.5)	55.9 (20.8)	(989) -0.401	0.02
Sense of community	high=positive	78.1 (14.8)	76.2 (15.2)	(989) 1.949	-0.13
<i>Outcome scale – Copenhagen Psychosocial Questionnaire (COPSOQ)</i>					
Job satisfaction	high=positive	70.4 (11.1)	69.3 (11.7)	(989) 1.475	-0.10
<i>Outcome scale – Copenhagen Burnout Inventory (CBI, adapted client-related burnout)</i>					
Patient related burnout	high=negative	33.4 (17.4)	32.1 (18.0)	(989) 1.141	-0.07
Leadership	Interpretation (0/1=minimum value, 100/5=maximum value)	Mean (SD) (hospital 1 = 544)	Mean (SD) (hospital 2 = 409)	(df) t-value ¹	d _{Cohen}
<i>Transformational Leadership Inventory (TLI short)</i>					
Transformational leadership	5=positive	3.2 (0.8)	3.2 (0.8)	(951) 0.191	0.00
<i>Copenhagen Psychosocial Questionnaire (COPSOQ)</i>					
Quality of leadership	high=positive	52.7 (22.6)	51.0 (23.4)	(951) 1.095	-0.07
Patient safety climate	Interpretation	Mean	Mean	(df) t	d _{Cohen}

(Continued)

	(1=minimum value, 5=maximum value)	(SD) (hospital 1 = 560)	(SD) (hospital 2 = 414)	value ¹	
Hospital Survey on Patient Safety Culture (HSPSC-D)					
Staffing	5=positive	2.5 (0.8)	2.6 (0.8)	(972) -0.965	0.13
Organizational learning	5=positive	3.1 (0.7)	3.0 (0.7)	(972) 0.758	-0.14
Communication openness	5=positive	3.6 (0.7)	3.5 (0.7)	(972) 2.207*	-0.14
Feedback & communication about error	5=positive	3.4 (0.8)	3.3 (0.9)	(972) 2.315*	-0.12
Nonpunitive response to error	5=positive	3.5 (0.8)	3.2 (0.8)	(843) 4.385*	-0.38
Teamwork within units	5=positive	3.4 (0.6)	3.3 (0.6)	(972) 1.669	-0.17
Teamwork across units	5=positive	3.1 (0.6)	3.0 (0.6)	(972) 1.800	-0.17
Handoffs & transitions	5=positive	3.1 (0.6)	3.0 (0.6)	(972) 2.187*	-0.17
Supervisor/ manager expectations	5=positive	3.3 (0.7)	3.3 (0.7)	(972) -0.273	0.00
Management support for patient safety	5=positive	2.8 (0.9)	2.7 (0.9)	(972) 1.579	-0.11
Outcome scales – Hospital Survey on Patient Safety Culture (HSPSC-D)					
Frequency of event reported	5=positive	3.0 (1.0)	3.0 (1.0)	(972) -0.191	0.00
Overall perceptions of patient safety	5=positive	3.0 (0.8)	3.1 (0.8)	(972) -1.262	0.13
Patient safety grade	1=positive	2.8 (0.8)	2.8 (0.7)	(972) 0.405	0.00
Safety grade in the medication process	1=positive	2.8 (0.7)	3.0 (0.8)	(972) -2.730*	0.27
Patient safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (hospital 1 = 544)	Mean (SD) (hospital 2 = 409)	(df) t-value¹	d_{Cohen}
TWINS Patient Safety (TWINS-PS)					
Supervisor support for patient safety	5=positive	3.5 (0.8)	3.5 (0.8)	(951) 0.702	0.00
My direct supervisor openly addresses problems concerning patient safety in our hospital	5=positive	3.3 (0.9)	3.3 (0.9)	(951) -0.794	0.00
My direct supervisor focuses more on patient safety than a year ago	5=positive	2.8 (0.9)	2.8 (1.0)	(847) 0.191	0.00
It is important to my direct supervisor that our hospital pays great attention to patient safety	5=positive	3.5 (0.9)	3.5 (0.9)	(951) 0.380	0.00
Hospital management openly addresses problems concerning patient safety in our hospital	5=positive	2.9 (0.8)	2.8 (0.9)	(864) 2.555*	-0.12
Hospital management focuses more on patient safety than a year ago	5=positive	2.7 (0.9)	2.8 (0.9)	(951) -0.382	0.11
It is important to the Hospital management that our hospital pays great attention to patient safety	5=positive	3.2 (0.9)	3.0 (1.0)	(951) 2.344*	-0.21
Do you have an individual influence on how well patient safety is implemented at the workplace	1=positive	3.1 (0.9)	3.0 (1.0)	(951) 1.434	-0.11
Occupational safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (hospital 1 = 544)	Mean (SD) (hospital 2 = 409)	(df) t-value¹	d_{Cohen}
TWINS Occupational Safety (TWINS-OS)					
Supervisor support for occupational safety	5=positive	3.5 (0.8)	3.4 (0.8)	(951) 0.736	-0.13
My direct supervisor openly addresses problems concerning occupational safety in our hospital	5=positive	3.3 (0.9)	3.2 (0.9)	(951) 1.683	-0.11
My direct supervisor focuses more on occupational safety than	5=positive	2.8 (0.9)	2.8 (0.9)	(853) 0.852	0.00

(Continued)

a year ago					
It is important to my direct supervisor that our hospital pays great attention to occupational safety	5=positive	3.3 (0.9)	3.2 (1.0)	(951) 1.252	-0.11
Hospital management openly addresses problems concerning occupational safety in our hospital	5=positive	3.1 (0.9)	2.9 (0.9)	(951) 2.470*	-0.22
Hospital management focuses more on occupational safety than a year ago	5=positive	2.7 (0.9)	2.7 (1.0)	(820) 0.220	0.00
It is important to the Hospital management that our hospital pays great attention to occupational safety	5=positive	3.1 (1.0)	3.0 (1.0)	(951) 1.193	-0.10
Do you have an individual influence on how well occupational safety is implemented at the workplace	1=positive	3.3 (0.9)	3.3 (1.0)	(951) 0.826	0.00
Occupational safety climate	Interpretation (1=minimum value, 5=maximum value)	Mean (SD) (hospital 1 = 560)	Mean (SD) (hospital 2 = 413)	(df) t-value¹	d_{Cohen}
Outcome scales – self constructed indices					
Subjective assessment of specific protective measures (behaviour & regulations) related to infectious diseases	1=positive	1.8 (0.6)	1.8 (0.6)	(971) 0.396	0.00
Subjective assessment of occupational safety measures initiated by the employer, related to own safety	1=positive	1.8 (0.6)	1.9 (0.6)	(835) -1.632	0.17
Personal perception of the frequency of occupational risks	5=positive	3.4 (0.7)	3.3 (0.8)	(825) 1.870	-0.13

Notes: ¹p-value* ≤.05

Author details

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, Wilhelmstraße 27, 72074 Tübingen, Germany. ²University of Applied Sciences and Arts Northwestern Switzerland, FHNW School of Applied Psychology, Riggenbachstrasse 16, 4600 Olten, Switzerland. ³Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tübingen, Silcherstraße 5, 72076 Tübingen, Germany. ⁴Berlin Institute of Health (BIH), Clinical Research Unit (CRU), Anna-Louisa-Karsch-Str. 2, 10178 Berlin, Germany. ⁵Institute of Biometry and Clinical Epidemiology, Charité – Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin, Germany. ⁶Institute for Patient Safety, University Hospital of Bonn, Sigmund-Freud-Str. 25, 53127 Bonn, Germany. ⁷independent consultant, Berlin, Germany.

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2.2 Publication 2

Objective: Identification of (shared) predictors for perceived patient and occupational safety culture from the perspective of nurses and physicians in the WorkSafeMed study

Authors: Anke Wagner*, Antje Hammer*, Tanja Manser, Peter Martus, Heidrun Sturm, Monika A. Rieger

*Anke Wagner and Antje Hammer contributed equally

Title: Do Occupational and Patient Safety Culture in Hospitals Share Predictors in the Field of Psychosocial Working Conditions? Findings from a Cross-Sectional Study in German University Hospitals

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Article

Do Occupational and Patient Safety Culture in Hospitals Share Predictors in the Field of Psychosocial Working Conditions? Findings from a Cross-Sectional Study in German University Hospitals

Anke Wagner^{1,†}, Antje Hammer^{2,*†}, Tanja Manser^{2,3}, Peter Martus⁴, Heidrun Sturm¹,
Monika A. Rieger¹ and on behalf of the WorkSafeMed Consortium^{1,‡}

¹ Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, Wilhelmstraße 27, 72074 Tübingen, Germany; Anke.Wagner@med.uni-tuebingen.de (A.W.); Heidrun.Sturm@med.uni-tuebingen.de (H.S.); Monika.Rieger@med.uni-tuebingen.de (M.A.R.)

² Institute for Patient Safety, University Hospital of Bonn, Sigmund-Freud-Str. 25, 53127 Bonn, Germany; Tanja.Manser@fhnw.ch

³ FHNW School of Applied Psychology, University of Applied Sciences and Arts Northwestern Switzerland, Riggensbachstrasse 16, 4600 Olten, Switzerland

⁴ Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tübingen, Silberstraße 5, 72076 Tübingen, Germany; Peter.Martus@med.uni-tuebingen.de

* Correspondence: Antje.Hammer@ukbonn.de; Tel.: +49-0228-287-13980

† Equal contribution.

‡ During the study: members of the WorkSafeMed Project Consortium were: Luntz, E., Rieger, M.A. (Project lead), Sturm, H., Wagner, A. (Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen), Hammer, A., Manser, T. (Institute for Patient Safety, University Hospital Bonn), Martus, P. (Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tübingen), Holderried, M. (University Hospital Tübingen).

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Abstract: Background: In the healthcare sector, a comprehensive safety culture includes both patient care-related and occupational aspects. In recent years, healthcare studies have demonstrated diverse relationships between aspects of psychosocial working conditions, occupational, and patient safety culture. The aim of this study was to consider and test relevant predictors for staff's perceptions of occupational and patient safety cultures in hospitals and whether there are shared predictors. From two German university hospitals, 381 physicians and 567 nurses completed a questionnaire on psychosocial working conditions, occupational, and patient safety culture. Two regression models with predictors for occupational and patient safety culture were conceptually developed and empirically tested. In the Occupational Safety Culture model, job satisfaction ($\beta = 0.26, p \leq 0.001$), work-privacy conflict ($\beta = -0.19, p \leq 0.001$), and patient-related burnout ($\beta = -0.20, p \leq 0.001$) were identified as central predictors. Important predictors in the Patient Safety Culture model were management support for patient safety ($\beta = 0.24, p \leq 0.001$), supervisor support for patient safety ($\beta = 0.18, p \leq 0.001$), and staffing ($\beta = 0.21, p \leq 0.001$). The two models mainly resulted in different predictors. However, job satisfaction and leadership seem to play an important role in both models and can be used in the development of a comprehensive management of occupational and patient safety culture.

Keywords: Germany; hospitals; occupational safety culture; patient safety culture; psychosocial working conditions; regression analysis; safety culture; transformational leadership

1. Introduction

In recent years, an increasing number of studies on safety culture have been carried out in the healthcare sector. Safety culture can be seen as part of the organizational culture and refers to “the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of an organization’s health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures” [1].

The safety of healthcare workers and patients is a particular challenge, especially for hospitals. A comprehensive view of safety culture comprises both occupational and patient safety culture. Most studies, however, observed occupational and patient safety culture separately [for occupational safety culture see, e.g., [2,3] and for patient safety culture, e.g., [4–9]. Recently, several studies were conducted that included both constructs [10–14].

Previous studies on occupational and patient safety culture analysed associations between different aspects of working conditions, organizational culture, safety culture, patient and worker outcomes [10–13]. The research group of Hofman and Mark adapted a questionnaire for safety culture in industrial organizations and surveyed hospital nurses in the United States [10]. They found that safety culture predicted nurse back injuries, nurse satisfaction, and patient-related adverse events, like medication errors, urinary tract infections, and patient satisfaction [10]. A literature review found evidence that organizational climate influenced such nurse outcomes as, for example, less fluctuation among nurses, burnout, and job dissatisfaction [11]. There were also some tendencies showing that organizational climate was associated with patient outcomes, such as treatment errors and infections, but the authors stated that the results were inconsistent [11]. A survey of 723 American nurses by Taylor and colleagues showed that a poor safety culture was associated with injuries to both nurses and patients [12]. In another survey of 1866 clinical staff in Scotland, Agnew and colleagues again tested which dimensions of hospital safety climate were associated with patient and worker safety outcome measures (self-reported behaviour, patient injury, worker injuries), and also examined the influence of hospital climate perceptions on patient and worker-related safety outcomes [13]. In their study, Agnew and colleagues confirmed the previous results of Hofman et al. (2006) and Taylor et al. (2012).

A recently published study examined the relationship between occupational and patient safety culture [14]. Pousette and colleagues surveyed 1154 nurses, 886 assistant nurses, and 324 physicians in Sweden [14]. Their findings indicated that both kinds of safety culture had a strong positive correlation to each other. The authors concluded that integrated and coordinated interventions to improve safety culture should focus on occupational and patient safety together [14]. In an article published in 2005, Yassi and Hancock already proposed a comprehensive approach to safety culture that takes into account organizational factors and psychological and physical aspects of healthcare workers, among other things [15]. The authors stated that a comprehensive approach represents the best way to improve the healthcare workplace and as a consequence patient safety [15].

In summary, previous studies on occupational and patient safety culture in healthcare supported the presumed associations between working conditions and occupational and patient safety cultures. Yet, safety culture was often investigated with a special emphasis on either staff-related or patient-related injuries. In order to develop integrated interventions to manage occupational and patient safety culture, further research is needed on relevant predictors and their possible interrelationships. Currently, little or no research exists identifying predictors of both types of safety culture. However, identifying and examining similar and comprehensive predictors are important, because these predictors can be relevant components in a concept for the comprehensive integrated management of occupational and patient safety culture.

Therefore, we investigated the following research question in the current study: From the point of view of nurses and physicians, which predictors (from the areas of psychosocial working conditions, patient safety, and occupational safety) affect the occupational and patient safety culture in the hospital?

The aim of our study was to consider and to identify potential predictors that were similar for both kinds of safety culture and whether there are shared predictors. After choosing relevant predictors for occupational and patient safety culture, models will be developed and tested simultaneously for the first time. Thus, we seek contributing to existing theories on occupational and patient safety and provide first insight in comprehensive and integrated models for occupational and patient safety culture to be tested in future studies. In long term, such models will help to identify common drivers for effective and resource efficient interventions in practice that serve both outcomes.

2. Materials and Methods

2.1. Study Design, Survey Instrument, and Data Collection

Between 2014 and 2017, we conducted the cross-sectional, bicentric, mixed-methods project “Working Conditions, Safety Culture and Patient Safety in Hospitals—What predicts the Safety of the Medication Process (WorkSafeMed)” [16]. Part of the WorkSafeMed project was a staff survey that formed the basis of the study presented here. The staff survey was conducted between April and July 2015, in two German university hospitals. Hospital selection was based on a convenient sample to have an appropriate sample size large enough to perform multivariate analyses and keep organizational characteristics as comparable as possible. We included inpatient units that treat at least 500 patients per year. We excluded intensive care and psychiatric units. In total, we collected data from 37 departments, including 73 units using a standardized paper-based questionnaire. The questionnaire was distributed to a total of 2512 physicians and nurses. We conducted at least one oral or written reminder one month after survey distribution.

The questionnaire included scales from common and validated instruments to measure psychosocial working conditions, transformational leadership, patient safety culture, and added self-constructed items to assess occupational safety culture:

- To measure psychosocial working conditions, we employed 17 scales of the German version of the Copenhagen Psychosocial Questionnaire (COPSOQ) [17,18]. We also adapted one scale from the Copenhagen Burnout Inventory (client-related burnout) [19] to measure patient-related burnout, and we used the short scale on Transformational Leadership (TLI-short) to assess transformational leadership [20,21].
- To capture different dimensions of patient safety culture, we focussed on the German version of the Hospital Survey on Patient Safety Culture (HSPSC-D) [22], and on a newly developed set of twin-items worded correspondingly to occupational safety culture items (TWINS Patient Safety).
- To measure different dimensions of occupational safety culture, we inserted three self-constructed indices (good Cronbach’s alpha from 0.76 to 0.82) and a set of twin items worded analogously to some patient safety culture items (TWINS Occupational Safety).

Prior to data collection, a pretest was carried out with 4 physicians and 8 nurses. An overview of all scales and items of the final questionnaire is provided in Table 1.

Table 1. Overview of scales and items of the questionnaire.

Topic	Instrument	Scales/Indices/Single Items	Interpretation
Psychosocial working conditions	COPSOQ ¹ [17,18]	Quantitative demands (scale, 4 items)	High = negative
		Emotional demands (scale, 3 items)	High = negative
		Work-privacy-conflict (scale, 5 items)	High = negative
		Influence at work (scale, 4 items)	High = positive
		Degree of freedom at work (scale, 4 items)	High = positive
		Possibilities for development (scale, 4 items)	High = positive
		Meaning of work (scale, 3 items)	High = positive
		Workplace commitment (scale, 4 items)	High = positive
		Predictability (scale, 2 items)	High = positive
		Role clarity (scale, 4 items)	High = positive
		Role conflicts (scale, 4 items)	High = negative
		Social relations (scale, 2 items)	High = positive
		Feedback (scale, 2 items)	High = positive
		Social support (scale, 4 items)	High = positive
		Sense of community (scale, 3 items)	High = positive
		Quality of leadership (scale, 4 items)	High = positive
		Job satisfaction (scale, 7 items)	High = positive
	adapted from CBI ² [19]	Patient-related burnout (scale, 6 items)	High = negative
	TLI short ³ [20,21]	Transformational leadership (scale, 6 items)	High = positive
	Patient safety dimensions	HSPSC-D ⁴ [22]	Teamwork within units (scale, 4 items)
Staffing (scale, 4 items)			High = positive
Organizational learning (scale, 3 items)			High = positive
Nonpunitive response to error (scale, 3 items)			High = positive
Supervisor/ manager expectations (scale, 4 items)			High = positive
Feedback and communication about error (scale, 3 items)			High = positive
Communication openness (scale, 3 items)			High = positive
Management support for patient safety (scale, 3 items)			High = positive
Teamwork across units (scale, 4 items)			High = positive
Handoffs and transitions (scale, 4 items)			High = positive
Frequency of event reported (scale, 3 items)			High = positive
Overall perceptions of patient safety (scale, 4 items)			High = positive
Patient safety grade (single item)			Low = positive
Safety grade in the medication process (single item)		Low = positive	
TWINS Patient Safety ⁴		Supervisor support for patient safety (scale, 3 items)	High = positive
		My direct supervisor openly addresses problems concerning patient safety in our hospital (single item)	High = positive
		My direct supervisor focuses more on patient safety than a year ago (single item)	High = positive
		It is important to my direct supervisor that our hospital pays great attention to patient safety (single item)	High = positive
		Hospital management openly addresses problems concerning patient safety in our hospital (single item)	High = positive
		Hospital management focuses more on patient safety than a year ago (single item)	High = positive
	It is important to the hospital management that our hospital pays great attention to patient safety (single item)	High = positive	
Do you have an individual influence on how well patient safety is implemented at the workplace? (single item)	Low = positive		

Table 1. Cont.

Topic	Instrument	Scales/Indices/Single Items	Interpretation
Occupational safety dimensions	Self-developed indices ⁵	Subjective assessment of specific protective measures (behaviour and regulations) related to infectious diseases (index, 7 items)	Low = positive
		Subjective assessment of occupational safety measures initiated by the employer, related to own safety (index, 6 items)	Low = positive
		Personal perception of the frequency of occupational risks (index, 4 items)	High = positive
	TWINS Occupational Safety ⁵	Supervisor support for occupational safety (scale, 3 items)	High = positive
		My direct supervisor openly addresses problems concerning occupational safety in our hospital (single item)	High = positive
		My direct supervisor focuses more on occupational safety than a year ago (single item)	High = positive
		It is important to my direct supervisor that our hospital pays great attention to occupational safety (single item)	High = positive
		Hospital management openly addresses problems concerning occupational safety in our hospital (single item)	High = positive
		Hospital management focuses more on occupational safety than a year ago (single item)	High = positive
		It is important to the hospital management that our hospital pays great attention to occupational safety (single item)	High = positive
Do you have an individual influence on how well occupational safety is implemented at the workplace? (single item)	Low = positive		

¹ COPSOQ scales (possible range 1–4 or 1–5), before calculating scale scores, scales were transformed into scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”). ² CBI scale (possible range 1–5), before calculating scale scores, scales were transformed into scores ranging from 0 (minimum value, “do not agree at all”) to 100 points (maximum value, “fully agree”). ³ TLI short scale (possible range 1–5). ⁴ HSPSC-D scales, TWINS Patient Safety single items (possible range 1–5). ⁵ Self-developed indices, TWINS Occupational Safety single items (possible range 1–5).

2.2. Ethics and Confidentiality Issues

Ethical approval was obtained from the ethical committees at the two participating university hospitals (reference numbers: #350/14 and #547/2014BO1). Informed consent was sought from participants, who were informed that the study was voluntary and that they could withdraw at any time. All data were analysed anonymously.

2.3. Statistical Analyses

Prior to data analyses, we imputed missing values in the survey data by grouping items into four separate imputation groups. Within each imputation group, respondents with missing values of >30% for scale items were excluded due to the limited data quality. Data for each imputation group were imputed with NORM 2.03 software using the Expectation-Maximization-algorithm [23,24].

In this study, statistical analyses included descriptive statistics, bivariate correlations, exploratory factor analysis, and stepwise multiple regression analysis [25]. Descriptive statistics were used to determine mean values and standard deviations of continuous variables and scale-scores, and absolute and percentage frequencies of categorical variables. Exploratory factor analysis was conducted to reduce and summarize the two twin-item sets for occupational and patient safety culture into four factors. In each case three items related to the direct supervisor formed the factors “occupational safety-related behaviour of the direct supervisor” (factor) and “patient safety-related behaviour of

the direct supervisor" (factor). Also three items were used to create the following factors related to hospital management: "occupational safety-related behaviour of the hospital management" (factor) and "patient safety-related behaviour of the hospital management" (factor). In addition, two scales and two single items on patient safety culture (HSPSC-D) were combined into one factor that represents the "perceived patient safety" by physicians and nursing staff. The five factors we developed are shown in Table 2.

Table 2. Results of the exploratory factor analysis.

Source	Single Items	Constructed Factor
TWINS Occupational Safety	<ul style="list-style-type: none"> - My direct supervisor openly addresses problems concerning occupational safety in our hospital (single item) - My direct supervisor focuses more on occupational safety than a year ago (single item) - It is important to my direct supervisor that our hospital pays great attention to occupational safety (single item) 	Factor "Occupational safety-related behaviour of the direct supervisor"
TWINS Occupational Safety	<ul style="list-style-type: none"> - Hospital management openly addresses problems concerning occupational safety in our hospital (single item) - Hospital management focuses more on occupational safety than a year ago (single item) - It is important to the hospital management that our hospital pays great attention to occupational safety (single item) 	Factor "Occupational safety-related behaviour of the hospital management"
TWINS Patient Safety	<ul style="list-style-type: none"> - My direct supervisor openly addresses problems concerning patient safety in our hospital (single item) - My direct supervisor focuses more on patient safety than a year ago (single item) - It is important to my direct supervisor that our hospital pays great attention to patient safety (single item) 	Factor "Patient safety-related behaviour of the direct supervisor"
TWINS Patient Safety	<ul style="list-style-type: none"> - Hospital management openly addresses problems concerning patient safety in our hospital (single item) - Hospital management focuses more on patient safety than a year ago (single item) - It is important to the hospital management that our hospital pays great attention to patient safety (single item) 	Factor "Patient safety-related behaviour of the hospital management"
HSPSC-D [22]	<ul style="list-style-type: none"> - Frequency of event reported (scale, three items) - Overall perceptions of patient safety (scale, four items) - Patient safety grade (single item) - Safety grade in the medication process (single item) 	Factor "Perceived patient safety"

For further data analysis in the process, all scales and variables were orientated in the same direction to ensure a uniform interpretation of bivariate correlations and multiple regression analysis. Positive therefore means a favourable interpretation and negative is to be equated with an unfavourable interpretation. Prior to the stepwise multiple regression analysis, bivariate correlations (Pearson) were conducted to investigate the relationship between all content-relevant variables in the questionnaire (see Supplementary Materials, Table S1). Then, two regression models were developed on a conceptual basis, with regard to both, an Occupational Safety Culture model and a Patient Safety Culture model. All tests were two-sided and a p -value ≤ 0.05 was considered statistically significant. We checked the developed models for the following parameters: Durbin-Watson test, multicollinearity, and residuals for the evidence of bias [25]. Cluster effects were adjusted for by using Generalized Estimating Equations (GEE) [26]. The specific type was GEE 1 with IEE (Independence Estimating Equations).

This method is a robust approach applicable if cluster effects are nuisance parameters and not of scientific interest, which is the case in our study. Essentially GEE 1 with IEE leaves regression parameter estimates unchanged but corrects the standard errors for cluster effects. In multiple regression models with variable selection the set of chosen variables might change compared to the naïve analysis without correction after application of GEE. Data were analysed using IBM Statistics SPSS for Windows, version 25 (IBM Corp., Armonk, NY, USA).

To develop the Occupational Safety Culture model, different scales were taken from the questionnaire since we assumed that well-designed psychosocial working conditions and leadership impact on perceived occupational safety culture. Therefore, we used the following scales, factors and single items from the areas of general psychosocial working conditions (stress, according strain, leadership), and occupational safety dimensions as independent variables (predictors):

- Stress: “quantitative demands” (COPSOQ), “emotional demands” (COPSOQ), “work-privacy-conflict” (COPSOQ),
- Strain: “job satisfaction” (COPSOQ) and “patient-related burnout” (adapted from CBI),
- Leadership focusing on a specific leadership style: “transformational leadership” (TLI-short),
- Leadership with regard to occupational safety: “supervisor support for occupational safety” (TWINS Occupational Safety), “occupational safety-related behaviour of the direct supervisor” (factor—TWINS Occupational Safety), “occupational safety-related behaviour of the hospital management” (factor—TWINS Occupational Safety), and
- Occupational safety dimension: “individual influence on how well occupational safety is implemented at the workplace” (single item—TWINS Occupational Safety).

The self-developed index “personal perception of the frequency of occupational risks” (see Table 1) represented the dependent variable, as we considered it a good indicator of perceived occupational safety culture.

The Patient Safety Culture model was developed analogously to the Occupational Safety Culture model. As for the Occupational Safety Culture model we presumed that well-designed psychosocial working conditions and leadership impact on perceived patient safety culture. However, the rather unspecific COPSOQ scales were not integrated into the Patient Safety Culture model, with the exception of the scale job satisfaction. Instead, HSPSC-D scales with similar contents as the respective COPSOQ scales but with a specific reference to patient safety were included in the model. We also used the following scales as independent variables (predictors) from the areas of psychosocial working conditions (strain, leadership), and patient safety dimensions:

- Strain: “job satisfaction” (COPSOQ), “patient-related burnout” (adapted from CBI),
- Leadership focusing on a specific leadership style: “transformational leadership” (TLI short),
- Leadership with regard to patient safety: “management support for patient safety” (HSPSC-D), “supervisor support for patient safety” (TWINS Patient Safety), “patient safety-related behaviour of the direct supervisor” (factor—TWINS Patient Safety), “patient safety-related behaviour of the hospital management” (factor—TWINS Patient Safety),
- Patient safety dimensions: “staffing” (HSPSC-D), “feedback and communication about error” (HSPSC-D), “organizational learning” (HSPSC-D), “handoffs and transitions” (HSPSC-D), and “individual influence on how well patient safety is implemented at the workplace” (single item—TWINS Patient Safety)

The factor “perceived patient safety” (see Table 2) represented the dependent variable.

3. Results

3.1. Descriptive Results

Out of 2512 distributed questionnaires, 995 (39.6%) were completed and returned. The characteristics of the sample are summarized in Table 3. In particular, the following socio-demographic characteristics

were requested: profession, gender, age, supervisor function, and professional experience in years. Overall, there were more nurses than doctors in our sample. The mean age of the participants was 37.67 years (SD = 10.69), and the average professional experience was 13.49 years (SD = 10.91) (see Table 3).

Table 3. Demographic characteristics of study respondents.

Characteristic	Responders	
	<i>n</i>	% ¹
Profession		
Nurse	567	57.0%
Physician	381	38.3%
Others	19	1.9%
Missing	28	2.8%
Gender		
Male	291	29.2%
Female	656	65.9%
Missing	48	4.8%
Age, mean (SD) years		
	37.67 (10.69)	
Missing	90	
Supervisor function		
Yes	195	19.6%
No	759	76.3%
Missing	41	4.1%
Professional experience, mean (SD) years		
	13.49 (10.91)	
Missing	61	

¹ Percentages do not sum up to 100% due to rounding.

3.2. Occupational Safety Culture Model

3.2.1. The Association between Psychosocial Working Conditions, Occupational Safety Dimensions, and Occupational Safety Culture

As shown in Table 4, there were significant associations between all independent variables and the dependent variable. Significant negative associations between our indicator for perceived occupational safety culture and independent variables were found for “quantitative demands” ($r = -0.25, p = 0.000$), “emotional demands” ($r = -0.23, p = 0.000$), “work-privacy conflict” ($r = -0.33, p = 0.000$), and “patient-related burnout” ($r = -0.35, p = 0.000$). We can therefore state that increasing values for these parameters were accompanied by a lower rating of the perceived occupational safety culture. Significant positive associations were found for “job satisfaction” ($r = 0.40, p = 0.000$), “transformational leadership” ($r = 0.21, p = 0.000$), “supervisor support for occupational safety” ($r = 0.23, p = 0.000$), “occupational safety-related behaviour of the direct supervisor” ($r = 0.20, p = 0.000$), “occupational safety-related behaviour of the hospital management” ($r = 0.24, p = 0.000$), and the “individual influence on how well occupational safety is implemented at the workplace” ($r = 0.21, p = 0.000$).

3.2.2. The Independent Variables Influencing Occupational Safety Culture

A stepwise multiple regression analysis was then carried out to identify relevant predictors for the perceived occupational safety culture (see Table 5). The following significant predictors prevailed: “job satisfaction” ($\beta = 0.26, p \leq 0.001$), “patient-related burnout” ($\beta = -0.20, p \leq 0.001$), and “work-privacy-conflict” ($\beta = -0.19, p \leq 0.001$), and “individual influence on how well occupational safety is implemented at the workplace” ($\beta = 0.08, p \leq 0.01$). Overall, the Occupational Safety Culture model achieved an explained variance of 0.27 R^2 .

Table 4. Occupational Safety Culture model—correlations of independent variables and the outcome “personal perception of the frequency of occupational risks”.

Independent Variables (Scales and Factors)	Dependent Variable ¹ (Index)		
	Pearson correlation	Sig0. (2-tailed)	N
<i>COPSOQ—Psychosocial working conditions</i>			
Quantitative demands (scale)	−0.25 **	0.000	970
Emotional demands (scale)	−0.23 **	0.000	970
Work-privacy-conflict (scale)	−0.33 **	0.000	970
Job satisfaction (scale)	0.40 **	0.000	970
<i>CBI—Patient-related burnout</i>			
Patient-related burnout (scale)	−0.35 **	0.000	970
<i>TLI short—Transformational leadership</i>			
Transformational leadership (scale)	0.21 **	0.000	940
<i>TWINS Occupational Safety—Occupational Safety Culture</i>			
Supervisor support for occupational safety (scale)	0.23 **	0.000	940
Occupational safety-related behaviour of the direct supervisor (factor)	0.20 **	0.000	940
Occupational safety-related behaviour of the hospital management (factor)	0.24 **	0.000	940
Individual influence on how well occupational safety is implemented at the workplace (single item)	0.21 **	0.000	940

¹ Dependent variable: personal perception of the frequency of occupational risks (index). ** Correlation is significant at the 0.01 level (two-tailed).

Table 5. Occupational Safety Culture model—stepwise linear regression analysis adjusted for cluster effects.

Variable Group	Variables	B	SE	β	Chi-Square	p
	Constant	3.01	0.21		197.056	0.000
<i>Psychosocial working conditions</i>	Job satisfaction (scale)	0.02	0.00	0.26	54.981	0.000
	Work-privacy conflict (scale)	−0.01	0.00	−0.19	33.513	0.000
	Patient-related burnout (scale)	−0.01	0.00	−0.20	37.331	0.000
<i>Occupational Safety Culture</i>	Individual influence on how well occupational safety is implemented at the workplace (single item)	0.06	0.02	0.08	7.830	0.005

N = 921, R² = 0.27, Adj. R² = 0.27. Dependent variable: personal perception of the frequency of occupational risks (index); Adjustment for cluster effects via Generalized Estimating Equations (GEE).

3.3. Patient Safety Culture Model

3.3.1. The Association between Psychosocial Working Conditions, Patient Safety Dimensions, and Patient Safety Culture

As shown in Table 6, we found one significant negative association between “perceived patient safety” and “patient-related burnout” (r = −0.30, p = 0.000). Only significant positive associations were found for all other variables. The highest positive correlations were found for the following variables: “management support for patient safety” (r = 0.66, p = 0.000), “organizational learning” (r = 0.60, p = 0.000), “supervisor support for patient safety” (r = 0.57, p = 0.000), “feedback and communication about error” (r = 0.55, p = 0.000), “patient safety-related behaviour of the hospital management” (r = 0.55, p = 0.000), “staffing” (r = 0.52, p = 0.000), and “job satisfaction” (r = 0.54, p = 0.000).

Table 6. Patient Safety Culture model—Correlations of independent variables and the outcome “perceived patient safety”.

Independent Variables (Scales and Factors)	¹ Dependent Variable (Factor)		
	Pearson correlation	Sig. (2-tailed)	N
<i>COPSOQ—Psychosocial working conditions</i>			
Job satisfaction (scale)	0.54 **	0.000	971
<i>CBI—Patient-related burnout</i>			
Patient-related burnout (scale)	−0.30 **	0.000	971
<i>TLI short—Transformational leadership</i>			
Transformational leadership (scale)	0.39 **	0.000	949
<i>HSPSC-D and TWINS Patient Safety—Patient Safety Culture</i>			
Staffing (scale)	0.52 **	0.000	974
Management support for patient safety (scale)	0.66 **	0.000	974
Organizational learning (scale)	0.60 **	0.000	974
Feedback and communication about error (scale)	0.55 **	0.000	974
Handoffs and transitions (scale)	0.44 **	0.000	974
Supervisor support for patient safety (scale)	0.57 **	0.000	949
Patient safety-related behaviour of the direct supervisor (factor)	0.45 **	0.000	949
Patient safety-related behaviour of the hospital management (factor)	0.55 **	0.000	949
Individual influence on how well patient safety is implemented at the workplace (single item)	0.46 **	0.000	949

¹ Dependent variable (factor): perceived patient safety (factor). ** Correlation is significant at the 0.01 level (two-tailed).

3.3.2. The Independent Variables Influencing Patient Safety Culture

The stepwise multiple regression analysis revealed the following significant predictors for the dependent variable “perceived patient safety”: “management support for patient safety” ($\beta = 0.24, p \leq 0.001$), “staffing” ($\beta = 0.21, p \leq 0.001$), “supervisor support for patient safety” ($\beta = 0.18, p \leq 0.001$), “organizational learning” ($\beta = 0.14, p \leq 0.001$), “feedback and communication about error” ($\beta = 0.14, p \leq 0.001$), “individual influence on how well patient safety is implemented at the workplace” ($\beta = 0.13, p \leq 0.001$), “handoffs and transitions” ($\beta = 0.12, p \leq 0.001$), “patient safety-related behaviour of the direct supervisor” ($\beta = -0.08, p \leq 0.01$), and “job satisfaction” ($\beta = 0.06, p \leq 0.05$) (see Table 7). Particularly relevant predictors were “management support for patient safety,” “supervisor support for patient safety,” and “staffing”. Overall, the Patient Safety Culture model achieved an explained variance of 0.64 R^2 .

Table 7. Patient Safety Culture model—stepwise linear regression analysis adjusted for cluster effects.

Variable Group	Variables	B	SE	β	Chi-Square	<i>p</i>
	Constant	−4.03	0.24		275.8	0.000
<i>Psychosocial working conditions</i>	Job satisfaction (scale)	0.01	0.002	0.06	4.94	0.026
	Management support for patient safety (scale)	0.28	0.03	0.24	72.1	0.000
<i>Patient Safety Culture</i>	Supervisor support for patient safety (scale)	0.24	0.05	0.18	27.5	0.000
	Staffing (scale)	0.27	0.03	0.21	95.7	0.000
	Organizational learning (scale)	0.21	0.04	0.14	23.0	0.000
	Feedback and communication about error (scale)	0.16	0.03	0.14	22.4	0.000
	Individual influence on how well patient safety is implemented at the workplace (single item)	0.13	0.02	0.13	29.8	0.000
	Handoffs and transitions (scale)	0.18	0.04	0.12	19.2	0.000
	Patient safety-related behaviour of the direct supervisor (factor)	−0.08	0.03	−0.08	6.64	0.010

N = 945, *R*² = 0.65, Adj. *R*² = 0.64. Dependent variable (factor): perceived patient safety (factor), Adjustment for cluster effects via Generalized Estimating Equations (GEE).

3.4. Comparison of the Shared Predictors Used in the Occupational Safety Culture model and in the Patient Safety Culture Model

In another comparison using the previous bivariate correlation analysis, the following independent variables were contrasted: “job satisfaction” (COPSOQ), “patient-related burnout” (adapted from CBI), and “transformational leadership” (TLI short). We also reviewed and compared the bivariate correlations to the TWINS on Occupational and Patient Safety Culture. The comparison demonstrated that the correlations of the independent variables to our dependent variable for Patient Safety Culture performed better than the correlations of the independent variables to the dependent variable for Occupational Safety Culture (see Table 8).

An additional correlation analysis (Pearson) performed between the dependent variable for Occupational Safety Culture (“personal perception of the frequency of occupational risks”) and the dependent variable for Patient Safety Culture (“perceived patient safety”) revealed a significant positive association (*r* = 0.352, *p* = 0.000). The correlation coefficient corresponded to a medium effect.

Table 8. Correlations of independent variables used in both models.

	Associations between Independent Variables and the Dependent Variable ¹ for Occupational Safety Culture			Associations between Independent Variables and the Dependent Variable ² for Patient Safety Culture		
	Pearson Correlation	Sig. (2-Tailed)	N	Pearson Correlation	Sig. (2-Tailed)	N
COPSOQ			Job satisfaction (scale)			
	0.40 **	0.000	970	0.54 **	0.000	971
Adapted from CBI			Patient-related burnout (scale)			
	−0.35 **	0.000	970	−0.30 **	0.000	971
TLI short			Transformational leadership (scale)			
	0.21 **	0.000	940	0.39 **	0.000	949

Table 8. Cont.

	Associations between Independent Variables and the Dependent Variable ¹ for Occupational Safety Culture			Associations between Independent Variables and the Dependent Variable ² for Patient Safety Culture		
	TWINS Occupational Safety versus TWINS Patient Safety	Supervisor support for occupational safety (scale)			Supervisor support for patient safety (scale)	
0.23 **		0.000	940	0.57 **	0.000	949
Occupational safety-related behaviour of the direct supervisor (factor)			Patient safety-related behaviour of the direct supervisor (factor)			
0.20 **		0.000	940	0.45 **	0.000	949
Occupational safety-related behaviour of the hospital management (factor)			Patient safety-related behaviour of the hospital management (factor)			
0.24 **	0.000	940	0.55 **	0.000	949	
Individual influence on how well occupational safety is implemented at the workplace (single item)			Individual influence on how well patient safety is implemented at the workplace (single item)			
0.21 **	0.000	940	0.46 **	0.000	949	

¹ Dependent variable: personal perception of the frequency of occupational risks (index). ² Dependent variable: perceived patient safety (factor). ** Correlation is significant at the 0.01 level (two-tailed).

4. Discussion

In this study, we investigated potential predictors as similar as possible in the field of psychosocial working conditions, occupational and patient safety culture. Based on the selected predictors, models for occupational and patient safety culture were developed and tested simultaneously for the first time. Identifying and examining similar and comprehensive predictors is important, because these predictors can be used in the ongoing discussion for developing a comprehensive and integrated management of occupational and patient safety culture. Our results allow first insight for identifying common drivers—e.g., the concept of common education and training addressing both, occupational and patient safety culture in health care—to support effective and resource efficient interventions that serve both outcomes.

4.1. Occupational Safety Culture Model

In the correlation analyses, we discovered negative associations between demands, work-privacy-conflict, patient-related burnout, and our dependent variable to depict perceived occupational safety culture (“Personal perception of the frequency of occupational risks”). Based on these finding, we can conclude that more stressful psychosocial working conditions, such as high demands and increased risk for burnout, go hand in hand with a lower perception of occupational safety culture. Unfortunately, there are few studies in the healthcare sector that have investigated these links between demands, work-privacy conflict, patient-related burnout, and occupational safety culture. A previous study with 250 nurses investigated the relationship between occupational burnout and safety climate in the workplace [3]. They found a significant negative correlation between safety climate and all dimensions of occupational burnout. As a consequence, a higher occupational burnout implied a lower level of safety climate, and nurses with no or lower stress had a better perception of safety climate [3].

In our correlation analyses, positive associations were found for “job satisfaction”, “transformational leadership”, “supervisor support for occupational safety”, “occupational safety-related behaviour of the direct supervisor”, “occupational safety-related behaviour of the hospital management”, and the “individual influence on how well occupational safety is implemented at the workplace”. Thus, job satisfaction as a variable for strain and positively experienced leadership style and behaviour seem to contribute to a favourable occupational safety culture. Zarei and colleagues also found that nurses with higher job satisfaction and higher job interest had a better perception of safety climate in the workplace [3]. Another study investigated the link between leadership and safety outcomes in hospitals and conducted a survey with 600 nurses [27]. This study showed the positive association

of resonant leadership and interactional justice on relationships, quality of work environment, and specific outcomes of safety climate, e.g., decreased reported medication errors, intentions to leave, and emotional exhaustion [27].

In our tested Occupational Safety Culture model, “job satisfaction,” “work-privacy conflict,” and “patient-related burnout” were identified as central predictors of “perceived occupational safety culture.” Surprisingly, transformational leadership and the other scales of leadership with regard to occupational safety are not relevant in the model. A possible explanation for this result might be that the variable “job satisfaction” in the single items partly includes some attitudes to leadership as an indirect question. This could be the reason why other scales for leadership do not play a role in the model. Based on the identified predictors in the model, the promotion of high job satisfaction and the reduction of psychosocial strain and stress such as patient-related burnout and work-privacy conflict could contribute to an improved occupational safety culture. Hospital work is currently characterized by high demands in the field of psychosocial working conditions, especially in Germany. There is an increasing number of patients with multimorbidity and need for care. At the same time, there is a high shortage of nurses and physicians in the health care system. This could lead to high demands and stress for nurses and physicians. In our opinion, this development can also impede or even hinder the implementation and improvement of an occupational safety culture.

In summary, our investigated predictors in the Occupational Safety Culture model explained only 27% of the variance. Due to this rather low model quality, we assume that the occupational safety culture was insufficiently captured in our questionnaire and that essential predictors are still missing in the model. Flin already proposed a model with important elements for occupational safety culture in healthcare [28]. Elements in the model were derived from research in industrial settings and based on organisational aspects (e.g., perceptions of management and supervisor; prioritisation of safety), motivational aspects (e.g., expectations regarding outcomes for particular behaviours), unsafe behaviours (e.g., not taking precautions, rule breaking, risk taking, not speaking up, not reporting incidents/near misses), and errors (e.g., worker injury) [28]. Our questionnaire focussed mainly on organisational aspects with the perceptions of management and supervisors regarding safety issues. So, in future studies, our questionnaire should be augmented to question and analyse more motivational aspects, unsafe behaviours, and specific worker injuries in the hospital setting.

4.2. Patient Safety Culture Model

In our correlation analysis, we found one significant negative association between “perceived patient safety” and “patient-related burnout.” Similar to the Occupational Safety Culture model, patient-related burnout as indicator for psychosocial strain also seemed to be accompanied by a lower perception of patient safety culture. However, our study only covered one dimension of burnout. Therefore, this result can only be compared with other studies to a very limited extent. The negative relationship between burnout and a lower perception of patient safety culture has been confirmed in other studies e.g., [29–33]. In 2008, Halbesleben and colleagues questioned 148 nurses and showed an association between burnout and the perception of a lower patient safety culture and an unsafe environment [29]. Alves and colleagues conducted a correlation study with 267 nurses and found that a lower level of emotional exhaustion was accompanied by a more positive perception of the patient safety climate [30,31]. Profit et al. investigated the relationship between burnout and patient safety culture in neonatal intensive care units [32]. They questioned 2073 nurses, nurse practitioners, respiratory care providers, and physicians. As a result, neonatal intensive care units with more burnout had a lower teamwork climate and a lower patient safety climate [32]. Vifladdt and colleagues also conducted a study in intensive care units with 143 nurses and confirmed the previous results. A favourable safety culture was therefore associated with the absence of burnout [33].

Only significant positive associations were found for all other variables in the correlation analyses. Positive correlations were found for “management support for patient safety,” “supervisor support for patient safety,” and “patient safety-related behaviour of the hospital management.” This

shows the importance of leadership for a patient safety culture. Positive correlations were also evident in “organizational learning,” “feedback and communication about error,” “staffing”, and “job satisfaction.” Alves and colleagues were also able to confirm the positive correlation between better work environment, higher job satisfaction and a more positive judgment of the patient safety climate [30,31].

In the tested Patient Safety Culture model the following predictors prevailed:

- predictors about work-related psychosocial strain (job satisfaction),
- predictors about leadership with regard to patient safety, e.g., management support for patient safety (scale), supervisor support for patient safety (scale), patient safety-related behaviour of the direct supervisor (factor),
- predictors about patient safety dimensions, e.g., staffing (scale), feedback and communication about error (scale), organizational learning (scale), handoffs and transitions (scale), and individual influence on how well patient safety is implemented at the workplace (single item).

Studies to date confirm these results in part, and reveal the importance of certain scales for patient safety culture. For example Alves and colleagues found that the job satisfaction variable was predictive of safety climate [31]. In our study, the impact of the scale job satisfaction on our dependent variable, perceived patient safety, was very low. This may be because the job satisfaction scale from the COPSOQ questionnaire is already better represented in other HSPSC scales with a specific emphasis on patient safety (e.g., support for patient safety, staffing, organizational learning and, feedback and communication about error).

A recently conducted review examined the relationship between nurse working conditions and patient outcomes, and reported the association between staffing, resource adequacy, and patient outcomes [34]. Aiken and colleagues conducted the well-known RN4CAST study. As part of their study, they demonstrated the relationship between an increase in workload and the likelihood of hospital mortality in different European countries [35]. The results imply that nurse staffing cuts might adversely affect patient outcomes [35]. Schubert and colleagues explored the relationship between rationing of nursing care and inpatient mortality in Swiss hospitals [36]. The results of the study revealed that patients treated in hospitals with an increased rationing level and a high patient-to-nurse ratio had a higher risk of mortality [36].

To improve the perceived patient safety culture for nurses and physicians, the following measures can be derived from the tested predictors. Managers and direct supervisors play a pivotal role and should be supported in implementing a patient safety culture. In addition, dealing with errors, open communication, and feedback can contribute to improving patient safety culture. The results imply that adequate staffing and other factors, such as organisational learning, have a high influence on how patient safety culture is experienced by both nurses and physicians. The chosen predictors in the model explained 64% of the variance. In general, the Patient Safety Culture model demonstrated a high and satisfying model quality.

4.3. Summary and Implications for a Comprehensive Integrated Management of Occupational and Patient Safety Culture

We identified and tested different potential predictors in the area of psychosocial working conditions, occupational, and patient safety with an impact on perceived occupational and patient safety culture. The initial correlation analyses revealed that job satisfaction and leadership were associated with higher and patient-related burnout with a lower occupational and patient safety culture. The Patient Safety Culture model showed a high and satisfactory quality in contrast to the Occupational Safety Culture model. General job satisfaction was the only significant predictor in both tested models, but the impact in the Patient Safety Culture model was comparably very low. Leadership (support and role model function) was also identified as an important indirect (occupational safety culture—modifying job satisfaction) or direct (patient safety culture) predictor

in both models. In summary, job satisfaction and leadership seem to play a crucial role and should therefore be considered in a comprehensive integrated management of both, occupational and patient safety culture. However, further studies are needed to confirm our results.

4.4. Strengths and Limitations

For the first time, an attempt was made to develop models for occupational and patient safety culture simultaneously and to present interrelationships. The two models were developed in such a way that each model is as broad as possible in content but still empirically verifiable. By looking at two kinds of safety culture in parallel, a deeper understanding of overarching and specifically relevant predictors can be achieved. For professional practice, this means that communication on these topics and intervention approaches can benefit more specifically from synergies and specific influencing factors can also be taken into account.

There were also some limitations in our study. First, the survey was conducted at one point in time at two university hospitals in Germany. So—despite the rather good response rate of 39.6%—the results were neither representative for other university hospitals nor all hospitals in Germany. Thus, the generalizability for other healthcare contexts (type of hospital, healthcare sector, country) is unknown and need to be considered in further studies. In addition, the results were based on self-reports with highly subjective judgements in the survey data.

Second, we pursued a highly theoretical and explorative approach with a cross sectional design while developing the two models, so we cannot discuss causality. Even so, for drawing causal conclusions, further research is required to study the nature of these relationships using longitudinal studies. Moreover, we chose stepwise regression analyses to test our models. Even, this method is acceptable for exploratory model building [25], in future research different types of variable inclusion should be considered for further developments of these models [37]. Nonetheless, our data allow a first insight in comprehensive models for occupational and patient safety culture and point towards common predictors, providing an important base for future research.

Third, the two professional groups were analysed together in the regression analysis. In the future, it may be worthwhile to develop models separately according to each professional group. These models could be used to derive occupational group-specific interventions and improvements.

Fourth, variables of the two models were measured with different constructs, as no differentiated measure exists for occupational and patient safety so far. While patient safety culture was measured with the specific and established HSPSC-D, which also assesses the perception of some working conditions (e.g., staffing) in relation to patient safety, no such specific measure in relation to occupational safety was available. Instead, psychosocial working conditions were measured with the more generic COPSQ-questionnaire. Hence, the analyses of the possible impact of working conditions with regard to occupational and patient safety culture resulted in different models: in the Patient Safety Culture model, several constructs from the more generic measure were excluded, but from variables from the more specific measure were retained. However, the results show, that basic assumptions (e.g., for Transformational leadership and Job satisfaction) remain relevant. In future research the development of more differentiated measures on working conditions with regard to occupational and patient safety should be considered for improving our models. Moreover, as we focussed solely on transformational leadership, other leadership styles, such as transactional leadership, relationship-based approaches or laissez faire might be worth to consider.

Finally, another limitation lies in the Occupational Safety Culture model. Essential predictors seemed to be missing in this model; we achieved a rather low model quality. The additional comparison of some independent variables used in both models revealed for example that the correlation analyses for the dependent variable for patient safety (“perceived patient safety”) performed better than the correlation analyses for the dependent variable for occupational safety (“personal perception of the frequency of occupational risks”). We also found only a medium-strong association between the dependent variables for the two models. In principle, there are two possible interpretations of our

findings: (1) Both concepts, occupational and patient safety culture are only moderately related to each other and thus do not share common predictors. However, due to the overall limited predictability of occupational safety culture we favor a different interpretation: (2) The operationalization of occupational safety culture has not been successful, and by improving the measurement of this concept, we would find stronger correlations of the two concepts and a larger number of shared predictors.

5. Conclusions

In our study we found a good predictability of patient safety, but not of occupational safety using established and novel predictors. Moreover, we only found a limited number of shared predictors of both concepts. However, the identified predictors (job satisfaction and leadership) might be useful for the ongoing discussion and later development of a concept for the comprehensive integrated management of occupational and patient safety culture. Additionally, we hypothesize that operationalization of occupational safety has to be improved. Further studies should focus not only on safety culture, but also on outcomes relevant to patients and staff, like specific indicators for safety [38]. These studies should also analyse which predictors are relevant for perceived occupational safety culture in the hospital setting. Answering these questions can support the integrated management of occupational and patient safety culture, and the further holistic development of a safety culture in the hospital setting.

Supplementary Materials: The following table is available online at <http://www.mdpi.com/1660-4601/15/10/2131/s1>, Table S1: Additional correlations of independent variables (COPSOQ, adapted CBI, TLI short, TWINS) with the two dependent variables.

Author Contributions: A.W., and A.H. drafted the manuscript. M.A.R., H.S., T.M., and P.M. gave valuable input for the text. A.W., A.H., M.A.R., T.M., and P.M. developed the study design, A.H., H.S., T.M., P.M., and M.A.R. developed the questionnaire including the pretest. A.H., H.S., T.M., and M.A.R. planned the data collection, wrote the study protocol, and performed the survey. A.W. and P.M. performed the statistical analysis and received valuable advice from A.H. and M.A.R. All authors read and approved the final manuscript. Conceptualization, A.W., A.H., T.M., P.M., H.S. and M.R.; Data curation, A.W.; Formal analysis, A.W. and P.M.; Investigation, A.H., T.M., H.S. and M.R.; Methodology, A.W., A.H., T.M., H.S. and M.R.; Project administration, A.W. and A.H.; Supervision, A.H., P.M. and M.R.; Writing—original draft, A.W. and A.H.; Writing—review & editing, T.M., P.M., H.S. and M.R.

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2.3 Publication 3

Objective: Assessment of working conditions of nurses and physicians in the WorkSafeMed study and comparison with corresponding reference data from the German COPSQ-Database

Authors: Anke Wagner, Matthias Nübling, Antje Hammer, Tanja Manser, Monika A. Rieger

Title: Comparing perceived psychosocial working conditions of nurses and physicians in two university hospitals in Germany with other German professionals - Feasibility of scale conversion between two versions of the German Copenhagen Psychosocial Questionnaire (COPSQ)

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RESEARCH

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Comparing perceived psychosocial working conditions of nurses and physicians in two university hospitals in Germany with other German professionals - feasibility of scale conversion between two versions of the German Copenhagen Psychosocial Questionnaire (COPSOQ)

Anke Wagner^{1*} , Matthias Nübling², Antje Hammer³, Tanja Manser⁴, Monika A. Rieger¹
and on behalf of the WorkSafeMed Consortium

Abstract

Background: In 2015, the WorkSafeMed study assessed, amongst others, perceived psychosocial working conditions in nurses ($n = 567$) and physicians ($n = 381$) from two German university hospitals using scales from the German standard version of the COPSOQ (Copenhagen Psychosocial Questionnaire). This standard version is based on the international COPSOQ I and II. Since 2017, a further developed version of the German COPSOQ (G-COPSOQ III) has been available and data from this version are stored in the German COPSOQ database. The aim of the present study was to compare scales depicting perceived psychosocial workloads and strain in hospital staff from the WorkSafeMed study with reference data (hospital care nurses, general hospital physicians, reference values across all occupations) from the German COPSOQ database (2012–2017). As preliminary work, we explored whether a conversion of COPSOQ scales based on data from the WorkSafeMed study to the G-COPSOQ III scales was possible.

Methods: We applied a multistep approach for conversion. First, we compared 17 COPSOQ scales used in the WorkSafeMed study with the corresponding scales from the G-COPSOQ III according to content and then decided if a conversion was appropriate. If possible, we converted WorkSafeMed scales - the converted scales comprised the same content and number of items as in G-COPSOQ III. An explorative statistical analysis for each original and converted WorkSafeMed scale followed detecting possible statistical and relevant differences between the scales. We then compared converted WorkSafeMed scales with reference data from the German COPSOQ database.

(Continued on next page)

* Correspondence: anke.wagner@med.uni-tuebingen.de

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, Wilhelmstraße 27, 72074 Tübingen, Germany
Full list of author information is available at the end of the article



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Results: Based on the comparison undertaken according to content, a conversion was possible for 16 scales. Using the data from the WorkSafeMed study, the statistical analysis showed only differences between original and converted COPSOQ scales “control over working time” (mean 40.2 vs. 51.8, $d_{\text{Cohen}} = 0.56$) and “social relations” (mean 55.6 vs. 41.8, $d_{\text{Cohen}} = -0.55$). Comparing converted WorkSafeMed scales with reference data revealed higher values for “quantitative demands”, “work-privacy-conflict”, and “job satisfaction” in the WorkSafeMed sample.

Conclusions: The conversion of WorkSafeMed scales was appropriate, allowed a comparison with three reference values in the German COPSOQ database and revealed some implications for improving psychosocial working conditions of nurses and physicians in university hospitals in Germany.

Keywords: Psychosocial working conditions, Hospitals, Copenhagen psychosocial questionnaire, Physicians, Nurses, Explorative statistical analysis, COPSOQ database, Reference data

Background

The Copenhagen Psychosocial Questionnaire (COPSOQ) is a well-known and widely accepted instrument for measuring psychosocial working conditions in different professional branches. COPSOQ I was originally developed in Denmark in 1997, capturing a broad range of psychosocial working conditions [1]. According to the authors, the questionnaire should fulfil the following criteria: “...theory-based, but not attached to one specific theory..., ...consist of dimensions related to different levels of analysis (organization, department, job, person-work interface, and individual), ...include dimensions related to work tasks, the organization of work, interpersonal relations, cooperation and leadership, ...cover potential work stressors, as well as resources such as support, feedback, commitment, and good health, ... should be comprehensive..., ...should be generic, meaning that it should be applicable in all sectors of the labor market..., the medium-length and short versions should be “user friendly” with regard to work environment professionals and respondents (employees)” [1]. In 2004/2005, a validation study took place in Denmark to develop the second version of the Copenhagen Psychosocial Questionnaire (COPSOQ II) [2]. Since 2013, an international study has been carried out by researchers of the COPSOQ network (www.copsq-network.org) to develop the third version of the Copenhagen Psychosocial Questionnaire (COPSOQ III) [3]. This study contained in total 23.361 data records and more than 10.000 data records from Germany. The authors demonstrated within their study on the basis of the core items a comparable reliability of COPSOQ II and COPSOQ III. The developed COPSOQ III questionnaire contains new occupational health topics and intends to ensure international comparability [3]. Meanwhile, there are several validation studies on COPSOQ II and COPSOQ III from different countries that report satisfying values for reliability and validity [3–8].

In Germany, a first standard version of the COPSOQ questionnaire based on COPSOQ I was established and

tested in 2004 in a sample of 2561 employees [4]. As part of the validation study, a shortened version of the instrument was developed to have a suitable instrument for assessing psychosocial working conditions [9, 10]. This shortened version (2005) included 87 items and 25 aspects and has found widespread use as a paper and pencil questionnaire and as an online tool [10]. In 2011, new occupational health topics from the international COPSOQ II were included into the questionnaire, such as social capital, trust, and justice. Until 2017, the German standard version based on COPSOQ I and II was continuously further developed and completed. In 2017, the new German standard version based on COPSOQ III was made available. This German standard version based on COPSOQ III comprises 85 items and 26 aspects, and the psychometric validation of the questionnaire has recently been carried out [11]. To ease understanding, the following abbreviations for the different versions of the German COPSOQ standard version will be used throughout the rest of the article: G-COPSOQ I is the German standard version after the validation study based on COPSOQ I. G-COPSOQ II is the second German standard version based on COPSOQ I and II; G-COPSOQ III is the German standard version based on COPSOQ III.

In most cases, G-COPSOQ III utilizes the same items as in G-COPSOQ II, meaning there are only small differences in content between the scales used in both versions. There are mainly differences regarding the number of items. Table 1 shows an overview of the scales and number of items used in both versions.

In addition to the continuous development of the German COPSOQ questionnaire, new data were added to a steadily growing German COPSOQ database to enable the development of job-specific profiles of psychosocial factors at work [10]. Thus, institutions can compare their results with results from other jobs and with their job-specific reference values in the COPSOQ database [10]. In 2020, the COPSOQ database contains more than 400.000 reference values from various occupational

groups (e.g. manufacturers, technicians, teachers, social workers, waste management...) [10, 12]. As staff surveys using the COPSOQ are voluntary for companies and institutions, the COPSOQ database is not representative. This means that for some professions there is a high number of reference values, while other professions are not well represented. On top it has to be borne in mind, that in Germany staff surveys using the COPSOQ are often performed within the so-called psychosocial risk assessment i.e. as an occupational health and safety activity [13] and not within a study. For the hospital sector there exist currently a sufficient number of reference values for both nurses (> than 8000 cases) and physicians (> than 2000 cases) to perform comparisons. Yet,

the values are not classified according to the type or size of hospital (e.g. university hospital, general hospital).

Since 2017, the previous comparative dataset from surveys with G-COPSOQ I and II was transformed to the content of G-COPSOQ III, and only information fitting to or data assessed with this version (G-COPSOQ III) are now stored in the German COPSOQ database. Therefore, only scales and single items based on this version can be compared in the current COPSOQ database, whereas comparative data for studies using scales from G-COPSOQ II are no longer available. In general, it is important for further studies to find a way for the comparisons of results gathered with different versions of a questionnaire. One study compare COPSOQ I and

Table 1 Scales and number of items used in G-COPSOQ II and G-COPSOQ III

Scales	G-COPSOQ II N items	G-COPSOQ III N items
Domain: Demands		
Quantitative demands	4 items	3 items
Emotional demands	3 items	2 items
Demands for hiding emotions	2 items	2 items
Work-privacy-conflict	5 items	2 items
Domain: Influence and development		
Influence at work	4 items	3 items
Degree of freedom at work / control over working time	4 items	2 items
Possibilities for development	4 items	3 items
Meaning of work	3 items	2 items
Workplace commitment	4 items	2 items
Domain: Interpersonal relations and leadership		
Predictability	2 items	2 items
Role clarity	4 items	3 items
Role conflicts	4 items	3 items
Quality of leadership	4 items	4 items
Social support	4 items	4 items
Feedback	2 items	2 items
Social relations	2 items	Single item
Sense of community	3 items	2 items
Bullying	Single item	Single item
Trust & Justice	4 items	4 items
Further parameters		
Insecurity over employment	4 items	4 items
Domain: Strain (effects, outcomes)		
Intention to leave	Single item	Single item
Job satisfaction	7 items	6 items
General health	Single item	Single item
Burnout (CBI)	6 items	3 items
Overcommitment	3 items	Single item

COPSOQ II regarding the influence of psychosocial factors on a specific health outcome (need for recovery) [14]. But there are currently no studies that compare and convert scales from different versions of the COPSOQ questionnaire. Since the COPSOQ questionnaire is commonly used in Germany in both, science and occupational health and safety activities, and enables the continued comparison of results from studies that used the G-COPSOQ II questionnaire with data from the COPSOQ database, to us the question arose whether scales from G-COPSOQ II can be converted to scales from G-COPSOQ III.

Methods

Aim of the study

Our interest in this methodological question originates from the WorkSafeMed study as we wanted to compare scales depicting perceived psychosocial workloads and strain in hospital staff from this study in two university hospitals performed in 2015 with reference data (hospital care nurses, general hospital physicians as well as the reference value across all occupations) from the German COPSOQ database (2012–2017). The comparison with reference data can be used to derive some implications for improving psychosocial working conditions for nurses and physicians in university hospitals in Germany.

As the WorkSafeMed study used the G-COPSOQ II questionnaire and not the G-COPSOQ III questionnaire, we applied a multistep approach for conversion between these two versions to finally enable a comparison between the converted scales from the WorkSafeMed study and reference data (hospital care nurses, general hospital physicians as well as the reference value across all occupations) from the German COPSOQ database.

Design and setting

The WorkSafeMed study ("*Working conditions, safety culture and patient safety in hospitals – what predicts the safety of the medication process*") was a cross-sectional, multicenter, mixed-methods project conducted between 2014 and 2017 [15–18]. The study included a staff survey using a standardized paper-based questionnaire to assess psychosocial working conditions (G-COPSOQ II), patient and occupational safety cultures [15, 16], a chart review to evaluate the quality of the medication process [17] and the explorative correlation analysis of questionnaire and routine data to depict workload and quality of care [18].

Data collection, response rates, and sample characteristics

We conducted the survey of nursing staff and physicians at two German university hospitals between April 2015

and July 2015. All inpatient units (except for intensive care and psychiatric units) which treat at least 500 patients per year were included [16]. The paper-based questionnaire was distributed to a total of 2512 physicians and nurses. After about 2 to 4 weeks, one written reminder was sent and, if necessary, one oral reminder was communicated [16]. In the WorkSafeMed study, a total of 995 questionnaires were returned [16]. The overall response rate was 39.6% [16]. In total, we collected data from 37 departments, including 73 units. The sample consisted of 381 physicians and 567 nurses [16]. Forty-seven persons participated who either belonged to another professional group (19 persons) or gave no information on their professional status (28 persons) [16]. Table 2 describes the sample of nurses and physicians in the WorkSafeMed study. In the sample of nurses, more females and persons without supervisor functions were represented than in the physicians' sample. The mean age of the participating nurses was 38.6 years (± 11.9) and the average work experience was around 16.5 years (± 11.7). In the physician sample, there were slightly more men than women. The physicians' mean age was 36.1 years (± 8.2). Compared to nurses, physicians had less work experience of about 9.0 years (± 7.8).

Questionnaire

The paper-based questionnaire for the staff survey in the WorkSafeMed study used common and validated instruments [15, 16]. To assess *psychosocial working conditions*, we employed 17 scales of the G-COPSOQ II [9, 19]. Items were answered on a 4-point or 5-point Likert scale. Reverse coding was necessary for one item ("Do you work separate from your colleagues?") before scale calculation. To calculate scores, we followed the recommendation for COPSOQ transformation [10] and answering scales were transformed into scores ranging from 0 (minimum value, "do not agree at all") to 100 points (maximum value, "fully agree"). Depending on the wording of items within each COPSOQ scale, maximum values can be positive (high = positive) or negative (high = negative). An overview of the scales used in our questionnaire is shown in Fig. 1.

Ethics and confidentiality issues

Ethics approval was received from the ethical committees at the two university hospitals involved (Reference numbers #350/14 and #547/2014BO1). During the survey, participants were asked for informed consent. Participants were also informed that the study was voluntary and that they could withdraw their consent at any time. Only anonymized data were used for the statistical analysis [16].

Table 2 Description of the sample in the WorkSafeMed study (N = 995)

Profession	Variable	Categories	n (%)
Nurses n = 567	Gender	female	470 (82.9%)
		male	87 (15.3%)
		missing values	10 (1.8%)
	Supervisor function	yes	71 (12.5%)
		no	491 (86.6%)
		missing values	5 (0.9%)
	Direct patient contact	yes	565 (99.6%)
		no	2 (0.4%)
	Age (in years)	≤30	193 (34.0%)
		31–49	197 (34.7%)
≥50		177 (31.2%)	
Work experience (in years)	0–10	224 (39.5%)	
	11–20	135 (23.8%)	
	≥21	208 (36.7%)	
Work experience in the hospital (in years)	0–10	250 (44.1%)	
	11–20	115 (20.3%)	
	≥21	201 (35.4%)	
	missing values	1 (0.2%)	
Physicians n = 381	Gender	female	167 (43.8%)
		male	202 (53.0%)
		missing values	12 (3.1%)
	Supervisor function	yes	123 (32.3%)
		no	247 (64.8%)
		missing values	11 (2.9%)
	Direct patient contact	yes	377 (99.0%)
		no	3 (0.8%)
		missing value	1 (0.3%)
	Age (in years)	≤30	109 (28.6%)
31–49		214 (56.2%)	
≥50		58 (15.2%)	
Work experience (in years)	0–10	253 (66.4%)	
	11–20	80 (21.0%)	
	≥21	48 (12.6%)	
Work experience in the hospital (in years)	0–10	261 (68.5%)	
	11–20	41 (10.8%)	
	≥21	79 (20.7%)	

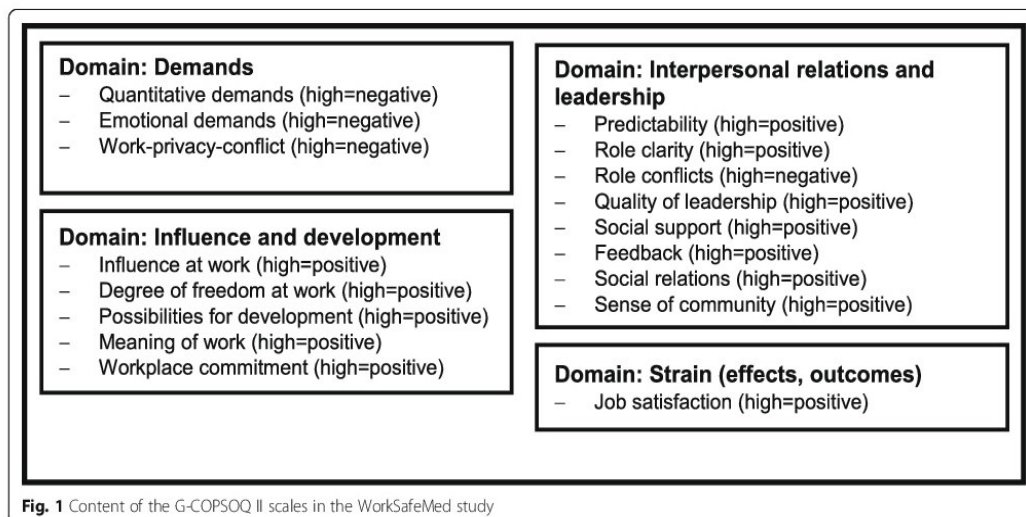


Fig. 1 Content of the G-COPSOQ II scales in the WorkSafeMed study

Data analysis

Before data analysis, missing values were imputed with NORM 2.03 software using the Expectation-Maximization-algorithm [20, 21]. Items of the COPSOQ scales were placed into two separate imputation groups (group 1: psychosocial working conditions/group 2: leadership) [16]. Respondents with missing values of >30% of items were excluded prior to the imputation because of the limited data quality. We excluded responses with missing values in imputation group 1 (psychological working conditions) $n = 4$ (0,4%), and in imputation group 2 (leadership): $n = 42$ (4,2%) [16].

Preliminary work

We applied, as preliminary work for the comparison with reference data, a multistep approach to convert original WorkSafeMed scales as formulated in the G-COPSOQ II to the scales from the current German COPSOQ database (G-COPSOQ III).

a) Comparison at a level of content

In a first step, we compared 17 G-COPSOQ II scales used in the WorkSafeMed study with the 17 corresponding scales from the G-COPSOQ III at a content level (including single items and response categories). The results of the comparison between the two versions (G-COPSOQ II versus G-COPSOQ III) can be summarized as follows:

- **Domain Demands:** In this domain, we found some differences at the item level for two scales (“*quantitative demands*” and “*work-privacy-conflict*”). For example, the number of items for both scales was reduced in G-COPSOQ III and the response categories for the scale “*work-privacy-conflict*” were modified. We discovered large differences for one scale (“*emotional demands*”). For this scale, two previous items were no longer used. Instead, a completely new item was introduced.
- **Domain Influence and development:** In this domain, we found some differences at the item level for all five scales. The number of items for all five scales was reduced. A slightly different item formulation was used in two scales (“*influence at work*” and “*workplace commitment*”), and response categories were modified for one scale (“*possibilities for development*”). Additionally, the scale name “*degree of freedom at work*” was renamed to “*control over working time*”.
- **Domain Interpersonal relations and leadership:** We also discovered some differences in this domain. The number of items for four scales (“*role clarity*”, “*role conflicts*”, “*social relations*”, and “*sense of*

community”) was reduced and there was an added response category for two scales (“*social relations*” and “*sense of community*”). For four scales (“*predictability*”, “*social support*”, “*feedback*”, and “*quality of leadership*”), only minimal differences were found, and the number of items remained the same. We found a slightly different item formulation and an added response category for three scales (“*social support*”, “*feedback*”, and “*quality of leadership*”).

- **Domain Strain:** There were some differences at the item level for the scale “*job satisfaction*”. The number of items was reduced, a slightly different item formulation was used, and we found modified response categories.

Table 3 shows the comparison of scales, single items, and response categories of the two versions.

After the comparison, all differences found regarding the content were discussed by the team (AW, MN and MAR) and a consensus was reached as to whether a conversion of the original scales from the WorkSafeMed dataset would be appropriate or not, i.e. the post-hoc reconstruction of the G-COPSOQ III using data assessed by the G-COPSOQ II. We decided not to convert the scale “*emotional demands*”, since the discovered differences in content were considered too comprehensive.

b) Post-hoc reconstruction of WorkSafeMed scales

In a second step, 16 original WorkSafeMed scales (G-COPSOQ II) were converted in accordance to the scales from the current G-COPSOQ III. For the post-hoc-reconstruction of original WorkSafeMed scales, we converted the items of a scale, which are also used for the respective scale of G-COPSOQ III, so that the scales comprised the same content and the same number of items of this version. In most cases, the same response options were used for the different versions of the questionnaire. In two cases, the response options in the G-COPSOQ III questionnaire were slightly modified. However, the differences were very marginal, so that they were not considered when converting the scales.

c) Reliability analysis and statistical tests for assessment of differences: original WorkSafeMed scales versus converted WorkSafeMed scales

In a third step, we conducted a reliability analysis and assessed Cronbach’s alpha for each original and newly converted WorkSafeMed scale. We thereby considered values between .70 and .90 as good [22, 23]. We then performed an explorative statistical analysis to determine whether there were statistically significant and relevant

Table 3 Comparison of scales, single items and response categories - G-COPSOQ II versus G-COPSOQ III

G-COPSOQ II		G-COPSOQ III		Summary of amendments
Scales and items	Response categories	Scales and items	Response categories	
Domain: Demands				
Quantitative demands (4 items) – Do you have to work very fast? – Is your workload unevenly distributed so it piles up? – How often do you not have time to complete all your work tasks? – Do you have to do overtime?	always / often / sometimes / seldom / never, hardly ever	Quantitative demands (3 items) – Do you have to work very fast? – How often do you not have time to complete all your work tasks? – Do you have to do overtime?	always / often / sometimes / seldom / never, hardly ever	– reduced from 4 to 3 items
Emotional demands (3 items) – Does your work put you in emotionally disturbing situations? – Do you get emotionally involved in your work? – Is your work emotionally demanding?	always / often / sometimes / seldom / never, hardly ever	Emotional demands (2 items) – Do you have to deal with other people's personal problems as part of your work? – Is your work emotionally demanding?	always / often / sometimes / seldom / never, hardly ever to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	– introduction of a new item – modified response categories
Work-privacy-conflict (5 items) – The demands of my work interfere with my home and family life. – The amount of time my job takes up makes it difficult to fulfil my family responsibilities. – Things I want to do at home do not get done because of the demands my job puts on me. – My job produces strain that makes it difficult to fulfill family duties. – Due to work-related duties, I have to make changes to my plans for family activities.	strongly agree / slightly agree / neither agree nor disagree / slightly disagree / strongly disagree	Work-privacy-conflict (2 items) – The demands of my work interfere with my home and family life. – The amount of time my job takes up makes it difficult to fulfil my family responsibilities.	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	– reduced from 5 to 2 items – modified response categories
Domain: Influence and development				
Influence at work (4 items) – Do you have a large degree of influence concerning your work? – Do you have a say in choosing who you work with? – Can you influence the amount of work assigned to you? – Do you have any influence on what you do at work?	always / often / sometimes / seldom / never, hardly ever	Influence at work (3 items) – Do you have a large degree of influence on the decisions concerning your work? – Can you influence the amount of work assigned to you? – Do you have any influence on what you do at work?	always / often / sometimes / seldom / never, hardly ever	– reduced from 4 to 3 items – slightly different formulation for one item
Degree of freedom at work (4 items) – Can you decide when to take a break? – Can you take holidays more or less when you wish? – Can you leave your work to have a chat with a colleague? – If you have some private business, is it possible for you to leave your place of work for half an hour without special permission?	always / often / sometimes / seldom / never, hardly ever	Control over working time (2 items) – Can you decide when to take a break? – Can you take holidays more or less when you wish?	always / often / sometimes / seldom / never, hardly ever	– reduced from 4 to 2 items – new scale designation (control over working time)
Possibilities for development (4 items) – Is your work varied? – Does your work require you to take the initiative? – Do you have the possibility of learning new things through your work? – Can you use your skills or expertise in your work?	always / often / sometimes / seldom / never, hardly ever	Possibilities for development (3 items) – Is your work varied? – Do you have the possibility of learning new things through your work? – Can you use your skills or expertise in your work?	always / often / sometimes / seldom / never, hardly ever to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	– reduced from 4 to 3 items – for 2 items modified response categories
Meaning of work (3 items) – Is your work meaningful? – Do you feel that the work you do is important? – Do you feel motivated and involved in your work?	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	Meaning of work (2 items) – Is your work meaningful? – Do you feel that the work you do is important?	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	– reduced from 3 to 2 items

Table 3 Comparison of scales, single items and response categories - G-COPSOQ II versus G-COPSOQ III (Continued)

G-COPSOQ II		G-COPSOQ III		Summary of amendments
Scales and items	Response categories	Scales and items	Response categories	
<p>Workplace commitment (4 items)</p> <ul style="list-style-type: none"> - Are you proud to be part of this organization? - Do you enjoy telling others about your place of work? - Do you feel that the problems at your place of work are yours too? - Do you feel that your place of work is of great personal importance to you? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<p>Workplace commitment (2 items)</p> <ul style="list-style-type: none"> - Are you proud of being part of this company? - Do you enjoy telling others about your place of work? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<ul style="list-style-type: none"> - reduced from 4 to 2 items - slightly different formulation for one item
Domain: Interpersonal relations and leadership				
<p>Predictability (2 items)</p> <ul style="list-style-type: none"> - At your place of work, are you informed well in advance concerning for example important decisions, changes, or plans for the future? - Do you receive all the information you need in order to do your work well? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<p>Predictability (2 items)</p> <ul style="list-style-type: none"> - Does your work exactly inform you well in advance concerning for example important decisions, changes, or plans for the future? - Do you receive all the information you need in order to do your work well? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<ul style="list-style-type: none"> - same number of items - slightly different item formulation
<p>Role clarity (4 items)</p> <ul style="list-style-type: none"> - Do you know exactly how much say you have at work? - Does your work have clear objectives? - Do you know exactly which areas are your responsibility? - Do you know exactly what is expected of you at work? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<p>Role clarity (3 items)</p> <ul style="list-style-type: none"> - Does your work have clear objectives? - Do you know exactly which areas are your responsibility? - Do you know exactly what is expected of you at work? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<ul style="list-style-type: none"> - reduced from 4 to 3 items
<p>Role conflicts (4 items)</p> <ul style="list-style-type: none"> - Do you do things at work, which are accepted by some people but not by others? - Are contradictory demands placed on you at work? - Do you sometimes have to do things, which ought to have been done in a different way? - Do you sometimes have to do things, which seem to you to be unnecessary? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<p>Role conflicts (3 items)</p> <ul style="list-style-type: none"> - Are contradictory demands placed on you at work? - Do you sometimes have to do things, which ought to have been done in a different way? - Do you sometimes have to do things, which seem to you to be unnecessary? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<ul style="list-style-type: none"> - reduced from 4 to 3 items
<p>Quality of leadership (4 items)</p> <p>To what extent would you say that your immediate superior...</p> <ul style="list-style-type: none"> - ...makes sure that the individual member of staff has good development opportunities? - ...gives high priority to job satisfaction? - ...is good at work planning? - ...is good at solving conflicts? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent	<p>Quality of leadership (4 items)</p> <p>To what extent would you say that your immediate superior...</p> <ul style="list-style-type: none"> - ...makes sure that the members of staff have good development opportunities? - ...gives high priority to job satisfaction? - ...is good at work planning? - ...is good at solving conflicts? 	to a very large extent / to a large extent / some - what / to a small extent / to a very small extent / I don't have a superior	<ul style="list-style-type: none"> - same number of items - slightly different item formulation - new response category (I don't have a superior)
<p>Social support (4 items)</p> <ul style="list-style-type: none"> - How often do you get help and support from your colleagues? - How often are your colleagues willing to listen to your problems at work? - How often do you get help and support from your nearest superior? - How often is your immediate superior willing to listen to your work-related problems? 	always / often / sometimes / seldom / never, hardly ever	<p>Social support (4 items)</p> <ul style="list-style-type: none"> - How often do you get help and support from your colleagues, if needed? - How often are your colleagues willing to listen to your problems at work, if needed? - How often do you get help and support from your immediate superior, if needed? - How often is your immediate superior willing to listen to your problems at work, if needed? 	always / often / sometimes / seldom / never, hardly ever / I don't have a superior, colleagues	<ul style="list-style-type: none"> - same number of items - slightly different item formulation - new response category (I don't have a superior, colleagues)

Table 3 Comparison of scales, single items and response categories - G-COPSOQ II versus G-COPSOQ III (Continued)

G-COPSOQ II		G-COPSOQ III		Summary of amendments
Scales and items	Response categories	Scales and items	Response categories	
Feedback (2 items) – How often do you talk with your superior about how well you carry out your work? – How often do you talk with your colleagues about how well you carry out your work?	always / often / sometimes / seldom / never, hardly ever	Feedback (2 items) – How often does your immediate superior talk with you about how well you carry out your work? – How often do your colleagues talk with you about how well you carry out your work?	always / often / sometimes / seldom / never, hardly ever / I don't have a superior, colleagues	– same number of items – slightly different item formulation – new response category (I don't have a superior, colleagues)
Social relations (2 items) – Do you work separate from your colleagues? – Is it possible for you to talk to your colleagues while you are working?	always / often / sometimes / seldom / never, hardly ever	Social relations (single item) – Is it possible for you to talk to your colleagues while you are working?	always / often / sometimes / seldom / never, hardly ever / I don't have a superior, colleagues	– reduced from 2 to 1 item – new response category (I don't have a superior, colleagues)
Sense of community (3 items) – Is there a good atmosphere between you and your colleagues? – Is there good co-operation between your colleagues at work? – Do you feel part of a community at your place of work?	always / often / sometimes / seldom / never, hardly ever	Sense of community (2 items) – Is there a good atmosphere between you and your colleagues? – Is there good co-operation between the colleagues at work?	always / often / sometimes / seldom / never, hardly ever / I don't have a superior, colleagues	– reduced from 3 to 2 items – new response category (I don't have a superior, colleagues)
Domain: Strain (effects, outcomes)				
Job satisfaction (7 items) Regarding your work in general. How pleased are you with... – ...your work prospects? – ...the people you work with? – ...the physical working conditions? – ...the way your department is run? – ...the way your abilities are used? – ...the interest and skills involved in your job? – ...your job as a whole, everything taken into consideration?	very satisfied / satisfied / unsatisfied / highly unsatisfied	Job satisfaction (6 items) Regarding your work in general. How pleased are you with... – ...your work prospects? – ...the people you work with? – ...the physical working conditions? – ...the way your group is run? – ...the way your abilities are used? – ...your job as a whole, everything taken into consideration?	very satisfied / satisfied / neither, nor / unsatisfied / highly unsatisfied	– reduced from 7 to 6 items – slightly different formulation for one item – modified response categories

differences between the original and the newly converted WorkSafeMed scales. For detecting statistical differences, a t-test was calculated to compare the mean of the original WorkSafeMed scales with the mean of the converted WorkSafeMed scales. For the evaluation of the t-tests, an adjustment for multiple testing was applied computing Bonferroni corrected *p*-values [24] and therefore indicating *p* < 0.001 (two-sided) as statistically significant. In addition to the t-test, the effect size (d_{Cohen}) was calculated to evaluate the magnitude of differences. We categorized the effect size according to Cohen's suggestions: <.30 = small effect/difference, <.50 = medium effect/difference and ≥ .50 = large effect/ difference [25]. In accordance with previous COPSOQ studies [26, 27], we applied the following nomenclature for identifying differences in the scales: a difference of at least 5 points in the mean values

of groups is considered a clear difference; a deviation of 10 or more points is considered a very clear deviation [10]. This principle is based on the effect size measure (Cohen's *d*): COPSOQ scales usually have standard deviations of 15–25 points, thus 5 points represent a small to intermediate effect size of 0.2–0.33 and 10 points represent middle to strong effect sizes 0.4 to 0.66 [26].

Comparison of converted WorkSafeMed scales with reference data

To compare results on psychosocial working conditions of the converted WorkSafeMed scales with reference data from the COPSOQ database (hospital care nurses, general hospital physicians as well as the reference value across all occupations), we performed an analysis of variance (ANOVA). For the interpretation of differences, we

employed the previously described nomenclature and considered 5 points as a clear difference. Due to the high number of tests (16 scales, 2 study groups, 3 reference values), a p -value < 0.01 (two-sided) was established as statistically significant. In addition, we calculated the effect size (d_{Cohen}) for all significant results.

All statistical analyses were performed using IBM Statistics SPSS for Windows, version 25 (IBM Corp., Armonk, NY, USA). Based on the results of the comparison undertaken with reference data, we derived some implications for improved psychosocial working conditions for nurses and physicians in university hospitals.

Results

Reliability analysis and statistical tests for assessment of differences: original WorkSafeMed scales versus converted WorkSafeMed scales

Based on the dataset derived from the WorkSafeMed study, the original WorkSafeMed scales and the converted WorkSafeMed scales were compared. Table 4 shows the descriptive statistics and the results of the reliability analysis, the t-test including the results for the Bonferroni correction and the effect size, as well as the applied nomenclature.

The reliability analysis showed similar and satisfying values of Cronbach's α above .70 for most of the original and the converted scales. Three original WorkSafeMed scales ("control over working time", "predictability", "feedback") and three converted WorkSafeMed scales ("quantitative demands", "predictability", "feedback") achieved only values between .60 and .70. The original WorkSafeMed scale "social relations" revealed a Cronbach's alpha of .35. Since the converted WorkSafeMed scale "social relations" consisted of a single item, no calculation of the Cronbach's alpha was possible for this scale. The converted WorkSafeMed scale "control over working time" resulted in a Cronbach's alpha of only .41.

The t-test revealed significant differences between original and converted WorkSafeMed scales ($p < 0.001$ after Bonferroni correction) for the following four scales: "influence at work", "control over working time", "meaning of work", and "social relations". The differences for "influence at work" ($d = 0.25$) and "meaning of work" ($d = 0.26$) represented small effects, while the differences for "control over working time" ($d = 0.56$) and "social relations" ($d = -0.55$) showed a large effect. The interpretation of the nomenclature resulted in a value greater than 10 for the scales "control over working time" and "social relations", indicating that there is a very clear difference between the original and the converted WorkSafeMed scales.

Comparison of converted WorkSafeMed scales with reference data (German COPSOQ database)

Table 5 presents the differences in the means for all converted WorkSafeMed scales for nurses and physicians and the job-specific reference values for general hospital care nurses (COPSOQ nurses) and general hospital physicians (COPSOQ physicians), as well as the reference value across all occupations (COPSOQ all occupations).

WorkSafeMed nurses versus COPSOQ nurses

The comparison of the scales between WorkSafeMed nurses and COPSOQ nurses revealed a mixed picture. For three scales, we discovered statistically significant differences with medium to large effects. WorkSafeMed nurses indicated a higher (= better) level of "job satisfaction" (66.7 vs. 57.8). However, they also rated "quantitative demands" higher (68.4 vs. 61.9) and "social relations" lower (39.5 vs. 52.9) (i.e. worse) than the corresponding reference values for COPSOQ nurses. For five other scales, we found significantly better values for WorkSafeMed nurses, but with a rather small effect size: "influence at work" (41.5 vs. 37.3), "possibilities for development" (70.7 vs. 65.9), "predictability" (53.3 vs. 50.4), "quality of leadership" (53.8 vs. 49.9) and "sense of community" (77.1 vs. 73.5). Concerning "work-privacy-conflict", the values were slightly higher (i.e. worse) for WorkSafeMed nurses (59.8 vs. 55.4) than for the reference group, representing only a small effect. For eight scales ("control over working time", "meaning of work", "workplace commitment", "role clarity", "role conflicts", "social support", "feedback", and "social relations"), we found no statistically significant differences and values were in a similar range.

WorkSafeMed nurses versus COPSOQ all occupations

The comparison with reference values for COPSOQ all occupations showed significantly poorer values with medium to large effects for the following scales: "quantitative demands" (68.4 vs. 56.3), "work-privacy-conflict" (59.8 vs. 42.7), "control over working time" (51.0 vs. 61.5), "workplace commitment" (49.8 vs. 58.3) and "social relations" (39.5 vs. 54.0). WorkSafeMed nurses also indicated more "role conflicts" (52.1 vs. 45.7). This difference was significant but represented a small effect. In further comparisons, we found significantly better values for WorkSafeMed nurses with small to medium effects for the scales "possibilities for development" (70.7 vs. 61.9), "meaning of work" (83.0 vs. 74.6), "role clarity" (74.2 vs. 71.5), and "job satisfaction" (66.7 vs. 62.3). For seven scales ("influence at work", "predictability", "quality of leadership", "social support", "feedback", "social relations", and "sense of community"), we found no statistically significant differences between the two groups.

Table 4 Comparison of original WorkSafeMed scales and converted WorkSafeMed scales: Descriptive statistics, results of the student's t test, effect size and, nomenclature

Scales (n=)	Original WorkSafeMed scales Mean (SD) Cronbach's α	Converted WorkSafeMed scales Mean (SD) Cronbach's α	(df) t-value ¹	Effect size d_{Cohen}	Nomenclature ²
Domain: Demands					
Quantitative demands (n = 991)	68.6 (14.0) $\alpha = .71$	70.5 (14.3) $\alpha = .66$	(990) 3.241	0.13	< 5 points
Work-privacy-conflict (n = 991)	63.8 (25.2) $\alpha = .92$	63.0 (27.7) $\alpha = .88$	(990) -1.116	-0.03	< 5 points
Domain: Influence and development					
Influence at work (n = 991)	37.3 (18.8) $\alpha = .75$	42.1 (19.6) $\alpha = .70$	(990) 8.179***	0.25	< 5 points
Control over working time (n = 991)	40.2 (18.5) $\alpha = .65$	51.8 (22.5) $\alpha = .41$	(990) 16.528***	0.56	> 10 points
Possibilities for development (n = 991)	74.8 (15.9) $\alpha = .77$	74.5 (17.2) $\alpha = .75$	(990) -0.940	-0.02	< 5 points
Meaning of work (n = 991)	79.7 (16.8) $\alpha = .79$	84.1 (17.0) $\alpha = .81$	(990) 7.639***	0.26	< 5 points
Workplace commitment (n = 991)	53.7 (20.1) $\alpha = .75$	55.2 (25.2) $\alpha = .81$	(990) 1.561	0.07	< 5 points
Domain: Interpersonal relations and leadership					
Predictability (n = 991)	53.0 (17.8) $\alpha = .62$	53.0 (17.8) $\alpha = .62$	(990) 0.026	0.00	< 5 points
Role clarity (n = 991)	73.1 (15.6) $\alpha = .84$	73.6 (16.0) $\alpha = .80$	(990) 1.223	0.03	< 5 points
Role conflicts (n = 991)	48.4 (18.0) $\alpha = .73$	49.2 (19.5) $\alpha = .74$	(990) 1.979	0.04	< 5 points
Quality of leadership (n = 953)	52.0 (22.9) $\alpha = .90$	52.0 (22.9) $\alpha = .90$	(952) -0.053	0.00	< 5 points
Social support (n = 991)	65.8 (17.0) $\alpha = .76$	65.8 (17.0) $\alpha = .76$	(990) -0.444	0.00	< 5 points
Feedback (n = 991)	41.5 (21.3) $\alpha = .67$	41.5 (21.3) $\alpha = .67$	(990) -0.666	0.00	< 5 points
Social relations (n = 991)	55.6 (20.6) $\alpha = .35$	41.8 (28.7) n/a (single item)	(990) 20.778***	-0.55	> 10 points
Sense of community (n = 991)	77.3 (15.0) $\alpha = .80$	77.5 (14.6) $\alpha = .83$	(990) 0.993	0.01	< 5 points
Domain: Strain (effects, outcomes)					
Job satisfaction (n = 991)	69.9 (11.4) $\alpha = .80$	69.1 (11.9) $\alpha = .77$	(990) -2.340	-0.07	< 5 points

¹*** Bonferroni-corrected p-values ($p < 0.001$)

²Nomenclature: differences of more than 5 points are considered relevant and presented in bold
n/a = not applicable

WorkSafeMed physicians versus COPSOQ physicians

The comparison of WorkSafeMed physicians and COPSOQ physicians revealed several statistically significant differences. WorkSafeMed physicians stated slightly higher "quantitative demands" than the reference group (73.9 vs. 70.1). This difference represented only a small effect. For four other scales, we found better values for WorkSafeMed physicians with small to medium effects. WorkSafeMed physicians rated "meaning of work" higher (85.9 vs. 81.8) and "role conflicts" lower (45.1 vs. 49.3) than the corresponding reference values. "Possibilities for

development" (80.1 vs. 75.0) and "workplace commitment" (63.0 vs. 53.6) were also assessed more positively by WorkSafeMed physicians. Concerning "job satisfaction", we found a significant difference between the two samples. WorkSafeMed physicians indicated higher "job satisfaction" than the COPSOQ physicians (72.7 vs. 62.4). This difference represented a large effect. For the remaining 10 scales ("work-privacy-conflict", "influence at work", "control over working time", "predictability", "role clarity", "quality of leadership", "social support", "feedback", "social relations", and "sense of community"),

Table 5 Study results for WorkSafeMed nurses and WorkSafeMed physicians and COPSOQ database reference values (COPSOQ nurses, COPSOQ physicians, COPSOQ all occupations). Scale means, standard deviations, *p*-values, and effect sizes (*d*_{Cohen})

Scales	WorkSafeMed nurses (converted scales)	COPSOQ nurses (COPSOQ database)	WorkSafeMed nurses vs. COPSOQ nurses	WorkSafeMed physicians (converted scales)	COPSOQ physicians (COPSOQ database)	WorkSafeMed physicians vs. COPSOQ physicians	COPSOQ all occupations (COPSOQ database)	WorkSafeMed nurses vs. all occupations	WorkSafeMed physicians vs. all occupations	<i>p</i>	<i>d</i>
Domain: Demands											
Quantitative demands (high = negative)	Mean (SD) 68.4 (13.9) (<i>n</i> = 564)	Mean (SD) 61.9 (15.9) (<i>n</i> = 8973)	<i>p</i> +	Mean (SD) 73.9 (13.9) (<i>n</i> = 380)	Mean (SD) 70.1 (16.9) (<i>n</i> = 2356)	<i>p</i> sig.	Mean (SD) 56.3 (19.3) (<i>n</i> = 194,073)	<i>p</i> +	<i>d</i> -0.63	+	-0.92
Work-privacy-conflict (high = negative)	Mean (SD) 59.8 (26.8) (<i>n</i> = 564)	Mean (SD) 55.4 (28.1) (<i>n</i> = 8969)	<i>p</i> sig.	Mean (SD) 68.8 (27.7) (<i>n</i> = 380)	Mean (SD) 67.7 (27.9) (<i>n</i> = 2354)	<i>p</i> +	Mean (SD) 42.7 (30.5) (<i>n</i> = 194,079)	<i>p</i> +	<i>d</i> -0.56	+	-0.86
Domain: Influence and development											
Influence at work (high = positive)	Mean (SD) 41.5 (18.6) (<i>n</i> = 564)	Mean (SD) 37.3 (20.1) (<i>n</i> = 8960)	<i>p</i> sig.	Mean (SD) 42.7 (20.9) (<i>n</i> = 380)	Mean (SD) 42.8 (20.3) (<i>n</i> = 2354)	<i>p</i> sig.	Mean (SD) 42.4 (22.9) (<i>n</i> = 192,670)	<i>p</i> -	<i>d</i> 0.42	-	0.35
Control over working time (high = positive)	Mean (SD) 51.0 (22.8) (<i>n</i> = 564)	Mean (SD) 50.5 (22.5) (<i>n</i> = 8982)	<i>p</i> sig.	Mean (SD) 52.6 (22.0) (<i>n</i> = 380)	Mean (SD) 51.6 (22.3) (<i>n</i> = 2354)	<i>p</i> +	Mean (SD) 61.5 (25.2) (<i>n</i> = 186,554)	<i>p</i> +	<i>d</i> -0.40	+	-0.82
Possibilities for development (high = positive)	Mean (SD) 70.7 (17.2) (<i>n</i> = 564)	Mean (SD) 65.9 (18.2) (<i>n</i> = 8976)	<i>p</i> sig.	Mean (SD) 80.1 (14.7) (<i>n</i> = 380)	Mean (SD) 75.0 (16.1) (<i>n</i> = 2359)	<i>p</i> sig.	Mean (SD) 74.6 (21.4) (<i>n</i> = 194,220)	<i>p</i> +	<i>d</i> -0.39	+	-0.53
Meaning of work (high = positive)	Mean (SD) 83.0 (17.2) (<i>n</i> = 564)	Mean (SD) 81.0 (18.5) (<i>n</i> = 8976)	<i>p</i> sig.	Mean (SD) 85.9 (16.4) (<i>n</i> = 380)	Mean (SD) 81.8 (17.8) (<i>n</i> = 2359)	<i>p</i> +	Mean (SD) 58.3 (25.4) (<i>n</i> = 193,423)	<i>p</i> -	<i>d</i> 0.34	sig.	-0.18
Workplace commitment (high = positive)	Mean (SD) 49.8 (23.9) (<i>n</i> = 564)	Mean (SD) 52.7 (24.6) (<i>n</i> = 8970)	<i>p</i> sig.	Mean (SD) 63.0 (24.6) (<i>n</i> = 380)	Mean (SD) 53.6 (23.8) (<i>n</i> = 2359)	<i>p</i> +	Mean (SD) 51.3 (22.2) (<i>n</i> = 192,212)	<i>p</i> -	<i>d</i> -0.14	sig.	-0.27
Domain: Interpersonal relations and leadership											
Predictability (high = positive)	Mean (SD) 53.3 (16.4) (<i>n</i> = 564)	Mean (SD) 50.4 (20.1) (<i>n</i> = 8944)	<i>p</i> sig.	Mean (SD) 52.5 (19.3) (<i>n</i> = 380)	Mean (SD) 49.9 (20.3) (<i>n</i> = 2350)	<i>p</i> sig.	Mean (SD) 71.5 (18.7) (<i>n</i> = 192,463)	<i>p</i> +	<i>d</i> 0.21	sig.	0.26
Role-clarity (high = positive)	Mean (SD) 74.2 (15.0) (<i>n</i> = 564)	Mean (SD) 72.7 (16.7) (<i>n</i> = 8932)	<i>p</i> sig.	Mean (SD) 72.7 (16.8) (<i>n</i> = 380)	Mean (SD) 70.5 (17.5) (<i>n</i> = 2350)	<i>p</i> sig.	Mean (SD) 66.1 (21.1) (<i>n</i> = 189,209)	<i>p</i> -	<i>d</i> -0.51	-	0.26
Role-conflicts (high = negative)	Mean (SD) 52.1 (18.6) (<i>n</i> = 564)	Mean (SD) 51.9 (21.6) (<i>n</i> = 8918)	<i>p</i> sig.	Mean (SD) 45.1 (19.6) (<i>n</i> = 380)	Mean (SD) 49.3 (20.6) (<i>n</i> = 2347)	<i>p</i> sig.	Mean (SD) 51.4 (25.4) (<i>n</i> = 192,044)	<i>p</i> -	<i>d</i> 0.51	-	0.26
Quality of leadership (high = positive)	Mean (SD) 53.8 (22.7) (<i>n</i> = 543)	Mean (SD) 49.9 (25.3) (<i>n</i> = 8875)	<i>p</i> sig.	Mean (SD) 49.2 (22.9) (<i>n</i> = 369)	Mean (SD) 48.6 (23.6) (<i>n</i> = 2296)	<i>p</i> sig.	Mean (SD) 66.1 (21.1) (<i>n</i> = 192,147)	<i>p</i> -	<i>d</i> -0.26	sig.	-0.61
Social support (high = positive)	Mean (SD) 66.7 (17.0) (<i>n</i> = 564)	Mean (SD) 65.9 (19.8) (<i>n</i> = 8938)	<i>p</i> sig.	Mean (SD) 64.2 (17.0) (<i>n</i> = 380)	Mean (SD) 64.4 (18.8) (<i>n</i> = 2334)	<i>p</i> sig.	Mean (SD) 43.0 (22.5) (<i>n</i> = 191,336)	<i>p</i> -	<i>d</i> 0.51	-	0.26
Feedback (high = positive)	Mean (SD) 41.9 (21.0) (<i>n</i> = 564)	Mean (SD) 40.4 (22.2) (<i>n</i> = 8928)	<i>p</i> sig.	Mean (SD) 41.0 (21.5) (<i>n</i> = 380)	Mean (SD) 40.1 (20.7) (<i>n</i> = 2330)	<i>p</i> sig.	Mean (SD) 54.0 (28.5) (<i>n</i> = 190,298)	<i>p</i> -	<i>d</i> -0.26	sig.	-0.61
Social relations (high = positive)	Mean (SD) 39.5 (28.7) (<i>n</i> = 564)	Mean (SD) 52.9 (24.7) (<i>n</i> = 8897)	<i>p</i> sig.	Mean (SD) 46.7 (27.5) (<i>n</i> = 380)	Mean (SD) 50.4 (26.6) (<i>n</i> = 2324)	<i>p</i> sig.	Mean (SD) 76.2 (18.7) (<i>n</i> = 191,074)	<i>p</i> -	<i>d</i> -0.26	sig.	-0.61
Sense of community (high = positive)	Mean (SD) 77.1 (15.0) (<i>n</i> = 564)	Mean (SD) 73.5 (16.3) (<i>n</i> = 8955)	<i>p</i> sig.	Mean (SD) 78.0 (14.3) (<i>n</i> = 380)	Mean (SD) 76.5 (15.3) (<i>n</i> = 2328)	<i>p</i> sig.	Mean (SD) 62.3 (16.9) (<i>n</i> = 190,431)	<i>p</i> -	<i>d</i> -0.26	sig.	-0.61
Domain: Strain (effects, outcomes)											
Job satisfaction (high = positive)	Mean (SD) 66.7 (10.6) (<i>n</i> = 564)	Mean (SD) 57.8 (16.7) (<i>n</i> = 8888)	<i>p</i> sig.	Mean (SD) 72.7 (12.6) (<i>n</i> = 380)	Mean (SD) 62.4 (16.8) (<i>n</i> = 2323)	<i>p</i> sig.	Mean (SD) 62.3 (16.9) (<i>n</i> = 190,431)	<i>p</i> -	<i>d</i> -0.26	sig.	-0.61

Significant differences in means of > = 5 are marked with a "+", (=study group value for WorkSafeMed is higher than COPSOQ database reference value) or by a "-", (=study group value for WorkSafeMed is lower than COPSOQ database reference value); further differences not reaching the 5-point difference but significant with at least *p* < 0.01 indicated with a "sig."

no statistically significant differences between the two groups were detectable.

WorkSafeMed physicians versus COPSOQ all occupations

The comparison between WorkSafeMed physicians and reference values from COPSOQ all occupations was similar to the comparison of WorkSafeMed nurses: We found significantly poorer values for “control over working time” (52.6 vs. 61.5) and “social relations” (46.7 vs. 54.0). This difference represented a small to medium effect. We identified significantly higher “quantitative demands” (73.9 vs. 56.3) and a higher “work-privacy-conflict” (68.8 vs. 42.7) for WorkSafeMed physicians with a rather large effect size. In further comparisons, we found significantly better values for “workplace commitment” (63.0 vs. 58.3), “possibilities for development” (80.1 vs. 61.9), “meaning of work” (85.9 vs. 74.6) and “job satisfaction” (72.7 vs. 62.3). The differences for “possibilities for development”, “meaning of work” and “job satisfaction” represented a large effect, while the difference for “workplace commitment” showed only a small effect size. For nine scales (“influence at work”, “predictability”, “role clarity”, “role conflicts”, “quality of leadership”, “social support”, “feedback”, “social relations”, and “sense of community”), we identified no statistically significant differences between the two groups. Values were within a similar range.

Discussion

In this study, we applied a multistep approach to convert COPSOQ scales from the WorkSafeMed study (G-COPSOQ II) to the COPSOQ scales from the current German COPSOQ database (G-COPSOQ III). We then compared the converted WorkSafeMed scales with corresponding reference data from the German COPSOQ database.

Preliminary work

The explorative statistical analysis included different procedures to examine original and newly converted WorkSafeMed scales and was performed after a comprehensive comparison at the content level. A newly published study on COPSOQ III, conducted in Canada, Spain, France, Germany, Sweden, and Turkey, also highlighted the differences in content between the international version of COPSOQ II and COPSOQ III [3]. This content-based explorative approach was, in our opinion, suitable for finding relevant differences between the original scales of the questionnaire used within the WorkSafeMed study and the converted WorkSafeMed scales.

The performed reliability analysis resulted for most of the original and converted WorkSafeMed scales in satisfying Cronbach’s alpha values above .70. Unfortunately, the

results of the German validation study for G-COPSOQ III have not yet been published. But compared with respective values from the validation studies of G-COPSOQ I and the international COPSOQ III [3, 19], we identified in most cases similar values. In some cases, we had lower Cronbach’s alpha values in our sample compared to results from other validation studies [3, 19]. We detected lower values especially for four original WorkSafeMed-scales (“social relations”, “control over working time”, “predictability”, and “feedback”) and also for four converted WorkSafeMed scales (“quantitative demands”, “control over working time”, “predictability”, and “feedback”). A possible explanation for these low values is certainly that Cronbach alpha is influenced by the number of items [28]. The affected scales have on average only two items. Scales that contain more items usually have higher Cronbach’s alpha values [28]. On top, specific answering patterns of our sample of nurses and physicians have to be considered.

Based on our sample, we found clear differences for the original and converted WorkSafeMed scales “control over working time” and “social relations”.

The difference in scale composition for the scale “control over working time” may explain the higher mean value for the converted scale than for the original scale (51.8 vs. 40.2), and the high measures for effect size ($d_{\text{Cohen}} = 0.56$) and nomenclature (> 10 points). The original scale “control over working time” was reduced by the following two single items (“Can you leave your work to have a chat with a colleague?” / “If you have some private business, is it possible for you to leave your place of work for half an hour without special permission?”). We detected for the first item a ceiling effect of more than 80%. For the other item, we could not find any floor or ceiling effects. This effect is probably explained by the special work environment of nurses and physicians in the present case. Nurses and physicians can neither “leave the place of work to have a chat” nor can they “leave the place of work for half an hour without special permission” due to the special work circumstances. Thus, the original scale did not fit well for the hospital workplace. The sample’s agreement and the variance within the two items of the converted scale were higher than with the other two items of the original scale. The converted scale included only single items that are relevant for work in hospitals.

For the scale “social relations”, the lower mean derived applying the converted scale (i.e. single item) may capture the situation of employees in hospitals better than the original scale (41.8 vs. 55.6). Additionally, the effect size ($d_{\text{Cohen}} = -0.55$) and nomenclature (> 10 points) of this difference are high, indicating a clear difference between original and converted scales. The converted scale “social relations” was reduced by one single item (“Do

you work separate from your colleagues?”). This item also was not formulated appropriately for hospital work. The work in hospitals is characterized by a frequent turnover of patients, some processes take place in a team, and some tasks are carried out by persons alone. Therefore, the converted scale included only one single item “Is it possible for you to talk to your colleagues while you are working?” which may well depict this aspect of work in the hospital environment.

As for the other scales, the differences between original and converted WorkSafeMed scales were not relevant; a comparison of our converted data with data from the current German COPSQ database, as well as with current studies applying the new COPSQ version was possible.

Comparison of converted WorkSafeMed scales with reference data

After reconstructing the scales, we compared 16 converted scales from the WorkSafeMed study with corresponding reference data from the current German COPSQ database.

The values for WorkSafeMed and COPSQ nurses showed a rather typical appearance of the nursing profession with high values for “*quantitative demands*” and “*work-privacy-conflict*”, but also positive results for “*meaning of work*” and “*sense of community*”. Other studies also indicated high levels of job stress and work burden among German nurses and physicians [29, 30]. The comparison between our sample and the database revealed better values for WorkSafeMed nurses for the scales “*job satisfaction*”, “*influence at work*”, “*possibilities for development*”, “*predictability*”, “*quality of leadership*”, and “*sense of community*”. We identified worse values for the scales “*quantitative demands*”, “*social relations*”, and “*work privacy conflict*”. These differences are maybe on the one hand due to the different work settings (university hospital versus general hospital). On the other hand, the WorkSafeMed nurses covered a smaller sample and cannot be considered as representative compared to other nurses in general hospitals. In summary, the comparative results should be interpreted with caution as all effect sizes were only small except for the scales “*job satisfaction*”, “*quantitative demands*”, and “*social relations*” with medium effect sizes.

The values for WorkSafeMed and COPSQ physicians also represented well-known findings for this medical profession. Physicians in hospitals had to struggle with high “*quantitative demands*”, and a high “*work-privacy-conflict*”. A recent study showed that high perceived psychosocial stress and extended working time were associated with a higher rate of physicians’ intention to leave direct patient care [31]. But physicians also reported positively about “*possibilities for*

development” and “*meaning of work*”. The comparison between our sample and the database demonstrated in some scales (“*meaning of work*”, “*role conflicts*”, “*possibilities for development*”, “*workplace commitment*”, and “*job satisfaction*”) better values for the WorkSafeMed physicians. Only the scale “*quantitative demands*” was rated worse by the WorkSafeMed physicians. Some differences may be also linked to the different workplaces. Physicians at university hospitals are often simultaneously involved in patient care, teaching, and research, and therefore perceive a high level of quantitative demands. However, likewise, the sample of WorkSafeMed physicians cannot be regarded as representative for other physicians at general hospitals, so also the identified differences should be interpreted with caution.

Compared with COPSQ data on all occupations, we identified higher “*quantitative demands*” and lower values for “*social relations*” in the WorkSafeMed sample. WorkSafeMed nurses and physicians had also to struggle with a higher “*work-privacy-conflict*” compared to other professions. The difficulty of combining requirements from working and private life is also reported in other studies using a comparable scale for work-privacy-conflict: the work-family-conflict scale by Netemeyer [32, 33]. As part of his COPSQ validation study in 2004, Nübling et al. used a modified version of the work-family-conflict scale by Netemeyer and thus replaced the term family with the term privacy in the name of the scale [9]. In a recent study, Mache et al. examined working conditions and work-family-conflict in the medical profession in 15 hospitals in Germany by means of G-COPSQ II [33]. They found similarly high levels of work-family conflict (mean = 76) and quantitative demands (mean = 75) among German hospital physicians [33]. In 2005, Fuß et al. surveyed physicians regarding their perceived work-family conflict and their working conditions in two university hospitals in Germany with G-COPSQ I, too [32]. They also discovered high levels of work-family-conflict (mean = 74) and higher quantitative demands (mean = 73) compared to the general German working population as depicted in the then-current COPSQ database [32]. On the basis of our comparison undertaken with reference data from the current German COPSQ database, as well as with regard to the correlation of perceived psychosocial working conditions in hospitals and quality of patient care [18, 34–39], it is all in all crucial to reduce high quantitative demands and high work-privacy-conflicts of physicians and nurses in Germany. Therefore, measures at the legislative level in Germany are necessary to further-reduce high quantitative demands for nurses and physicians [40]. Based on the high correlation of documented work overtime and perceived high quantitative demands, as well as high work-privacy-conflict in physicians [18],

comprehensive measures should be implemented leading to an effective adherence to (daily and weekly) maximum working hours like e.g. new shift models [41–43].

Another interesting finding in the WorkSafeMed sample was a surprisingly high “*job satisfaction*” despite high “*quantitative demands*”. One possible explanation for this result can be found in the work setting (university hospital versus non-university hospital). University hospitals offer to physicians and nurses a variety of learning opportunities due to interesting and complex treatment cases. Further training and qualification opportunities at a university hospital can also contribute to high job satisfaction. However, the results from a standard assessment of job satisfaction with classical global ratings should generally be considered with caution. A recent study by Hiemisch et al. considered the discrepancy between challenging working conditions and subjective job satisfaction [44]. In their study, the authors conducted an assessment of job satisfaction using classical global ratings and additionally included the measurement of qualitative job satisfaction based on the cognitive-emotional concept of the “Schweizer Modell” [44]. According to the global rating, they found a high level of job satisfaction among the medical, nursing, and administrative/technical staff [44]. In contrast, however, the additional analysis showed that only 1 in 4 employees was actually satisfied with his or her job [44]. The authors concluded that the assessment with classical global ratings was not appropriate, because it showed only responses of resignatively satisfied employees and missed perceptions of unsatisfied employees [44].

In accordance to other studies [45–47], we found low values for “*control over working time*” and high values for “*possibilities for development*” and “*meaning of work*” among the WorkSafeMed sample. In our opinion, these results are typical for the two professions and for the work in university hospitals. The work is characterized by mandatory regulations and standards for both professions. Therefore, it can be assumed that physicians and nurses perceive that they actually have little control over their own working time. The high demands in this specific environment lead - especially in the setting of university hospitals investigated in the WorkSafeMed study - to high values for “*possibilities for development*” and for “*meaning of work*”. According to Leape and colleagues, it is crucial for healthcare organisations to create a working environment where employees find meaning in their work [48]. This can be encouraged by the following measures: every employee is treated with respect, has the possibility (by education, training, encouragement) to make an essential contribution at work that gives meaning to their life, and feel valued for what they do [48].

Strength and limitations

The WorkSafeMed study was not designed to compare both COPSOQ versions. However, in our opinion, the explorative approach chosen to convert COPSOQ scales used in the WorkSafeMed study to G-COPSOQ III and to compare both versions statistically was appropriate. In addition, this may present a good possibility for other COPSOQ studies that used G-COPSOQ II to compare their results with more current data. In general, our explorative approach can be applied in other studies to compare findings gathered with different versions of a questionnaire used e.g. in different research projects over time. As not only the COPSOQ but also other questionnaires may be developed further it seems crucial to report all respective details of the questionnaire (e.g. version, year) used in a research project to enable the correct comparison with results from other studies.

Our approach also made it possible to look more critically at single items of the original COPSOQ questionnaire (G-COPSOQ II) for the hospital sector. The comparison with corresponding reference data from the current COPSOQ database proved to be valuable, and possible implications for improved psychosocial working conditions could be identified, e.g. reduction of high quantitative demands and high work-privacy-conflicts of physicians and nurses at university hospitals in Germany.

We can also address some limitations in our study. We developed an explorative approach to compare and convert scales. Unfortunately, there are currently few studies that describe such a scale adjustment. Therefore, we cannot refer to any validated methodology for our explorative approach. The WorkSafeMed study included a cross sectional design with subjective judgements of self-reported data from nurses and physicians. The reference data comprised nurses and physicians from both general hospitals and university hospitals often taking part in the survey as one step of the psychosocial risk assessment. The different work setting, particular in general hospitals, and the different embedding of the survey may explain some of the identified differences. Thus, the different results must be considered with caution. Also, the data from the WorkSafeMed study comprised a smaller sample and was based on only two university hospitals in Germany. We obtained in the WorkSafeMed sample a response rate of 39.6%. This response rate is quite high for surveys with nurses and physicians in the German hospital sector. Unfortunately, it was not possible to conduct a non-responder analysis to identify potential differences and to assess whether the WorkSafeMed sample can be considered representative for nurses and physicians in German university hospitals. Thus, we cannot completely rule out a possible response bias and that the results may be representative

for neither other medical professions in university hospitals nor for all hospitals in Germany. Furthermore, the survey data used (WorkSafeMed and reference data from the COPSOQ database) originated from surveys conducted at different times. Therefore, also time trends might account for some of the identified differences. The high mean values for the scale job satisfaction together with scales illustrating the high psychosocial strain suggest that resignatively satisfied employees also took part in the survey. In future studies, a more differentiated measurement of job satisfaction would help to detect potentially dissatisfied employees.

Conclusions

In this study, we performed an explorative approach for the conversion of WorkSafeMed scales (G-COPSOQ II) for hospital nurses and physicians to the current version of the German COPSOQ questionnaire (G-COPSOQ III). In our opinion, the conversion of WorkSafeMed scales was possible and appropriate and thus allowed a comparison between three reference values in the current German COPSOQ database. The comparison with reference values revealed some implications for the improvement of psychosocial working conditions of nurses and physicians which should be considered in university hospitals in Germany. In all studies, enough details on the questionnaires used for data assessment (i.e. version, year) should be published to enable comparative analyses.

Abbreviations

COPSOQ: Copenhagen Psychosocial Questionnaire; G-COPSOQ I: German standard version based on Copenhagen Psychosocial Questionnaire I; G-COPSOQ II: German standard version based on Copenhagen Psychosocial Questionnaire I and II; G-COPSOQ III: German standard version based on Copenhagen Psychosocial Questionnaire III; WorkSafeMed: Working conditions, safety culture, and patient safety in hospitals – what predicts the safety of the medication process

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Authors' contributions

AW drafted the manuscript. MAR, TM, AH and MN made valuable modifications to the text. AW and MAR developed the study design. AW, MN and MAR discussed the comparison of scales on the level of content. MAR, TM, and AH developed the questionnaire including the pretest. MAR, TM, and AH planned the data collection, wrote the study protocol, and performed the survey. AW and MN performed the statistical analysis and received valuable advice from MAR, AH, and TM. All authors read and approved the final manuscript.

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Availability of data and materials

The reference data are from the COPSOQ database of FFAW GmbH. Due to data security aspects, data from the WorkSafeMed study will not be made available to the public domain. However, data will be used by students of both project partners for their theses. Data will be stored in accordance with national and regional data security standards.

Ethics approval and consent to participate

The WorkSafeMed study with all its components was approved by the responsible ethics committees of the medical faculties of the University Hospital in Bonn (reference number: #350/14) and the University Hospital in Tuebingen (reference number: #547/2014BO1). Each partner complied with confidentiality requirements according to German law. Informed verbal consent was sought from participants, who were informed that the study was voluntary and that they could withdraw at any time. The need for written consent is deemed unnecessary according to national regulations. The method of acquiring consent was approved by the ethics committees.

Consent for publication

Informed verbal consent was sought from participants. All participants consented to have the results published as part of the informed consent process. The participants were assured of their confidentiality. The need for written consent is deemed unnecessary according to national regulations. The method of acquiring consent was approved by the ethics committees.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tuebingen, Wilhelmstraße 27, 72074 Tuebingen, Germany. ²Freiburg Research Centre for Occupational Sciences (FFAW GmbH), Bertoldstr. 63, 79098 Freiburg, Germany. ³Institute of Patient Safety, University Hospital of Bonn, Venusberg-Campus 1, 53127 Bonn, Germany. ⁴FHNW School of Applied Psychology, University of Applied Sciences and Arts Northwestern Switzerland, Riggbachstrasse 16, 4600 Olten, Switzerland.

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2.4 Publication 4

Objective: Identification of determinants of an occupational safety culture by comparing studies in the hospital setting with studies conducted in other workplaces

Authors: Anke Wagner, Ladina Schöne, Monika A. Rieger

Title: Determinants of Occupational Safety Culture in Hospitals and other Workplaces—Results from an Integrative Literature Review

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*Review*

Determinants of Occupational Safety Culture in Hospitals and other Workplaces—Results from an Integrative Literature Review

Anke Wagner ^{*}, Ladina Schöne and Monika A. Rieger

Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen, 72074 Tübingen, Germany; la.sch@t-online.de (L.S.); monika.rieger@med.uni-tuebingen.de (M.A.R.)

* Correspondence: anke.wagner@med.uni-tuebingen.de; Tel.: +49-07071-2980154

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Abstract: Background: The aim of the present study was to obtain an overview of occupational safety culture by assessing and mapping determinants in different workplaces (hospital workplaces and workplaces in construction, manufacturing, and other industry sectors) using an already established theoretical framework with seven clusters developed by Cornelissen and colleagues. We further derived implications for further research on determinants of occupational safety culture for the hospital workplace by comparing the hospital workplace with other workplaces. Methods: We conducted an integrative literature review and searched systematically for studies in four research databases (PubMed, Web of Science, CINAHL, and PsycINFO). The search was undertaken in 2019, and updated in April 2020. Results of the included studies were analyzed and mapped to the seven clusters proposed by Cornelissen and colleagues. Results: After screening 5566 hits, 44 studies were included. Among these, 17 studies were conducted in hospital workplaces and 27 were performed in other workplaces. We identified various determinants of an occupational safety culture. Most studies in hospital and other workplaces included determinants referring to management and colleagues, to workplace characteristics and circumstances, and to employee characteristics. Only few determinants in the studies referred to other factors such as socio-economic factors or to content relating to climate and culture. Conclusions: The theoretical framework used was helpful in classifying various determinants from studies at different workplaces. By comparing and contrasting results of studies investigating determinants at the hospital workplace with those addressing other workplaces, it was possible to derive implications for further research, especially for the hospital sector. To date, many determinants for occupational safety culture known from workplaces outside of the healthcare system have not been addressed in studies covering hospital workplaces. For further studies in the hospital workplace, it may be promising to address determinants that have been less studied so far to gain a more comprehensive picture of important determinants of an occupational safety culture in the hospital sector.

Keywords: integrative review; occupational safety culture; workplaces; hospital

1. Introduction

The promotion of occupational safety culture remains an important issue in various workplaces. Previous studies, mainly conducted in the industrial sector, identified several determinants and predictors that promote an occupational safety culture. Zohar (2011) addressed different antecedents of safety climate, and based on these, developed a conceptual model [1]. According to Zohar, the following seven antecedent variables shape a good safety climate: structural attributes of the work environment, symbolic social interaction, group and organization leadership, psychological work ownership, organizational commitment, job stress, burnout, and personality [1].

One recent quantitative review by He et al. [2] extended Zohar's conceptual model by providing a quantitative overview on different antecedents and factors of safety climate. The identified antecedents were grouped into three main categories: situational factors (e.g., job and organizational characteristics, leadership, co-worker influence), interpersonal interactions (e.g., leader-member exchange, team-member exchange), and personal factors (e.g., personality characteristics, demographics) [2]. The authors calculated effect sizes for 38 antecedents to determine the magnitude of each within the three categories [2]. The authors detected the strongest effect sizes and associations for safety climate in particular for antecedents of interpersonal interactions, and situational factors [2]. As stated by He et al., there is an ongoing need for research on further antecedents and determinants of safety culture [2].

Another study by Beus et al. combined different theories about workplace safety in one integrated safety model and evaluated components of the model in the context of a systematic literature search [3]. The hereby developed model distinguished between distal (e.g., individual differences, contextual factors, job characteristics) and proximal antecedents (e.g., personal resources, safety knowledge, skills, or motivation) of safety-related behaviors and subsequent accidents and accident rates across individual and group levels of analysis, and suggested future research activities [3]. The authors found strong empirical support for the linkage between work behaviour and accidents, and for example weak empirical support for the linkage between individual differences (attitudes, abilities) and safety knowledge, skills and motivation [3]. According to previous work by Clarke (2010), some dimensions of psychological climate (job, role, group, leader, and organizational attributes) are also important antecedents and predictors of safety climate [4].

One of the most comprehensive and detailed overviews on determinants in literature on occupational safety is demonstrated by Cornelissen and colleagues [5]. The authors identified and clustered possible determinants that support occupational safety of employees in the following high-risk industries: construction, petro-chemistry, warehouses, and manufacturing [5]. In their study, they categorized the identified factors into seven clusters: Workplace characteristics and circumstances (cluster 1), Climate and culture (cluster 2), Management and colleagues (cluster 3), Employee characteristics (cluster 4), External (cluster 5), Performance (cluster 6), and Safety outcomes (cluster 7) [5]. Table 1 shows a detailed description of each cluster with the corresponding topics and categories.

Table 1. Clusters, topics and categories according to Cornelissen et al. [5].

Cluster	Topics and Categories
1. Workplace characteristics and circumstances	Physical work environment: Company size, workplace hazards, safety equipment, safety of equipment, physical workplace (design) Work characteristics: work characteristics, perceived workplace safety, goal setting, stress, shifts, working hours, job demands, job resources, production pressure, task clarity, safety control Workforce: contract type, job level, workforce quantity, workforce composition, unions, HR
2. Climate and culture	Organizational climate and culture: Organizational climate, organizational culture Safety climate and culture: safety climate, safety culture
3. Management and colleagues	Management attitudes and behaviours: leadership style, management attitudes, management behaviours, safety importance for management Co-worker attitudes and behaviours: co-worker attitudes, co-worker behaviours Management of safety: management of safety, inspections, accident analysis and record keeping, safety representations, sanctions, rewards, accident reducing measures, training, safety communication, safety policies and procedures, safety meetings and activities
4. Employee characteristics	Employee demographics: age, gender, education, disabilities, psychophysical states Career and job attitudes: tenure/experience, employee work attitudes, trust Safety characteristics: employee safety attitudes, safety motivation, safety knowledge (sharing), responsibility Lifestyle: work-life balance, marital status, children, lifestyle, lifestyle disorders and substance abuse
5. External	Governmental bodies: law and legislation, governmental bodies Stakeholders: client involvement, customer satisfaction Socio-economic: economic factors, insurance, and costs of safety
6. Performance	Safety-related performance: safety performance, PPE use, safety compliance, safety participation Organizational performance: organizational performance, financial performance, (employee) work performance, organizational quality performance, production performance, environmental performance
7. Safety outcomes	Incidents Accidents Injuries

In healthcare, and especially in the hospital workplace, meanwhile, there is a variety of studies addressing safety culture. However, in many studies, safety culture refers only to patient safety culture [6,7], and occupational safety culture of employees is not addressed. In some studies, occupational safety culture was considered in addition to patient safety culture [8–14], but did not represent the main aspect. The role of working conditions with regard to work-related injuries in healthcare (e.g., needle stick injuries) has been widely studied [15,16]. Similarly, the general relationship between safety culture and work-related injuries in healthcare has been well documented [14,17]. Employees in healthcare, and particularly in hospital workplaces, are confronted with high demands in their daily working conditions. Besides high workload, staff shortage, and shift working, employees have to deal with suffering and dying patients and their families, time pressure, perceived lack of reward, and sometimes conflict with other professions [18]. For employees in these professions, there is both a physical as well as a continuous psychological burden, which can have an impact on safety culture.

However, determinants of a comprehensive occupational safety culture have not often been described or categorized in contrast to other workplaces. Furthermore, at the current time, findings on determinants of occupational safety culture from other workplaces are seldom discussed to develop and promote an occupational safety culture in hospitals. In our opinion, it can be very useful, in particular for the development and promotion of an occupational safety culture, to include the experiences of other workplaces. In recent years, a lot of research on occupational safety culture has taken place, especially in the area of construction [19], and manufacturing [20]. Therefore, knowledge from these work areas may be useful to further promote occupational safety culture in hospitals. We therefore conducted an integrative review and focused on the following two research questions:

1. What are possible determinants of occupational safety culture from the perspective of employees in different workplaces (hospital, construction, manufacturing, and other industry sectors)?
2. What implications for further research on determinants of occupational safety culture for the hospital workplace can be derived by comparing the hospital workplace with other workplaces?

We pursued the objective to build a link between hospital workplaces and other workplaces by generating an overview of determinants of occupational safety culture in different workplaces. The obtained overview and the comparison of determinants in different workplaces can be helpful in identifying possible research requirements and implications, especially for hospital workplaces. The seven clusters from Cornelissen et al. [5] were thereby considered as a suitable framework to identify, summarize, and classify possible determinants in different workplaces since the authors considered quantitative and qualitative studies [5], and included determinants (e.g., external factors), which have received so far little attention in previous models.

2. Materials and Methods

The integrative review was carried out according to the procedure described by Whitemore and Knafl [21]. According to Whitemore and Knafl, an integrative literature review comprises the main methodical steps: (1) literature search, (2) data evaluation, and (3) data analysis [21]. We followed and adapted the PRISMA checklist (Preferred Reporting Items for Systematic reviews and Meta-Analyses) for the current review [22] (Supplementary Material, Table S1).

2.1. Literature Search

2.1.1. Search Strategy

The aim for the search strategy was to perform a highly specific search by combining the central terms (using the Boolean operators “AND” and “OR”). We developed a search strategy for one database (Pubmed) and combined different terms for safety culture (e.g., safety culture, culture of safety, safety climate, prevention culture, organizational culture or climate) occupational safety

(e.g., occupational health, occupational safety or occupational health and safety, industrial safety, job-safety, working safety or safety at work), and workplaces (e.g., workplace, working condition, work environment, hospital) using “AND”. We used different strategies and developed a text word search for each database, and if possible, a MeSH term or thesaurus term search. The search strategy was subdivided according to the setting: One search strategy followed studies in the hospital setting; the other search strategy was directed at studies conducted in other workplaces. For quality assurance reasons, the search strategy was evaluated by two different persons (A.S. and M.A.R.) based on the PRESS Guideline [23]. After feedback, the search strategy was revised, finalized, and then transferred (if necessary, including translation) to three other databases (Web of Science, PsycINFO and CINAHL). The final search strategy for the database Pubmed can be viewed in the Supplementary Material (Table S2 and Table S3).

2.1.2. Inclusion and Exclusion Criteria

We used the SPIDER-Framework [24] to determine inclusion and exclusion criteria with regard to the four dimensions: Sample, Phenomenon of Interest, Design, Evaluation, and Research type. We also considered the inclusion and exclusion criteria of the systematic literature review conducted by Cornelissen and colleagues for orientation [5]:

- “Sample”: The targeted sample comprised employees at different workplaces. Investigated workplaces were hospital workplaces and other workplaces (e.g., construction, manufacturing, services, and other industry sectors). We excluded studies conducted in some countries (Israel, Iran, Africa, Chile and Korea) [25–35], due to the difficulties to compare the results to the German healthcare system. Furthermore, we excluded studies at nuclear power stations or in the oil and gas industry since the comparison with workplaces in construction and manufacturing was of primary interest to us. In addition, the nuclear power and gas industries often focus on the prevention of accidents/serious incidents, whereas we were interested in the occupational safety culture “in everyday life”.
- “Phenomenon of Interest”: We included studies that described different determinants of an occupational safety culture. We excluded studies in which occupational safety culture at the workplace was not the main aspect.
- “Design”: We intended to consider studies with different research methods (questionnaire, qualitative interviews, focus group discussions).
- “Evaluation”: Studies of interest included the perceptions and experiences of employees on occupational safety culture. We used the seven clusters from Cornelissen et al. as a raster to evaluate and sort the determinants that were assessed in the individual studies.
- “Research type”: We included studies with different research designs (qualitative, quantitative, mixed-method) aiming to gain a more comprehensive view on utilized determinants of an occupational safety culture in different workplaces. We excluded intervention studies on occupational safety culture or on occupational safety as we did not want to evaluate the effects of individual interventions. Our interest was focused on the determinants identified in the studies.

For our study, we used a rather broad definition of safety culture to find sufficient hits in the literature search. Therefore, we did not distinguish between the two concepts of safety culture and safety climate. The studies had to be published in peer-reviewed journals since the year 2000 to cover the last 15 years, and to reflect potential changes in the way occupational safety culture is seen at different workplaces. The studies had to be published in German or English language.

2.1.3. Literature Search

We searched in four databases (Pubmed, PsycINFO, CINAHL, and Web of Science) to identify relevant literature for our research aim. The search was conducted in February and March 2019 (last search was carried out on March 21, 2019) and updated in April 2020 (last search performed on April

04, 2020). In addition to the database search, the reference list of selected publications was considered. Furthermore, the following websites were searched for further literature: OSHA (Occupational Safety and Health Administration), DGUV, BAuA, and INQA.

2.1.4. Screening and Selection Procedure

Two raters (A.W. and L.S.) screened all references independently. In the screening process, we included studies that examined safety culture and occupational health and safety. The screening was conducted using the Rayyan program [36]. At the stage of the full text analysis, we included studies that described or identified possible determinants of safety culture in the workplace. In case of disagreement between the two reviewers, there was always the possibility to call in a third person (M.A.R.). Disagreement between the two reviewers was resolved by consensus discussion.

2.2. Data Evaluation

2.2.1. Critical Appraisal

A quality appraisal for each selected study was conducted in the next step. We used the SURE Checklist for Cross-sectional studies (12 items) [37], and for longitudinal studies, we employed the SURE Checklist for Cohort studies (13 items) [38]. In both checklists, all single quality rating items were answered with “yes”, “can’t tell”, or “no”. For mixed-methods studies, we applied the Mixed Methods Appraisal Tool (MMAT), which included five questions and also the possibility to answer with “yes”, “can’t tell”, or “no” [39]. All quality rating items are shown in the Supplementary Material (see Table S4). For each study, we calculated how often items from the checklist were answered with “yes” in percent and considered values above 60% as satisfying quality (see Table S5 in Supplementary Material).

2.2.2. Data Analysis

We followed the procedure described by Whitemore and Knafl for data analysis with data reduction, data display, and data comparison [21]. For data analysis, we developed a data sheet and extracted study characteristics from the included studies (see Table S5 in Supplementary Material). We investigated the variables of the individual studies and categorized them according to each of the seven clusters of Cornelissen et al. using a concept mapping strategy [40]. The detailed mapping of the individual variables is shown in Table S5 in Supplementary Material. After mapping, we calculated how often the clusters are represented in the different workplaces (hospital versus other workplaces) to identify possible research gaps (see Tables 2 and 3).

3. Results

3.1. Summary of Search Results

The literature search yielded 5566 hits. After removing duplicates, 3038 results remained for title and abstract screening. Following the screening, we included 172 publications in the full text analysis. After the full text analysis and critical appraisal, a total of 44 studies were included in the literature review. The selection process of the studies is outlined in Figure 1.

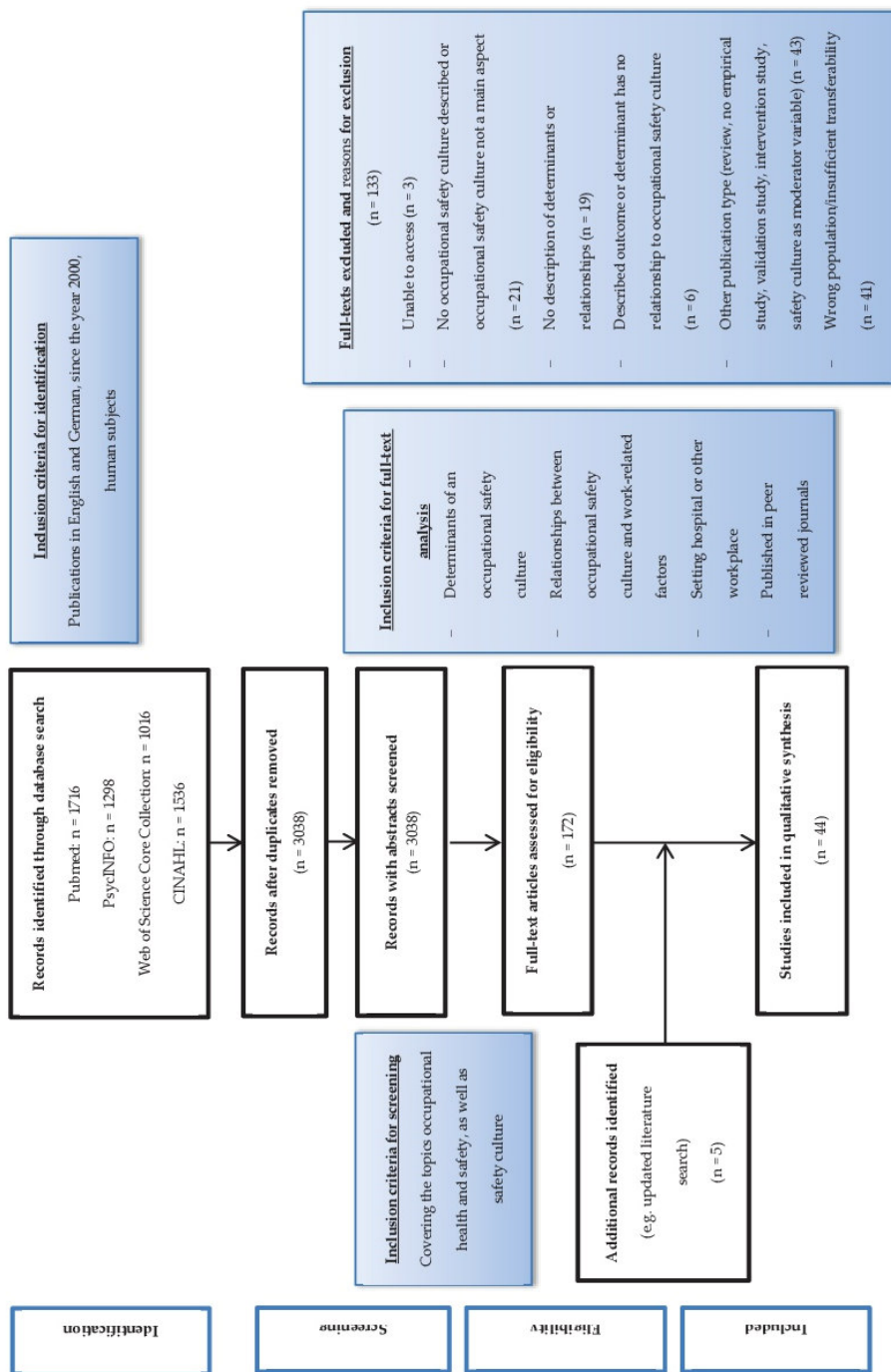


Figure 1. Study selection.

3.2. Characteristics of Included Studies.

We identified 44 studies investigating various determinants of an occupational safety culture [41–84]. Seventeen studies referred to hospital workplaces [41,44,48,54,56,62–67,69–71,80,81,84] and 27 studies were conducted at other workplaces, mostly manufacturing, construction, and other industry sectors [42,43,45–47,49–53,55,57–61,68,72–79,82,83].

The 44 studies were published between 2000 and 2020. Most of the studies applied a cross-sectional research design [41–55,57–65,68,69,71–81,83,84]. We identified four cohort studies using a longitudinal research design [56,67,70,82], and only one study employing a mixed-methods design [66]. Fifteen studies were conducted in European countries: five in Spain [51–53,73,83], three in Sweden [61,72,82], two in Italy [43,48], one in the Netherlands [44], one in Austria [45], one in the United Kingdom [47], one in Serbia [68], and one in Portugal [78]. Seventeen studies were carried out in the United States of America (USA) [41,49,50,54,56,58–60,62,71,74–77,79–81]. We identified three studies conducted in Canada [46,63,64], seven studies conducted in Australia [55,57,66,67,69,70,84], and one cross-national study referred to research undertaken in the United States of America and in Canada [65]. One study did not specify where the research was carried out, but only stated that the results referred to 19 countries [42].

Most of the studies used self-report questionnaires to capture safety culture. In some studies, the questionnaires were combined with other gathered data (e.g., routine data, injury reports, injury database, safety audit) [41,56,59,67,70,75,76,78,81,84]. One mixed-methods study used both a scale from a questionnaire and qualitative interview data [66]. The conducted quality appraisal revealed satisfying quality values above 60% for most of the studies. Some studies achieved values under 60% [44,48,55,67,69,71,74,75,77]. The main reasons for the negative appraisals were lack of information on eligibility and on selection of the study participants. A comprehensive overview of the studies is presented in the Supplementary Material (Table S5).

The overview of how frequently and in which clusters determinants from the individual studies were represented is shown with regard to hospital (Table 2) and other workplaces (Table 3). Neither for hospital workplaces nor for other workplaces were all clusters addressed simultaneously by at least one study. Instead, most of the studies reported on determinants attributed to the cluster “Management and colleagues” (16/17 studies on hospital workplaces, 25/27 studies on other workplaces), followed by “Employee Characteristics” (14/17 (hospitals) and 23/27 (other), respectively), and “Workplace characteristics and circumstances” (14/17 studies on hospitals and 21/27 studies on other workplaces, respectively). The least frequently investigated determinants belonged to the clusters “External (Factors)” (0/17 studies on hospital workplaces and 2/27 studies on other workplaces) and “Climate and Culture” (3/17 on hospital workplaces and 1/27 on other workplaces, respectively).

Table 2. Hospital workplaces—17 studies—mapping of the investigated determinants to clusters according to Cornelissen et al. [5] (for details of the studies see Table S5 in supplementary material, for topics and categories of the clusters see Table 1)

Author and Year of Publication	(1) Workplace Characteristics and Circumstances	(2) Climate and Culture	(3) Management and Colleagues	(4) Employee Characteristics	(5) External	(6) Performance	(7) Safety Outcomes	Summary of Investigated Factors (According to Cornelissen et al. [5])
Aljabri et al. 2020 [41]	X		X	X		X	X	(1) (3) (4) (6) (7)
Bronkhorst et al. 2016 [44]	X		X	X			X	(1) (3) (4) (7)
Dal Corso 2008 [48]		X	X	X		X		(2) (3) (4) (6)
Gershon et al. 2000 [54]	X		X	X		X	X	(1) (3) (4) (6) (7)
Halbesleben et al. 2013 [56]			X			X	X	(3) (6) (7)
Manapragada et al. 2019 [62]	X		X			X		(1) (3) (6)
McCaughy et al. 2011 [63]	X		X					(1) (3)
McCaughy et al. 2013 [64]	X		X	X			X	(1) (3) (4) (7)
McCaughy et al. 2015 [65]	X		X	X			X	(1) (3) (4) (7)
McLinton et al. 2018 [66]	X		X	X			X	(1) (3) (4) (7)
McLinton et al. 2019 [67]	X		X	X			X	(1) (3) (4) (7)
Neal et al. 2000 [69]	X	X	X	X		X		(1) (2) (3) (4) (6)
Neal et al. 2006 [70]			X	X		X	X	(3) (4) (6) (7)
Nixon et al. 2015 [71]	X		X	X		X	X	(1) (3) (4) (6) (7)
Silver et al. 2019 [80]	X		X	X		X		(1) (3) (4)
Stone et al. 2006 [81]	X	X	X	X			X	(1) (2) (4) (7)
Zadow et al. 2017 [84]	X		X	X			X	(1) (3) (4) (7)
Summary of counting	14/17	3/17	16/17	14/17	0/17	8/17	12/17	

Table 3. Other workplaces—27 studies—mapping of the investigated determinants to clusters according to Cornelissen et al. [5] (for details of the studies see Table S5 in Supplementary Material, for topics and categories of the clusters see Table 1)

Author and Year of Publication	(1) Workplace Characteristics and Circumstances	(2) Climate and Culture	(3) Management and Colleagues	(4) Employee Characteristics	(5) External Performance	(6) Performance	(7) Safety Outcomes	Summary of Investigated Factors (According to Cornelissen et al. [5])
Beus et al. 2010 [42]	X		X	X				(1) (3) (4)
Brondino et al. 2012 [43]	X		X	X		X		(1) (3) (4) (6)
Bunner et al. 2018 [45]	X		X	X		X		(1) (3) (4) (6)
Chen et al. 2017 [46]	X		X	X			X	(1) (3) (4) (7)
Clarke et al. 2006 [47]	X		X	X		X		(1) (3) (4) (6)
DeJoy et al. 2004 [49]	X		X	X		X		(1) (3) (4) (6)
DeJoy et al. 2010 [50]	X	X	X	X		X		(1) (2) (3) (4) (6) (7)
Fernández-Muñiz et al. 2007 [51]			X	X		X		(3) (4) (6) (7)
Fernández-Muñiz et al. 2012 [52]	X		X	X	X	X		(1) (3) (4) (5) (6) (7)
García et al. 2004 [53]	X		X	X		X		(1) (3) (4) (6)
Griffin et al. 2000 [55]	X		X	X		X		(1) (3) (4) (6)
Hicks et al. 2016 [57]	X		X	X		X		(1) (3) (4) (6) (7)
Huang et al. 2006 [58]	X		X	X		X		(3) (4) (7)
Kath et al. 2010 [59]	X		X	X		X		(1) (3) (4) (7)
Katz et al. 2019 [60]	X		X	X		X		(1) (4) (6) (7)
Larsson et al. 2008 [61]	X		X	X		X		(1) (4) (6)
Miljić et al. 2014 [68]	X		X	X		X		(1) (3) (4) (7)
Nordlöf et al. 2017 [72]	X		X	X	X	X		(1) (3) (4) (5) (6) (7)
Oliver et al. 2006 [73]	X		X	X		X		(1) (3) (4) (6) (7)
Pandit et al. 2019 [74]	X		X	X		X		(1) (3) (4) (7)
Probst et al. 2004 [75]	X		X	X		X		(1) (3) (4) (6) (7)
Probst et al. 2008 [76]			X	X		X		(3) (7)
Probst et al. 2015 [77]			X	X		X		(3) (7)
Rodrigues et al. 2015 [78]	X		X	X		X		(1) (3) (4) (6)
Schwatka et al. 2016 [79]	X		X	X		X		(3) (6)
Tholén et al. 2013 [82]	X		X	X		X		(1) (3) (6)
Tomás et al. 2011 [83]	X		X	X		X		(1) (3) (4) (6) (7)
Summary of counting	21/27	1/27	25/27	23/27	2/27	19/27	16/27	

3.3. Determinants of An Occupational Safety Culture

3.3.1. Cluster “Workplace Characteristics and Circumstances”

Fourteen out of the 17 studies in hospital workplaces addressed “Workplace characteristics and circumstances” (see Table 2). Studies in this cluster covered the following topics: accessibility, availability, and quantity of safety equipment [54]; exposure to workplace hazards and risks [54,71,80,81]; perceived workplace or job safety [63–65]; and description of work and hospital characteristics (e.g., work arrangement, work role and position, workload, job stress, role clarity, patient/client contact, and patient care rates, hours worked, number of workers in the team, hospital status) [41,44,54,62–64,66,69,80,81,84]. Some individual data, like union membership [80], work engagement [67], and employment status [64,84], were also addressed. Two studies mentioned aspects of psychosocial working conditions (e.g., conflict with others, lack of support, emotional demands, bullying, skills discretion) [62,67].

In 21/27 of the studies in other workplaces, topics from the cluster “Workplace characteristics and circumstances” were also included (see Table 3). Common topics were safety-related issues like average working environment risk level or exposure to common workplace hazards [42,68,73,78,83], availability and safety conditions of safety equipment and machinery [53,78], promotion of overall health and well-being [60], and perceived safety or health at work [49,50,59,60,72,75,78]. Some studies also focused on descriptions of workplace characteristics and covered the following topics: type of organization or department [43,68,72,73,78], OHSAS 18001 (Occupational Health and Safety Assessment Series) certification [72], geographical location of the organization [57], and company size or number of employees [45,46,53,72,73]. Other topics included information on employees, like kind of job contract or type of employment [43,53,57,73], respondents’ role or job position [45–47,53,57,60,68,72,73,78], work shift [43], weekly working hours or number of hours worked [46,49,60,72], and individual data like union membership [46]. Some studies addressed organizational environment and functionality [68,72], environmental or physical working conditions [49,57,72], the quality of environmental working conditions (e.g., humidity, lighting, ventilation, temperature, workspace) [49,73,83], and work-related safety practices [74]. Other studies focused on different aspects of psychosocial working conditions [42,45,46,52,53,61,72,74,75,82]. One study mentioned specific work limitations (e.g., physical demands, time management) [60].

3.3.2. Cluster “Climate and Culture”

Only 3/17 of the studies in hospital workplaces mentioned “Climate and culture” aspects (see Table 2). We identified three studies referring to organizational climate [48,69,81]. One study from the hospital sector reported the following topics: affective, cognitive, and instrumental factors of organizational climate [48]. The affective factor included aspects of social and interpersonal relationships between employees [48]. The cognitive factor comprised perceptions related to psychological involvement in the workplace, and the instrumental factor consisted of structural aspects [48]. Further topics within this cluster were general organizational climate with specific aspects of the work environment (e.g., appraisal and recognition, goal congruency, participative decision-making, professional growth, professional interaction) [69], and perceived organizational climate [81].

Only 1/27 of the studies from other workplaces included topics that could be assigned to the cluster “Climate and culture” (see Table 3).

3.3.3. Cluster “Management and Colleagues”

Most studies in hospital workplaces (16/17) addressed topics from the cluster “Management and colleagues” (see Table 2). Topics can be assigned to management (e.g., management priority given to health and safety; management commitment to health and safety, manager values, manager support ...) [44,48,54,62–67,69,70,80,84], to supervisors (e.g., supervisor safety, supervisor support, supervisor safety leadership ...) [41,56,63–65], and to co-workers (e.g., co-worker influence, group-norms, co-worker safety, and co-worker support) [44,63–65]. On the other hand, some of the studies in hospital workplaces included themes that referred to the management of occupational safety, e.g.,

organizational communication and feedback about safety issues [44,54,62,66,67,69,80,84], organizational participation [44,66,67,84], and the implementation of different safety systems and safety procedures (safety precautions, safety trainings, safety workarounds and safety programs) [54,62–65,69,71,80].

Similar to studies from hospital workplaces, topics from the cluster “Management and colleagues” were also addressed in 25/27 of the studies from other workplaces (see Table 3). Common topics for management were: safety communication [43,45,49,51,52,55,57,59,68,72,73,75–78,82,83], safety training or safety practices [43,45,46,51,53,55,58,68,72,75,77], safety rules, safety standards or safety policies and programs [49–51,53,57,68,72,73], safety management and leadership [57,72,73,83], management values [43,45,55,75,77], management commitment to safety and competence, managers’ attitudes towards safety, and managers’ behaviour towards safety [46,51,52,58,59,72,74,79,82]. Safety inspections [42,55], improvement of safety systems and continuous improvements [43,72,75,77,78], priority and importance of safety issues within the organization [49,50,53,79,82], and organizational or management support for safety [49,50,68] were also included. Specific topics in individual studies comprised return-to-work policies [58], accident or risk prevention [53,68], post-injury administration [58], deployment of safety delegates [53,72], occupational health services [72], top management safety empowerment, and safety justice [79]. Other topics that affect management are: management reaction and investment [53,68,78], planning and control activities [51,53,72]. Finally, the following topics were also addressed: specific and different leader influence tactics [47,72], and incentives [51,52]. Common topics for supervisors were: safety communication [42], supervisor’s reaction to workers’ behaviours [43], supervisor’s effort to improve safety [42,43,53], supervisor safety perception [46], supervisory action and expectation [42,47,53], supervisor enforcement of safety policies [42,77], supervisor concerns related to workers’ safety practices [78], supervisor support [74], supervisor safety priority, commitment and competence, and supervisor safety empowerment and justice [79]. Common topics for co-workers were: safety communication [43], safety mentoring [43], safety systems [43], co-workers values [43], co-worker safety perception [46], co-worker support [49], and co-worker safety commitment [79].

3.3.4. Cluster “Employee Characteristics”

Fourteen of 17 of the studies in hospital workplaces included employee characteristics (see Table 2). The most common topics were age [41,44,54,64–66,80,81,84], gender [41,44,54,65,80,84], years of experience [64,65,81], tenure or length of employment [41,44,66,80], and educational level [54,64,65,80,81]. In addition to safety culture, further studies in hospital workplaces assessed job satisfaction [64,65,71], turnover intentions [64,65,71], self-rated health status [65,67], and lifestyle habits (e.g., smoking, exercise) [44]. Some studies also recorded negative affect [70,71], race, ethnicity, and social background information [80].

Twenty-three of 27 of the studies conducted at other workplaces also addressed employee characteristics (see Table 3). Similar to the studies in hospital workplaces, the most common topics were age [42,43,46,47,49,53,57,60,68,72,73,78], gender [43,46,47,49,53,57,60,68,72,73,78], educational level [43,53,60,68,73], and length of employment or work experience and organizational tenure [42,43,46,47,49,53,68,78]. Further studies also included specific safety characteristics (e.g., safety motivation, safety knowledge, safety awareness and competency, hazards recognition, safety control, previous involvement in work accidents, and individual responsibility) [45,46,51,54,55,58,59,61,68,72–75,78,83]. Other factors within this cluster were assessments of individual resilience [46], organizational trust [59,78], employee satisfaction [52,59–61], lateness [50], and turnover intention [50,52,59]. Additionally, self-rated health (e.g., vitality) [50,60], lifestyle behaviours (tobacco, alcohol, emotional or physical abuse, physical activity, nutrition, sleep) [60], and other socio-demographic data were collected (e.g., nationality, children) [43,53].

3.3.5. Cluster “External (Factors)”

We were unable to identify any studies in hospital workplaces which addressed topics belonging to the cluster “External (factors)”.

Only 2/27 of the studies conducted in other workplaces addressed aspects from the cluster “External (factors)” (see Table 3). Two studies included customer satisfaction as part of firm competitiveness and the existence of a budget for occupational health and safety management as part of occupational health and safety management [52,72].

3.3.6. Cluster “Performance”

Eight of 17 of the studies in hospital workplaces included topics that could be assigned to the cluster “Performance” (see Table 2). The studies addressed safety compliance [41,48,54,56,62,69–71] and safety participation of the employees [48,62,69,70].

Nineteen of 27 of the studies from other workplaces included topics from the cluster “Performance” (see Table 3). The most common topics were also safety compliance and adherence [43,45,52,53,55,57,75,79,82], and safety participation of the employees [43,45,47,49,52,55,79]. Other topics within this cluster were safety involvement and safety-specific behaviour (e.g., suggestions and reports to supervisors, using available safety protection equipment, structural safety behaviour, interactive safety behaviour, personal safety behaviour, choosing safe working methods and procedures, taking no shortcuts with safety, prioritizing safety, workers’ commitment to safety, organizational commitment, risk acceptance, and safety audit) [45,50,51,53,55,57,61,72,73,78,82,83]. Three studies dealt with aspects of organizational performance within this cluster. Two studies included aspects of production performance (e.g., product quality, productivity, image and reputation, and innovation) [52,60], and another study employed aspects of financial performance (e.g., company profitability, solvency, and creditworthiness [72].

3.3.7. Cluster “Safety Outcomes”

Twelve of 17 of the studies in hospital workplaces included topics related to the cluster “Safety outcomes” (see Table 2). Topics were injuries [41,56,64,65,71,81,84], safety incidents and accidents [54,66,67,70], reporting and underreporting of injuries [56,84]. Sick days, illnesses, physical and psychosocial disorders (e.g., musculoskeletal disorders, emotional exhaustion, burnout), days missed from work, and other factors (e.g., absenteeism; presenteeism; healthcare utilization) were also addressed [41,44,64,67,84].

Topics from the cluster “Safety outcomes” were included in 16/27 of the studies from other workplaces (see Table 3). Analogously to the studies in hospital workplaces, common topics were reported, such as injuries [51,52,58,59,75] and safety incidents and accidents [46,50,68,72,75]. One study distinguished between safety incidents with regard to expected frequency and expected severity [74]. Some studies also addressed topics like reporting and underreporting of injuries and accidents, and provided information about reported and unreported injuries and accident rates [76,77]. Two studies classified work-related accident rates into four categories: number of near misses, minor accidents, accidents resulting in up to 3 days off work, and severe accidents resulting in more than 3 days off work [73,83]. Another study also addressed work time missed because of health-related and non-health-related issues [60]. Three studies mentioned consequences from safety incidents, like physical and psychological stress symptoms (e.g., emotional exhaustion) [46,57] and disorders (e.g., back pain, depression) [60]. Three studies also communicated other safety-related outcomes (e.g., absenteeism from work and material damage) [50–52].

3.3.8. Classification of the Studies into the Topics and Categories according to Cornelissen et al.

We compared our findings with topics and categories identified by Cornelissen et al. [5]. Table 4 summarizes for each cluster which of the studies addressed the respective topics and categories as proposed by Cornelissen et al. [5].

Table 4. Summary and classification of the studies addressing cluster, topics, and categories according to Cornelissen et al. [5]

Cluster	Categories	Studies at Hospital Workplace	Studies at other Workplaces
1. Workplace characteristics and circumstances	Physical work environment	[54,63,71,80,81]	[42,49,53,57,60,68,72,73,78,83]
	Work characteristics	[41,44,62–67,69,80,84]	[42,43,45,46,49,50,52,53,57,59–61,72,74,75,82]
	Workforce	[41,44,64,66,80,84]	[43,45–47,53,57,60,68,72,73]
2. Climate and culture	Organizational climate and culture	[48,69,81]	[50]
	Safety climate and culture		
3. Management and colleagues	Management attitudes and behaviours	[41,44,48,54,56,62–67,69,70,80,84]	[43,45–47,49–52,55,57–59,68,72,74,75,77–79,82,83]
	Co-worker attitudes and behaviours	[44,63–65]	[43,46,49,79]
	Management of safety	[44,54,62–67,69,71,80,84]	[42,43,45,46,49–53,55,57–59,68,72,73,75–78,82,83]
4. Employee characteristics	Employee demographics	[41,44,54,64–66,80,81,84]	[43,46,47,49,53,57,60,68,72,73,78]
	Career and job attitudes	[41,44,64–66,71,80,81]	[42,43,46,47,49,50,52,53,59–61,68,78]
	Safety characteristics	[48,65,69,70]	[45,46,51,55,59,61,68,72–75,83]
	Lifestyle	[44,67]	[50,60]
5. External	Governmental bodies		
	Stakeholders		[52]
	Socio-economic		[72]
6. Performance	Safety-related performance	[41,48,54,56,62,69–71]	[43,45,47,49–53,55,57,58,61,72,73,75,78,79,82,83]
	Organizational performance		[52,60,72]
7. Safety outcomes	Incidents	[66,67]	[46,72]
	Accidents	[70]	[50,68,73,75,77,83]
	Injuries	[41,54,56,64,65,71,81,84]	[51,52,58,59,74–77]

4. Discussion

We conducted an integrative literature review to assess and map determinants of an occupational safety culture in different workplaces (hospitals and workplaces in construction, manufacturing, warehouses, and others) using the seven clusters described by Cornelissen et al. [5] as a framework.

The obtained overview and the comparison of determinants in different workplaces facilitate the identification of possible research requirements and implications, especially for hospital workplaces. We discuss the results for each of the seven clusters below, and compare our findings with antecedents identified in other models [2–4].

4.1. Determinants of An Occupational Safety Culture

4.1.1. Cluster “Workplace Characteristics and Circumstances”

The topics addressed within this cluster were almost used equally by the studies at different workplaces (14/17 at hospital workplaces versus 21/27 at other workplaces). In general, we found a variety of different determinants. This cluster represented also determinants mentioned in other models, like job demands or job role [2,4]. Compared with topics and categories from Cornelissen et al. [5], we found determinants for physical work environment, work characteristics, and workforce. Most

determinants were addressed in the category work characteristics (see Table 4). This may be because the included studies in the different workplaces mainly considered the perspective of employees and how employees perceive their workplace, for example. Therefore, other characteristics such as workforce quantity and workforce composition were covered less in the studies. Generally, studies in hospital workplaces revealed fewer determinants in this cluster compared to studies from other workplaces. In particular, physical and psychosocial working conditions were not recorded to the same extent. In addition, new and emerging occupational safety and health risks associated with digitalization like increasing work stress and ergonomic risks [85] were also not addressed in the studies included in this review. For future studies in hospital workplaces, it may be promising to include and address further determinants from this cluster, and to cover aspects from physical work environment, (changing) work characteristics, and workforce. It also seems promising to address further topics associated with digitalization since the emergence of digitalization affects more and more employees in their workplaces [85].

4.1.2. Cluster “Climate and Culture”

Overall, this cluster was not very well represented in the studies on hospital workplaces (3/17) or other workplaces (1/27). In our opinion, it is not completely clear why this cluster is so rarely represented in studies. One reason is certainly that the topics in this cluster were not further differentiated, but were only divided into organizational culture/climate and safety culture/climate. This complicated the assignment of content within the mapping. Another explanation could be that the included studies mainly considered the perspective of employees and not the perspective of management and supervisors. The evaluation of organizational safety culture and climate aspects may be better captured in studies that surveyed supervisors and management besides employees. Another explanation may be that topics from this cluster were not often included in questionnaires. In many cases, safety culture questionnaires focus on specific and easily detectable topics, such as leadership, safety behaviour or safety outcomes, and other themes are not assessed. Other models also included topics from this cluster [2]. He et al. named organizational culture as one facet of organization characteristics and as a subtopic from situational factors [2]. The study by He et al. found a strong association between organizational climate and safety climate. One implication for future surveys is certainly to use more assessment instruments that measure these topics in order to gain more insights and to address comprehensively the content of this cluster.

4.1.3. Cluster “Management and Colleagues”

Topics from the cluster “Management and colleagues” were most represented among the studies included in this review. Sixteen of 17 of the studies in hospital workplaces and 25/27 from other workplaces were related to the cluster “Management and colleagues”. Compared with topics and categories by Cornelissen et al. [5], we identified determinants for management attitudes and behaviours, for co-worker attitudes and behaviours, and also for management of safety. It was not surprising that management and supervisors played an important role regarding safety culture in all identified studies. Other studies also confirmed the important role of management, supervisors, and co-workers in shaping safety culture [86]. Christian et al. performed a meta-analysis about workplace safety and confirmed that leadership constituted an integral component for improved workplace safety in addition to other person and situation-related factors [87]. The relevance of leadership and the influence of co-workers is also addressed in other models. He et al. was also able to show in his quantitative overview moderate to strong associations of leadership and co-workers with safety climate [2]. Thus, leadership and co-workers are important determinants of an occupational safety culture.

4.1.4. Cluster “Employee Characteristics”

Another frequently discussed cluster was “Employee characteristics”. The topics addressed within this cluster were used equally by the studies addressing hospital (14/17) and other workplaces (23/27).

Most of the studies assessed demographic aspects of the employees like age, gender or education. Specific career and job attitudes (e.g., tenure, job satisfaction, trust) and some lifestyle habits were also captured. In contrast to hospital workplaces, studies at other workplaces addressed specific safety characteristics (e.g., safety motivation, knowledge, awareness and competency . . .) to a larger extent. He et al. did not mention safety characteristics in his overview although previous work indicated the important role of safety knowledge and safety motivation [3,87]. Also, lifestyle habits were rarely listed as determinants in the studies included in the overview [2]. It seems useful to reflect safety characteristics and lifestyle habits in hospital workplaces as well, and future studies should address these aspects.

4.1.5. Cluster “External (Factors)”

Topics from the cluster “External (Factors)” were given the least attention. We found no studies that included determinants from this cluster for hospital workplaces, and identified only 2/27 for other workplaces. The determinants identified according to Cornelissen et al. were only related to stakeholders (customer satisfaction) and to socio-economic issues (budget for occupational health and safety management). We found no studies that addressed aspects of governmental bodies, for example. This finding is supported by Cornelissen et al. [5], who stated that this cluster is rarely represented in other workplaces and that there is a gap in research regarding this cluster [5]. We did not find other published models who discussed these topics either.

4.1.6. Cluster “Performance”

The cluster “Performance” was represented differently in the various workplaces. Only 8/17 of the topics from this cluster referred to hospital workplaces. In contrast, 19/27 of the studies at other workplaces included topics that could be assigned to this cluster. In hospital workplaces, the topics referred only to safety-related performance, like safety compliance and/or safety participation. No other topics were addressed. At other workplaces, most of the topics also concentrated on safety compliance and/or safety participation. However, we identified three studies that included topics related to organizational performance. This uneven distribution is in line with findings by Cornelissen et al. [5]. The authors also found that safety-related performance aspects were more addressed in their study than aspects of organizational performance [5]. In other models, performance and in particular safety-related work behavior is a common topic of discussion [3]. However, there is no difference between safety-related or organizational performance, and topics from organizational performance were seldom discussed. In general, studies in hospital workplaces should integrate more topics from the cluster “Performance”, and possibly also aspects of organizational performance.

4.1.7. Cluster “Safety Outcomes”

This cluster was mentioned more often in hospital workplaces than in other workplaces (12/17 versus 16/27). Compared with topics and categories by Cornelissen et al., the studies included in the current study covered work-related incidents, accidents, and injuries in employees. We also assigned other topics into this cluster, like physical and psychological or psychosomatic disorders, although these topics are not mentioned in this cluster by Cornelissen et al. In our opinion, this cluster plays an important role for safety culture in hospitals. Hospital workers are generally at a high risk of getting injured (e.g., needle stick injury) or suffering an accident at work (e.g., heavy lifting while transferring patients). Another reason why this cluster is well represented in studies in the hospital setting may be the now well-established patient safety reporting system. In many countries, it is now standard to monitor and analyze (patient) safety outcomes carefully. We therefore assume that many studies in this area particularly consider safety outcomes as essential when it is necessary to assess occupational safety culture. As already mentioned, the relationship between safety culture and safety outcomes is well-documented in healthcare research [8,81], and future studies should comprehensively consider topics from this cluster. However, in our opinion, this cluster needed to be broadened in order to

be able to address topics such as physical, psychological, and psychosomatic disorders. In addition, the reporting and underreporting of safety outcomes seems to be an important issue that should be addressed to a larger extent in further studies in the hospital sector.

4.2. Summary and Recommendations for Future Studies

We identified and mapped different determinants of occupational safety culture in various workplaces (hospital and workplaces in construction, manufacturing, and other industry sectors) using the seven clusters described by Cornelissen et al. [5]. As indicated in Tables 2 and 3, we were unable to find a study in the different workplaces that covered determinants in all seven clusters. This raises the question of whether future studies should cover determinants from as many clusters as possible. Our overview shows that, in particular, determinants in the clusters “Climate and Culture” and “External (Factors)” have received little consideration in previous studies, so far. For future studies, it may be promising to include determinants from these two clusters. The integration of further factors can help to discover relationships between further determinants and to broaden perspectives on occupational safety culture. The overview also revealed that the same determinants of occupational safety culture are often measured in studies at different workplaces. We did not find any major differences regarding the investigated determinants in different workplaces. It may be helpful for future studies in the hospital sector to (1) consider the findings of studies on occupational safety culture in other workplaces, and (2) specifically select determinants and investigate them in the hospital sector. This may help to understand occupational safety culture in hospital workplaces more comprehensively.

4.3. Strengths and Limitations of the Study

The use of the seven clusters from Cornelissen et al. to classify and map possible determinants from different workplaces was suitable and helpful in comparing studies assessing hospital workplaces and other workplaces. Based on the conducted concept mapping of different determinants and the standardized comparison of studies reporting on different workplaces, we gained insights into the priorities in previous research on occupational safety culture and which aspects deserve future priorities. In addition to the imbalance in the assessment of determinants covering the seven individual clusters, new and emerging occupational health and safety risks associated with digitalization should be presented, e.g., in surveys or observations of work processes.

This review also had some methodological limitations. We conducted an integrative literature review with highly heterogeneous studies and diverse definitions of safety culture and safety climate. The concept mapping of possible determinants was carried out based on the information in the studies. In rare cases, the information lacked details, e.g., some studies did not provide the complete questionnaire with scales and items. In addition, it can be assumed that certain variables are only published in internal reports. For future research work, it might be useful to include internal reports or results from industry sector surveys or similar approaches in hospitals in order to get a more comprehensive picture of different determinants of occupational safety culture. Another limitation lies in the exclusion criteria. We excluded some countries due to a poor comparability to the working situations in Germany, and focused only on specific workplaces (mainly hospital, construction, manufacturing, and other industry sectors) and on the perspectives of employees. Also, the inclusion of studies only published in English or German should be considered as a limitation. It is possible that including studies from more countries, other workplaces, and the perspectives of supervisors and management would have resulted in more hits and more detected possible determinants in the seven clusters.

5. Conclusions

The seven clusters by Cornelissen et al. were useful in classifying various determinants from studies at different workplaces. By comparing and contrasting previously investigated determinants at the hospital workplace with other workplaces, it was possible to derive implications for further

research, especially for the hospital sector. Comparing different economic sectors, many determinants identified from workplaces in e.g., construction work have not been addressed to the same extent in studies covering hospital workplaces, to date. In particular, specific topics from Cluster 2 according to Cornelissen et al. (e.g., safety climate/culture), Cluster 4 (e.g., safety characteristics, lifestyle habits), Cluster 5 (e.g., external factors), Cluster 6 (e.g., organizational performance), and Cluster 7 (e.g., consideration of other outcomes such as physical and psychosomatic disorders, reporting and underreporting of injuries) have been given little attention in hospital workplaces so far and should be included in further studies. It may be promising for future studies on hospital workplaces to assess these topics and to gain a more comprehensive picture of important determinants of an occupational safety culture in the hospital sector. In general, new and emerging occupational safety and health risks associated with digitalization should be also included in the assessment of determinants of occupational safety culture in all workplaces.

Supplementary Materials: The following are available online at <http://www.mdpi.com/1660-4601/17/18/6588/s1>, Table S1: Modified PRISMA checklist according to Moher et al. 2009 [22]; Table S2: Example for search strategy in Pubmed: Text word search; Table S3: Example for search strategy in Pubmed: MeSH-Tetabterm search; Table S4: Quality appraisal items; Table S5: Overview of the study characteristics and mapping the clusters according to Cornelissen et al. [5].

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3 Discussion

This dissertation comprises four publications dealing with patient and occupational safety culture and psychosocial factors within working conditions from the perspective of nurses and physicians in the hospital setting. Results previously mentioned in the discussion sections of the four publications will be raised, but not discussed again in detail. Subsequently, individual findings on patient and occupational safety culture as well as working conditions not previously discussed are presented here in more detail.

3.1 Patient Safety Culture in University Hospitals: Assessment and Predictors

Assessment of Patient Safety Climate: Discussion of Main Results

Publication 1 focused on the assessment of patient safety climate using the HSPSC-D (version 1) and additionally developed twin items [27]. HSPSC is one of the most commonly used instruments in hospitals to measure patient safety climate [176]. The HSPSC was originally developed by Sorra and Nieva in 2004, consisting of 42 items grouped into twelve dimensions [177]. The original questionnaire was created on the basis of a literature review (on safety, accidents, errors, safety and organizational climate and culture), existing surveys, and background interviews with hospital staff [177, 178]. Thus, there is no theoretical model underlying the questionnaire. Previous studies yielded acceptable results regarding reliability (Cronbach's alpha between .63 and .84), and satisfying results related to validity of the scales [177–181]. For German speaking countries, Pfeiffer and Manser developed a Swiss version of the HSPSC (version 1.0) in 2010, and conducted confirmatory and exploratory factor analyses [182]. Hammer et al. (2011) adapted the Swiss version for medical directors in Germany (HSPSC-M) [183]. Based on these two instruments, a German version for healthcare workers was developed within the WorkSafeMed study (HSPSC-D), and psychometric properties of this version (e.g. model fit, internal consistency, construct validity) were tested and showed satisfying values [184]. HSPSC assesses patient safety climate from the perspective of hospital workers at three levels (individual or unit level, hospital level, and outcome variables) [177, 178].

In the WorkSafeMed study and this dissertation, the following scales of the HSPSC-D were assessed at the three levels [27]:

- **Assessment at the individual or unit level:** Supervisor / manager expectations, organizational learning, teamwork within units, communication openness, feedback and communication about error, nonpunitive response to error, and staffing
- **Assessment at the hospital level:** Management support for patient safety, teamwork across units, and handoffs and transitions
- **Assessment of outcome variables:** Overall perceptions of patient safety, frequency of event reporting, patient safety grade, overall safety grade in the medication process

At all three levels, the WorkSafeMed study and the dissertation identified different perceptions by nurses and physicians [27]. In the following, mainly the results with a large effect size $d_{\text{Cohen}} > .50$ are further discussed. Accordingly, this refers to the scales “staffing”, “management support for patient safety”, and “overall perceptions of patient safety”.

At the **individual or unit level**, a significantly different assessment was found for the scale “staffing”: Nurses in the WorkSafeMed sample rated this scale significantly lower (2.4 ± 0.8) than physicians (2.8 ± 0.8) [27]. The scale consisted of four items: one positively worded item (“We have enough staff to handle the workload”) and three negatively worded items (“Staff in this unit work longer hours than is best for patient care” / “We use more agency/temporary staff than is best for patient care” / “We work in “crisis mode” trying to do too much, too quickly”). According to Schriesheim et al. (1991), negatively worded items can lead to misunderstanding among study participants and a lower reliability [185]. To reduce misunderstanding and ambiguities regarding the wording of items, our questionnaire and all items within were pretested among nurses and physicians before the survey [27]. In the WorkSafeMed study, we determined a Cronbach’s α of .69 for the scale “staffing”. According to previous recommendations, only Cronbach’s alpha values between .70 and .90 can be considered as satisfactory [186]. However, other studies using the HSPSC also revealed lower Cronbach’s alpha values for the scale “staffing” [180]. Compared with previous research, a recent

meta-analysis and systematic review with 59 included studies revealed that the scale “staffing” belonged to the lowest rated dimensions among the HSPSC [64]. Within this review and meta-analysis, 18 studies were conducted in Europe [64]. In their study, the scale “staffing” received only 36% positive responses [64]. Thus, it can be assumed that staffing levels of nurses and physicians are also perceived as inadequate in other countries. To date, mainly international studies on nursing have demonstrated associations between staffing, quality of care, and patient outcomes [16, 17, 131–134]. Similarly, previous studies also found some indication that adequate staffing and nurse-to-patient ratios are associated with fewer occupational accidents and injuries [15], and a lower risk of adverse cardiovascular health events [187] for nurses. From this, it can be concluded that adequate staffing and nurse-to-patient ratios lead to improvements in patient safety, but also to improvements in the occupational safety and health of nurses.

Overall, as noted at the beginning of this dissertation, the introduction of DRGs in German hospitals was accompanied by a massive reduction in nursing staff positions [20], and a political discussion about nursing staff standards and appropriate patient-to-nurse-ratios that has not ended to this day. This reduction in staffing and the shortage of nurses could not be recruited and retained in hospitals before the start of the WorkSafeMed study. Thus, the subjective results of the scale “staffing” reflect the reality that there is a massive shortage of nurses in German hospitals overall. A major policy development since the WorkSafeMed study has therefore been, most notably, the “Concerted Action on Care” program (“Konzertierte Aktion Pflege”) [188]. Since 2018, the Federal Ministry of Health, the Ministry of Labor and Social Affairs, and the Ministry for Family Affairs, Senior Citizens, Women and Youth have collaborated and developed strategies to improve the education and training of nurses, the staffing situation, and salaries [188]. In November 2020, the first report on their implementation in the various working groups was presented [189]. With regard to the staffing situation in hospitals, the German Nursing Council (“Deutscher Pflegerat”), the German Hospital Federation (“Deutsche Krankenhausgesellschaft”), and ver.di have developed an interim proposal for a nursing staff assessment procedure (PPR 2.0) [189]. Currently, the Federal Ministry of Health is engaged in further discussions [189], and

it is unclear whether this proposal will be implemented in hospitals. There are currently staffing guidelines for some units in hospitals (“Pflegepersonaluntergrenzen”) [190], but not for all units. Since 2020, the nursing staff ratio (“Pflegepersonalquotient“) has also been implemented, which determines the ratio of nursing staff to individual nursing services provided by a hospital [190]. Overall, however, it remains uncertain to what extent the staffing situation for nurses in Germany will improve in the long term and to what extent these recently implemented policy measures will contribute to this. In recent years, the staffing situation of physicians has been less discussed at the political level. In a repeated survey of the Marburger Bund (2019), physicians stated they were still confronted with overtime, staff shortages, and increasing time pressures [12]. Another qualitative study also addressed high workloads, lack of staff, and working overtime as perceived stress factors [191]. However, a recent study conducted in England illustrated the association between sufficient medical staff and lower mortality among patients [192]. Thus, as already shown in many studies, ensuring a high level of patient safety requires both a sufficient number of nurses and physicians.

At the hospital level, we also found a different assessment of both professional groups regarding the scale “management support for patient safety” [27]. The scale consisted of three items (“Hospital management provides a work climate that promotes patient safety” / “The actions of hospital management show that patient safety is a top priority” / “Hospital management seems interested in patient safety only after an adverse event happens” (negatively worded)) and revealed a Cronbach’s α of .84. Physicians evaluated this scale (3.0 ± 0.8) significantly more positively than nurses (2.6 ± 0.8) [27]. As already discussed in publication 1, we assumed that nurses have little contact with hospital management and may therefore think that managing staff is not involved in activities for the improvements of patient safety issues in hospital units [27]. Generally speaking, according to Flin (2007) and Sammer et al. (2010), management support of, or commitment to safety issues and leadership are among the most important dimensions for safety culture [193, 194]. Previous studies for example demonstrated the relevance and the important role of leadership for safety culture [195–198]. Thus, improvements

are needed so that nurses also perceive that hospital management supports them in advancing patient safety.

Regarding the **outcome variables**, we observed that nurses evaluated the scale “overall perceptions of patient safety” significantly poorer (2.9 ± 0.7) than physicians (3.3 ± 0.8) [27]. The scale included four items (“It is just by chance that more serious mistakes don’t happen around here (negatively worded) / “Patient safety is never sacrificed to get more work done” / “We have patient safety problems in this unit (negatively worded)” / “Our procedures and systems are good at preventing errors from happening”) and showed a Cronbach’s α of .76. Compared with the systematic review and meta-analysis by Okuyama et al. [64], nurses in the WorkSafeMed sample also gave a poorer grade for patient safety [27]. As already discussed in publication 1, the perceived worsening of nursing working conditions may lead to lower ratings of patient safety climate [27]. A recently study conducted by Mihdawi et al. (2020) described the impact of the working environment for patient safety and recommended improvements, especially with regard to staffing, resource adequacy, nurses’ participation, and communication style [199]. Besides the self-reported outcome variables for patient safety culture in the HSPSC-D, we did not include additional objective outcome measures for patient safety in publication 1. Within the WorkSafeMed study, Sturm et al. (2019), for example, correlated survey-related perceptions of working conditions and patient safety with specific routine data for quality of care and workload [26]. Routine data for quality of care comprised readmission rates and disease-related patient length of stay [26]. In their study, the authors identified associations between higher readmission rates and lower perceived patient safety by nurses and physicians, as well as an association between shorter patient length of stay and better teamwork within units for both groups and lower risk of burnout among physicians [26]. The combination of subjective survey data with other more “objective data” is valuable as it provides additional insights and relationships.

In summary, physicians in the WorkSafeMed study rated scales assessing patient safety climate more positively than nurses in our sample [27]. Other studies have also identified and reported varying scores on patient safety climate scales [56, 65]. The different assessments are presumably also based in part on the

different work responsibilities of the two occupational groups in Germany. Nevertheless, the nurses in our sample see a need for further improvement, particularly in patient safety. According to Albalawi et al. (2020), the following factors contribute to improvements in patient safety climate: establishing a blame-free culture, improving communications and leadership capacity, learning from errors, and involving patient perspectives [68].

Overall, the HSPSC-D (version 1) used in the WorkSafeMed study and this dissertation provided good insights into patient safety climate perceived by nurses and physicians in two German university hospitals. In the meantime, a second version of the HSPSC (version 2.0) was released in 2019 [200, 201], but there is currently no German version. Further validation of the German HSPSC (version 2) should therefore be another research priority. According to the Agency for Healthcare Research and Quality (AHRQ), there is also the ability to compare survey data with other hospitals in terms of benchmarking [202]. In our study, we did not compare our results of the HSPSC-D with reference data from other hospitals to gain further insights. However, in future studies a benchmark with other reference data may be helpful to place the results in a broader context.

Predictors for Patient Safety Culture: Discussion of Main Results

Based on the assessments of patient safety climate, in publication 2 we developed two regression models and identified several predictors for perceived patient safety culture in the patient safety culture (PSC) model from the perspective of both nurses and physicians [28]. The developed model revealed a high and satisfactory model quality and the chosen predictors explained 64% of variance [28]. In summary, according to nurses and physicians, the most important predictors for perceived patient safety culture were the scales “management support for patient safety”, “supervisor support for patient safety”, and “staffing” [28]. These identified predictors for perceived patient safety cover the elements that are also considered as central elements of good safety culture in the previous literature [193, 194]. As already suggested by Mihdawi et al. (2020), an investment in staffing and resource adequacy can lead to a more positive assessment of perceived patient safety by nurses and physicians [199]. Further approaches

should be directed at direct supervisors of nurses and physicians, as well as hospital management, to raise awareness of their roles and the different responsibilities for patient safety in the hospital. Kristensen et al. (2015) conducted a study in seven European countries with 3,622 clinical leaders and 4,903 frontline clinicians [203]. The authors discovered relevant differences regarding the assessment of patient safety climate: clinician leaders had a more positive perception of patient safety climate than frontline clinicians [203]. These results were also confirmed in other studies [204, 205]. Future approaches for patient safety climate should therefore take these different assessments into account and develop strategies for the mutual sharing of communication for the benefit of patient safety.

3.2 Occupational Safety Culture in University Hospitals: Assessment, Predictors and Determinants

Assessment of Occupational Safety Climate: Discussion of Main Results

In the WorkSafeMed study and the dissertation within, we used three self-developed indices and specific twin-items to assess occupational safety climate [27] based on the results of our preliminary ABSK study [23], since we could not rely on a well-established instrument for the hospital sector. EU-OSHA generally describes several instruments and tools for the assessment of occupational safety climate [33]. Unfortunately, no instrument was originally developed for the healthcare and hospital sector. In some studies, original patient safety climate assessment questionnaires were adapted to represent staff perspective [88]. Many studies also used instruments and scales originally developed for the manufacturing industry with some modifications to be appropriate for the healthcare setting [48]. Flin (2006) identified different instruments that are occasionally used to measure occupational safety climate in healthcare [206]. However, according to Flin (2006), many instruments did not have a sufficient psychometric quality or theoretical foundation [206]. Thus, there is a lack of validated instruments for assessing occupational safety climate in healthcare, especially in the hospital sector, and there is still a lack of theoretically well-founded and validated instruments with good psychometric quality for assessing occupational safety climate.

In publication 1, we detected some major differences between nurses and physicians [27]. In the following, the dissertation focuses on specific findings with a medium to large effect size d_{Cohen} . This refers to the following two indices: (1) “subjective assessment of occupational safety measures initiated by the employer, related to own safety”, and (2) “personal perception of the frequency of occupational risks” [27].

The first index comprises six items (“regulations for behavior in case of fire/emergency” / “escape and emergency exits” / “behavior after an accident at work” / “first aid facilities” / “regulations on working hours” / “instruction on hazards at workplace and first aid”) answering the following questions: How do you evaluate the following measures with regard to your own safety and health at work in your department/hospital? Nurses in the WorkSafeMed study evaluated this index more positively than physicians [27]. For individual items in this index, the poorer ratings by the physicians can be explained as follows. We assumed that nurses desired more regulations on occupational health and safety from their employers. For physicians, it may be possible that they are already aware of most of the regulations. Recent studies revealed large gaps in knowledge [207] and the need for more information [13] regarding the handling of universal precautions among nurses. Another explanation would be that it is often the nurses who are confronted with providing first aid or handling other regulations, as they are constantly present on the unit and are therefore the first contact persons. Therefore, the relevance and importance of these regulations may be considered higher by nurses than by physicians.

A surprising result emerged for the second index “personal perception of the frequency of occupational risks”. This index consisted of four items (“infections” / “skin diseases” / “consequences of working too long” / “hazardous substances”) and answered the following question: How do you assess your personal risk in your department/hospital? Do you feel exposed to...? Nurses in our sample stated that they experience a higher exposure to these work-related risks than physicians [27]. Previous studies, however, demonstrated that physicians were at higher risk for injuries [208, 209]. In our study, the individual items for this index were formulated in general terms and do not, for example, specifically ask about

invasive tasks, which are usually performed by physicians. Nurses, for example, are at a high risk for skin diseases (e.g., hand dermatitis) [210] due to frequent mandatory hand disinfections after contact with patients. Thus, the selection and the kind of questions may have contributed to this result.

Overall, we did not include specific safety outcomes (e.g. incidence of needlestick injuries, other work-related injuries, work absenteeism) when assessing occupational safety climate. This should be considered in further studies to provide a more comprehensive depiction of occupational safety climate in hospitals.

Predictors for Occupational Safety Culture: Discussion of Main Results

In Publication 2, we developed an occupational safety culture (OSC) model alongside the PSC model and identified specific predictors for perceived occupational safety among nurses and physicians [28]. The most important predictors in the OSC model were job satisfaction, patient-related burnout, and work-privacy-conflict [28]. Unfortunately, the OSC model revealed a moderate model quality of 0.27 R^2 [28].

In this publication we discussed some points as to why we think the OSC model performs worse than the PSC model [28]. One main explanation is the assumption that occupational safety culture is not fully addressed in the questionnaire [28]. Some important predictors seem to be missing. Based on the model by Flin (2007) [193], we concentrated mainly on organizational aspects with the perceptions of management and supervisors regarding safety issues [28]. Other studies assessed safety performance, including safety compliance and safety participation [47, 211], or specific safety outcomes (e.g., [83, 86]). Another possible explanation for the moderate model quality lies in the chosen dependent variable. We used the index “personal perception of the frequency of occupational risks” as the dependent variable [28]. In the PSC model, a special factor for perceived patient safety was formed by four HSPSC-D-outcome variables [28]. In the OSC model, we defined the index as an outcome, as there were no other outcome variables on occupational safety climate in our questionnaire available. Thus, for

future research, it may be beneficial to expand the questionnaire for the assessment of occupational safety climate and to use explicit outcome variables as dependent variables in further OSC models.

Overall, we found several significant correlations between predictors (in the areas working conditions and occupational safety culture) and the chosen dependent variable [28]. Therefore, we can assume that there is a close connection between working conditions and occupational safety culture.

Determinants of an Occupational Safety Culture: Discussion of Main Results

Publication 4 addressed some of the further research questions identified in publication 2. In an integrative literature review, an overview of possible determinants of an occupational safety culture was created using a theoretical framework [30]. Besides the hospital sector, we also considered research from other, mainly industrial, areas in an attempt to present a more comprehensive picture of occupational safety culture [30]. Considering previous research in other disciplines may be helpful when looking for further variables for the measurement of occupational safety climate in hospitals. Overall, the chosen theoretical framework by Cornelissen et al. [212] was supportive in classifying different determinants of an occupational safety culture [30]. It became apparent that, to date, determinants of an occupational safety culture have been illustrated more for other industrial sectors than for hospitals [30].

Overall, occupational safety culture does not yet seem to be a consistent concept in the healthcare sector. Previous studies, mainly in the industrial sector, have captured different determinants of an occupational safety culture using established questionnaires. Studies for the hospital sector with suitable questionnaires are currently lacking. As Flin (2006) stated, there is a lack of instruments with sufficient psychometric quality and theoretical foundation [206]. Further studies should therefore concentrate on the selection of suitable dimensions of occupational safety culture in hospitals when creating a questionnaire. The overview in the literature review can serve as an initial basis for this. Possible content of the mandatory risk analysis [213] can also support the development of a suitable

questionnaire for the measurement of occupational safety climate. Overall, there is still a great need for further research on occupational safety culture in hospitals.

3.3 Patient and Occupational Safety Culture in University Hospitals:

Shared Predictors

Based on publication 2, we further aimed to identify shared predictors for both patient and occupational safety culture [28]. We identified job satisfaction as a significant shared predictor for perceived patient and occupational safety of nurses and physicians [28]. Previous studies already investigated job satisfaction of nurses and physicians [214, 215, 158]. However, there has been little association between job satisfaction and patient and occupational safety culture. Zarei et al. (2016) showed that nurses with good job satisfaction also perceived a higher safety climate [216]. McCaughey et al. (2013) identified associations between safety climate perceptions and, for example, further employee outcomes like job stress, turnover intention, and job satisfaction [89]. In addition to these isolated studies, further work should focus on the relationship between job satisfaction and safety culture.

In the OSC model, leadership was identified as a further indirect predictor via the scale “job satisfaction” [28]. In the PSC model, we identified the relevance of leadership for perceived patient safety mainly via the two variables “management support for patient safety” and “supervisor support for patient safety” [28]. As already mentioned, leadership is one of the main dimensions of a safety culture [193, 194]. Thus, both shared predictors, job satisfaction and leadership, should be further considered when discussing and developing a comprehensive concept for both kinds of safety culture [28].

Overall in publication 2 we discussed little about why we found only few shared predictors. One possible explanation lies in the chosen variables for the two models. We mainly included variables from different instruments when developing the two models [28]. This also limited the identification of shared predictors. For the PSC model, we used the well-established HSPSC-D questionnaire, which has various patient safety dimensions and outcome variables. Thus, the variables in the PSC model were well balanced. For the OSC model, we were not able to use

a previously well-established questionnaire for the hospital sector. Variables from different instruments (COPSOQ, Copenhagen Burnout Inventory (CBI), Transformational Leadership Inventory (TLI-Short), twin-items for occupational safety) were included, and thus the developed OSC model consisted mainly of (1) variables for describing psychological stress and strain within working conditions and (2) variables demonstrating the relevance of leadership within occupational safety climate. A future OSC model should comprise variables that are better aligned, and further research should also include more variables from the same instruments in both models. However, the two models represent a first explorative attempt to find shared predictors for both kinds of safety culture.

We further demonstrated in publication 2 that both dependent variables are related to each other [28]. Previous studies to date also confirmed a close relationship between patient and occupational safety culture. Pousette et al. (2017) found that these concepts were highly interrelated [217]. A more recently study published in 2020 by Aghaei et al. investigated relationships among hospital safety climate, patient safety climate, and safety outcomes among 211 nurses in Iran [218]. The authors also found a close connection between patient and occupational safety climate and nurses' safety performance, and concluded that promoting both patient and occupational safety climate had an impact on nurses safety performance [218]. In summary, only few studies to date focus on the broad assessment of both kinds of safety culture. To the best of my knowledge, this dissertation (within the WorkSafeMed and the ABSK study) is one of the first studies in Germany to examine both types of safety culture in a broader context.

3.4 Working Conditions in University Hospitals: Assessment and Comparison

Assessment of Working Conditions: Discussion of Main Results

In Publication 1, we performed an assessment of psychosocial factors within working conditions of nurses and physicians in the WorkSafeMed study using scales from G-COPSOQ II, CBI, and TLI-short [27]. Overall, we identified various differences regarding working conditions of nurses and physicians [27]. In the following, mainly the results with a rather large effect size $d_{\text{Cohen}} > .50$ are further

discussed. This refers to four G-COPSOQ II scales (“degree of freedom at work”, “possibilities for development”, “workplace commitment”, “job satisfaction”), and to one scale from the CBI (“patient-related burnout”) [27].

The scale “degree of freedom at work” was rated worse by nurses than by physicians in the WorkSafeMed study [27]. Both groups rated the scale rather poorly. This result is not surprising when regarding the items of the scale (see table 3 in publication 3 [29]). As already stated in publication 3, the items on this scale did not fit well for the hospital workplace, because nurses and physicians cannot for example leave the workplace without special permission because of their responsibility for patients [29]. Therefore, some content of the scale “degree of freedom at work” was not appropriate, at least for the hospital sector.

The scale “possibilities for development” was evaluated more positively by physicians than by nurses [27]. In general, the evaluation of this scale was at a high level for both occupational groups [27]. As already discussed in publication 3, the high demands and the work in a university hospital can lead to high perceived possibilities for development for both groups [29]. According to our results, physicians used their skills and expertise more at work than nurses and also had a higher possibility of learning new things [27]. Nurses in our sample rated this scale slightly worse. In Germany, there has been a long-standing general discussion whether there is a lack of opportunities for promotion, particularly for nurses. This is certainly justified in-part by the current structures. In contrast to other European countries, nursing training in Germany is still predominantly organized as vocational training. Although it is now also possible to study for a Bachelor's degree in nursing [219, 220], this is not yet widely used. Furthermore, there are currently few structures targeting academically trained nursing staff and providing professional opportunities to apply special expertise in hospitals [219, 220].

A rather surprising result was the different assessment of the scale “workplace commitment” [27]. Nurses in the WorkSafeMed study rated this scale much worse than physicians [27]. Compared with other studies [221, 222], we identified a lower workplace commitment among nurses [27]. According to a recently conducted study, a high workplace commitment can act as moderator variable and

reduce the effect of high workload on burnout in nurses [222]. The authors stated that a high workplace commitment transported “*a feeling of belonging, security and stability.*” [222] Based on our results, therefore, future efforts should particularly work to strengthen the workplace commitment of nurses [27].

Within the G-COPSOQ II, our scales were divided into stress and strain factors according to the general stress-strain-model [115]. According to this model, all scales for the domains “demands”, “influence and development”, “interpersonal relations and leadership” are stress factors/work-related demands in a neutral sense. Thus, these factors can have positive or negative attributes for employees. The scale “job satisfaction” is therefore considered as a strain and represents the effects of the different stressors. In the WorkSafeMed study, we observed a different evaluation of the scale “job satisfaction” between the occupational groups [27]. Physicians rated this scale more positively than nurses [27]. However, both occupational groups reported a relatively high job satisfaction score despite high values for quantitative demands and work-privacy-conflict [27]. Studies available to date identify predictors for job satisfaction. According to Schmidt et al. (2008), quality of leadership, cooperation with physicians, work family conflict, and meaning of work are important factors for job satisfaction of nurses [215]. Another study identified job demand, control, and social support as essential predictors for job satisfaction of nurses [214]. In general, these studies included only nurses. In the WorkSafeMed sample, however, we also observed high values for meaning of work and social support among nurses and physicians [27], which are likely resources that may contribute to the high levels of job satisfaction found. As outlined earlier, work-related psychosocial demands or stressors can have positive or negative effects on health depending on individual resources [108]. Therefore, depending on individual resources, high job demands can sometimes be perceived as something positive and lead to a positive perceived strain (in this case high job satisfaction).

The scale “patient-related burnout” was assessed using the Copenhagen Burnout Inventory (CBI) [223]. The CBI originally included three sub-dimensions: personal burnout, work-related burnout, and client-related burnout [223]. For the WorkSafeMed study and this dissertation, the focus was on the sub-dimension

“client-related burnout” and the wording was changed from client to patient. Thus, only a specific aspect of burnout was represented and cannot give a comprehensive picture of burnout as provided by the CBI measurement tool. Client-related burnout was originally defined as *“the degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his/her work with clients.”* [223] In the WorkSafeMed study, nurses evaluated the outcome scale “patient-related burnout” worse than physicians [27], but the values in both groups were low compared with other studies [224]. Overall, burnout is associated with poorer safety outcomes [169, 150] and also with the intention to leave the profession [149]. It is therefore important that this outcome, with its associations to other aspects of safety culture and working conditions, is carefully monitored.

The scales “job satisfaction” and “patient-related burnout” were the only two outcome dimensions used to assess working conditions in the WorkSafeMed study. We did not assess other outcome variables according to the stress-strain-model (for example, missed nursing or medical care, intention to leave the job, or other subscales for burnout). Therefore, we cannot compare our results with previous findings from the NEXT study or other international studies.

In general, however, G-COPSOQ II, together with the CBI and TLI-short, was helpful in capturing psychosocial factors within working conditions of nurses and physicians. In addition to the G-COPSOQ II and the CBI, there are several instruments for the assessment of working conditions, for example, the Effort-Reward Imbalance (ERI) questionnaire [112, 225] the Organizational Justice Scale [226], and the Stress-Energy Questionnaire (SEQ) [227]. Regarding the different domains from the GDA in the stress-strain-model [108], most of the G-COPSOQ II scales used in the WorkSafeMed study focused on work content and task, organization of work, and social relations. Specific aspects of work environment and new forms of work were included in our study, but to a lesser degree. In summary, future studies aiming to assess psychosocial factors within working conditions comprehensively should, if possible, consider all five areas of the GDA.

Comparison of Working Conditions: Discussion of Main Results

In publication 3, we compared findings from working conditions with corresponding reference data from the German COPSQ database (2012-2017) [29]. As preliminary work, we converted the original scales from the WorkSafeMed study (G-COPSQ II) to the scales of the G-COPSQ III using an explorative approach with different steps [29].

The multistep approach was in my opinion appropriate [29], since, in general, questionnaires evolve based on newer findings. The COPSQ is a good example of the continuous integration of new scientific advances. However, results obtained with earlier versions can no longer be easily compared, as stated in publication 3 [29]. Therefore, our approach was a first attempt to adapt and compare the earlier scales from the questionnaire to the current version. To the best of my knowledge, there is currently no validated procedure for such a scale conversion. Of course, this approach can be regarded critically, since we eliminated items from scales as part of the conversion process. This interferes with the original composition of the questionnaire, wherein each question was deliberately built into the questionnaire [228]. Thus, it is necessary to examine whether the procedure we developed for converting to a newer version of a questionnaire is also suitable in other studies.

The conversion allowed us to compare our results with reference data from the German COPSQ database [29]. We intentionally selected reference data that also date back to the period around the time of our survey (2012-2017) [29]. Studies in other countries also try to establish benchmarks, for example using the results of COPSQ surveys for psychosocial risk management [229]. The comparison conducted with reference values in our study was helpful in deriving some implications for improving working conditions for nurses and physicians in university hospitals and to place our results in a broader context. We found large differences when comparing nurses and physicians from our sample with hospital nurses and hospital physicians [29]. As previously discussed, we identified higher job satisfaction in our sample compared with the respective reference values [29]. Another interesting result is the lower score for social relations for nurses in the

WorkSafeMed sample compared with hospital nurses from the COPSOQ-database (39.5 vs. 52.9) [29]. Interestingly, this scale was rated similarly among the WorkSafeMed nurses (55.5) before the conversion to the G-COPSOQ III version [230]. The preceding statistical analysis of the original and converted scales revealed a clear differences between the two scales [29]. It is unclear whether the difference between the two scales was caused by the scale conversion. Therefore, the observed difference in the rating of the “social relations” scale between nurses in the WorkSafeMed study and hospital nurses should be interpreted with caution.

Overall, there is a need for more research on possible approaches and interventions to reduce high work stress for physicians and nurses, in addition to other necessary legislative measures. This includes working conditions and self-care of employees, i.e. structural and behavioral prevention. Mimura et al. (2003) investigated the effectiveness of different stress management programs for nurses [231]. Interventions for workplace stress management involved education, role playing, relaxation, music, exercise, humor, and cognitive techniques [231]. One approach focusing on cognitive technique and personal support seemed to be effective in reducing stress for nurses [231]. Possible positive effects described in other studies should be considered with caution due to methodological weaknesses. [231]. Ruotsalainen et al. (2015) repeated the assessment of stress reduction interventions for healthcare workers [232]. They categorized the interventions in three groups: person-directed interventions (e.g. changing personal behavior and coping), person-work interface intervention (e.g. improving the fit between employee and organization), and organizational interventions (e.g. organizational restructuring) [232]. The authors found limited evidence for a small, but possibly relevant reduction in stress levels from three different interventions for healthcare workers. However, they also stated that none of the studies were addressed towards physicians [232]. Further studies also applied interventions in the following areas: intervention to improve working conditions [233], intervention for (lifestyle) health promotion [234, 235], occupational health intervention [236], and intervention with regard to working conditions, occupational health services, and health promotion [237]. Bartholomeyczik et al. (2008) performed, as already

in the introduction section stated, an organizational intervention which addressed nurses and physicians as a team to improve the collaboration in single hospital units and within the hospital [173]. Weigl et al. (2013) implemented a work design intervention among physicians based on continuous group meetings [238]. Participating physicians identified work-related problems in the areas of work organization, leadership, internal information flow and quality, as well as qualification and training [238]. Based on the identified problems, the physicians developed and implemented solutions in a bottom-up approach [238]. The results, based on a small sample of 57 physicians, indicate that a participatory intervention might be a promising approach for improving working conditions for physicians in hospitals [238]. Currently, as part of the project “Mental health in the hospital workplace” (“(SEE)lische GESundheit am Arbeitsplatz KrankeNhaus - SEEGEN), a complex intervention is being carried out to strengthen mental health and well-being among hospital staff in Germany [239]. The results of the intervention evaluation are not yet available. In summary, to date, only few studies have employed different approaches and interventions to improve working conditions for both nurses and physicians, and further studies are therefore crucially needed.

3.5 Strengths and Limitations

The present dissertation and the publications within demonstrate both strengths and limitations.

The dissertation is highly relevant to the field of occupational medicine and health services research, as there are implications for both clinicians and health services researchers regarding patient and occupational safety culture and working conditions. Although the publications in this dissertation covered only the first two phases (theory and modelling) according to the classification by Campbell et al. [240] (i.e. the development phase with regard a future complex intervention according to the current MRC recommendation) [241], as a whole it combined different research methods (quantitative methods, integrative literature review) to obtain a comprehensive view of the research topics. Therefore, further studies are needed to derive more recommendations regarding the development or improvement of patient and occupational safety culture and working conditions in

the hospital practice. The dissertation further demonstrated within its publications that it is promising to consider both kinds of safety culture together, and more research following this approach is crucially needed to develop a comprehensive patient and occupational safety culture in the hospital.

Besides these strengths, there are also a number of limitations which I would like to address:

- First, our results in publications 1-3 are based on cross-sectional self-reports of nurses and physicians in our questionnaire, and we conducted the survey at only two German university hospitals. Our results are therefore not representative and can hardly be transferred to other hospitals. We also jointly analyzed two different occupational groups (nurses and physicians) with different job profiles and levels of responsibility in Germany.
- Second, as already stated, we could not rely on established instruments for the assessment of occupational safety climate. Therefore, we employed self-developed indices and twin items from the preliminary study ABSK [23], and can therefore assume that the study did not comprehensively depict occupational safety climate.
- Third, a further limitation lies in the cross-sectional design of the publications. The survey data collection took place at one point in time in 2015. The results therefore do not permit a discussion of causality.
- Fourth, in our publications, safety culture and climate were mainly examined at the individual level. No analysis of aggregated data was conducted at the departmental (group) level, as recommended in other studies of safety culture (see [42, 242]). However, previous studies in hospitals also assessed safety culture using individual level analysis (see for example [243–245]). Furthermore, due to the explorative nature of the research questions, for example in publications 2 and 3, we could not refer to a more established analysis procedure.
- Fifth, in the publications, we devoted little attention to the terminological discourse of safety culture and safety climate, and that there is an increasing agreement on the differences between the two terms (see 1.3.1). In publication 1, we used the term safety climate. In publications 2 and 4, we

referred to the term safety culture. In addition, the WorkSafeMed study and this dissertation were not based on a theoretical safety culture model. Haligan et al. (2011), for example, addressed several theories and models most commonly used in healthcare [39]. The use of a model helps to embed results in another context and contributes to the further theoretical development.

- Sixth, attitudes of nurses and physicians towards safety climate and working conditions are strongly influenced by current health policy and political decisions. As already stated in 1.3.1, safety climate can only be seen as a “temporary snapshot” and can give indications of the underlying safety culture. Therefore, it has to be assumed that the subjective views of employees on safety climate and working conditions have changed in the meantime and have also been strongly influenced by the current COVID-19 pandemic.

Both a strength and limitation of the dissertation as a whole could be attributed to my professional background as a nurse and nurse scientist. Steinke (2004) identified reflected subjectivity as an important quality criterion of research and recommended the consideration and reflection of one’s own research interests, assumptions, communication styles, and biographical background during the research process [246]. My professional background as a nurse and nurse scientist was indeed important to classify and interpret the results from the four different publications. However, the results, especially regarding the nurses, were easier to interpret against this background. To compensate for possible gaps when interpreting the results regarding the physicians, close consultations took place with the physicians in the interdisciplinary team.

3.6 Conclusion

The present dissertation addressed patient and occupational safety culture and working conditions within four publications. Overall, it became clear that patient and occupational safety culture and working conditions are closely interrelated and, in some cases, mutually dependent. Nurses assessed scales for patient

safety culture and working conditions worse than physicians. The poorer evaluation can be explained by accompanying developments in the field of working conditions (especially lack of staff in hospitals). Overall, creating good working conditions for nurses and physicians in Germany is essential so that they can properly manage the high demands of their professions.

In future research, safety culture should be understood more comprehensively and should include both patient and occupational safety culture. For this purpose, it is certainly worthwhile to develop and validate an instrument for occupational safety culture applicable in the hospital setting that comprehensively covers individual determinants of an occupational safety culture. The literature review conducted demonstrated that comparison with other workplaces was helpful to gain an overview of different determinants of occupational safety culture. Furthermore, patient and occupational safety culture and working conditions should not only be considered in a cross-sectional design. More longitudinal studies are crucially needed to better-illustrate relationships and possible causalities of these issues as basis for the design and evaluation of appropriate interventions. Subgroup analysis and comparison of, for example, the perspectives of medical and nursing specialties on patient and occupational safety culture and working conditions may contribute to further insights. In addition, involving further groups, such as patients or management, is helpful in obtaining other perspectives, especially on the topics of patient and occupational safety culture.

Overall, implementing and promoting patient and occupational safety culture and good working conditions for nurses and physicians remains a major challenge for German hospitals, especially during the current COVID-19 pandemic. However, this should be further promoted so that nurses and physicians can (1) continue to deliver their important contribution to promoting health and providing safe care for patients, and (2) remain healthy and have a safe workplace, which they in turn actively help to shape with a vibrant patient and occupational safety culture.

4 Summary

4.1 English summary

Background

In previous studies, patient safety culture has often been considered separately from occupational safety culture. In addition, there are few studies that examine both kinds of safety culture in the context of working conditions. The aim of the dissertation was to illustrate the perspectives of nurses and physicians at two German university hospitals on patient safety culture, occupational safety culture and working conditions within four publications. Publications 1-3 were based on survey data from nurses and physicians (n=995), which were gathered in the year 2015 as part of the WorkSafeMed study at two German university hospitals.

Methods

In study 1, the perceptions of nurses and physicians on working conditions, patient safety climate and occupational safety climate were assessed and examined with regard to occupational group differences. These differences were determined using a t-test for independent samples. In addition to the p-value (significance), the effect size was also calculated to evaluate the relevance of the results. Study 2 examined the impact of working conditions, patient and occupational safety culture on perceived patient and occupational safety culture from the perspective of physicians and nurses, and whether there are shared predictors for both kinds of safety culture. Regression models for patient safety culture and occupational safety culture were developed and tested. In study 3, results of the survey on working conditions of nurses and physicians from the WorkSafeMed study were compared with the respective reference data (hospital nurses, hospital physicians, general population) from the COPSOQ database (period 2012-2017). For the comparison, the G-COPSOQ scales from the WorkSafeMed study (G-COPSOQ II) were converted to the G-COPSOQ III scales and tested in several statistical analyses. For the comparison with reference data from the COPSOQ database, a one-way analysis of variance (ANOVA) was performed and additionally the effect size was calculated as a measure of relevance. In study 4, an integrative literature review was carried out in addition with the aim of

creating an overview of determinants of an occupational safety culture for the hospital setting. In addition to the hospital setting, industrial work areas were integrated to enable a comparison of different settings. A systematic literature search was conducted in four databases in March 2019 considering the PRISMA statement. The search was updated again in April 2020.

Results

In study 1, a statistically significant difference with a strong effect size $d_{\text{Cohen}} > .50$ was found with regard to the following scales. With respect to patient safety climate, physicians gave a more positive rating than nurses for “staffing” (2.8 vs. 2.4), “management support for patient safety” (3.0 vs. 2.6), and “overall perception of patient safety” (3.3 vs. 2.9). There were less relevant differences with regard to occupational safety climate; nurses rated the index “subjective assessment of occupational safety measures initiated by the employer, related to own safety” more positively than physicians (1.7 vs. 2.0). Nurses rated the following working conditions worse than physicians: “Degree of freedom at work” (36.0 vs. 46.2), “possibilities for development” (71.6 vs. 79.6) and “workplace commitment” (48.4 vs. 61.3). In addition, nurses reported poorer scores for “patient-related burnout” (36.5 vs. 28.0) and “job satisfaction” (67.5 vs. 73.4) compared to physicians.

In study 2, “management support for patient safety” ($\beta=0.24$, $p \leq .001$), “staffing” ($\beta=0.21$, $p \leq .001$) and “supervisor support for patient safety” ($\beta=0.18$, $p \leq .001$) were identified by nurses and physicians as significant predictors of perceived patient safety culture. Important predictors for perceived occupational safety culture were “job satisfaction” ($\beta=0.26$, $p \leq .001$), “work-privacy conflict” ($\beta=-0.19$, $p \leq .001$) and “patient-related burnout” ($\beta=-0.20$, $p \leq .001$). The patient safety culture model achieved a high model fit of $R^2=0.64$, while the occupational safety culture model revealed a more moderate model fit of $R^2=0.27$. “Job satisfaction” and leadership (via the two variables “management support for patient safety” and “supervisor support for patient safety”) were identified as overarching shared predictors in both models.

In study 3, the following converted G-COPSOQ scales showed a statistically significant difference with a strong effect size $d_{\text{Cohen}} > .50$. Nurses from the WorkSafeMed sample rated “social relations” poorer than hospital nurses from the COPSOQ database (39.5 vs. 52.9), but reported a higher “job satisfaction” (66.7 vs. 57.8). Physicians in the WorkSafeMed sample also indicated higher “job satisfaction” compared to hospital physicians in the COPSOQ database (72.7 vs. 62.4).

In study 4, 44 studies were included in the integrative literature review. The studies in the hospital sector and in other sectors were classified into seven clusters using a theoretical framework. Determinants of an occupational safety culture in the hospital sector were less represented in the studies compared to other sectors.

Discussion

Overall, it was found that nurses rated patient safety climate and working conditions worse than physicians. For both occupational groups, predictors were identified which are important for perceived patient and occupational safety culture. The comparison with reference data enabled a more in-depth and subsequent classification of the results on working conditions in the sense of a benchmark. Furthermore, it became clear that previous studies have not yet comprehensively presented determinants as influencing factors of an occupational safety culture for the hospital sector. Further studies are needed to capture all facets of an occupational safety culture in hospitals. The comprehensive assessment of an occupational safety culture in hospitals can presumably provide implications on how patient and occupational safety culture in hospitals can be jointly developed.

4.2 German summary

Hintergrund

In bisherigen Studien wurde Patientensicherheitskultur oftmals getrennt von Arbeitssicherheitskultur betrachtet. Zudem gibt es wenige Studien, die beide Arten von Sicherheitskultur im Zusammenhang mit Arbeitsbedingungen untersuchen. Ziel der Dissertation war es, im Rahmen von vier Publikationen Perspektiven von Pflegekräften, Ärztinnen und Ärzten an zwei deutschen Universitätskliniken zu Patientensicherheitskultur, Arbeitssicherheitskultur und Arbeitsbedingungen darzustellen. Die Grundlage für die Publikationen 1-3 bildeten Befragungsdaten von Pflegekräften, Ärztinnen und Ärzten (n=995), die im Jahr 2015 im Rahmen der WorkSafeMed-Studie an zwei deutschen Universitätskliniken erhoben wurden.

Methode

In Studie 1 wurden Sichtweisen von Pflegekräften und Ärzt:innen auf Arbeitsbedingungen, Patientensicherheitsklima und Arbeitssicherheitsklima betrachtet und hinsichtlich Berufsgruppenunterschiede untersucht. Diese Unterschiede wurden mithilfe eines t-Tests für unabhängige Stichproben bestimmt. Neben dem p-Wert (Signifikanz) wurde auch die Effektstärke berechnet, um die Relevanz der Ergebnisse zu bewerten. In Studie 2 wurde untersucht, welche Einflüsse, Arbeitsbedingungen, Patientensicherheitskultur und Arbeitssicherheitskultur auf wahrgenommene Patientensicherheitskultur und Arbeitssicherheitskultur aus Sicht von Ärzt:innen und Pflegekräften haben und ob es für beide Arten von Sicherheitskultur gemeinsame Prädiktoren gibt. Es wurden Regressionsmodelle für Patientensicherheitskultur und Arbeitssicherheitskultur entwickelt und geprüft. In Studie 3 wurden Befragungsergebnisse zu Arbeitsbedingungen von Pflegekräften und Ärzt:innen der WorkSafeMed-Studie mit jeweiligen Referenzdaten (Krankenhauspflegekräfte, Krankenhausärzt:innen, Allgemeinbevölkerung) aus der COPSOQ-Datenbank (Zeitraum 2012-2017) verglichen. Um den Vergleich durchführen zu können, wurden die G-COPSOQ-Skalen aus der WorkSafeMed-Studie (G-COPSOQ II) an die G-COPSOQ III-Skalen angepasst und in mehreren statistischen Verfahren überprüft. Für den Vergleich mit Referenzdaten der COPSOQ-Datenbank wurde eine einfaktorielle Varianzanalyse (ANOVA) durchgeführt und zusätzlich die Effektstärke als Maß für die Relevanz berechnet. In Studie 4 wurde

ergänzend ein integratives Literaturreview durchgeführt mit dem Ziel, einen Überblick zu Determinanten einer Arbeitssicherheitskultur für das Setting Krankenhaus zu erstellen. Neben dem Setting Krankenhaus wurden vor allem industrielle Arbeitsbereiche integriert, um die verschiedenen Settings vergleichend betrachten zu können. Eine systematische Literaturrecherche wurde im März 2019 in vier Datenbanken durchgeführt unter Berücksichtigung des PRISMA Statements. Die Suche wurde im April 2020 nochmals aktualisiert.

Ergebnisse

In Studie 1 zeigte sich hinsichtlich folgender Skalen ein statistisch signifikanter Unterschied mit einem starken Effekt $d_{\text{Cohen}} > .50$. Bezogen auf Patientensicherheitsklima gaben Ärzt:innen eine positivere Bewertung als Pflegekräfte für „personelle Ausstattung“ (2.8 vs. 2.4), „Unterstützung der Krankenhausleitung hinsichtlich Patientensicherheit“ (3.0 vs. 2.6) sowie „allgemeine Wahrnehmung der Patientensicherheit“ (3.3 vs. 2.9) an. Bezogen auf Arbeitssicherheitsklima zeigten sich weniger relevante Unterschiede, Pflegekräfte bewerteten den Index „Einschätzung von Maßnahmen für Arbeitssicherheit und Gesundheit, initiiert durch den Arbeitgeber“ positiver als Ärzt:innen (1.7 vs. 2.0). Folgende Arbeitsbedingungen bewerteten Pflegekräfte schlechter als Ärzt:innen: „Entscheidungsspielraum“ (36.0 vs. 46.2), „Entwicklungsmöglichkeiten“ (71.6 vs. 79.6) und „Verbundenheit mit dem Arbeitsplatz“ (48.4 vs. 61.3). Zudem gaben Pflegekräfte im Vergleich mit Ärzt:innen schlechtere Werte für „patientenbezogenes Burnout“ (36.5 vs. 28.0) und „Arbeitszufriedenheit“ (67.5 vs. 73.4) an.

In Studie 2 wurden von Pflegekräften und Ärzt:innen „Unterstützung der Krankenhausleitung hinsichtlich Patientensicherheit“ ($\beta=0.24$, $p \leq .001$), „personelle Ausstattung“ ($\beta=0.21$, $p \leq .001$) sowie „Unterstützung des direkten Vorgesetzten hinsichtlich Patientensicherheit“ ($\beta=0.18$, $p \leq .001$) als wesentliche Prädiktoren der wahrgenommenen Patientensicherheitskultur identifiziert. Wichtige Prädiktoren für wahrgenommene Arbeitssicherheitskultur stellten „Arbeitszufriedenheit“ ($\beta=0.26$, $p \leq .001$), „Work-Privacy-Konflikt“ ($\beta=-0.19$, $p \leq .001$) und „patientenbezogenes Burnout“ ($\beta=-0.20$, $p \leq .001$) dar. Das Patientensicherheitskulturmodell erreichte eine hohe Modellgüte von $R^2=0.64$, während das Arbeitssicherheitskulturmodell eine mäßige Modellgüte von $R^2=0.27$ offenbarte. Als übergeordnete

gemeinsame Prädiktoren wurden in beiden Modellen „Arbeitszufriedenheit“ und Führung (durch die zwei Variablen „Unterstützung der Krankenhausleitung hinsichtlich Patientensicherheit“ und Unterstützung des direkten Vorgesetzten hinsichtlich Patientensicherheit“) identifiziert.

In Studie 3 zeigten sich hinsichtlich folgender konvertierter G-COPSOQ-Skalen ein statistisch signifikanter Unterschied mit einem starken Effekt $d_{\text{Cohen}} > .50$. Pflegekräfte der WorkSafeMed-Stichprobe bewerteten „soziale Beziehungen“ schlechter als Krankenhauspflegekräfte aus der COPSOQ-Datenbank (39.5 vs. 52.9), gaben jedoch eine höhere „Arbeitszufriedenheit“ an (66.7 vs. 57.8). Ärzt:innen der WorkSafeMed-Stichprobe gaben ebenfalls eine höhere „Arbeitszufriedenheit“ an verglichen mit Krankenhausärzt:innen aus der COPSOQ-Datenbank (72.7 vs. 62.4).

In Studie 4 wurden 44 Studien in das integrative Literaturreview einbezogen. Die Studien im Krankenhaussektor und in anderen Sektoren wurden in sieben Cluster mithilfe eines theoretischen Rahmens eingeordnet. Determinanten einer Arbeitssicherheitskultur im Krankenhausbereich waren in den Studien verglichen mit den anderen Sektoren weniger vertreten.

Diskussion

Insgesamt zeigte sich, dass Pflegekräfte vor allem Patientensicherheitsklima und Arbeitsbedingungen schlechter bewerteten als Ärzt:innen. Für beide Berufsgruppen wurden Prädiktoren identifiziert, die bedeutsam für wahrgenommene Patienten- und Arbeitssicherheitskultur sind. Der Vergleich mit Referenzdaten ermöglichte ergänzend eine vertiefte und nachträgliche Einordnung der Ergebnisse zu Arbeitsbedingungen im Sinne eines Benchmarks. Ferner wurde deutlich, dass in bisherigen Studien Determinanten als Einflussgrößen einer Arbeitssicherheitskultur noch nicht umfassend für den Krankenhausbereich dargestellt wurden. Weitere Studien sind erforderlich, um sämtliche Facetten einer Arbeitssicherheitskultur im Krankenhaus zu erfassen. Die umfassende Erfassung einer Arbeitssicherheitskultur im Krankenhaus kann vermutlich Implikationen liefern, wie Patienten- und Arbeitssicherheitskultur im Krankenhaus gemeinsam weiterentwickelt werden können.

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6 Declaration of own contribution

The dissertation was conducted at the Institute of Occupational and Social Medicine and Health Services Research under the supervision of Prof. Dr. Monika A. Rieger.

The overall conception of the WorkSafeMed research project, on which the doctoral thesis was based, was carried out by Prof. Dr. Monika A. Rieger¹, Prof. Dr. Peter Martus², Dr. Jens Maschmann³ and Dr. Constanze Lessing⁴. The submission of the study protocol to the ethics committee, the development of the questionnaire, and the data collection were undertaken by Prof. Dr. Monika A. Rieger¹, Prof. Dr. Tanja Manser⁵, Dr. Antje Hammer⁴, Edwin Luntz¹ and Dr. Heidrun Sturm¹. I joined the study team prior to the start of the survey in both hospitals in 2015 and performed the recruitment, coordinated all the data collection at one of both university hospitals together with Dr. Antje Hammer⁴ and performed the data analysis in joint collaboration with Dr. Antje Hammer⁴, Prof. Dr. Peter Martus² and partly with Juliane Hardt² with feedback by Prof. Dr. Tanja Manser⁵ and Prof. Dr. Monika A. Rieger¹. Below, the detailed information is given with regard to the single publications.

¹Institute of Occupational and Social Medicine and Health Services Research, University Hospital of Tübingen

²Institute for Clinical Epidemiology and Applied Biometry, University Hospital of Tübingen

³Business Development & Quality Management Unit, University Hospital of Tübingen

⁴Institute of Patient Safety, University Hospital of Bonn

⁵FHNW School of Applied Psychology, University of Applied Sciences and Arts, Olten

Publication 1: Healthcare professionals' perspectives on working conditions, leadership, and safety climate: a cross-sectional study

The authors **Wagner (AW)**, Rieger (MAR), Manser (TM), Sturm (HS), Hardt (JH), Martus (PM), Lessing (CL), and Hammer (AH) contributed to the publication as indicated in Table 1 (indicated in %):

Table 1: Contribution to Publication 1

Contribution	AW	MAR	TM	HS	JH	PM	CL	AH
Obtaining approval by the ethics committee		20%	20%	20%		20%		20%
Development of the research questions	50%		25%					25%
Development of the theoretical background	100%							
Development of the questionnaire and data collection		20%	20%	20%		20%		20%
Data analysis	50%				25%	25%		
Interpretation of results	65%	10%						25%
Drafting the original manuscript	100%							
Critical comments to the manuscript		14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
Revision of the manuscript according to the comments	100%							
Final approval of the version and agreement to be accountable for all aspects of the work	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%

Publication 2: Do Occupational and Patient Safety Culture in Hospitals Share Predictors in the Field of Psychosocial Working Conditions? Findings from a Cross-Sectional Study in German University Hospitals

The authors **Wagner (AW)**, Hammer (AH), Manser (TM), Martus (PM), Sturm (HS), and Rieger (MAR) contributed to the publication as indicated in Table 2 (indicated in %):

Table 2: Contribution to Publication 2

Contribution	AW	AH	TM	PM	HS	MAR
Obtaining approval by the ethics committee		20%	20%	20%	20%	20%
Development of the research questions	50%	20%	10%			20%
Development of the theoretical background	100%					
Development of the questionnaire and data collection		20%	20%	20%	20%	20%
Data analysis	75%			25%		
Interpretation of results	40%	20%	10%	10%		20%
Drafting the original manuscript	100%					
Critical comments to the manuscript		20%	20%	20%	20%	20%
Revision of the manuscript according to the comments	100%					
Final approval of the version and agreement to be accountable for all aspects of the work	16.6%	16.6%	16.6%	16.6%	16.6%	16.6%

Publication 3: Comparing perceived psychosocial working conditions of nurses and physicians in two university hospitals in Germany with other German professionals - Feasibility of scale conversion between two versions of the German Copenhagen Psychosocial Questionnaire (COPSOQ)

The authors **Wagner (AW)**, Nübling (MN), Hammer (AH), Manser (TM), and Rieger (MAR) contributed to the publication as indicated in Table 3 (indicated in %):

Table 3: Contribution to Publication 3

Contribution	AW	MN	AH	TM	MAR
Obtaining approval by the ethics committee			33.3%	33.3%	33.3%
Development of research questions	50%				50%
Development of the theoretical background	100%				
Development of the questionnaire and data collection			33.3%	33.3%	33.3%
Data analysis	75%	25%			
Interpretation of results	75%				25%
Drafting the original manuscript	100%				
Critical comments to the manuscript		25%	25%	25%	25%
Revision of the manuscript according to the comments	100%				
Final approval of the version and agreement to be accountable for all aspects of the work	20%	20%	20%	20%	20%

Publication 4: Determinants of Occupational Safety Culture in Hospitals and other Workplaces—Results from an Integrative Literature Review

The authors **Wagner (AW)**, Schöne (LS), and Rieger (MAR) contributed to the publications as indicated in Table 4 (indicated in %):

Table 4: Contribution to Publication 4

Contribution	AW	LS	MAR
Development of the study design as a whole	50%		50%
Development of research questions	100%		
Development of the theoretical background	100%		
Development of the search strategy	75%		25%
Literature search in four different databases	100%		
Screening	50%	50%	
Full-text analysis	50%	50%	
Critical appraisal of the literature	100%		
Drafting the original manuscript	100%		
Critical comments to the manuscript		50%	50%
Revision of the manuscript according to the comments	100%		
Final approval of the version and agreement to be accountable for all aspects of the work	33.3%	33.3%	33.3%

I declare that I have written the manuscripts by myself and that I have not used any additional references than those cited by me. Proof reading of the whole dissertation for language errors in spelling, grammar and word choice was performed by Lisa Peterson using the commercial standard editing option.

Tübingen, 10 June 2021

Anke Wagner

7 Publications in connection with the doctoral project

7.1 Peer reviewed articles

Gambashidze N, Hammer A, **Wagner A**, Rieger MA, Brösterhaus M, Vegten A, Manser T on behalf of the WorkSafeMed Consortium. Influence of gender, profession and managerial function on clinicians' perceptions of patient safety culture. A cross-national cross-sectional study. *J Patient Saf.* 2021 Jun 1;17(4):e280-e287. doi: 10.1097/PTS.0000000000000585.

Wagner A, Hammer A, Manser T, Rieger MA. Arbeits- und Patientensicherheitskultur im Krankenhaus – die WorkSafeMed-Studie. *Public Health Forum* 2020; 28(2): 139–142.

Hammer A, **Wagner A**, Rieger MA, Manser T on behalf of the WorkSafeMed Consortium. Assessing the quality of medication documentation: Development and feasibility of the MediDocQ instrument for retrospective chart review in the hospital setting. *BMJ Open.* 2019;9:e034609; doi:10.1136/bmjopen-2019-034609.

Sturm H, Rieger MA, Martus P, Ueding E, **Wagner A**, Holderried M, Maschmann J, on behalf of the WorkSafeMed Consortium. Do *perceived* working conditions and patient safety culture correlate with *objective* workload and patient outcomes: A cross-sectional explorative study from a German university hospital. *PLoS One.* 2019;14(1):e0209487 doi: 10.1371/journal.pone.0209487.

Wagner A, Michaelis M, Lunz E, Wittich A, Schrappe M, Lessing C, Rieger MA. Assessment of patient and occupational safety culture in hospitals: Development of a questionnaire with comparable dimensions and results of a feasibility study in a German university hospital. *Int J Environ Res Public Health.* 2018;15(12):2625-2649.

7.2 Congress papers

Wagner A, Hammer A, Manser T, Martus P, Sturm H, Rieger MA. Identifikation von (gemeinsamen) Prädiktoren für Patientensicherheitskultur und Arbeitssicherheitskultur im Krankenhaus - Ergebnisse der WorkSafeMed-Studie. 18. Deutscher Kongress für Versorgungsforschung des Deutschen Netzwerks Versorgungsforschung, 09.-11. Oktober 2019, Berlin. doi: 10.3205/19dkvf127.

Hammer A, Manser T, Rieger MA, **Wagner A**. Teamarbeit und Führung als Ressourcen zur Entwicklung einer Patienten- und Arbeitssicherheitskultur im Krankenhaus. 18. Deutscher Kongress für Versorgungsforschung des Deutschen Netzwerks Versorgungsforschung, 09.-11. Oktober 2019, Berlin. doi: 10.3205/19dkvf130.

Hammer A, **Wagner A**. Studie zur Patienten- und Arbeitssicherheitskultur im Krankenhaus. Vortrag auf dem BGW-Forum, 2.-4. September 2019, Hamburg.

Gambashidze N, Hammer A, **Wagner A**, Rieger MA, Brösterhaus M, Vegten A, Manser T on behalf of the WorkSafeMed Consortium. Wie beeinflussen Geschlecht, Beruf und Führungsfunktion der Krankenhausmitarbeiter deren Wahrnehmung zur Patientensicherheitskultur? Querschnittsanalyse einer deutschen und schweizerischen Stichprobe. 14. APS Jahrestagung am 09.-10. Mai 2019, Berlin.

Wagner A, Hammer A, Sturm H, Martus P, Rieger MA, Manser T. Zusammenhänge und Einflüsse von psychosozialen Arbeitsbelastungen und Arbeitsbeanspruchungen auf Patientensicherheitskultur und Arbeitssicherheitskultur im Krankenhaus. 58. Wissenschaftliche Jahrestagung der Deutschen Gesellschaft für Arbeitsmedizin und Umweltmedizin e.V. 07.03.-09.03.2018 München. Poster und Vortrag.

Wagner A, Hammer A, Sturm H, Luntz E, Hardt J, Martus P, Rieger MA, Manser T. Arbeitsbedingungen und Patienten- und Beschäftigten-bezogene Sicherheitskultur aus Sicht von ärztlichem und pflegerischem Personal - erste Ergebnisse der WorkSafeMed-Studie. 15. Deutscher Kongress für Versorgungsforschung 5.- 7. Oktober 2016 Berlin. P121. doi: 10.3205/16dkvf258. Online verfügbar unter: <http://www.egms.de/static/de/meetings/dkfv2016/16dkvf258.shtml>.

Wagner A, Sturm H, Hammer A, Hardt J, Martus P, Manser T, Rieger MA. Psychosoziale Arbeitsbedingungen und Arbeitssicherheitskultur im Krankenhaus - Perspektive des ärztlichen und pflegerischen Personals. 20. Symposium Arbeitsmedizin und Arbeitswissenschaft für NachwuchswissenschaftlerInnen 11. – 13. November 2016 Freiburg. P7.

Hammer A, Manser T, Brösterhaus M, Sturm H, **Wagner A**, Rieger MA. Arbeitsbedingungen, Sicherheitskultur und Patientensicherheit – Erste Ergebnisse der WorkSafeMed-Studie. 11. APS Jahrestagung am 14.-15. April 2016, Berlin.

7.3 Final report of the research project “WorkSafeMed”

Sturm H, Ueding E, **Wagner A**, Hammer A, Martus P, Manser T, Rieger MA. WorkSafeMed - Arbeitsbedingungen, Sicherheitskultur und Patientensicherheit in Krankenhäusern - welche Prädiktoren lassen sich für die Sicherheit des Medikationsprozesses beschreiben? [WorkSafeMed - Working conditions, safety culture and patient safety in hospitals: what predicts the safety of the medication process?]. Schlussbericht des BMBF-Verbundprojekts WorkSafeMed (gemäß nach 3.2 BNBest-BMBF 98). doi: 10.2314/GBV:1028133529

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