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Strategies and implications of mitigating personnel shortages in nursing homes

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Strategies and Implications of Mitigating Personnel Shortages in Nursing Homes

Abstract

Amidst demographic shifts, advanced economies are facing critical nursing shortages. This study analyzes strategies of German nursing care providers to address these shortages using administrative data for the period 2007 to 2017. Our analysis reveals that higher nursing shortages correlate with decreased nurse-to-resident ratios, changes in the qualification mix of nurse personnel, and reduced care provision. These findings suggest that nurse shortages can be a threat to the quality of care and the financial sustainability of nursing homes at the margin of being profitable.

JEL-Code: C90, I10, I11, I18, J01

Keywords: Nursing home care; personnel shortage; capacity; nursing management

December 2023

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JEL Classification: C90, I10, I11, I18, J01

Keywords: nursing homes; personnel shortage; capacity;

1 Introduction

In numerous advanced economies, there has been a growing discrepancy between the number of retiring workers and incoming younger entrants in the labor market. Such demographic shifts have significantly contributed to labor shortages in various sectors (e.g. Duval et al., 2022). A prime example is the nursing sector where personnel shortages have been escalating over time, reaching critical levels (World Health Organization, 2020; Buerhaus et al., 2007).

The coronavirus pandemic further exacerbated the nurse shortages by decreasing the labor force participation among older nurses (e.g., Spetz, 2021). Additionally, those who continued working have been absent more often due to illness (e.g., Schug et al., 2022). Important health care consequences likely include prolonged waiting lists for people in need of care, inadequate care, and in extreme cases, the shutdown of entire nursing homes (Görres et al., 2020; Netten et al., 2003). While it appears paradoxical that the same demographic shift generates both an increased demand of nursing care and a potential reduction of supply of care services, in certain countries, like Germany, the magnitude of the problem has become so glaring that it has spurred intense public debates. These discussions recently started to revolve around triage protocols, questioning whether nursing homes should deprioritize elderly individuals with minimal care needs (ARD, 2023).

In this paper, we aim to investigate the strategies German nursing homes employ to address labor shortages within the elderly care sector. We employ data from the official German Care Statistic spanning 2007 to 2017, which encompasses the universe of German care facilities, personnel, and care recipients (both formal and informal). This data set is augmented with administrative vacancy information at the county-level on all publicly reported nursing positions that stem from the capacity planning of individual nursing homes, provided by the Research Institute of the Federal Employment Agency (Statistik der Bundesagentur für Arbeit, 2023).

With the objective of protecting financial sustainability, nursing homes facing nurse shortages are compelled to implement mitigation measures that allow

them to continue operating without turning away residents and, thus, preserving its revenue stream. Once traditional capacity planning measures, such as job advertisements in local newspapers and at the Federal Employment Agency, are exhausted, they might replace registered nurses with relatively less scarce nurse assistants and increase nurse-to-resident ratios. However, this approach can dilute the quality of personalized care that residents receive. With this risk for the quality of care in mind, regulators often stipulate minimum nurse-to-resident ratios and staff qualification levels, which act as a safeguard to prevent a decline in care quality (Van den Heede et al., 2020). As a result, nursing homes may find their mitigation strategies be restricted, causing those having reached the critical threshold to leave rooms empty. In this case, the occupancy ratio will decrease, diminishing profitability. If a nursing home is unprofitable over several years, the probability to exit the market increases.

This paper empirically analyzes measures of nursing homes to mitigate unfilled nursing vacancies and discusses possible repercussions on the sector. We investigate how various metrics of nursing homes including the nurse-to-resident ratio, the qualification mix of the nursing personnel, and the occupancy ratio correlate with the county-level number of published vacancy notes, which we use as our measure of nursing shortages. Notably, on average, there are three times as many vacancy notes as there are nursing candidates, indicating that many of these positions remain vacant for extended periods (Federal Employment Agency, 2022). Our methodological approach involves utilizing pooled cross-sectional data and linear regression analyses.

The examined mitigation measures are highly relevant from a public health policy perspective. For instance, the nurse-to-resident ratio likely serves as proxy for the nursing homes' ability to provide personnel intensive, high-quality care. With a shortage of nursing staff, a higher risk of compromised patient safety, reduced attention to detail, and a greater likelihood of patient mistreatment have been reported (Kang et al., 2023; Shi et al., 2023; Dierckx de Casterlé et al., 2020; Sefidani Forough et al., 2020; Teng et al., 2010).

We find higher nursing shortages to be accompanied by a substantially lower nurse-to-resident ratio, a shift of the staff qualification mix, and a reduced overall provision of care. As to the latter, we find a negative relationship between nurse shortages and the occupancy ratio. We also report that the number of nursing home residents is reduced. This is problematic for the financial sustainability of nursing homes because reimbursement rates are negotiated based

on the assumption of maximum utilization of available beds. With persistently reduced occupancy ratios, the long-term financial viability of these institutions comes into question. In fact, current trends suggest that every fourth nursing home operates at a deficit (Heger et al., 2021). Consequently, the looming nursing shortages stand as a potential threat to the sustainability and future of elderly care in countries like Germany. In the conclusion, we draw from existing literature and discuss potential public policy measures to address the problem (e.g. Van den Heede et al., 2023; Tomblin Murphy et al., 2012; Chiha and Link, 2003; Humphries et al., 2012; Daniels et al., 2012).

This paper is the first to empirically study strategies used by nursing homes in response to nursing shortages. As opposed to nursing shortages, Ching et al. (2015) show that limited bed capacity results in the rationing of services for nursing home residents. Other studies estimate the effects of nursing shortages on the well-being of the nursing workforce (e.g., Sebastiano et al., 2017). To develop a better understanding of provider decisions in relation to nurse capacity planning, as opposed to the management of existing capacity examined in our paper, Harrington and Swan (2003) assess the relationship between nursing hours and nurse turnover rates, resident case mix, and nursing wages. Our empirical results on the measures of nursing homes to mitigate unfilled vacancies is novel.

Our paper connects with several studies that examine the relationship between demand and capacities in nursing homes. For example, Bae et al. (2019) simulate the interaction of nursing capacity and demand, finding that appropriate capacity planning can improve system indicators such as waiting times for beds, occupancy, and quality. Similarly, Pilny and Stroka (2015) examine the relationship between the demand for long-term in-patient care and the regional supply of nursing home beds. Van Gameren and Woittiez (2005) relate the demand for higher elderly care provision to access to informal care. Bauer and Stroka (2013) investigate whether the labour market participation and the education level of women are correlated with the prices of nursing homes.

There is some more literature available for hospital care. Most closely connected with our study is the analysis of Blegen et al. (2008) showing that patient care staffing levels in both intensive care and non-intensive care units decrease as the supply of registered nurses in the surrounding geographic area decreases. Further available studies examine ways to use existing nursing capacity in hospitals more effectively (Maloney et al., 2007; Elkhuizen et al.,

2007) and the effects of nursing shortages on quality of medical care as well as care costs (Griffiths et al., 2023; Milstein and Schreyoegg, 2020; Bridges et al., 2019; Weiss et al., 2011; Needleman et al., 2002).

The remainder of the paper is organized as follows. Section 2 presents shortly the institutional background and a theoretical analysis of the implications of nursing shortages for nursing homes. Section 3 describes the data sources and defines the variables, Section 4 explains the estimation strategy. Section 5 presents descriptive statistics and the regression results. Section 6 discusses the findings and concludes.

2 Background

We first present the institutional background and then provide theoretical considerations concerning the implications of nursing shortages for nursing homes.

2.1 Institutional background

Nursing homes (NHs) in Germany face low entry restrictions, but high entry costs. The largest part of the marginal costs is driven by nursing care personnel. The mandatory long-term care insurance as well as the social security system for the poor negotiate the prices, which are fixed at the NH level for at least one year. Prices depend on past costs and the NH's bargaining power. NHs receive public funds to cover investment costs. In order to receive the maximum amount of the respective public funds, NHs need high occupancy ratios (Kienitz, 2016). Thus, the occupancy ratio is directly linked to the financial situation of NHs. With respect to potential mitigation strategies regarding the lack of personnel, NHs are restricted by a legally binding predefined nurse-to-residents ratio that varies across care levels and federal states (see Table A.1 for the year 2023 in the Appendix).

2.2 Theoretical considerations

We apply a standard equilibrium model of the labor market to explain the situation of personnel shortage. The model is illustrated in Figure A.1 in the Appendix.

A shift in the supply curve indicates that, at a specific wage, fewer nursing

personnel are willing to provide care. This causes the equilibrium between demand and supply of labor to be reached at a higher wage and a reduced number of nurses who provide care in the market. This limits the facilities' ability to provide sufficient, high-quality care as they either need to employ fewer qualified nursing personnel (NP) per resident or stop admitting new residents, i.e., reducing the occupancy ratio.

In Germany, the nursing shortage problem is likely to have disproportionate effects due to substantive wage rigidity in the market. This is explained by difficult and time-consuming negotiations about the NH reimbursement rates between the providers and the long-term care insurers that have provided nursing homes' limited margins to pay higher wages (Krachler et al., 2021; Rothgang, 2010). Under the assumption that wages cannot increase, even less nurses will supply care.[1]

3 Data

We combine data covering the (pre-pandemic) period 2007 to 2017 from three sources. First, we use the German Care Statistic provided by the Statistical Offices of the Länder at the Research Data Center (FDZ) of Hannover (FDZ, 2020). It is collected biennially in December and includes rich information on the universe of German NHs and their residents, home health care providers and their clients as well as informal care recipients. We restrict our analysis to care provision for the elderly in long-term care facilities[2] and exploit information on the NH level, covering the number and care level of their permanent residents as well as the qualification mix, contractual working time, and tasks performed by the staff (FDZ, 2020).

Second, to capture staff shortages, we include vacancy data from the Research Institute of the Federal Employment Agency (Statistik der Bundesagentur für Arbeit, 2023). This data provides us with the number of all open positions

[1] Consistent with the focus of the empirical analyses which are on the shift on the supply side, in our model, we abstract from shifts of the demand curve resulting from the demographic change. With flexible wages, an increased demand for nursing care may offset the effects of nurse supply shortages as the willingness to pay for nursing services will provide incentives for individuals to supply more labor in the nursing market. Under this condition, it will be an empirical question whether the supply- or demand-side effect of the demographic shift prevails. Yet, in the presence of wage rigidity, changes on the demand side are not affecting the effects of a shift in the supply of nurses in the model.

[2] We drop individuals below 65 years of age (around 500,000 individuals) and facilities that are only providing day- and short-term care (15,823 facilities)

(yearly averages) in NHs for nursing assistants (NA), registered nurses (RN), and specialists (SN) aggregated at the county level (Statistik der Bundesagentur für Arbeit, 2023).[3] Whereas other research aims to approximate personnel shortage by the nurses' workload (Bridges et al., 2019), open positions are arguably a more direct measure of personnel shortage. NHs publish job advertisements for one specific nurse type even if they look for more than one. Thus, the vacancy ratio likely underestimates the actual nurse shortage. This measurement error yields attenuation bias and, hence, conservative point estimates in the regression analyses.

Lastly, we draw indicators of regional and urban development from the Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung, 2023, INKAR). The county-level information relates to the working population, medical infrastructure, wealth, and demographic composition.

The analyses are conducted at FDZ in Hannover.[4]

As the first outcome, we analyze the NP to NH resident ratio (NP/resident) calculated individually for each facility j in year t, where the number of personnel is measured in full-time equivalent staff (FTE) and we focus on permanent residents. With the objective of considering differences in skill-mix, We calculate this ratio for all NP, RNs, and NAs separately. While NP does not include all personnel working in a NH, as shown in Figure 1, it represents the input most crucial to care provision.

We also use the qualification mix (NA share) to examine the different compositions of nursing personnel and their potential for substitution. This ratio is calculated as the relation of registered nurses (or nursing assistants) in FTE to the total number of nursing personnel in FTE.

In addition, we utilize the number of beds for permanent care, the number of residents per NH, and the home-specific occupancy ratio. This ratio is calculated as the proportion of permanent NH beds occupied by NH residents compared to all available permanent beds in the NH at a given point in time.

We employ the county-specific NP vacancy ratios to assess NP shortage. This

[3]Employers are required by law to report open positions to the federal employment agency (REF - add: § 164 SGB IX).

[4]To protect the confidentiality of individual care facilities in the Care Statistic, for certain years, we aggregate smaller counties that lack representation of at least three different NH ownership types. This implies some additional measurement error in our main explanatory variable.

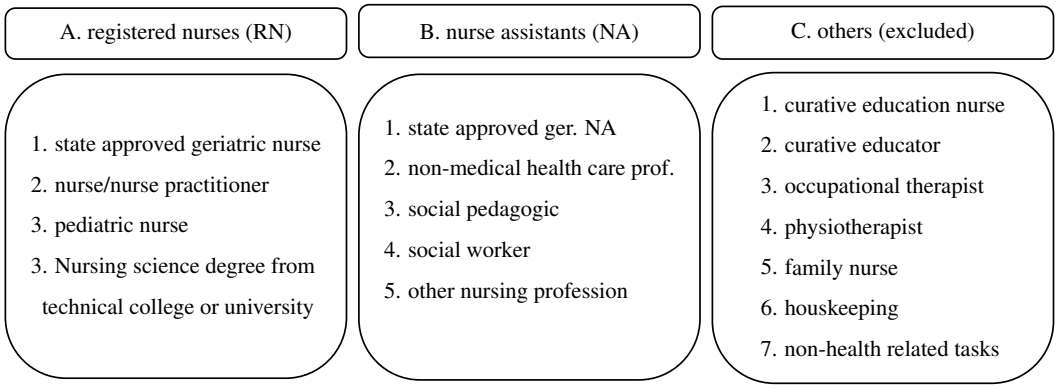


Figure 1: Overview of nurse qualifications

Note: We follow the profession classification of the Research Institute of the Federal Employment Agency (Bundesagentur für Arbeit, 2011, IAB).
A. *Registered nurses (RN) are professional care givers with a specific vocational training of 3 to 5 years. They provide basic care, medical treatments, and administrative support.*
B. *Nurse assistants (NA) are care givers with a vocational training of 1 to 2 years. They assist with personal hygiene, meal assistance, and, under supervision, administer medications and work alongside other RN.*
C. *We exclude professions that do not involve direct care contact with residents.*

measure has already been applied in other studies (Grumbach et al., 2001; Buchan and Calman, 2004; Rondeau et al., 2008). Here, we define the vacancy ratio (NP-vacancy) as the number of open positions divided by the total budgeted positions. The latter includes both vacant and filled positions at the county level. To differentiate the personnel shortages by types of qualification, we calculate qualification-specific vacancy ratios for all NP, RN, and NA for each qualification level i in county c at time t (Eq. 1).

$$\text{NP-vacancy}^{i}_{c,t} = \frac{vac^{i}_{c,t}}{bud.\ pos.^{i}_{c,t}} = \frac{vac^{i}_{c,t}}{filled\ pos.^{i}_{c,t} + vac^{i}_{c,t}},\ \text{where } i \in \{all, RN, NA\} \tag{1}$$

4 Estimation strategy

We employ a multiple linear regression model with pooled cross-sectional data to regress NH metrics on the NP-vacancy (Eq. 2). Note that the metrics are measured at the facility level (j), while we observe the NP-vacancy at the county level (c). We include control variables both at the facility as well as county level. Furthermore, we include time fixed effects (τ_t) and regional fixed

effects at the medical review board (MRB) level[5] (κ_r), and ownership type fixed effects (ρ_p).[6]

$$\begin{aligned} \mathrm{M}^i_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^i_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}, \\ \text{where i} \in \{all, RN, NA\} \text{ and M different NH metrics.} \end{aligned} \tag{2}$$

To ensure that our observed relationships between vacancy ratios and the NH metrics are not driven by other factors, we include control variables that might influence NH capacities (Kelly et al., 2022; Winter et al., 2020; Huiwen et al., 2020; Lee et al., 2012; Blegen et al., 2008; Harrington and Swan, 2003). We group the control variables into categories such as facility characteristics, working population, medical infrastructure, wealth, and demographics, with the latter category primarily focusing on the working population.[7] To rule out concerns of multicollinearity, we pairwise calculate Pearson correlations and variance inflation factors (VIF). We find no abnormalities or high VIF values, indicating that multicollinearity is not an issue in the regression analysis (results are available upon request).

5 Results

In this section, we first present descriptive statistics and then report the results for the relationship between NH metrics and nurse shortage.

Table 1 presents descriptive statistics for the key variables. On average, 42 NHs are located within one county, each providing residence for, on average, 70 residents with a mean age of slightly below 83 years. The average NP-to-resident ratio in a facility is 0.4, indicating that approximately one NP-FTE supervises two to three residents. On average, a NH employs 15 RN and 13 NA (all numbers represent FTE). The RN-to-resident ratio equals 0.22, which corresponds to a bit more than five residents per RN. For assistant nurses (NA), the average ratio is 0.19, i.e. slightly lower than the ratio for RNs.

[5]The MRBs are important administrative entities that support the statutory health and long-term care insurance regionally. The 15 MRB regions are comparable to the 16 German federal-states, but more homogeneously in size since two city states are aggregated with neighboring states and the largest state, North Rhine-Westphalia, is split into two administrative regions.

[6]Results are robust to clustering standard errors at the county level. They are available upon request.

[7]Descriptive statistics for all covariates are presented in A.2 in the Appendix.

Table 1: Descriptive statistics

	2007-2017			
	mean	sd	p10	p90
Basic NH information				
Nursing homes, county	42.21	45.40	13	62
All nurses (NP, FTE)	28.41	16.77	10.75	48.75
Registered nurses (RN, FTE)	15.16	9.04	6.00	26.25
Nursing assistants (NA, FTE)	13.25	8.89	3.75	24
NH residents	70.27	40.76	25	120
Age of NH residents	82.77	3.81	79.12	86.07
Personnel-to-resident ratios				
NP	.404	.160	.314	.527
RN	.216	.117	.156	.309
NA	.189	.085	.113	.267
Skill-mix				
NA share	.450	.120	.310	.580
Beds				
Occupancy ratio	.885	.127	.724	1
Nursing home size (beds)	79.88	45.49	31	120
Vacancy ratio				
NP-vacancy	.053	.024	.026	.083
RN-vacancy	.066	.030	.033	.104
NA-vacancy	.037	.022	.012	.067
Observations	59,865			

Data source: Long-term care (LTC) statistics (facility level), vacancies from the German Institute of Employment Research (IAB) (county level), INKAR data (county level). 59,903 observations (nursing home LTC facilities): [six waves] 2007 (9,205), 2009 (9,676), 2011 (9,972), 2013 (10,197), 2015 (10,383), 2017 (10,432). German LTC statistic: Research center of the Federal and State Statistical Offices, care statistics, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]

This latter finding is also documented by the average skill mix. The mean NA share equals 0.55. Descriptive information for further control variables including additional facility-specific and regional information as well as data on outpatient and informal care are provided in the Appendix in Table A.2.

Figure 2 illustrates the regional variation of NH vacancy ratios separately for all NP, RNs, and NAs aggregated at the spatial planning region level. Vacancy ratios tend to be somewhat lower in Southern Germany and, on average, higher for RNs than for NAs. Vacancy ratios for RNs are, e.g., especially high in the North and North-East of Germany, while the East shows particularly high

vacancy ratios for NAs.

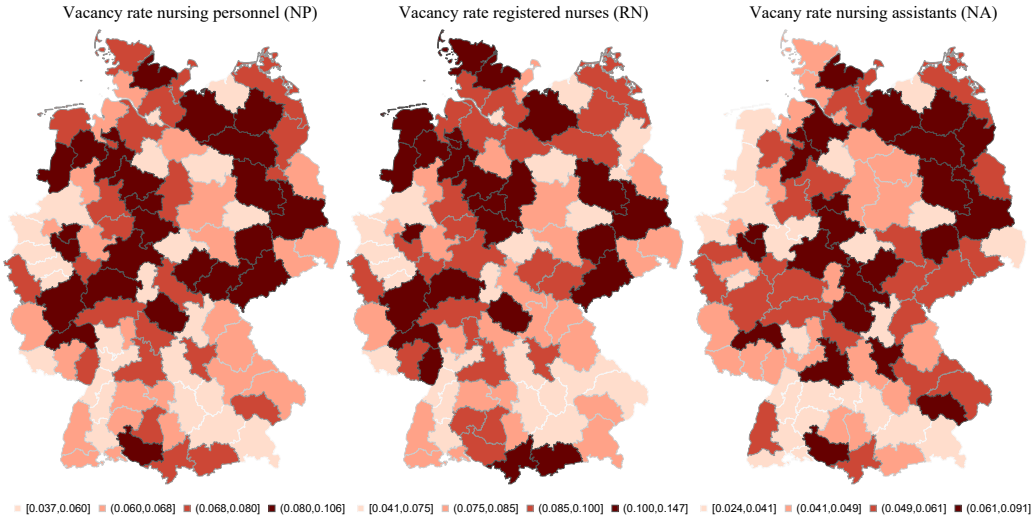


Figure 2: Vacancy ratios across the German spatial planning regions in 2017

Note: Vacancy ratios are derived from own calculations (Eq. 1). We calculate the vacancy ratio for all nurses (NP), registered nurses (RN) and nursing assistants (NA). Profession definitions are provided in Figure 1. The 97 spatial planning regions (groups of counties) correspond to OECD TL3. *Sources:* (1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0] (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB

Figure 3 illustrates the time trends of the average vacancy ratios. NP-vacancy goes down between 2007 and 2009, but has continuously increased since. While the overall development of RN- and NA-vacancy ratios is similar, the RN-vacancy ratio has experienced a small decline between 2011 and 2013, while the NA-vacancy ratio shows a small decline between 2009 and 2011. Overall, the vacancy ratio appears low relative to the extent of the public discourse about the nursing shortage problem, which is consistent with an underestimated nurse shortage. Still, the variation across counties is very informative since this underestimation is true for all regions.

Figure 4 visually confirms a negative linear relationship between the vacancy ratio and the nurse-to-resident ratio controlling for time-varying regional covariates. Our multivariate regression results analyze this relationship further.

Our regression results for the nurse-to-resident ratios are displayed in Table 2. The first column presents the results for the shortage of all NP. The findings reveal a statistically significant negative point estimate of -0.23. In a county with a one standard deviation higher NP-vacancy (2.4 percentage points), the NP-to-resident ratio is lower by 0.6 percentage points or 1.4 percent. The second and third columns display the estimates for the respective ratios for

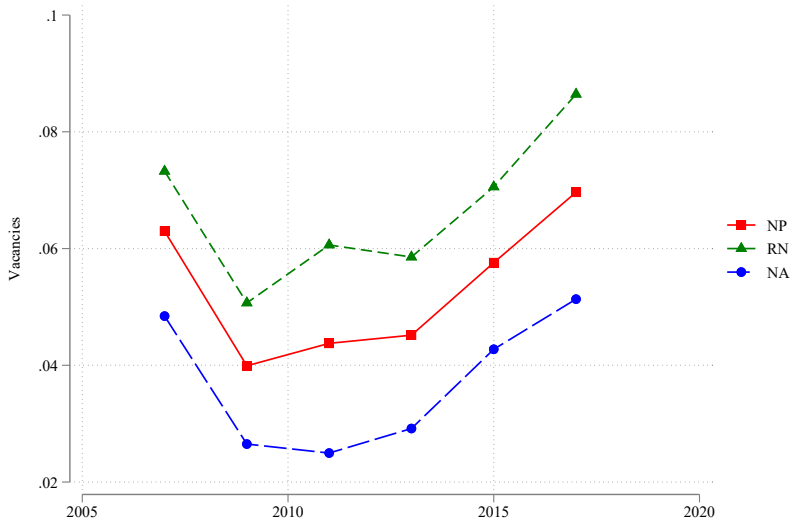


Figure 3: Vacancy ratios by nurse qualification from 2007 to 2017

Note: Vacancy ratios are derived from own calculations (Eq. 1). We calculate the vacancy ratio for all nurses (NP), registered nurses (RN) and nursing assistants (NA). Profession definitions are provided in Figure 1. *Source:* (1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0] (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB

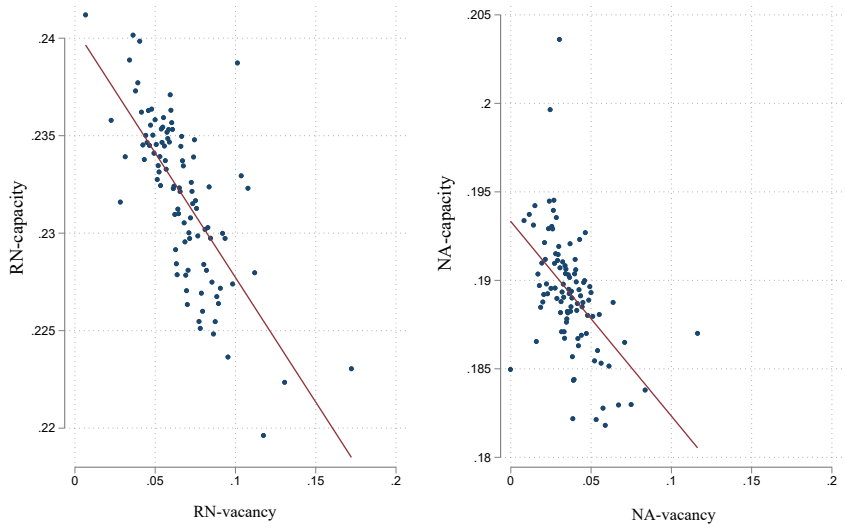


Figure 4: Scatter plot of nurse-to-resident ratios and nurse vacancies by qualification

Note: Figure 4 is a bin scatter plot with RN left and NA right, which clusters all observations into 100 bins with comparable observations thereby controlling for covariates and fixed effects. *Source:* (1) Care Statistic: Statistical Offices of the Länder, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]. (2) Vacancy data: Research Institute of the Federal Employment Agency, IAB.

RNs (−2.1 percent in a county with a one s.d. higher RN-vacancy) and NAs (−3.2 percent, respectively).[8]

[8]Since preferences for NH care, as well as regulations regarding nursing personnel requirements differ across Germany by state, we additionally analyze the vacancy ratios in

Table 2: Relationship between nurse-to-residents ratio and nursing vacancies

	NP	RN	NA
NP-vacancy	-.2261***		
	(.0386)		
RN-vacancy		-.1504***	
		(.0229)	
NA-vacancy			-.1252***
			(.0233)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean depend. variable	0.404	0.216	0.189
Observations	59,865	59,865	59,865
F-statistic	23.07	24.80	24.23
R2	0.152	0.171	0.087

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007-2017 (59,865). Estimating equation: Nurse-to-resident ratio$_{j,t}$ = $\beta_0 + \beta_1$NP-vacancy$^{N}_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}$; Outcome: Nurse-to-resident ratio by qualification. Explanatory variable: Vacancy ratio nurses (NP-vacancy), Vacancy ratio registered nurses (RN-vacancy), Vacancy ratio nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table A.2 in the Appendix. Fixed effects: time fixed effects, regional fixed effects, and ownership fixed effects.

We also examine the potential substitution effects between RNs and NAs. The degree to which these two professional qualifications serve as complements rather than substitutes is an empirical question. Table 3 presents the estimation results for the skill composition in terms of the share of NAs. The first column displays the model for RN-vacancy ratios, while the second column shows the same model for NA-vacancy ratios. In both cases, the vacancy ratios are significantly correlated with the qualification mix. The share of NAs is 0.3 percentage points or 0.6 percent larger if the vacancy ratio for registered nurses per county is larger by 1 s.d. (or 0.3 percentage points).

The opposite relationship is observed for the shortage of nurse assistants (-0.8 percent at the mean if NA-vacancy is 2.2 percent higher). Based on the results in this table, we conclude that, to some degree, nurse assistants act as substitutes for the shortage of registered nurses and vice-versa. Hence, NHs have a valuable lever to manage a skill-specific nurse shortage.

In addition, we look at the number of residents per NH and beds per NH (Table 4) as additional NH metrics. While our findings do not show any significant

the counties relative to the state average. The results are in line with those from our main specification and show that higher vacancy ratios correspond to lower state NP-to-resident ratio relative to the state average (see Table A.3 in the Appendix). Hence, we can eliminate the concern that state regulations or varying long-term care policies influence our findings.

Table 3: Relationship between qualification mix and nursing vacancies

	NA share	NA share
RN-vacancy	.1054***	
	(.0225)	
NA-vacancy		-.1624***
		(.03)
Controls	×	×
Wave FE	×	×
Regional FE	×	×
Owner FE	×	×
Mean depend. variable	0.450	0.450
Observations	59865	59865
F-statistic	40.49	40.58
R2	0.141	0.141

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007-2017 (59,865). Estimating equation: Qualification $\text{mix}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^N_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}$; outcome: Nursing personnel qualification (NP-qualification); explanatory variable: vacancy ratio registered nurses (RN-vacancy), vacancy ratio nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table A.2 in the Appendix. Fixed effects: time fixed effects, regional fixed effects, and ownership type fixed effects.

relationships between vacancy ratios and the average number of NH beds, we observe that the NH has 1.2 fewer residents considering the distance of the 10^{th} percentile of the NP-vacancy ratio to the 90^{th} percentile. The results for RN and NA are quantitatively similar and weakly statistically different from zero .

Finally, we bring the two metrics together in the occupancy ratio. It relates the number of residents to the number of beds in a NH and might be lower or higher, depending on whether the numerator or denominator correlates more strongly with our nurse shortage measure. Table 5 shows that the occupancy ratio is significantly lower with a higher vacancy ratio. This result is mostly driven by the shortage of RNs. For a one percentage point higher RN vacancy ratio, the occupancy ratio is .1 percentage points lower. Considering a difference in the RN-vacancy ratio between several adjacent spatial planning regions of 10 percentage points (Figure 2), our estimation results imply a difference in the number of residents and the occupancy ratio between the same planning regions of 1.2 residents and roughly 1 percentage point, respectively.

These findings appear plausible. While altering the number of beds is arguably difficult in the short- and even medium-term, due to regulated nurse-to-resident ratios, the number of residents and, thus, the occupancy ratio is directly related

Table 4: Relationship between access and nursing vacancies

	Permanent beds			Number of residents		
NP-vacancy	-13.96			-21.84**		
	(13.46)			(9.688)		
RN-vacancy		-4.222			-13.15*	
		(10.5)			(7.496)	
NA-vacancy			-17.31			-18.69*
			(13.56)			(11.05)
Controls	×	×	×	×	×	×
Wave FE	×	×	×	×	×	×
Regional FE	×	×	×	×	×	×
Owner FE	×	×	×	×	×	×
Mean depend. variable	79.876	79.876	79.876	70.27	70.27	70.27
Observations	59,865	59,865	59,865	59.865	59,865	59,865
F-statistic	21.16	21.19	21.16	60.35	55.42	48.65
R2	0.153	0.153	0.153	0.129	0.129	0.129

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007 -2017 (59,865). Estimating equation: (1) $\text{Beds}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{N}_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}$, (2) $\text{residents}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{N}_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,k,t}$; Outcome: Permanent beds or number of residents per nursing home. Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table A.2 in the Appendix. Fixed effects: time fixed effects, regional fixed effects, and ownership fixed effects.

to personnel shortage and especially to a shortage of RN. Since NHs need a high occupancy ratio to generate sufficient income, this finding suggests an increase in the risk of NHs at the margin exiting the care market as a result of the nursing shortage.

6 Discussion and conclusion

This study explores the relationship between nursing personnel shortage and mitigation strategies employed by NHs, a topic of increasing relevance given the demographic development in most high-income countries. We measure personnel shortage using county-level vacancy ratios, differentiated by the skill-level of nursing personnel. We observe a negative correlation of the vacancy ratios with the nurse-to-resident ratios. We show that another mitigation measure of NHs is to adjust the qualification mix of their nursing workforce, depending on the degree of shortage for different types of nurses. We further find a moderate reduction in the occupancy ratio of NHs. This finding is supported by the statistically insignificant relationship between nursing shortages and the number of NH beds, which indicates that managing the shortage of nurses by reducing the number of beds is not an immediate solution. Hence, a reduction

Table 5: Relationship between occupancy ratio and nursing vacancies

	Occupancy ratio		
NP-vacancy	-.1062***		
	(.0281)		
RN-vacancy		-.0996***	
		(.0221)	
NA-vacancy			-.054*
			(.0304)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean depend. variable	0.886	0.886	0.886
Observations	59.865	59,865	59,865
F-statistic	49.74	49.81	49.69
R2	0.197	0.197	0.197

$^{*}\, p < 0.10$, $^{**}\, p < 0.05$, $^{***}\, p < 0.01$. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007-2017 (59,865). Estimating equation: $\text{Occ-ratio}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{N}_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}$; Outcome: occupancy ratio (Occ-rate)= (occupied beds)/(total perm. beds). Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table A.2 in the Appendix. Fixed effects: time fixed effects, regional fixed effects, and ownership fixed effects.

in the workforce will tautologically translate into a reduced occupancy ratio.

In quantitative terms, our estimation results suggest a difference of 1.2 home residents and a percentage point in the occupancy ratio between adjacent planning regions that display a strong difference in the shortages of nurses, respectively. However, multiple hires for a single vacancy or institutions not advertising vacancies as required could cause us to substantially underestimate these correlations. Finding nevertheless significant correlations underscores the relevance of the uncovered relationships.

While our results can strictly only be interpreted as correlations, we argue that a causal effect is probable. First, we include various control variables to capture variation in the NH residents or substitution on the demand side. Second, we control for factors that may shift labor supply more generally. Third, we include wave, regional, and ownership type fixed effects, effectively excluding additional potential confounding factors.

Our study sheds light on the expected changes in the NH market as a result of this trend of increasing personnel shortage. For one, the number of residents per nurse is expected to increase while the individual time for each resident and therefore the intensity of care is expected to decrease. The resulting time pressure for nurses is likely to compromise patient safety and increase the risk of mistreatment. For another, while NH size does not correlate with nurse shortages in our study, occupancy ratios and the number of residents are lower when vacancy rates are higher. A persistently reduced occupancy ratio can imply the financial instability of NHs, especially if these are already at an elevated risk to exit the market (Heger et al., 2021). A promising area for future research is to employ a longer time frame to empirically analyze the relationship between nursing shortages and NH closures.

Our research underscores the importance of public policies aimed at addressing the nursing shortage in order to ensure adequate care availability and security. It seems crucial to enhance the attractiveness of the nursing profession by offering competitive wages and improving working conditions. Increased wages can positively affect the enrollment in nursing programs (e.g. Chiha and Link, 2003). Public programs aimed at enhancing job stability as well as benefits can be effective in encouraging young individuals to pursue nursing careers (e.g. Daniels et al., 2012), but such policies should be part of a holistic plan for achieving improved staffing levels (Van den Heede et al., 2023). Potential measures to lessen the workload of nurse practitioners include streamlined access to electronic health records, the implementation of telemedicine for remote consultations, the use of wearable technology for continuous patient monitoring, and the deployment of assistive robotic systems in NHs and home healthcare settings. Tomblin Murphy et al. (2012) simulate the effects of various policies to balance the supply and demand for registered nurses. Their findings indicate that an integrated approach, focusing on attracting new nursing staff, retaining existing nurses, reducing absenteeism, and enhancing productivity, can resolve nursing shortages within a few years.

Data availability

The German Care Statistic data was obtained via the following DOI-Number references: 10.21242/22411.2007.00.02.1.1.0 (2007) and 10.21242/22411.2017.00.02.1.1.0 (2017) at the following URL: https://www.forschungsdatenzentrum.de/de/10-21242-22411-2007-00-02-1-1-0.

The information on open nursing positions had been made available by the Statistik der Bundesagentur für Arbeit (Research Institute of the Federal Employment Agency: https://statistik.arbeitsagentur.de).

The INKAR dataset, containing regional demographic and economic data for Germany, was freely accessible at https://www.inkar.de.

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A Appendix

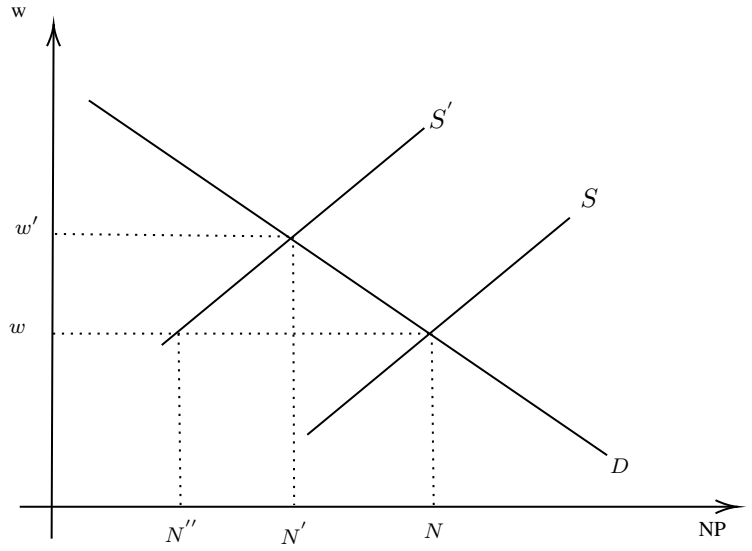


Figure A.1: Illustration of the nurse labor market in case of personnel shortages

The figure shows the relationship between nursing personnel, NP, (x-axis) and wages (y-axis). The nursing supply at a given wage is displayed by S. The demand for nurses is displayed by D. A general equilibrium exists with N and w. For an illustration of the implications of nursing shortages, we introduce a shift of the NP supply curve from S to $S^{'}$, which results in a different equilibrium at $N^{'}$ and $w^{'}$ with less nurses at at higher wage. The shift can be interpreted as regional differences. Under the assumption that wages cannot increase, even less nurses will supply care. For example, in the extreme case of full wage rigidity, we observe a reduction from N to $N^{''}$.

Table A.1: Nurse-to-resident regulation

	Care level 1	Care level 2	Care level 3	Care level 4	Care level 5
Schleswig-Holstein	6.96-5.71	5.43-4.45	3.99-3.27	3.12-2.56	2.81-2.3
Hamburg	13.4	4.6	2.8	1.99	1.77
Lower Saxony	6.5-4.6	4.29-3.7	3-2.59	2.2-1.96	2.05-1.76
Bremen	6.14-6.53	4.79-5.09	2.92-3.1	2.07-2.2	1.84-1.96
North Rhine-Westphalia	8.00	4.66	3.05	2.24	2.00
Hesse	7	1.0	1.5	1.9	2.1
Rhineland-Palatine	7	4.07	3.23	2.56	1.8
Baden-Wuerttemberg	6.11-4.37	4.76-3.40	3.26-2.41	2.55-1.84	2.32-1.67
Bavaria	6.70	3.49	2.56	2.00	1.82
Saarland	6.32	3.16	2.85	2.59	2.49
Berlin	7.25	3.9	2.8	2.2	1.8
Brandenburg	4.21	3.28	2.89	2.25	1.76
Mecklenburg Wester-Pommerania	8.05-6.08	4.52-3.59	3.41-2.40	2.71-1.76	2.48-1.76
Saxony	8	4.41	3.21	2.47	2.23
Saxony-Anhalt	NA	4.5-3.67	3.34-2.7	2.61-2.11	2.1-1.82

Regulation at the state level: Number of residents per registered nurse (RN) full-time equivalents. Not applicable (NA) for Thuringia. URL: https://www.michael-wipp.de/fachbeitraege/pflegekennzahlen/ [Last time accessed October 2023].

Table A.2: Descriptive statistics for the control variables

	2007-2017			
	Mean	S.D.	p10	p90
Facility characteristics				
Share of single-rooms	.6224	.277	.2133	1
Weighted average price, NH care [EUR]***	1649	437.6	1104	2200
Age stationary LTC recipients	82.78	3.817	79.13	86.08
Working population				
Female unemployed ratio	.06904	.03116	.033	.115
Share female unemployed older 55	.1827	.04789	.123	.246
Share unemployed professionals	.4233	.05824	.353	.498
Share employed in service sector	.2245	.04351	.17	.2817
Medical infrastructure				
GPs [/100,000 inh.]	201.3	49.56	147	251.7
Hospital beds [/10,000 inh.]	6.086	3.047	2.79	9.7
Amb. facility density	58.99	93.79	13	99
Ambulatory personnel [/10,000 inh.]	24.97	7.31	16.65	35.23
Regional wealth				
Monthly household income [EUR]	1677	232	1393	1963
Monthly gross income [EUR]	2398	396.3	1916	2902
Communal depts [EUR/ inhabitant]	1581	1320	364.6	3237
Land price [EUR/m^2]	154.6	180.2	31.7	327
Avg. pension [EUR]	844.9	80.8	735.5	952.5
Share in need of social assistance	.2197	.1466	.071	.447
Demographics				
Share age group 50–65	.2732	.02288	.243	.303
Avg. age female population	45.05	2.006	42.8	48.1
Population density [/km^2]	694.5	932.4	95	2113
Rurality [% inh. in region $\leq 150\, inh./km^2$]	.2521	.2731	0	.679
Care-dependency, weighted average level	1.771	.2091	1.526	2.019
Share severe need of amb. LTC recipients	.134	.05012	.08054	.2069
Share severe need of inf. LTC recipients	.08763	.03388	.05532	.139
Ppl in need of inf. LTC	12499	18606	3227	20469
Observations	59,865			

Data source: care statistics (FDZ, 2020) (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), INKAR data (Bundesamt für Bauwesen und Raumordnung, 2023) (district level). 59,903 observations (nursing home LTC facilities): [six waves] 2007 (9,211 obs.), 2009 (9,678 obs.), 2011 (9,973 obs.), 2013 (10,200 obs.), 2015 (10,389 obs.), 2017 (10,452 obs.). German LTC statistic: Research center of the Federal and State Statistical Offices, care statistics, [10.21242/22411.2007.00.02.1.1.0 - 10.21242/22411.2017.00.02.1.1.0]

Table A.3: Nursing capacity and vacancy ratio difference to state

	Capacity measure		
	NP-capacity-diff	RN-capacity-diff	NA-capacity-diff
NP-vacancy	-.2005***		
	(.0387)		
RN-vacancy		-.1314***	
		(.0229)	
NA-vacancy			-.118***
			(.0232)
Controls	×	×	×
Wave FE	×	×	×
Regional FE	×	×	×
Owner FE	×	×	×
Mean outcome variable	0.000	0.000	0.000
Observations	59,865	59,865	59,865
F-statistic	10.95	13.55	7.81
R2	0.127	0.147	0.050

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$; Standard errors clustered at the couty level in parentheses. Data source: care statistics (FDZ, 2020) (facility level), transparency reports (facility level), vacancies from the German Institute of Employment Research (Statistik der Bundesagentur für Arbeit, 2023) (county level), indicators and maps of regional and urban development (Bundesamt für Bauwesen und Raumordnung, 2023) (county level). Observations (stat. nursing facilities): [six waves] 2007-2017 (59,865). Estimating equation: $\text{NP-capacity-diff}_{j,t} = \beta_0 + \beta_1 \text{NP-vacancy}^{N}_{c,t} + \beta_2 \mathbf{X}_{j,t} + \beta_3 \mathbf{X}_{c,t} + \tau_t + \kappa_r + \rho_p + \epsilon_{j,c,t}$; Outcome: Nursing capacity (NP-capacity-diff), -registered nurses (RN-capacity-diff), -assistant nurses (NA-capacity-diff). Explanatory variable: Vacancy rate all nurses (NP-vacancy), Vacancy rate registered nurses (RN-vacancy), Vacancy rate nurse assistants (NA-vacancy). Control variables at the facility level and at the county level in Table A.2 in the Appendix. Fixed effects: time fixed effects, regional fixed effects, and ownership fixed effects.