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# Complex acute pain management in German hospitals: retrospective analysis of regional differences

Complex acute pain therapy is a therapeutic measure for special pain therapy and symptom control in patients with severe acute pain conditions. This severe acute pain can occur, for example, after operations, accidents or also with severe, exacerbated tumours. Complex acute pain therapy is coded using the operation and procedure code (OPS) 8-919 (DIMDI, 2023). In 2021, there were a total of more than 16.6 million hospital cases in Germany, and complex acute pain treatment was prescribed for more than 200,000 of these cases (InEK, 2023). Based on hospital diagnoses, it is known that there are regional differences in Germany for osteoporotic fractures as well as hospital deaths after femoral fracture and heart failure, among others (Möckel, 2022; Möckel et al., 2020, 2023; Wachter et al., 2015). A study by Hoffmann et al. (2020) was additionally able to show that there are regional differences in Germany in the prescription of the painkiller metamizole. In this analysis, the prevalence of use was lowest in Saxony with 7.0% and highest in Schleswig-Holstein with 11.1% (Hoffmann et al., 2020). It should also be noted here that between 1998 and 2008-2011, the use of painkillers in Germany increased from 19% to 21%. This increase is primarily due to over-the-counter painkillers (10.0% to 12.2%), whereas the use of prescription painkillers remained constant (Sarganas et al., 2015). In the study by Sarganas et al. (2015), females, increasing age, obese individuals and smokers showed the higher odds of using prescription painkillers. In contrast, higher socioeconomic status and more weekly physical activity were associated with lower odds (Sarganas et al., 2015).

>> As, to our knowledge, there are no recent data on possible regional differences in complex acute pain treatment in Germany, the aims of this study were: (i) to analyse the case numbers of complex acute pain treatment from German hospitals to identify possible state differences and (ii) toinvestigate correlations between the age-standardised rate of complex acute pain treatment and socioeconomic/health factors as well as the main diagnoses behind complex acute pain treatment in the states.

## Summary

**Aim:** The aim of this analysis was to identify state differences in the use of complex acute pain management.

**Methodology:** Hospital case numbers of complex acute pain treatment as well as all hospital cases of the year 2021 were taken from the InEK database. These were used to calculate age-standardised rates (ASR) for complex acute pain treatment per 100,000 hospital cases as well as standardised rate ratios (SRR) and 95% confidence intervals (95% CI).

**Results:** The ASR of complex acute pain treatment for Germany as a whole was 1376.8 (95% CI: 1370.3; 1383.3) per 100,000 hospital cases with state variations from 698.7 (95% CI: 671.1; 726.3; Thuringia) to 1994.2 (95% CI: 1943.6; 2044.9; Brandenburg). Significantly higher ASRs compared to the reference state of Baden-Württemberg were found in the states of Bavaria (SRR: 1.22 [95% CI: 1.20; 1.24]), Brandenburg (SRR: 1.44 [95% CI: 1.40; 1.49]), Mecklenburg-Western Pomerania (SRR: 1.09 [95% CI: 1.05; 1.13]) and North Rhine-Westphalia (SRR: 1.09 [95% CI: 1.08; 1.11]) and significantly lower in Berlin, Bremen, Hesse, Lower Saxony, Rhineland-Palatinate, Saarland, Saxony-Anhalt, Schleswig-Holstein and Thuringia.

**Conclusion:** This analysis indicates strong regional differences in the use of complex acute pain management in Germany.land hin.

## Keywords

Pain management, differences in care, severe pain, hospital diagnoses

## Crossref/doi

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## Methods

### Study design and data sources

This study is a retrospective analysis of case numbers from German hospitals. Case numbers for the provision of complex acute pain treatment (OPS 8-919), the number of all hospital cases for Germany as a whole and for the individual federal states in 2021 were taken from the InEK data browser (InEK, 2023).

The information on the total population in Germany in 2011 and 2021, the age-standardised rates for the ICD codes M17.1, M75.1, M16.1, M75.4, C20, C64, C67.8, S83.*, S42.2, T36.*-T50.* as well as Z38.0 in the individual Länder in 2021 were taken from the information system of the federal health reporting system (GBE database) (Gesundheitsberichterstattung des Bundes, 2023a, 2023b). Information on the proportion of social welfare recipients and the foreign population, the unemployment rate of all civilian labour force, the gross monthly income, the proportion of inhabitants per km2, the proportion of adults who smoke, life expectancy from the age of 0 and health expenditure per km2 were taken from the GBE database. The data on the gross monthly income of all civilians in the labour force per km2 , the proportion of adults who smoke, life expectancy from the age of 0 and health expenditure per inhabitant for the individual federal states were taken from the Destatis/Genesis database, the Federal Agency for Civic Education, the statistical offices of the Federation and the Länder and Statista (Federal Agency for Civic Education, 2023; Destatis, 2023c, 2023a, 2023b, 2023d; Statista, 2023; Statistical Offices of the Federation and the Länder, 2023; Federal Statistical Office, 2023). As this study is a retrospective analysis of published data, an ethics vote was not necessary for the implementation.

Statistical analysis Based on the case numbers of complex acute pain treatmentand all hospital cases, age-specific case number rates of complex acute pain treatment (<18 years, 18-39 years, 40-59 years, 60-74 years, ≥75 years) as well as the gender-specific rate per 100,000 hospital cases (all diagnoses, procedures, etc.) with the corresponding 95% confidence intervals (95% CI) were calculated for Germany as a whole and for the individual federal states. Subsequently, age-standardised case rates (ASR) of complex acute pain treatment per 100,000 hospital cases and 95% CIs were calculated for Germany as a whole and for the individual German states (ASRBL). In order to identify significant differences in ASRs across the Länder,

Standardised Rate Ratios (SRRs) and associated 95% CIs were calculated using the following formulae (Boyle & Parkin, n.d.):

$$95\,\%\,KI = \left(\frac{ASR_{BL}}{ASR_{Ref}}\right)^{1\pm\frac{Z_{\alpha/2}}{X}}$$

$$X = \frac{ASR_{BL} - ASR_{Ref}}{\sqrt{SE(ASR_{BL})^2 + SE(ASR_{Ref})^2}}$$

and SE (ASR) represents the standard error of the age-standardised rates (Boyle & Parkin, n.d.). The state whose ASR was most comparable to that for Germany as a whole (Baden-Württemberg) was taken as the reference (ASRRef) when calculating the SRR in each case.

Correlations were determined using Pearson correlation, calculating the correlation factor r and the corresponding 95% CIs. The statistical analysis was carried out using the JASP programme (JASP Team, 2022).

## Results

### Characteristics of hospital cases and age-specific rates

A total of 221,287 cases of complex acute pain treatment were available in the InEK database for the year 2021. The proportion of female patients was 54.79% and for male patients 45.21% (Tab. 1). The age group of 60-74 years was most frequently represented with 33.25%, followed by 40-59 years (27.22%) and ≥75 years (21.57%). The most common diagnosis among patients with complex acute pain treatment was other primary gonarthrosis (9.20%). In total (all diagnoses, procedures, etc.), 16.6 million cases were available in the InEK database, with 52.21% of patients being female and the age group of ≥75 years (29.33%) being most frequently affected by the intervention (Tab. 1) (InEK, 2023).

With one exception, both in Germany as a whole (men 1260.8 [95% CI: 1253.1; 1268.6] and women 1398.6 [95% CI: 1390.8; 1406.5] per 100,000 hospital treatments) as well as in the individual federal states, the non-age-standardised rates of complex acute pain treatment in men were numerically lower or comparable to the rates in women (Fig. 1A). Only in Saarland was the complex acute pain treatment rate per 100,000 hospital treatments significantly higher for men (1414.1 [95% CI: 1345.9; 1482.4]) than for women (989.4 [95% CI: 934.3; 1044.6]).

The age-specific number of cases of complex acute pain treatment per 100,000 hospital treatments in Germany was 295.4 (95% CI: 287.5; 303.2) for ≤18-year-olds, with state variations between 61.7 (95% CI: 38.4; 84.9; Thuringia) and 604.8 (95% CI: 545.5; 664.1; Hamburg) (Fig. 1B). For 18-39 year-olds and 40-59 year-olds, the rates for Germany were 1378.1 (95% CI: 1363.6; 1392.5) and 1846.2

**Charakteristika der Fälle mit komplexer Akutschmerzbehandlung sowie aller Krankenhausfälle in Deutschland**

| | Fälle komplexer Akutschmerzbehandlungen (n = 221.287) | | Alle Krankenhausfälle (n = 16.603.418) | |
|---|---|---|---|---|
| **Geschlecht** | | | | |
| Frauen | 54,79% | | 52,21% | |
| Männer | 45,21% | | 47,79% | |
| **Alter** | | | | |
| <18 Jahre | 2,46% | | 11,10% | |
| 18–39 Jahre | 15,52% | | 15,01% | |
| 40–59 Jahre | 27,22% | | 19,65% | |
| 60–74 Jahre | 33,25% | | 24,92% | |
| ≥ 75 Jahre | 21,57% | | 29,33% | |
| **Zehn häufigste Hauptdiagnosen** | | | | |
| | 1. M17.1 | Sonstige primäre Gonarthrose: 9,20% | 1. Z38.0 | Einling, Geburt im Krankenhaus: 3,35% |
| | 2. M75.1 | Läsionen der Rotatorenmanschette: 5,03% | 2. J12.8 | Pneumonie durch sonstige Viren: 1,22% |
| | 3. M16.1 | Sonstige primäre Koxarthrose: 1,98% | 3. S06.0 | Gehirnerschütterung: 1,07% |
| | 4. M75.4 | Impingement-Syndrom der Schulter: 1,92% | 4. I50.01 | Sekundäre Rechtsherzinsuffizienz: 0,93% |
| | 5. C20 | Bösartige Neubildung des Rektums: 1,54% | 5. N39.0 | Harnwegsinfektion, Lokalisation nicht näher bezeichnet: 0,87% |
| | 6. C61 | Bösartige Neubildung der Prostata: 1,15% | 6. I50.14 | Linksherzinsuffizienz: mit Beschwerden in Ruhe: 0,87% |
| | 7. C64 | Bösartige Neubildung der Niere, ausgenommen Nierenbecken: 1,05% | 7. I48.0 | Vorhofflimmern, paroxysmal: 0,84% |
| | 8. C67.8 | Bösartige Neubildung: Harnblase, mehrere Teilbereiche überlappend: 1,05% | 8. O80 | Spontangeburt eines Einlings: 0,84% |
| | 9. S83.53 | Verstauchung und Zerrung des Kniegelenkes: Riss des vorderen Kreuzbandes: 1,04% | 9. M17.1 | Sonstige primäre Gonarthrose: 0,81% |
| | 10. S42.21 | Fraktur des proximalen Endes des Humerus: Kopf: 1,03% | 10. I10.01 | Benigne essenzielle Hypertonie: mit Angabe einer hypertensiven Krise: 0,79% |

***Tab. 1:*** Characteristics of cases with complex acute pain treatment and all hospital cases in Germany (InEK, 2023).

| Pearson-Korrelationen zwischen der ASR der komplexen Akutschmerzbehandlung und sozioökonomischen sowie gesundheitlichen Faktoren in den Bundesländern | | | | |
|---|---|---|---|---|
| **ASR komplexe Akutschmerzbehandlung** | **Pearsons r** | **p-Wert** | **U95% KI** | **O95% KI** |
| Sozialhilfeempfänger:innen je 1000 EW | -0,18 | 0,500 | -0,62 | 0,35 |
| Ausländeranteil | -0,07 | 0,793 | -0,55 | 0,44 |
| Arbeitslosenquote aller zivilen Erwerbspersonen | -0,02 | 0,939 | -0,51 | 0,48 |
| Bruttomonatseinkommen in EUR | 0,03 | 0,927 | -0,48 | 0,51 |
| Einwohner:innen pro km2 in 2021 | 0,04 | 0,892 | -0,47 | 0,52 |
| Gesundheitsausgaben je Einwohner:innen in 2020 | 0,20 | 0,452 | -0,33 | 0,64 |
| Lebenserwartung ab 0 Jahren | 0,35 | 0,178 | -0,17 | 0,72 |
| Anteil rauchende Erwachsene | -0,26 | 0,336 | -0,67 | 0,27 |
| ASR M17.1 Sonstige primäre Gonarthrose | -0,06 | 0,815 | -0,54 | 0,45 |
| M75.1 Läsionen der Rotatorenmanschette | 0,16 | 0,561 | -0,37 | 0,61 |
| ASR M16.1 Sonstige primäre Koxarthrose | -0,10 | 0,723 | -0,57 | 0,42 |
| ASR M75.4 Impingement-Syndrom der Schulter | 0,07 | 0,808 | -0,44 | 0,54 |
| ASR C20 Bösartige Neubildung des Rektums | -0,24 | 0,376 | -0,66 | 0,29 |
| ASR C64 Bösartige Neubildung der Niere, ausgenommen Nierenbecken | -0,02 | 0,940 | -0,51 | 0,48 |
| ASR C67.8 Bösartige Neubildung: Harnblase, mehrere Teilbereiche überlappend | -0,11 | 0,695 | -0,57 | 0,41 |
| ASR S83.* Luxation, Verstauchung und Zerrung des Kniegelenkes und von Bändern des Kniegelenkes | **0,61** | **0,012** | **0,16** | **0,85** |
| ASR S42.2 Fraktur des proximalen Endes des Humerus | 0,03 | 0,904 | -0,47 | 0,52 |
| ASR T36-T50 Vergiftungen durch Arzneimittel, Drogen und biologisch aktive Substanzen | -0,31 | 0,238 | -0,70 | 0,22 |
| ASR Z38.0 Einling, Geburt im Krankenhaus | -0,03 | 0,927 | -0,51 | 0,48 |
| Anteil Frauen komplexe Akutschmerzbehandlung | 0,03 | 0,912 | -0,47 | 0,52 |
| Anteil Frauen alle Fälle | 0,00 | 0,993 | -0,49 | 0,50 |

***Tab. 2:*** Pearson correlations between the ASR of complex acute pain treatment and socioeconomic and health factors in the federal states. Legend: ASR, age-standardised rate; U 95% CI, lower 95% confidence interval; O 95% CI, upper 95% confidence interval.

(95% CI: 1831.6; 1860.8) per 100,000 hospital cases, respectively. Between the federal states there were variations between 531.2 (95% CI: 448.3; 614.1; Bremen) and 2191.4 (95% CI: 2062.9; 2319.9; Brandenburg) n the 18-39 year-olds and 859.7 (95% CI: 800.2; 919.2; Thuringia) and 2527.4 (95% CI: 2419.5; 2635.4; Brandenburg) in the 40-59 year-olds. In the two oldest age groups, the case rates of complex acute pain treatment were 1778.3 (95% CI: 1765.6; 1791.0; 60-74-year-olds) and 980.2 (95% CI: 971.4; 988.9; ≥75-year-olds) per 100,000 hospital treatments for Germany. In the Länder, the rate varied between 1024.4 (95% CI: 971.9; 1076.9; Thuringia) and 2555.5 (95% CI: 2467.6; 2643.5; Brandenburg) for 60-74-year-olds and between 563.8 (95% CI: 538.6; 589.1; Hesse) and 1649.9 (95% CI: 1586.8; 1713.0; Brandenburg) per 100.000 hospital treatments (Fig. 1B).

**Age-standardised case rates and standardised rate ratios**

The age-standardised case rate (ASR) of complex acute pain treatment was calculated to be 1376.8 (95% CI 1370.3; 1383.3) cases per 100,000 hospital cases for Germany as a whole (Fig. 2). The highest age-standardised rate per 100,000 hospital cases was determined for the federal state of Brandenburg (1994.2 [95% CI: 1943.6; 2044.9]) and the lowest for Thuringia (698.7 [95% CI: 671.1; 726.3]) (Fig. 2).

Compared to the reference state of Baden-Württemberg, the standardised rate ratios (SRRs) of the ASRs of complex acute pain treatment were significantly lower in the states of Berlin, Bremen, Hesse, Lower Saxony, Rhineland-Palatinate, Saarland, Saxony-Anhalt and especially Thuringia (SRR: 0.51 [95% CI: 0.49; 0.52]) (Fig. 3). Significantly higher SRRs occurred in the states of Bavaria, Mecklenburg-Western Pomerania, North Rhine-Westphalia and especially Brandenburg (SRR: 1.44 [95% CI: 1.40; 1.49]).

Only the ASR of dislocation, sprain and strain of the knee joint and ligaments of the knee joint coded S83.* was significantly correlated with the ASRs of complex acute pain treatment (r: 0.61 [95% CI: 0.16; 0.85]; p=0.012) (Tab. 2). Other ICD-10 codes as well as socioeconomic factors in the federal states showed no significant correlations with the ASRs of complex acute pain treatment.

## Discussion

This analysis shows significant state differences in the use of complex acute pain management in German hospitals, with age-standardised case rates being highest in Brandenburg, Bavaria and North Rhine-Westphalia. Only the age-standardised rate of ICD-10 S83.* coded dislocation, sprain and strain of the knee joint showed a significant correlation with the age-standardised rate of complex acute pain treatment.

Unlike the prescription of metamizole (Hoffmann et al., 2020), no obvious east-west divide is observed for complex acute pain treatment. Interestingly, the prevalence of metamizole use in Länder such as Brandenburg and Saxony is below the prevalence for Germany (Hoffmann et al., 2020), but above the rate for Germany for the acute pain treatment analysed in this study. The federal states

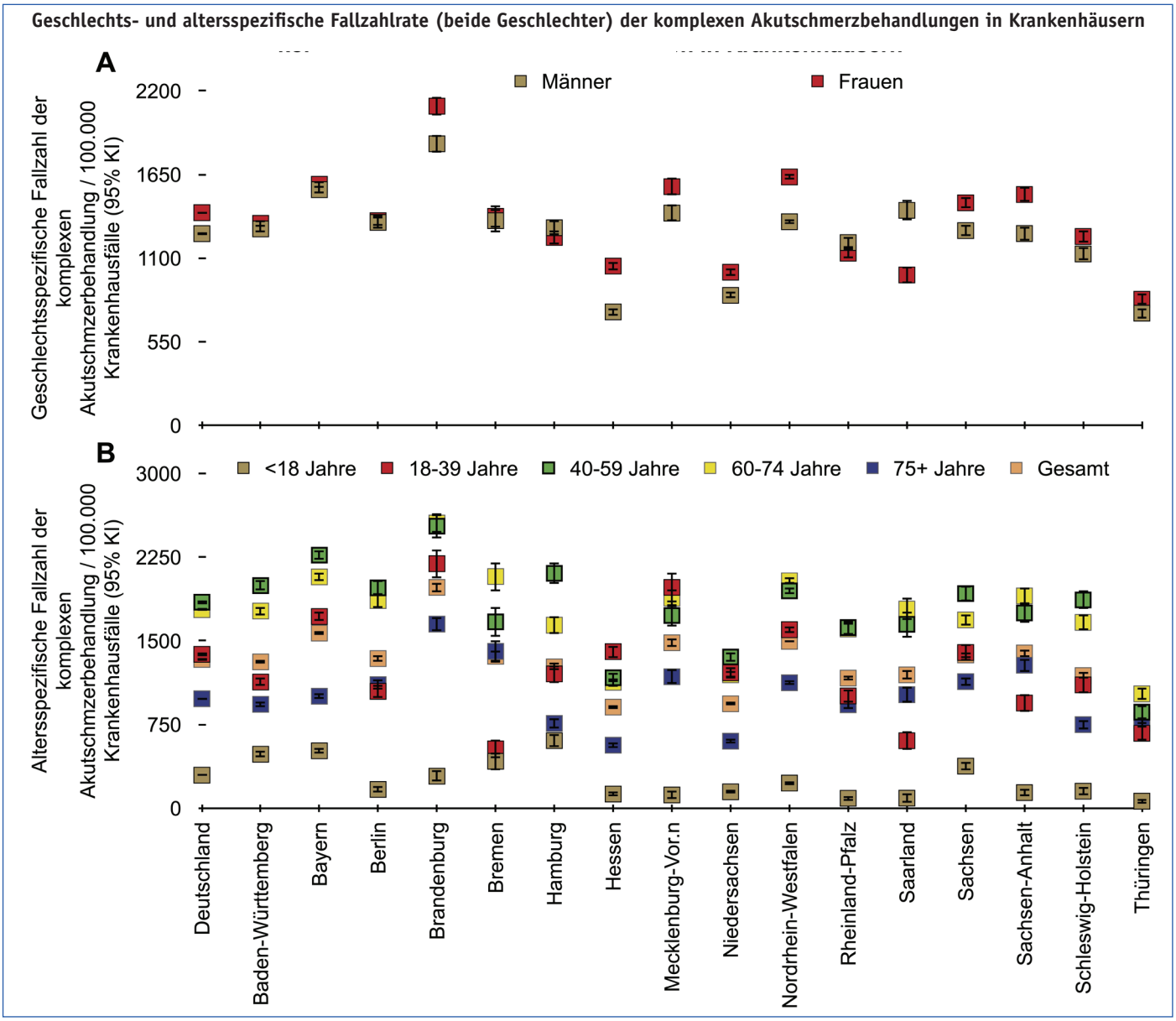



***Fig. 1:*** Sex- and age-specific case rate (both sexes) of complex acute pain treatment in hospitals.

of Mecklenburg-Western Pomerania and North Rhine-Westphalia, on the other hand, show a higher rate or prevalence than Germany as a whole, both in the present study and in the study on metamizole.

Through the correlations, with one exception, no indications of correlations between the age-standardised acute pain treatment rate with specific diagnoses, which are often considered as causes for pain treatment, can be identified. A vague indication of a possible reason for the regional differences can so far only be derived from the correlation between the case rate of acute pain treatment and the age-standardised rate of ICD-10 code S83.*. On a global level, on the other hand, it is known that the use of opioid analgesics is associated with the Human Development Index as well as the cancer-related death rate (excluding leukaemias) (Ju et al., 2022). For Germany as a whole, associations between socioeconomic status, overweight and smoking status with the use of analgesics and/or opioid analgesics have been reported (Sarganas et al., 2015). However, a correlation of complex acute pain treatments with gross monthly salary, life expectancy from the age of 0 or the proportion of smoking adults in the provinces could not be identified in the present analysis (Tab. 2).

At present, we are not aware of any other analyses of complex acute pain treatment in German hospitals that address the causes of the regional differences. Accordingly, there is a need for further quantitative surveys that are able to explain the differences in the use of the OPS code 8-919 in Germany. Particularly against the background of a possible dependence through the application of painkilling medication, education appears to be meaningful and important (Häuser et al., 2021). Painkiller addiction is currentlya problem of great significance in countries such as the USA or Great Britain (Kibaly et al., 2021; Roberts & Richards, 2023).

From the results of the analysis presented here, various questions arise that are related to the prescription of complex acute pain therapy and need to be answered by subsequent, more detailed studies. For example, it is important to identify the reason for the regional differences in Germany. Reasons could be, for example, regionally different incidences of diseases, but possibly also differences in care and problems. Furthermore, it is relevant to determine how long the complex pain therapy is carried out in the individual case and which drug classes are used. In Germany, TÜV Rheinland awards the certification

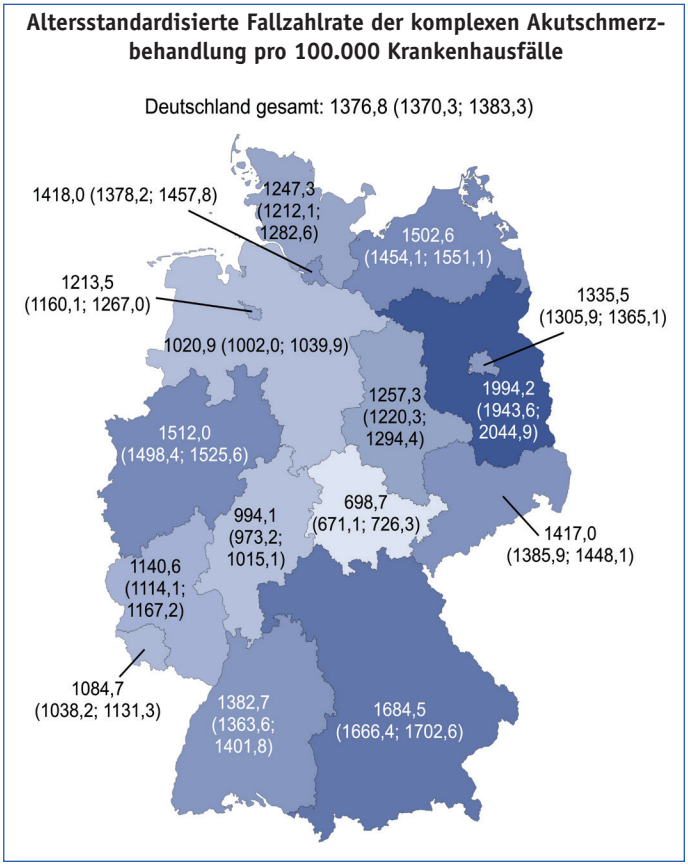



***Fig. 2:*** Age-standardised case rate of complex acute pain treatment per 100,000 hospital cases.

‚Quality Management Acute Pain Therapy', which allows clinics to call themselves pain-free clinics. The question of whether the number of prescriptions for complex acute pain therapy correlates with the number of clinics that have this certification could also be the subject of further research (Korczak et al., 2013).

This study has several limitations that have not yet been discussed. Firstly, it is an ecological study that was carried out with aggregated data from patients in the individual federal states and not with individual data. Secondly, the analysis cannot show any reasons for the regional differences. It should also be noted that the identified correlation cannot provide a causal link. Finally, it should be pointed out that only the data for the year 2021 was used for the calculation, which was a corona year.

## Conclusion

Based on this analysis, it can be assumed that regional differences exist in the use of complex acute pain treatment in Germany. Since these differences can be an indication of both a regionally different disease pattern, but also of differences in care, further analyses are necessary. These analyses should ideally be carried out with more detailed data sets than those used in the present correlation study. In particular, aspects of care such as regional hospital density or waiting times for diseases associated with severe pain could also be taken into account. <<

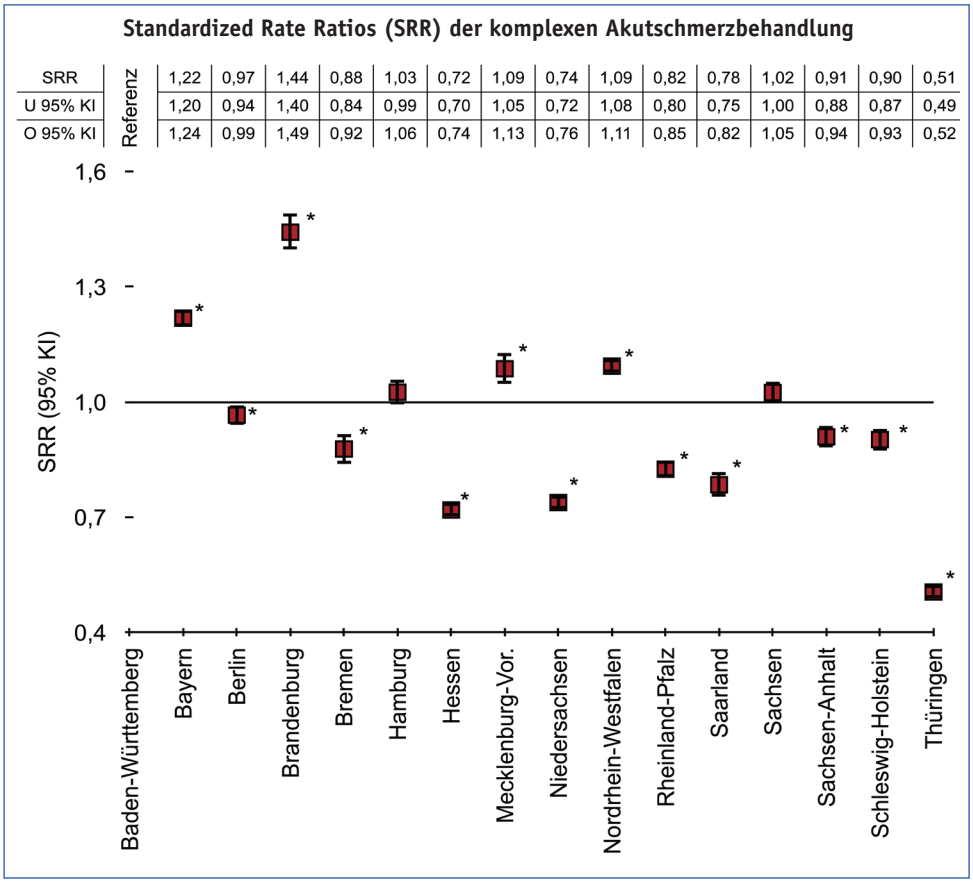



***Fig. 3:*** Standardised rate ratios (SRR) of complex acute pain treatment.

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