



Hospital staff shortages: Environmental and organizational determinants and implications for patient satisfaction

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ABSTRACT

Recent discussions and previous research often indicate that German hospitals are affected by a shortage of healthcare personnel on the labor market. However, until now, research has provided only limited insights into how environmental and organizational factors explain variations in staff shortages, how staff shortage measures relate to staffing ratios, and what relevance staff shortages have for patients. Regression analyses based on survey data of 104 German hospitals from 2015 to 2016, combined with labor market and patient satisfaction data, show that several environmental and organizational factors are significantly related to hospital staff shortages, measured by self-reports, vacancies, and turnover. These three measures of staff shortage do not correlate to the same degree for physicians and nurses, and none of the three significantly relate to nursing ratios, which indicates that the latter is a distinct concept rather than a direct consequence of staff shortage. The analyses further show that hospital staff shortages relate significantly to patient satisfaction with physician and nursing care. The findings suggest that hospitals are, to a certain extent, able to influence the degree to which they are affected by staff shortages and that hospitals' decisions about staffing levels depend on more than staff availability.

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1. Introduction

One of the major assumed challenges for health systems worldwide is securing a skilled workforce and avoiding the negative consequences of staff shortages. Many factors currently affect the healthcare labor market, including changes in staffing requirements based on changes in patient characteristics, changes in reimbursement of service provisions, aging staff, suboptimal planning of professional training and career pathways, exacerbating working conditions, and shifts in employee work values and preferences. Shortages of nurses and physicians are expected in both the outpatient and the inpatient sectors to varying extents and impacts. In Germany, an increasing number of hospitals overall report difficulties in filling vacant positions due to a lack of qualified applicants [1].

Most research on hospital staff shortages focuses on staffing ratios, predominantly related to nurses. The implicit idea is that staffing ratios are the main result of, and can therefore be esti-

mated by, staffing shortages. However, several studies indicate that low staffing ratios are a result of hospital staffing policies rather than shortages of healthcare personnel on the labor market [2,3]. Reforms in hospital financing, such as the implementation of a prospective payment system [4], increase financial pressure on hospitals and lead to a need to increase hospital efficiency, which translates into more restrictive staffing policies. Hence, low staffing ratios might not necessarily be due to a lack of qualified personnel on the labor market; they could also be the result of cost containment measures. In this regard, staffing ratios may not be a purposeful measure of, and might provide only limited insights into, staffing shortages.

Although the notion of staff shortages in health care is omnipresent, what is meant by staff shortage, and to what extent the measure used reflects the intended concept, is largely left open [2,5,41]. We follow prior literature's definition of hospital staff shortage and define it as a situation in which hospitals are unable to hire staff at prevailing wages to achieve the level of staffing desired [2,41]. Three of the most commonly used and more direct measures of staff shortages are hospital self-reports, vacancies, and fluctuations. All three provide insights into the difficulties of hospital recruitment and/or retainment of staff. Although the ability of hospitals to recruit and retain staff has eclectically been shown to vary with environmental and organizational factors, such as location,

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competitive environment, or ownership of the hospital [6–8], few systematic empirical investigations have been undertaken to assess and explain variations in hospital staff shortages [3]. The existing literature falls short of providing an overview of factors explaining variations in hospital staff shortages and a comprehensive analysis using a broad set of determinants and staff shortage measures.

Finally, research on the consequences of staff shortages predominantly relies on staffing ratios. While this literature stream has generated solid evidence on the relevance of staffing ratios, the importance of whether a hospital considers its staffing level as desired or not remains unclear. To illustrate, it is possible to think of a scenario in which two hospitals have the same staffing ratio but vary substantially in their extent of staff shortage, as one hospital might rely on more staff to perform the services than the other hospital (either due to differences in the organization of care or differences in the complexity of cases and services provided). In this case, it seems likely that not only the level of staffing but also the perception of a shortage will affect the quality of care.

The objective of this study is to shed further light on hospital staffing shortages. We apply the three most commonly used measures of shortages – a) hospital self-reports, b) vacancies, and c) turnover – and use these measures to characterize staff shortages for the two largest occupational groups in hospitals, nurses and physicians. We thereby aim to answer the following research questions (RQs):

RQ1: What organizational and environmental characteristics explain variations in staff shortages across hospitals?

RQ2: How do nurse shortages relate to nurse-to-patient ratios?

RQ3: How do hospital staff shortages and nurse-to-patient ratios relate to patient satisfaction?

Fig. 1 graphically depicts the relationships analyzed.

This study contributes to clarifying the nature of hospital staff shortages, the relationship between hospital staff shortages and staffing ratios, and the implications of hospital staff shortages for patient satisfaction. It adds to the existing literature in two ways: First, the existing literature on organizational and environmental precedents of staffing difficulties focuses on selected environmental and organizational characteristics and/or single staff shortage measures, hence failing to provide a comprehensive picture on the determinants of staff shortages. Second, while a number of studies have examined the implications of staffing ratios and staff satisfaction for patient satisfaction, there is hardly any evidence on the relationships between other measures of hospital staff shortages (such as perceived staffing difficulties) and patient satisfaction. In the context of the ongoing policy discussions on staff shortages, this study helps provide a more fine-grained understanding of staff shortages and whether it is low staffing ratios or hospital staff shortages that drive patient satisfaction.

2. Conceptual approach and previous literature

2.1. Determinants of hospital staff shortages

General variations across hospitals – concerning their behavior, challenges, and/or performance – have attracted plentiful attention in research. In this context, several environmental and organizational factors have been assessed quite extensively, as both theoretical expectations and prior empirical evidence support their relevance to explain behavioral or performance differences across hospitals. We identified hospital location and the degree of competition as two of the most commonly investigated environmental factors. With regard to organizational factors, we consider hospital size, ownership types (public, private nonprofit, and private for-profit), and hospital teaching status. Below, we will present the rationale behind why and how these environmental and organi-

zational characteristics might affect hospital staff shortages. The detailed results of an extensive literature search on empirical studies from the past two decades that related these determinants to staff shortages are provided in Appendix 1.

Several studies have analyzed the impacts of **hospital location** and local labor market characteristics on staff shortage indicators.

The expectations regarding differences between rural and urban areas thereby mostly rely on the availability of the workforce and the availability of alternative employment opportunities. As indicated, a lower availability of workers in the geographic region can substantially increase hospital staff shortages, and rural areas generally experience a substantially lower supply of both physicians and nurses [9]. However, a few studies have analyzed the association between a lower general labor supply and hospital staff shortage indicators; therefore, providing some evidence that the lack of availability of potential qualified staff increases hospital staff shortages at least to some extent, which would indicate hospital staff shortages to be higher in rural areas.

Regarding the availability of alternative job opportunities, it is possible that in areas where job opportunities are manifold, turnover and vacancies are higher than in areas with fewer job opportunities [5,10]. As existing studies only partially detect significant effects, differences in the availability of alternative job opportunities seem to affect hospital staff shortages only under certain conditions.

In sum, differences in the availability of workers and alternative jobs yield contrasting evidence towards urban versus rural hospitals' staff shortages, and prior evidence largely detects no significant effect in either direction. A closely related labor market characteristic is hospital competition, or conversely, market concentration. In areas where competition for patients is fiercer, hospitals might be under higher financial pressure [11]. This could lead to more suboptimal working conditions, which decrease job satisfaction and increase turnover intentions, hence increasing staff shortage problems. Additionally, higher financial pressures limit the resources available to invest in human resource management (HRM), and fewer investments in recruitment and retention activities might lead to higher staff shortages in more competitive areas. In support of this, Conway et al. [11] found that the share of hospitals below the mandated minimum staffing ratio is higher in areas that are more competitive (although the differences were quite small).

In addition to these environmental characteristics, organizational characteristics might be important predictors of hospital staff shortages. In this context, hospital size, ownership type and teaching status have been frequently mentioned as potential driving forces. Larger hospitals need more staff and might therefore be more strongly affected by a general unavailability of staff on the labor market. However, larger hospitals might also be more attractive as employers, as they offer broader internal career opportunities and might invest more in HRM, which would make them less vulnerable to staff shortages. Several studies have controlled for hospital size in analyzing hospital staff shortage outcomes, and the empirical evidence seems rather ambiguous.

Hospital ownership type, in particular, public and private ownership, is one of the most commonly researched organizational characteristics in hospital research. Differences in staff shortages across ownership types might occur due to differences in attractiveness – either based on stereotypes [12,13] or on working conditions [7] – or differences in desired staffing levels [2,14]. Again, the empirical evidence so far is mixed.

Finally, the teaching status of hospitals might be associated with staff shortages. On the one hand, teaching hospitals may offer more continuous education and promotion opportunities than other hospitals, which can be a positive factor for both nurses and physicians and reduce staff shortages [15]. On the other hand, teaching sta-

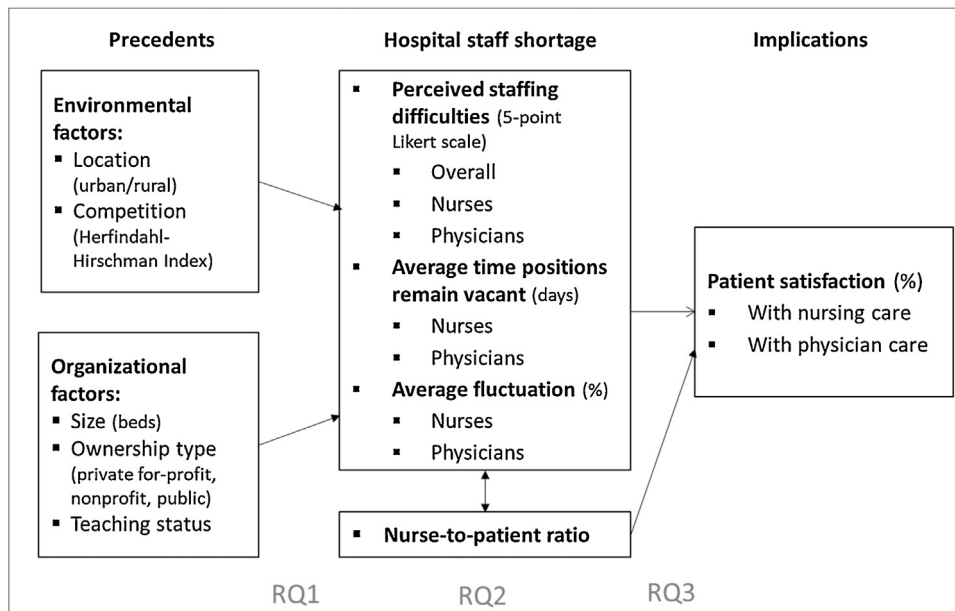


Fig. 1. Conceptual Model and Research Questions.

tus may also affect case complexity and the complexity of the working environment, leading to less favorable working conditions, which would increase staff shortages [16]. The empirical evidence currently indicates that teaching hospitals experience fewer staff shortages.

2.2. Implications of low staffing ratios and staff shortages

The consequences of low staffing ratios are well documented. High patient-to-nurse ratios have been shown to negatively affect patient outcomes. In a meta-analysis of 96 studies, Kane et al. [17] found significant associations between nurse staffing ratios and both adverse events and mortality. In an umbrella review and qualitative study, Dietermann et al. [18] derived a list of 24 nurse-sensitive patient outcomes with varying degrees of nurse sensitivity. Those with a high degree of nurse sensitivity included a perceived lack of quality of nursing care and patient dissatisfaction. For physicians, higher workloads and stress levels contribute to worse outcomes and patient perception of care [19].

However, less is known about whether staff shortage measures, other than staffing levels, would yield the same results regarding the implications of staff shortages. As a starting point for the assumption of different results when using different staff shortage measures, Bae et al. [20] did not find a significant association between nurse turnover and patient satisfaction. Oppel et al. (2018) found that having fewer physician shortage problems is significantly associated with higher levels of patient satisfaction, whereas this effect is not significant for nurses. Thus, it seems to matter which type of staff measure is used and which occupational group is considered. Relying on staffing levels might over- or underestimate the actual amount of staff shortage and hence its effect on patient outcomes, especially when variations of desired staffing levels are large across hospitals.

3. Methods

3.1. Data and setting

This study is based on data from a survey of German hospitals conducted in 2015–16. The questionnaire was developed in two phases. First, the scope and content of the questions were

determined by the research team. The resulting questionnaire was then tested with hospital practitioners as well as experts from academia before it was sent out to the hospitals. This pretest allowed the researchers to refine the wording and ensure that the questions were comprehensive and incorporated the potential to detect variations across hospitals. The study population consisted of all German hospitals excluding, for increased comparability, those offering only psychiatric care or outpatient care, day or night clinics, military hospitals, and hospitals with fewer than 50 or more than 2000 beds. We sent out one survey to each of the approximately 1000 remaining hospitals in November 2015, asking for either the Chief Executive Officer or, if applicable, the Head of Human Resources to provide the requested information. A second round of surveys was sent out in April 2016 as a reminder to increase the response rate. We received a total of 104 questionnaires, translating to a response rate of 10 %, which is acceptable for this type of extensive survey [21].

A summary of the variables and their measurement is provided in Table 1. Each measure and its rationale will be briefly described below.

The direct staff shortage measures chosen for this study relied on prior literature [2,5,41]. The most direct but also subjective measure represents hospitals' self-reports: whether they perceive difficulties in recruiting and/or retaining personnel (measured on a five-point scale). We thereby differentiate between nurses and physicians to analyze how there might be differences across occupational groups. Physicians and nurses are distinct in their education, remuneration, demand, and role in the health service provision process as well as in personal characteristics such as work motivation and mobility in seeking jobs [7,22]. As a third question, we ask about perceived general staff shortage (incl. nurses, physicians, and managers) to analyze to what extent this correlates with the occupation-specific measures and with environmental and organizational determinants as well as patient satisfaction. As the overall measure is less sensitive to occupation-specific conditions, it might relate less to external determinants but might also reflect a general management stance towards HRM.

To support these self-reports, we further included average vacancies as a primary measure of recruitment difficulties and average fluctuation as a primary measure of retention difficulties for nurses and physicians, respectively. All of these measures

Table 1
Variables, definitions and sources.

Variable	Definition	Source
<i>Indicators of hospital staff shortage</i>		
Hospital-perceived staffing difficulties	Answer to the question “In our hospital, we often find it difficult/require significantly more time than expected to fill positions in the following areas”, measured separately for nurses and physicians on 1–5 Likert scale	Questionnaire
Average time positions remain vacant	Estimation of the average number of days it takes a hospital to fill a vacant nurse/physician position	Questionnaire
Average fluctuation	Estimation of the average rate of fluctuation per year, measured separately for nurses and physicians in intervals ($\leq 5\%$, 6–10 %, 11–15 %, 16–20 %, $>20\%$)	Questionnaire
<i>Other variables</i>		
Patient-to-nurse ratio	Average patients per nurse in a day shift on a non-specialized ward	Questionnaire
Patient satisfaction	Measured as the average of four items for nurses and physicians separately; items cover quality of addressing patient concerns, civility, information provided and medical care provided	“Weisse Liste” Patient Experience Questionnaire (PEG)
<i>Indicators of availability of skilled personnel on the labor market</i>		
	Number of job seekers with relevant qualifications per open position per state divided by employees in the relevant category Number of registered open positions per state divided by employees in the relevant category	Federal Employment Agency (BA)
<i>Control variables</i>		
Location of the hospital	Location of the hospital in rural or urban environment	Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)
Market concentration	Market concentration measured based on the discharges within a fixed radius of 3 km around the hospital and calculated using the Hirschman-Herfindahl Index (HHI) of concentration	Hospital annual quality reports
Hospital ownership	Public, private for-profit or private nonprofit	Hospital annual quality reports
Hospital size	Number of beds	Hospital annual quality reports
Hospital teaching status	Yes/No	Hospital annual quality reports

have strengths and weaknesses; while self-reports allow us to directly ask about the phenomenon of interest and compare different occupational groups, they are most vulnerable to biases, such as social desirability. Average vacancies and turnover rates might be more objective but are also affected by various conditions, including occupational groups. For instance, it is rather meaningless to compare fluctuation rates of nurses and physicians and draw any conclusions on which occupational group is more affected by staff shortages. To measure the actual level of staffing, we additionally asked for the patient-to-nurse ratio, i.e., the average number of patients per nurse in a day shift on a nonspecialized ward.

We chose patient satisfaction because it has been found to be an important indicator for quality of care [23], to make patients more compliant [24] and to be strongly associated with clinical outcomes [25]. Additionally, patient satisfaction is important for hospitals to secure a sound patient base. Patients are increasingly able to determine their choice of hospital based on publicly available data sources, which makes high levels of reported patient satisfaction an important factor in attracting more patients and ultimately promotes hospital performance [26].

To avoid common method bias, we combined the information collected from the survey with other data sources. The data on patient satisfaction are part of the “Weisse Liste” database, which contains the results of a patient satisfaction survey based on the “Patients’ Experience Questionnaire”, aggregated at the hospital level, to measure patients’ satisfaction with nurses and physicians separately (Schwappach et al. 2010). Patients’ satisfaction with care was measured on a 0–100 % scale, with 100 being the best possible answer. The data were collected in October 2016. Data from 2014 on hospital size, teaching status and ownership were derived from the hospitals’ mandatory annual quality reports. Information on urban/rural location is based on data from the Federal Institute for Research on Building, Urban Affairs and Spatial Development’s (BBSR) database on indicators of spatial and urban development [27]. The two-year time lag reduces endogeneity through potential reverse causality. For additional sensitivity analyses, we used data on the local labor market situation (number of job seekers with

relevant qualifications (i.e., with the degree required for a nurse or physician) per open position, number of registered open positions aggregated on the state level) provided by the Federal Employment Agency [28].

To check the representativeness of our sample, we compared it to the general population of acute care hospitals in Germany concerning their main organizational characteristics (Statistical Office, 2013). Private nonprofit hospitals are slightly overrepresented (46 % in our study vs. 37 % in the general population), while public hospitals are slightly underrepresented (30 % vs. 37 %), and the share of private for-profit hospitals is nearly representative (23 % vs. 22 %). With a mean of 328 beds per hospital, the hospitals in our sample are slightly larger than the general hospital population (population mean = 248 beds). Hospitals in our sample are predominantly located in urban areas (71 % vs. 29 %; no population information available), with a slight majority of nonteaching hospitals (45%–55%; no population information available), and a rather low degree of market concentration (mean Herfindahl-Hirschman Index 0.12, standard deviation 0.11). As we are mainly interested in associations instead of in predicting prevalence, these deviations are considered of minor importance.

3.2. Empirical model

Depending on the form of the dependent variable, i.e., the staff shortage measure, we used different regression types to assess the effect of the environmental and organizational characteristics (RQ 1). For the questions on factors associated with hospital-perceived staffing difficulties, we used ordered logistic regression models. For the regressions on the average number of days to fill positions, we used zero-inflated negative binomial models, accounting for the fact that our count variable was distributed in a way that the variance exceeded the mean and the number of zeros among the responses. Interval regression was used for fluctuation, which allowed intervals of unequal size (the largest category being $>20\%$). We report Spearman rank correlations for the associations between the different hospital staff

Table 2
Descriptive statistics for direct staff shortage measures.

Measure Occupational group	Nurses	Physicians	General
Perceived staffing difficulties			
<i>Frequencies</i>			
1 (not affected at all)	11 %	12 %	2 %
2	12 %	13 %	15 %
3	28 %	22 %	26 %
4	22 %	25 %	36 %
5 (strongly affected)	27 %	27 %	20 %
<i>Mean</i>	3.42	3.42	3.58
<i>Std. Dev.</i>	1.30	1.34	1.04
<i>Observations</i>	100	99	99
Fluctuation			
<i>Frequencies</i>			
<5 %	33 %	19 %	
6–10 %	48 %	39 %	
11–15 %	15 %	27 %	
16–20 %	4 %	14 %	
>20 %	0 %	2 %	
<i>Observations</i>	98	96	
Vacant days			
<i>Mean</i>	61	71	
<i>Standard deviation</i>	40	53	
<i>Observations</i>	88	90	

indicators and hospital-reported patient-to-nurse ratios (RQ 2). Regressions on patient satisfaction were performed using ordered least square regressions (RQ 3). For each occupational group, we first ran bivariate regressions with the direct staff shortage measure and the patient-to-nurse ratio. Then, we performed two multivariate regressions: 1) on all three direct staff shortage measures and 2) adding the patient-to-nurse ratio. Given the small sample size, we report results up to a 90 % confidence level.

As a sensitivity analysis for RQ 1, we repeated all seven regressions including aggregate indicators concerning the labor market situation at the state level (number of job seekers with relevant qualifications per open position, number of registered open positions, adjusted for the total number of nurses/physicians) as additional predictors for hospital staff shortages. Furthermore, we repeated the twelve regressions for RQ 3, adding control variables: hospital location, size, ownership types, and teaching status. All analyses were performed in Stata/SE 13.1.

4. Results

As described above, we received a total of 104 questionnaires. As some hospitals did not respond to all questions (i.e., the data contain missing values), the number of hospitals usable in each data analysis is specified in the tables. Our results show a large degree of variation in the way hospitals consider themselves to be affected by staffing difficulties in general and specifically for physicians and nurses (see Table 2). For instance, while 20 % of the hospitals consider themselves to be strongly affected by staff shortages, 17 % of the hospitals report that they are hardly or not at all affected. It also shows that being affected or strongly affected by a general staff shortage is rated slightly higher than for an occupation-specific (nurse and physician) shortage, with both significantly correlating with the overall measure but not significantly relating to each other. As most of the cross-occupational correlations are insignificant, the approach to distinguish between the two occupational groups seems justified.

Table 3 depicts the associations between the staff shortage measures, including the associations with the patient-to-nurse ratio (RQ 2). Interestingly, the latter is not significantly related to any of the shortage measures. Four of the six within-occupational-group measures are significantly positively related; fluctuation, vacant days, and reported shortage of nurses all significantly correlate

(with Spearman rank correlation coefficients between 0.27 and 0.55). For physicians, only vacant days and reported shortages are significantly positively related, while vacant days and fluctuations are significantly negatively related. These differences in association might indicate that there are certain peculiarities to the measures and the occupational groups, which also need to be accounted for in the interpretation of the regression results.

Table 4 summarizes the results of the analyses for the first research question, showing the environmental and organizational characteristics associated with the variables on staff shortage. In total, seven regressions were performed.

Hospital location is significantly related to three of the seven staff shortage indicators. Hospitals in urban areas take less time to fill vacant positions for both nurses and physicians but experience a significantly higher average turnover of physicians. Market competition is only significantly related to one staff shortage indicator, with nurse fluctuations higher in less concentrated, i.e., more competitive markets.

Hospital size is significantly related to two of the seven indicators: larger hospitals consider themselves to be more affected by staffing difficulties in general but less affected by physician staffing difficulties. The private ownership dummies are significantly related to four (private nonprofit) and five (private for-profit) of the seven staff shortage indicators. Private nonprofit hospitals report that they are significantly more affected by staffing difficulties than public hospitals; they take more time to fill nursing and physician positions and have higher levels of nurse fluctuation. The same holds true for private for-profit hospitals, for which the effect is even greater in magnitude. Additionally, there is a significant positive relationship between private for-profit ownership and perceived nurse staffing difficulties. Teaching status is significantly related to one of the seven indicators, showing a positive relationship with nurse fluctuation.

With regard to the third research question, the results are presented in Table 5. In the bivariate regressions, satisfaction with nursing care is significantly negatively related to all our direct shortage measures (perceived nurse shortage, nurse vacancies, and nurse turnover) and to the patient-to-nurse ratio. In the multivariate analyses, the effect of nurse vacancies becomes insignificant, as does the effect of perceived nurse shortage when including the patient-to-nurse ratio. A similar pattern emerges with respect to satisfaction with physician care; it is significantly negatively related to all shortage measures in the bivariate analyses, while the effect of vacancies becomes insignificant in the multivariate analyses.

In the sensitivity analyses, the additional labor market indicators on the state level were not found to be related to hospital staff shortages. After adding the control variables to the regression on patient satisfaction, the directions of the coefficients remain stable, even though some effects become insignificant, which might also be due to losses in power. The detailed results are presented in Appendix B.

5. Discussion

The aim of our study was to provide further insights into variations in staff shortages across hospitals and to analyze the antecedents and consequences of staff shortages for patient satisfaction. In summary, the results show that there are large variations in staff shortages across hospitals, with some of the variations relating to environmental and organizational characteristics. However, the results are also highly dependent on which staff shortage measure is used. Furthermore, the nurse staff shortage measures do not significantly relate to nurse-to-patient ratios. Finally, both the direct shortage measures and the nurse-to-patient ratio affect patient satisfaction.

Table 3
Spearman rank correlations for direct staff shortages measures and patient-to-nurse ratio.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Patient-to-nurse ratio	1						
Vacant days Nurses	−0.08	1					
Fluctuation Nurses	−0.04	0.27*	1				
Reported shortage Nurses	−0.05	0.55*	0.42*	1			
Vacant days Physicians	−0.12	0.38*	−0.09	0.10	1		
Fluctuation Physicians	0.18	−0.21*	0.20*	0.02	−0.22*	1	
Reported shortage Physicians	−0.03	−0.02	−0.10	0.05	0.55*	−0.14	1
Reported shortage overall	0.02	0.28*	0.39*	0.58*	0.11	0.09	0.33*

* $p < 0.05$; correlations with patient-to-nurse ratio, analyzed in RQ2, are marked in bold.

Table 4
Environmental and organizational factors associated with indicators of hospital staff shortages (Regression coefficients with robust standard errors in parentheses).

	Dependent variable: Hospital-perceived staffing difficulties			Dependent variable: Average vacancy times		Dependent variable: Average fluctuation	
	Overall	Nurses	Physicians	Nurses	Physicians	Nurses	Physicians
<i>Environmental factors</i>							
Urban location	0.32 (0.46)	−0.16 (0.50)	−0.46 (0.53)	−0.35* (0.19)	−0.42** (0.19)	−0.42 (1.05)	3.57*** (1.31)
Market concentration	2.25 (1.79)	−3.01 (2.87)	3.51 (2.65)	0.04 (0.91)	−0.16 (0.58)	−9.99*** (3.69)	5.51 (6.31)
<i>Organizational factors</i>							
Hospital size (1000 beds)	1.23* (0.72)	0.90 (0.80)	−2.15* (1.10)	0.14 (0.29)	−0.53 (0.34)	0.57 (1.36)	1.61 (1.97)
Ownership (base group public)							
- Nonprofit hospital	1.01** (0.49)	0.45 (0.55)	0.21 (0.62)	0.48*** (0.16)	0.26* (0.15)	2.05** (0.94)	1.24 (1.21)
- For-profit hospital	1.51*** (0.53)	1.24** (0.61)	0.04 (0.67)	0.63*** (0.16)	0.31* (0.18)	3.30*** (1.14)	1.02 (1.51)
Teaching hospital	0.67 (0.51)	0.21 (0.37)	0.46 (0.45)	0.11 (0.14)	−0.01 (0.16)	1.89** (0.87)	−0.21 (1.12)
Constant				3.89*** (0.25)	4.54*** (0.22)	6.13*** (1.27)	5.67*** (2.05)
Regression type	Ordered logistic			Zero-inflated negative binomial		Interval	
Observations	98	99	98	86	88	97	95

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5
Measures of hospital staff shortages associated with patient satisfaction with nursing and physician care (Regression coefficients with robust standard errors in parentheses).

	Dependent variable: Satisfaction with nursing care						Dependent variable: Satisfaction with physician care					
	(N1)	(N2)	(N3)	(N4)	(N5)	(N6)	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)
PSS – nurses	−0.94*** (0.28)				−0.63** (0.30)	−0.51 (0.36)						
PSS – physicians							−0.55** (0.27)				−0.69** (0.33)	−0.80* (0.45)
Vacancies – nurse		−0.21** (0.09)			0.03 (0.10)	0.04 (0.12)						
Vacancies – physicians								−0.15** (0.07)			0.05 (0.08)	0.00 (0.11)
Fluctuation – nurse			−1.43*** (0.50)		−1.13** (0.54)	−1.13* (0.58)						
Fluctuation – physicians									−1.16*** (0.37)		−1.24*** (0.37)	−1.07** (0.49)
Patient-to-nurse ratio				−0.28*** (0.10)		−0.26*** (0.10)				−0.20** (0.09)		−0.15 (0.09)
Constant	85.32*** (0.97)	83.17*** (0.53)	85.05*** (0.96)	84.40*** (0.95)	86.32*** (1.16)	88.01*** (1.67)	85.12*** (0.98)	84.07*** (0.53)	86.13*** (1.04)	84.85*** (0.95)	88.43*** (1.39)	89.78*** (1.94)
Observations	87	84	85	61	82	59	86	85	83	61	82	59
R-squared	0.12	0.06	0.11	0.10	0.15	0.21	0.05	0.03	0.11	0.05	0.18	0.20

PSS = Perceived staff shortage; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Model N/P 1–4 contain the bivariate regressions with one direct staff shortage measure, respectively; model N/P 5 includes all direct staff shortage measures simultaneously; model N/P 6 includes all direct staff shortage measures and the patient-to-nurse-ratio.

Our first research question investigated the explanatory power of environmental and organizational factors for hospital staff shortages. As the different measures for staff shortages were only partially significantly related to each other, it is not surprising that most factors do not uniformly affect different staff shortage indica-

tors. In the following sections, we will discuss the results for each factor separately and relate them to prior evidence. To provide a clearer overview of how our results coincide with, contradict, or extend prior evidence, we also included our study findings in Appendix A.

Concerning hospital location, our study finds that while vacancies seem lower in urban areas, fluctuation for physicians is significantly higher, and perceptions of staff shortages (for nurses, physicians, and in general) do not significantly differ. Although it seems to only add to the already existing mixed evidence, we can still detect some interesting patterns and offer some tentative explanations. Regarding self-reported staff shortages, our results are in line with Seago et al. [3], who also found that hospitals did not differ in their reported staff shortages depending on population and population density. However, both studies are somewhat contradictory to Cramer et al. [29], who showed that the discrepancy between the actual staffing level and the predicted staffing need – a gap measure for the degree of shortage – was larger for rural hospitals. One potential explanation could be that the gap measure again relies more strongly on staffing levels, which are heavily affected by staffing policies. If rural hospitals employ more restrictive staffing policies, their staffing levels might be lower – and a potential gap to the predicted need would seem to be larger – than for urban hospitals. These are then not a result of staff shortage problems but rather deliberate decisions. Mark et al. (2000) provide empirical support for higher staffing levels in urban hospitals, hence backing up this potential explanation, even though the finding of Conway et al. [11] contradicts this reasoning, as they find the share of hospitals below the mandated minimum staffing ratio to be higher among urban hospitals than rural hospitals. Hence, further research is needed to illuminate differences in reported shortages across rural and urban hospitals.

Regarding fluctuation, our study adds to the unambiguous evidence of no significant association between hospital location and nurse turnover. Hence, it seems that hospital location is not a good discriminator for assessing variations in nurse turnover. Meanwhile, we find that physician turnover is significantly higher in urban areas – an association that has received less attention until now. Physicians might make use of the opportunity to change employers without needing to change residence more often than nurses. Future research might analyze whether differences in career ambitions between physicians employed in urban and rural hospitals explain parts of the variations in turnover rates and what other factors drive these variations. Furthermore, as the correlation analyses have also shown, physician turnover might not be a good indicator of physician staff shortages because it is (significantly) negatively related to the other physician shortage measures.

A more general explanation for the mixed evidence for hospital location and diverse staff shortage measures could be that the relationship between the former and the latter substantially depends on whether a greater availability of workforce outweighs the greater availability of alternative job opportunities, or vice versa. Future research might address the disentanglement of these two opposing forces more directly.

Our findings related to hospital size reveal that across occupational groups and shortage measures, no systematic predictive effect can be detected. The only two significant associations point in opposite directions; larger hospitals experience lower physician shortages but higher general shortages. Nurse shortages are also higher in larger hospitals, yet the effect is insignificant. Potentially, the effect might be larger for other occupational groups, such as medical technical assistants and administrative staff. One potential explanation for the contradictory effects of physicians and other occupational groups might be the varying impact of hospital size on employer attractiveness. The size of the hospitals might be particularly relevant for physicians, as larger hospitals might offer more opportunities for specialization, diversification, and career pathways. Higher employer attractiveness enables large hospitals to achieve the physician staffing levels they desire, hence reporting lower shortage levels than smaller hospitals. For other occupational groups, employer attractiveness might be less dependent on hos-

pital size. Larger hospitals then, as they require more staff than smaller hospitals, might be more strongly affected by staff shortages on the labor market and less able to achieve the staffing levels they desire. Future research could investigate these proposed associations between hospital size and employer attractiveness in more depth. As we do not find any significant differences in turnover rate and vacancies and prior evidence yielded highly mixed results as well, an extreme variety might exist in how hospital size interacts with staff shortages.

A clearer pattern emerges with respect to hospital ownership type. Both private for-profit and private nonprofit hospitals show higher staff shortage levels; they report higher general and nurse shortages (for nurses, the effect is only significant for for-profit hospitals) than public hospitals, higher nurse turnover rates, and higher vacancies for both nurses and physicians. These findings confirm prior evidence relying on direct staff shortage measures, which also mostly found nurse turnover to be higher in private hospitals [30,42]. Only one study using direct staff shortage indicators did not detect a significant association [3]. The findings might also indicate that the impact varies across occupational groups. For physicians, self-reported shortage and turnover rates do not vary significantly across ownership types. While two studies based on data from the U.S. indicate that staffing levels are higher in private hospitals [11,31], a German study finds staffing levels to be lower in private hospitals [14]. Thus, the national context – including the level of financing, scope of service provision, and role of private and public hospitals – might affect the associations and lead to varying results. A final aspect to be mentioned with respect to hospital ownership is that evidence is less clear when focusing on antecedent indicators, with three results even pointing towards less favorable employee attitudes in public hospitals [7,32].

With respect to hospital competition and teaching status, we only find one significant association with our shortage measures for each. This might indicate that those two determinants are of minor importance for predicting staff shortages.

The second research question examined the association between the direct staff shortage measures and staffing levels, i.e., the patient-to-nurse ratio. The analysis shows no statistically significant relationship between any of our seven staff shortage measures and patient-to-nurse ratios. While the relatively small sample size calls for caution in interpreting the findings, it suggests that the two concepts are at least to some extent distinct, and hospitals deliberately decide on staffing ratios; they are not the mere result of a lack of available workforce. Since the beginning of 2019, this situation has started to change in Germany, as minimum nurse staffing ratios have been introduced and hospitals have begun to receive deductions from reimbursement if they exceed a certain ratio of patients to nurses for selected hospital departments. In 2020, this measure will be supplemented with requirements for overall nurse staffing in hospitals and additional financial means to increase the nurse staff. Hence, hospitals' decisions on staffing ratios are affected by new regulatory and financial incentives, which might lead to different results if the study were to be repeated. In addition, our findings imply that both the antecedents and the consequences of staffing levels do not necessarily correspond to the determinants and consequences of staff shortages.

Finally, our third research question assessed how hospital staff shortages and nurse-to-patient ratios relate to patient satisfaction. In a bivariate setting, we find that all three direct staff shortage measures and the patient-to-nurse ratio are significantly related to patient satisfaction. The multivariate regressions suggest that the most substantial drivers of low patient satisfaction are high fluctuation and high patient-to-nurse ratios for satisfaction with nursing care. Additionally, perceived nurse and physician shortages seem to be negatively related to patient satisfaction. This suggests that

hospital-perceived staffing difficulties may influence the satisfaction with nursing care in more ways than through staffing ratios. For instance, the quality of the relationship between nurses and physicians might be unrelated to staffing ratios but significantly related to direct staff shortage measures and patient satisfaction [33,34]. The same might apply to further workplace characteristics, including autonomy [33–35]. More concrete explanations of these potential mechanisms require further empirical evidence on the interplay of the different variables.

The association between the patient-to-nurse ratio and patient satisfaction also needs to be noted. Patients are significantly less satisfied with their care when staffing ratios are low, which confirms existing studies [18]. This raises concerns that low staffing ratios may affect patient care in more ways than are directly measurable in outcomes such as mortality, readmission, or adverse events.

Although our study generated some valuable insights, it is not without some limitations, which also offer opportunities for further research. First, we relied on reports of a single respondent for each hospital. Although hospital HR managers should be knowledgeable about hospital staff shortages, future research could extend our study and validate our findings by investigating several respondents' views or employees' perceptions of staff shortages. One limitation related to our data collection method is the cross-sectional design, which prevents us from drawing causal conclusions regarding the link between organizational and environmental factors and staff shortages. To address the concern of reversed causality, we followed prior literature and used a time lag for most of our independent variables [7,36,37]. Future research could use longitudinal data to provide a better understanding of changes in staff shortages and its determinants over time, e.g., whether changes in the availability of alternative job opportunities affect staff shortages. Furthermore, we investigated a limited set of environmental and organizational factors as potential determinants of staff shortages. While we relied on the most commonly used factors and our findings provide important insights, we cannot provide a final conclusion as to which degree variations in staff shortages can be explained by environmental and organizational factors. Further research might build upon our findings and may find further determinants. In particular, Magnet® hospitals or equivalent outstanding hospitals in other countries with high employer attractiveness might provide valuable starting points for management to determine the causes of lower staff shortages [38–40]. Additionally, even though this study investigated staff shortages in a large number of hospitals and was able to detect substantial variations, the sample size of this study limited the quantitative data analyses as well as the generalizability of the findings. A greater number of hospitals would enable more powerful and comprehensive analyses, e.g., investigating more in-depth interactions between staff shortage measures, their determinants, or performing cross-country comparisons. Finally, our research design enabled us to detect whether the selected environmental and organizational factors significantly explain variations in staff shortages, but we cannot explain the underlying mechanisms. More qualitative research is needed to help fill this gap. For instance, further research could examine the underlying reasons for differences related to hospital ownership type, which might help specific hospitals improve recruitment and retention.

6. Policy implications

Despite its limitations, our study offers important implications for hospital policy and management. For hospitals, our findings regarding the determinants of staff shortages might provide an opportunity to evaluate their own vulnerability to staff shortages.

Hospitals that find themselves at greater risk of staff shortages (due to environmental and organizational characteristics) might be well advised to actively engage in countermeasures, e.g., by investing in strategic HRM practices that help to improve employee attitudes and employer attractiveness [7]. They might also strive to become Magnet® hospitals or hospitals with an extraordinary reputation as an employer. For instance, private for-profit hospitals might be well advised to carefully monitor labor market developments, as they might experience a competitive disadvantage compared to public hospitals and might be more likely to suffer from staff shortages. Hospitals in urban areas might be well advised not to rely on a potentially greater available workforce. A greater availability of alternative job opportunities might make investments in effective recruitment and retention activities advisable. Additionally, the developments outlined in the introduction – changes in staffing requirements, in reimbursement of service provision, in staff characteristics and preferences, and in the supply and demand for staff – could aggravate potential staff shortages for certain types of hospitals as the demand for staff grows, while the financial means for reimbursement and the supply (i.e., the number of employees willing to work under the given working conditions) decrease. Aging personnel will need to be replaced with new labor market entrants, who might have notably different work values, such that the attractiveness of hospitals might change substantially and hospitals will have to react accordingly.

Additionally, our findings imply that it is important to differentiate between occupational groups, such as nurses and physicians, when assessing staff shortages. Our analysis shows that hospital location more systematically relates to physician shortages, whereas private (especially for-profit) ownership has a stronger impact on nurse shortages. The overall staff measure adds further information; e.g., larger hospitals report significantly lower physician shortages but significantly higher general staff shortages, indicating that large hospitals need a well-functioning recruiting and retention HRM with a special focus on employees other than physicians.

Finally, our findings regarding the link between staff shortages and patient satisfaction underscore that fighting staff shortages is not only important to secure the quality of care but also the satisfaction of patients, which is increasingly important in the context of attracting enough patients for a sustainable service provision.

Regarding health policy, the main implication of this study is that staff shortages are only partially reflected in staffing ratios. Therefore, policies aimed at increasing staffing ratios should not focus solely on increasing the labor supply; rather, they should also take hospital policies into consideration. For instance, instead of relying on the assumption that increasing training opportunities will increase the availability of staff and hence staffing ratios, policy-makers might also carefully consider how far health service reimbursement mechanisms constrain hospital staffing decisions.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.healthpol.2020.01.001>.

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