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Associations of mental health with vaccination readiness in informal caregivers and the vaccination status of their care recipients during the Covid-19 pandemic – A cross sectional analysis

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ABSTRACT

Introduction: Vaccinations are important for informal caregivers and their care recipients. Mental health problems are common among care givers. The aim of this study was to investigate vaccination readiness in informal caregivers and associations with mental health issues. Associations between vaccination readiness in informal caregivers and the vaccination status of their aged care recipients were examined.
Methods: Within the multicenter prospective registry study 'Bavarian ambulatory Covid-19 Monitor (BaCoM) ', informal caregivers were asked for symptoms of depression (PHQ-9), burden of caretaking (BSFC-s), psychological antecedents of vaccination readiness (5C model) and previous Covid-19 infections of their care recipients. The vaccination status against Covid-19, seasonal influenza and pneumococcal disease was determined via vaccination certificates. Data analysis was performed using ordinal regressions and Mann-Whitney-*U* tests.
Results: Data of $n = 91$ informal caregivers, associated with $n = 84$ care recipients were collected. Symptoms of depression were associated with reduced vaccination readiness (Calculation: $p = 0.026$, OR = 1.18), as well as the perceived burden of caretaking (Confidence: $p = 0.006$, OR = 0.88). A previous Covid-19 infection of the care recipients was associated with decreased vaccination readiness of informal caregivers (Median (Q1–Q3) Confidence: 5.0 (4.5–6.0) vs. 4.0 (3.0–5.0); Calculation: 5.0 (3.0–6.0) vs. 4.0 (1.0–5.0)). The vaccination status of the care recipients interrelated significantly with vaccination readiness of their informal caregivers (Confidence: $p < 0.001$; Complacency: $p < 0.01$; Constraints $p < 0.05$). No significant interrelations between vaccination readiness and the vaccination status against seasonal influenza or pneumococcal disease occurred.
Conclusion: Mental health issues of informal caregivers seem to be associated with the actual vaccination status against Covid-19 in their care recipients. Target group specific counselling as well as an active involvement of informal caregivers in shared decision-making processes can be of relevance, but even more attention should be paid to the protection of mental health for informal caregivers.
Trial registration number: German Register of Clinical Studies DRKS 26039.

1. Introduction

The Covid-19 pandemic has led to a major challenge for societies and their health care systems worldwide. An excess mortality of 14.9 million between January 1, 2020 and December 31, 2021 was estimated by the WHO, describing the difference between the number of actual deaths

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that occurred and the expected mortality in the absence of the pandemic, [1]. >50% of the patients that were hospitalized with positive Covid-19 test results fulfilled criteria for frailty, typically defined as reduced physiological reserve to external stressors [2,3]. This population can be considered highly vulnerable with adverse health outcomes being expected in most clinical situations [3].

In Germany, five million people were dependent on care in 2021. Most of those care recipients were cared for in home settings (84%), mainly by informal caregivers (75%) [4]. Informal caregivers characteristically have a direct social relationship with the care recipient, no contracts regarding care responsibilities and no limits on time spent on care [5]. An ad-hoc survey with 1.000 informal caregivers performed in 2020 in Germany revealed that 25.5–39.7% of informal caregivers reported a worsening of their care situation during the Covid-19 pandemic [6].

Vaccination can be considered an effective preventive measure against Covid-19 with the overall efficacy of first and second dose vaccination against the alpha variant being at 84% and 77% respectively [7]. In respect of the social restrictions especially focused on aged frail care recipients during the pandemic, improved communication strategies to disseminate information on the importance of vaccinations were needed, especially for isolated population groups. The role of General Practitioners (GPs) is not yet well defined in this context in many European countries. Very often GPs claim a lack of time and capacity to address all their patients, especially by home visits [8]. This raises the demand for low-level access to information delivered by other professions involved in the care process like relatives and informal caregivers. It is already known, that beside intrapersonal influences (e.g., health-status, culture) and extra-personal influences (e.g., media impact), inter-personal aspects (e.g., informal caregiver distress) affect aged and frail persons access to vaccinations [9]. Informal caregivers have a higher mental and physical health burden and wellbeing compared to non-caregivers. Even before the pandemic, it could be shown, that informal caregivers psychological distress acts as a main barrier to influenza vaccination uptake in community-dwelling people suffering from dementia [10]. However, symptoms of depression worsened significantly during lockdown [11].

Therefore, the aim of this study was to investigate vaccination readiness in informal caregivers and potential associations with mental health issues like depression and perceived burden of caretaking during the pandemic. Furthermore, associations between vaccination readiness in informal caregivers and the vaccination status of their aged care recipients were examined.

2. Materials and methods

The reporting of this study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [12] (see Supplemental Materials: STROBE Statement—Checklist).

2.1. Study design and setting

This is a cross-sectional analysis based on data of the cohort study 'Bavarian ambulatory COVID-19 Monitor (BaCoM)', a dynamic prospective multicenter register in the State of Bavaria (Southern Germany) (German Register of Clinical Studies DRKS 26039) [13]. Study participants were recruited in outpatient care settings (home care provided by informal caregivers). In order to maximize the geographical spread of study participants, we implemented a Bavarian-wide recruitment campaign with broad publicity. The presented baseline data were collected from March 2021 to August 2023.

2.2. Study participants

A purposive sample of study participants was recruited at three study sites in Bavaria (Munich, Erlangen and Würzburg). Care recipients were identified via their general practitioner (GP), via outpatient care services, informal caregivers or via self-referral. Irrespective of how prospective care recipients were identified, they were either enrolled by their GP or a study physician. The GP recruitment was carried out within 240 GCP-qualified practices of the Bavarian Research Practice Network (BayFoNet) [14]. Additionally, eligible GPs with a past or current focus on managing patients with Covid-19 were identified. The participating GPs received compensation for their work within the study (participant inclusion and information, baseline examination, conducted surveys).

2.2.1. Eligibility criteria for care recipients

Care recipients were eligible for this cross-sectional analysis in case of presence and enrollment of an informal caregiver providing care and/or support. Care recipients could have been enrolled with more than one informal caregiver in the study. Exclusion criteria were an estimated life expectancy of <6 months, missing health insurance, or unclear legal residency status.

2.2.2. Eligibility criteria for informal caregivers

Informal caregivers of the enrolled care recipient were invited for participation, if they were at least 18 years old.

2.3. Variables

2.3.1. Parameters of interest among care recipients

Socio-demographic data considered age, gender, ethnicity, marital status and education. The Barthel index was gathered to illustrate the level of care-dependence in the investigated sample. It measures a person's ability to perform activities of daily living [15]. Data on previous Covid-19 infections were collected through questioning and via Covid-19 test certificates if available. Data on the vaccination status against Covid-19, seasonal influenza, and pneumococcal disease were collected via vaccination certificates.

2.3.2. Parameters of interest among informal caregivers

Socio-demographic data considered among other age, gender, ethnicity, marital status and education. The German version of the Patient Health Questionnaire-9 (PHQ-9) was applied to assess the presence and severity of depressive symptoms. This validated self-administered questionnaire consists of nine items referencing to the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria for major depression. Sum scores are ranging from 0 to 27, with a score of ≥10 indicating symptoms of a clinically relevant depression. Symptoms are assessed on a Likert scale from 0 ("not at all") to 4 ("almost every day") and a sensitivity of 0.80 (95% CI [0.71, 0.87] and a specificity of 0.92 (95% CI [0.88, 0.95] is reported for a cut-off of 10 or higher [16].

Experienced burden of caretaking was assessed via the short version of the Burden Scale of Family Caregivers (BSFC-s) in its German version ("Häusliche-Pflege-Skala" (HPS)) [17]. This validated short-version covers 10 items compared to the original version covering 28 and is based on the Caregiver Stress Model by Pearlin et al. and the Translational Stress Model by Lazarus and Folkman [18]. Sum scores range from 0 to 30 and items are assessed on a Likert scale from 0 ("strongly disagree") to 3 ("strongly agree"). Higher scores indicate elevated caregiver burden. However, a valid classification system denoting symptom severity is currently lacking [17].

Psychological antecedents of vaccination readiness were measured by applying the validated German version of the 5C model. Study participants might answer on a Likert scale from 1 ("I strongly disagree") to 7 ("I strongly agree"). The questionnaire is evaluated at item level. High levels of agreement with the items Confidence and low levels of agreement with the items Complacency, Constraints, Calculation, and Collective Responsibility are associated with an increased vaccination readiness [19].

2.4. Data sources/measurement

Each study participant answered pseudonymized paper-based questionnaires individually. As impairments of cognitive and communicative ability (measured by the Six-Item-Screener and Montreal Cognitive Assessment [20,21]) had to be expected among care recipients, the data collection of self-reported outcomes was ensured according to a pre-specified substitution principle (care recipient/ caregiver). In cases of physical impairment, questionnaires were answered with the support of a trained and qualified study assistant.

2.5. Bias

As in most research in outpatient care, the external validity of our findings is vulnerable to participation bias. For example, it is conceivable that non-responding persons were particularly burdened by the pandemic. Therefore, we provided a mobile study team (including study nurse and study physician), that no additional resources were required to conduct the study.

2.6. Study size

Sample size calculation was carried out for the prospective register study (BaCoM). The minimal statistical difference for major outcomes (age, comorbidities, and mortality) between the people in need of care with evidence of a previous Covid-19 infection, people in need of care without evidence of a previous Covid-19 infection, and people without need of care but with evidence of a previous Covid-19 infection was simulated. A two-tailed *t*-test or log-rank test, with the assumptions for the significance level $\alpha = 0.05$ and the power $\beta = 0.8$ and the given standard deviation, was used. Detectable differences for the following variables were obtained: age: SD = 10.0, detectable difference of −2.29 or 2.29; comorbidities: SD = 3.1, detectable difference of −7.10 or 7.10; mortality: median survival time = 4.0, detectable difference of 2.66 or 6.56; EQ-5D-5L: SD = 0.29, detectable difference of −0.07 or 0.07. With respect to the limited life expectancy of care recipients, it was estimated that after four years, about one-third of the study participants would still be alive across all levels of care [13].

2.7. Quantitative variables

Initially, all primary data were recorded in paper-based case report forms and transferred to electronic case report forms as part of a double data entry process using the LibreClinica scientific data management system. Data analysis in this study was conducted using SPSS statistical software version 29 (IBM Corp., Armonk, New York 10,504–1722 United States). Due to a relatively low number of cases, data collected on the ordinal Likert 7-scale for the 5C model was aggregated into three groups (0–2, 3, 4–6) for the regression model.

2.8. Statistical methods

Normally distributed sociodemographic data were presented with mean and standard deviation, while non-normally distributed socio-demographic as well as data on the dimensions of the 5C model were presented with median and Q1–Q3.

Ordinal regression analysis was performed for the collected data on the individual dimensions of the 5C model as dependent variables and PHQ-9 and BSFC-s as independent variables of interest. Age, sex, and education were added to the regression model for adjustment purpose as previous findings showed, that older age, the male sex, and higher education are associated with increased vaccination readiness [20,21]. Associations were described with Odds Ratio (OR) and 95% Confidence intervals (CI). The non-parametric Mann Whitney *U* test was applied to compare the vaccination status of care recipients against Covid-19, seasonal influenza, as well as pneumococcal disease with the psychological antecedents of vaccination readiness in their caregivers. *P*-values <0.05 were considered statistically significant. Missing data are indicated on the item level.

3. Results

3.1. Study participants

A total of $n = 175$ study participants, including $n = 84$ care recipients and $n = 91$ informal caregivers, were analyzed. Most of the analyzed care recipients ($n = 74$) were enrolled with a single informal caregiver. Just $n = 4$ care recipients were enrolled with two informal caregivers. One care recipient was enrolled with three informal caregivers.

3.1.1. Socio-demographic characteristics of the care recipients

The mean age of the care recipients was 79.9 ± 13.3 years. About half of the care recipients were female (52.4%) and married (50.0%). Most of the care recipients had a non-academic degree (82.1%).

Concerning the level of care-dependence, the median (Q1–Q3) of the Barthel Index Score was 70.0 (45.0–90.0). Total dependency was indicated in 11.9% ($n = 10$) of the care recipients, who had a Barthel Index Score between 0 and 20. Severe dependency was indicated in 25.0% ($n = 21$) with a Barthel Index Score between 21 and 60. A Barthel Index Score between 61 and 90 was evaluated in 39.3% ($n = 33$) care recipients, which indicates moderate dependency (*see* Table 1).

3.1.2. Socio-demographic and Covid-19 associated characteristics of the informal caregivers

The mean age of the enrolled informal caregivers was 65.6 ± 13.5, most of them were female ($n = 63$, 69.2%). The most common personal relationship between the enrolled care recipients and the informal caregivers was marriage ($n = 42$, 46.2%), as well as informal caregivers who cared for one of their parents ($n = 30$, 33.0%). The majority ($n = 60$, 65.9%) of the informal caregivers had suffered from a previous infection with Covid-19 by themselves and was vaccinated against Covid-19 at least once ($n = 83$, 91.2%; *see* Table 2).

3.1.3. Mental health characteristics of the informal caregivers

More than half ($n = 49$, 53.8%) of the assessed informal caregivers reported signs of depressive symptoms and 26.4% ($n = 24$) of them revealed symptoms of a clinically relevant depression with a total PHQ9 score of 10 or higher [16]. The median (Q1–Q3) BSFC-s score of 10.0 (5.25–18.0) indicates the presence of perceived burden of caretaking in the investigated sample (*see* Table 3).

Table 1
Socio-demographic characteristics of the care recipients ($n = 84$).

Socio-demographic data	Care recipients (n = 84)
Age (year), standard deviation	79.9 ± 13.3
Missing Data	3 (3.6%)
Female sex, n (%)	44 (52.4%)
Missing Data	3 (3.6%)
Marital Status, n (%)	
Not Married/Widowed	39 (46.4%)
Married	42 (50.0%)
Missing Data	3 (3.6%)
Education, n (%)	
Non-academic degree	69 (82.1%)
Academic degree	10 (11.9%)
Missing Data	5 (6.0%)
Barthel Index Score, Median (Q1–Q3)	70.0 (45.0–90.0)
Total dependency (score: 0–20)	10 (11.9%)
Severe dependency (score: 21–60)	21 (25.0%)
Moderate dependency (score: 61–90)	33 (39.3%)
Slight dependency (score: 91–99)	5 (6.0%)
No dependency (score: 100)	10 (11.9%)
Missing Data	5 (6.0%)

Table 2
Socio-demographic and Covid-19 associated characteristics of the informal caregivers (n = 91).

Socio-demographic data	Informal caregivers ($n = 91$)
Age (year), standard deviation	65.6 ± 13.5
Missing Data	4 (4.4%)
Female sex, n (%)	63 (69.2%)
Missing Data	1 (1.1%)
Marital Status, n (%)	
Not Married/Widowed	26 (28.6%)
Married	65 (71.4%)
Ethnic Origin, n (%)	
Caucasian	85 (93.4%)
Others	2 (2.2%)
Missing Data	4 (4.4%)
Education, n (%)	
Non-academic degree	67 (73.6%)
Academic degree	19 (20.9%)
Missing Data	5 (5.5%)
Professional qualification, n (%)	
No qualification	7 (7.7%)
Apprenticeship/ vocational training	40 (44.0%)
Technical school/ mastery school	16 (17.6%)
Engineering school/ polytechnic	4 (4.4%)
University	19 (20.9%)
Missing Data	5 (5.5%)
Care recipient relationship, n (%)	
Partner (married)	42 (46.2%)
Partner (unmarried)	2 (2.2%)
Sibling	1 (1.1%)
Parent	30 (33.0%)
Child	6 (6.6%)
Other	9 (9.9%)
Missing data	1 (1.1%)
Daily hours for caretaking, Median (Q1–Q3)	3.50 (2.00–8.00)
Missing Data	16 (17.6%)
Previous infection with Covid-19	
Yes	60 (65.9%)
No	29 (31.9%)
Missing data	2 (2.2%)
Own vaccination status against Covid-19	
Yes (at least one vaccination)	83 (91.2%)
No	6 (6.6%)
Missing data	2 (2,2%)

Table 3
Mental health characteristics of the informal caregivers (n = 91).

Mental health characteristics	Informal caregivers (n = 91)	Median (Q1–Q3)
Score PHQ-9 (4-Scale)	84 (92.3%)	6.0 (2.0–9.0)
No depression (total score 0–4)	35(38.5%)	
Mild depression (total score 5–9)	32(35.2%)	
Moderate depression (total score 10–14)	10(11.0%)	
Moderately severe depression (total score 15–19)	6(6.6%)	
Severe depression (total score 20–27)	1(1.1%)	
Missing Data	7 (7.7%)	
Clinical relevant depression (total score ≥ 10)	24 (26.4%)	
Score BSFC-s	84 (92.3%)	10.0 (5.25–18.0)

3.1.4. Psychological antecedents of vaccination readiness of the informal caregivers

The median (Q1–Q3) scores for both psychological antecedents of vaccination Confidence (5.0, 3.0–6.0) and Calculation (4.0, 2.0–5.0) were rather high in the sample. In comparison, the median (Q1–Q3) scores for Complacency were 0 (0.0–1.0), in terms of Constraints and Collective Responsibility 0.0 (0.0–0.0), indicating high levels of vaccination readiness. Informal caregivers of care recipients without previous Covid-19 infection revealed higher Confidence compared to those with previous Covid-19 infection (5.0 (4.5–6.0) vs. 4.0 (3.0–5.0)) as well as higher Calculation (5.0 (3.0–6.0) vs. 4.0 (1.0–5.0)) *(see* Table 4*)*.

Ordinal regression with $n = 72$ informal caregivers for Confidence and $n = 71$ for Calculation revealed several statistically significant associations. Age was significantly positive associated with a higher Confidence in the safety and efficacy of vaccination (OR = 1.08; 95%CI: 1.93–1.13, $p = 0.001$). Another professional qualification than an academic degree was negatively associated with Calculation (OR = 0.28, 95%CI: 0.08–0.98 $p = 0.047$). A positive association for the PHQ-9 sum score measuring depression with the item Calculation was confirmed OR = 1.18, 95%CI: 1.02–1.37, $p = 0.026$). The BSFC-s measuring the experienced burden of caretaking for family caregivers was negatively associated with Confidence (OR = 0.88, 95%CI: 0.80–0.96, $p = 0.006$) and Calculation (OR = 0.89, 95%CI: 0.81–0.96, $p = 0.004$). It was not possible to calculate regression models for the items Complacency, Constraints and Collective Responsibility, due to unequal distribution of answers with lacking values of 4–6 on the Likert scale among study participants (*see* Table 5).

3.1.5. Associations between informal caregivers` psychological antecedents of vaccination readiness and their care recipient's vaccination status

Comparison of the medians for existent and non-existent vaccination via the non-parametric Mann Whitney *U* test revealed significantly higher values for Confidence (5.0, 4.0–6.0, $p < 0.001$) in informal caregivers for those with care recipients that are vaccinated against Covid-19 compared to those with care recipients that are not vaccinated (0.0, 0.0–2.5). In addition, significantly lower values for Complacency (0.0, 0.0–1.0, $p < 0.01$) and Constraints (0.0,0.0–0.0, $p < 0.05$), occurred in this subgroup. There were no significant interrelations between the examined psychological antecedents of vaccinations and the vaccination status against seasonal influenza or pneumococcal disease (*see* Table 6).

4. Discussion

4.1. Summary of findings

Within this analysis, some psychosocial factors could be revealed that might be associated with actual vaccination behavior in the setting of informal outpatient care.

Sociodemographic as well as psychosocial factors were associated with vaccination readiness against Covid-19 in the investigated sample of informal caregivers. Whereas older age of informal caregivers was related to higher levels of Confidence in safety and effectiveness of vaccinations, symptoms of depression and a perceived burden of caretaking in informal caregivers were associated with decreased levels of vaccination readiness. Informal caregivers` Confidence in the safety and effectiveness of vaccinations was significantly associated with their care recipients` vaccination status against Covid-19.

4.2. Comparison to literature

4.2.1. Sociodemographic and vaccination-related factors

Previous studies could show, that older age is associated with increased levels of confidence in the safety and efficacy of vaccinations against Covid-19 [22,23]. A higher level of professional qualification was positively associated with intensified searching and conscious evaluation of vaccination information in the investigated study population (Calculation). This finding is supported by previous studies showing interrelations between educational levels and vaccination readiness and underscores the importance of health facilities providing accurate and easily accessible information about Covid-19 and other vaccinations [22,24,25].

Although Covid-19 vaccines have shown very good clinical efficacy and effectiveness in real-world settings, infection breakthroughs were associated with rising vaccination hesitancy in some people over the

Table 4
Psychological antecedents of vaccination readiness in informal caregivers n = 91 (5C).

		Informal caregivers (total study population)		Informal caregivers of care recipients with previous Covid-19 infection		Informal caregivers of care recipients without previous Covid-19 infection	
Scales		**n (%)**	**Median** (Q1–Q3)	**n (%)**	**Median** (Q1–Q3)	**n (%)**	**Median** (Q1–Q3)
5C (7-Scale)							
Confidence		91 (100%)	5.0 (3.0–6.0)	62 (100%)	4.0 (3.0–5.0)	29 (100%)	5.0 (4.5–6.0)
	0	6 (6.6%)					
	1	1 (1.1%)					
	2	2 (2.2%)					
	3	16 (17.6%)					
	4	14 (15.4%)					
	5	28 (30.8%)					
	6	24 (26.4%)					
Complacency		90 (99.0%)	0.0 (0.0–1.0)	61 (98.5%)	0.0 (0.0–1.0)	29 (100%)	0.0 (0.0–1.0)
	0	51 (56.0%)					
	1	20 (22.0%)					
	2	7 (7.7%)					
	3	8 (8.8%)					
	4	1 (1.1%)					
	5	0					
	6	3 (3.3%)					
Constraints		89 (98.0%)	0.0 (0.0–0.0)	60 (97.0%)	0.0 (0.0–0.0)	29 (100%)	0.0 (0.0–0.0)
	0	74 (81.3%)					
	1	8 (8.8%)					
	2	3 (3.3%)					
	3	2 (2.2%)					
	4	1 (1.1%)					
	5	1 (1.1%)					
	6	0					
Calculation		89 (98.0%)	4.0 (2.0–5.0)	60 (97.0%)	4.0 (1.0–5.0)	29 (100%)	5.0 (3.0–6.0)
	0	14 (15.4%)					
	1	7 (7.7%)					
	2	5 (5.5%)					
	3	13 (14.3%)					
	4	12 (13.2%)					
	5	18 (19.8%)					
	6	20 (22.0%)					
Collective Responsibility		89 (98.0%)	0.0 (0.0–0.0)	60 (97.0%)	0.0 (0.0–0.0)	29 (100%)	0.0 (0.0–0.5)
	0	68 (74.7%)					
	1	12 (13.2%)					
	2	3 (3.3%)					
	3	5 (5.5%)					
	4	0					
	5	1 (1.1%)					
	6	0					

Table 5
Ordinal regression analysis for informal caregivers.

Vaccination readiness (5C model)	**Investigated independent variables (Odds Ratio (95% Confidence Interval); p-value)**					
	Sex (ref.: male)	**Age**	**Highest professional qualification (ref.: academic)**	**PHQ9**	**BSFC-s (HPS)**	**R2**
Confidence (n = 72)	*1.5 (0.41–5.69); 0.528*	*1.08 (1.03–1.13); 0.001*	*0.50 (0.12–2.00); 0.327*	*1.04 (0.89–1.21); 0.611*	*0.88 (0.80–0.96); 0.006*	*0.36*
Calculation (n = 71)	*1.37 (0.49–3.86); 0.552*	*0.98 (0.95–1.22); 0.379*	*0.28 (0.08–0.98); 0.047*	*1.18 (1.02–1.37); 0.026*	*0.89 (0.81–0.96); 0.004*	*0.19*

course of the pandemic [26]. This evidence might support our finding that informal caregivers caring for care recipients who suffered a previous Covid-19 infection showed lower levels of Confidence in vaccinations compared to the informal caregivers caring for care recipients without a previous Covid-19 infection, which is in line with another analysis of health care workers of inpatient care in long-term care facilities in Bavaria, Germany [25].

In comparison to the investigated professional healthcare workers of inpatient care in long-term care facilities in Bavaria (Germany), informal caregivers analyzed in the presented analysis showed a higher level of Confidence with means of 4.0 and 5.0 respectively [25]. Vaccination readiness in the overall German population was dynamic in the timely course of the pandemic [27]. Therefore, shifted timeframes may limit the explanatory power of this observation with informal caregivers having been investigated between March 2021 and August 2023 and professional healthcare workers between March 2020 and February 2023.

4.2.2. Psychosocial factors - depression

The negative association between symptoms of depression and vaccination readiness against Covid-19 was observed already in chronically ill primary care patients, as well as in health care workers of inpatient care in long-term care facilities in Bavaria, Germany [22,25]. Reduced vaccination readiness in people with depression might be explained by various factors such as impaired cognitive function, social isolation or attitudes of hopelessness and pessimism [28]. Symptoms of

Table 6
Group comparisons for care recipient vaccination status on dependency of informal caregivers` psychological antecedents of vaccination readiness.

Vaccination status in index care recipients		Investigated independent variables in informal caregivers				
		Confidence	Complacency	Constraints	Calculation	Collective Responsibility
Vaccination against Covid-19 (n = 82 caregivers)	*Yes n = 74*	*5.0 (4.0–6.0) ****	*0.0 (0.0–1.0) ** missing = 1*	*0.0 (0.0–0.0) * missing = 2*	*4.0 (1.8–5.0) missing = 2*	*0.0 (0.0–0.0) missing = 2*
	No n = 6	*0.0 (0.0–2.5)*	*3.0 (1.0–3.8)*	*0.5 (0.0–3.3)*	*5.0 (0.0–6.0)*	*0.5 (0.0–1.3)*
Vaccination against seasonal influenza (n = 65 caregivers)	*Yes n = 42*	*5.0 (4.0–6.0)*	*0.0 (0.0–1.0)*	*0.0 (0.0–0.0) missing = 1*	*4.0 (2.0–5.5) missing = 1*	*0.0 (0.0–0.0) missing = 1*
	No n = 23	*4.0 (3.0–6.0)*	*0.0 (0.0–1.0)*	*0.0 (0.0–0.0)*	*4.0 (2.0–5.0)*	*0.0 (0.0–0.0)*
Vaccination against pneumococcal disease (n = 79 caregivers)	*Yes n = 21*	*5.0 (4.0–6.0)*	*0.0 (0.0–1.0)*	*0.0 (0.0–0.0)*	*4.0 (1.0–5.0)*	*0.0 (0.0–0.0)*
	No n = 45	*5.0 (3.0–6.0)*	*0.0 (0.0–1.0)*	*0.0 (0.0–0.0) missing = 1*	*4.0 (2.0–5.0) missing = 1*	*0.0 (0.0–0.0) missing = 1*

Legend: *: $p \leq 0.05$, **: $p \leq 0.01$, ***: $p \leq 0.001$.

depression were positively associated with higher levels of Calculation in terms of vaccinations, which indicates reduced vaccination readiness [19]. Our results are thereby in line with a previous study showing associations between depression and Covid-19 vaccination hesitancy [29]. A potential explanation for higher Calculation levels in study participants with depressive symptoms could be an often observed comorbidity of anxiety leading to skepticism and potentially fear of vaccination and an increased subjective need for in-detail evaluation [30]. In addition, persons suffering from symptoms of depression may take more advantage of health care services overall, but less advantage of preventative services [28,31].

4.2.3. Psychosocial factors – The burden of caretaking

An increased perceived burden of caretaking was negatively associated with both psychological antecedents of vaccinations (Calculation and Confidence). An explanation might be, that a high experienced level of caregiver burden may lead to burnout including depersonalization linked to less trust, less confidence, and less conscious evaluation of vaccine information [10,32]. Additionally, burnout symptoms in professional caregivers were previously shown to potentially negatively affect vaccination readiness [25].

4.2.4. Potential measures to take

As care recipients` vaccination status seems to be associated with informal caregivers' Confidence in the efficacy and safety of vaccinations, it is crucial to involve informal caregivers in shared decision making in terms of vaccinations [33]. To strengthen vaccination readiness, measures such as education on media, debunking of myths and stress- and pain-free vaccination could be relevant [34]. Furthermore, fact-based communication on risks as well as proactive provision of high-quality information material on vaccinations may be of relevance to provide evidence-based information for important multipliers in long-term care [34]. However, a special focus should be set on preventative as well as therapeutic interventions to protect informal and family caregivers' mental health. General practitioners may have an elevated role in such a measure as people typically obtain information about vaccinations in primary care [35–37].

4.3. Strengths and limitations

Several strengths characterize this study: a) data of an especially vulnerable and Covid-19 affected patient population was collected under highly dynamic and restrictive conditions during the pandemic, b) data collection for informal caregivers and their respective care recipients allowed direct linking for the investigation of associations, e.g., with actual vaccination status in care recipients, c) detailed attention was provided to informal family caregivers that often face challenging psychosocial and care-dependent situations. The study also faces some limitations: a) the design as a registry-based study without predefined primary outcomes and experienced recruitment complexities limited the number of investigated study participants to 91 informal caregivers and their corresponding care recipients, b) the applicability of findings to other countries or geographies may be limited given heterogenous vaccination policies and the dynamic of the pandemic, c) it is unclear how non-responders might have answered in the survey.

4.4. Generalizability

Within this cross-sectional analysis, we did not aim to measure incidences of mental health issues or to make any causal inference. Furthermore, it has to be considered that there might be strong temporal and regional influence on vaccination readiness due to the dynamics of an ongoing pandemic. It is also unclear how non-responders might have answered this survey. As our vaccine-specific sub analysis was only a small proportion of the topics surveyed, it was not apparent to potential study participants that the survey would ask for the vaccination status or vaccination readiness. Consequently, it has not to be assumed that only study participants in favor of vaccinations were represented in the survey. As the global event of the pandemic had comparable effects on the mental health of care givers worldwide, it can be assumed that the practical implications of this study can be generalized.

4.5. Conclusion

Mental health issues of informal caregivers seem to be associated with the actual vaccination status against Covid-19 in their care recipients. Involvement of informal caregivers in shared decision-making processes in primary health care is necessary. Target group specific counselling can be of relevance but even more attention should be paid to the protection of mental health for informal caregivers.

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Author contributions

Draft of Manuscript, F·B. and L.S.; Conceptualization F.B., L.S.; Methodology, M.R.; Interpretation of Results, F.B. M.R.; Validation, L.S., F.B.; Investigation, J.G., T.D., I.G., T.K., M.H., I.Z., and C.J.; Resources, T.K., I.G., A.H., M.H., D.T., T.D. and J.G.; Data acquisition, C.E., D.W., M.S., F.B., I.Z., M.S., D.W., C.J. and M.R.; Data analysis: L.S., F.B and M. R.; Supervision, L.S., T.K., I.G., A.H., M.H., D.T., T.D. and J.G.; Project Administration,; C.E., D.W., M.S., I.Z. and C.J.; Funding Acquisition, T.

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Institutional review board statement

Ethics approval and consent to participate: All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human patients were approved by the ethics committee of the Ludwigs-Maximilians-University in Munich under the case number 20–0860.

Informed consent statement

All participants provided informed written consent for their participation and the usage of their pseudonymized data.

All authors attest they meet the ICMJE criteria for authorship.

CRediT authorship contribution statement

Linda Sanftenberg: Writing – original draft, Validation, Supervision, Formal analysis, Conceptualization. **Felix Bader:** Writing – original draft, Validation, Investigation, Formal analysis, Conceptualization. **Marietta Rottenkolber:** Writing – review & editing, Validation, Supervision, Software, Methodology, Formal analysis, Data curation. **Maria Sebastiao:** Writing – review & editing, Project administration, Investigation. **Thomas Kühlein:** Writing – review & editing, Supervision, Resources. **Christine Eidenschink:** Writing – review & editing, Project administration, Investigation. **Ildikó Gágyor:** Writing – review & editing, Supervision, Resources. **Domenika Wildgruber:** Writing – review & editing, Project administration, Investigation. **Anita Hausen:** Writing – review & editing, Resources, Investigation, Conceptualization. **Christian Janke:** Writing – review & editing, Project administration, Investigation. **Michael Hoelscher:** Writing – review & editing, Supervision, Resources. **Daniel Teupser:** Writing – review & editing, Supervision, Resources. **Tobias Dreischulte:** Writing – review & editing, Supervision, Conceptualization. **Jochen Gensichen:** Writing – review & editing, Supervision, Resources, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix A. Supplementary data

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