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Fallacy of residence-based estimates of rehabilitation demand: a nationwide study linking residence, preceding hospitalization, and rehabilitation in Korean National Health Insurance claims

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Title

Fallacy of residence-based estimates of rehabilitation demand: a nationwide study linking residence, preceding hospitalization, and rehabilitation in Korean National Health Insurance claims

Running title

Fallacy of residence-based demand estimates

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Fallacy of residence-based estimates of rehabilitation demand: a nationwide study linking residence, preceding hospitalization, and rehabilitation in Korean National Health Insurance claims

Running title: Fallacy of residence-based demand estimates

Abstract

Background: Residence-based estimates of rehabilitation demand do not indicate where patients receive inpatient care before rehabilitation. We examined where patients with out-of-region rehabilitation had their preceding admission, and how regional patient distributions varied depending on where the patients were counted (attribution points).

Methods: In this nationwide retrospective study, we used National Health Insurance Service claims of all 37,480 adults with their first inpatient claim under Korea's designated rehabilitation program between March 2020 and December 2024. We linked registered residences, preceding-inpatient regions, and rehabilitation regions among Korea's 17 regions. The preceding admission was the most recent eligible episode ending on or within 90 days before the index admission date. We classified out-of-region rehabilitation by preceding-inpatient region and compared regional distributions using the index of dissimilarity.

Results: All three regions were identified in 36,984 patients (98.7%), of whom 10,870 (29.4%) underwent out-of-region rehabilitation. Among the patients who underwent out-of-region rehabilitation, 65.5% (n=7,121) had an out-of-region preceding admission. Of the 10,870 patients who underwent out-of-region rehabilitation, 51.2% had their preceding admission in the rehabilitation region and 14.3% in a third region. By residence region, the proportion of patients with an out-of-region preceding admission ranged from 29.9% in Seoul to 85.3% in Chungnam. The regional distributions also differed by attribution point. The index of dissimilarity between residence-based and preceding-admission-based counts was 13.91% (N=36,984). Among the 37,477 patients with residence and rehabilitation regions identified, the corresponding index for residence-based and rehabilitation-based counts was 16.69%. Relative to residence-based counts, Seoul's share was higher

when patients were counted at the preceding admission and lower when they were counted at the rehabilitation institution.

Conclusions: The proportion of out-of-region rehabilitation alone cannot be interpreted directly as a local shortage of rehabilitation beds. The regional patient distribution varies by attribution point; therefore, residence-based counts alone are insufficient for regional bed planning. Regional reports should state the attribution point and distinguish out-of-region rehabilitation according to the preceding-inpatient region.

Keywords: rehabilitation; inpatients; convalescence; subacute care; patient transfer; health services accessibility; regional health planning; administrative claims, healthcare; Republic of Korea

Background

As the number of people worldwide requiring rehabilitation grows, reaching an estimated 2.41 billion in 2019, 63% more than in 1990 [1], health planning that efficiently allocates limited inpatient rehabilitation beds across regions has become increasingly important. Inpatient rehabilitation bed planning usually begins with the number of patients each region is expected to serve [2]. However, patients often cross administrative boundaries to receive care in other regions. In the United States, 35% of Medicare stroke patients and 21.9% of Medicare patients across all diagnostic groups who received institutional post-acute care were treated outside their residential service area, an area defined by patterns of hospital use [3,4]. Moreover, interregional use of hospital rehabilitation has also been reported in Italy [5]. Such flows directly affect a region’s required bed estimates [2,6]. Therefore, whether patients are counted according to where they live or where they are treated is a central question for accurate resource allocation.

A rehabilitation patient's use of care often does not end with a single move from home to a rehabilitation institution. Recovery phase rehabilitation, an intensive inpatient rehabilitation known as post-acute or subacute rehabilitation in other systems, usually follows acute treatment for stroke, injury, or surgery, and the hospital that provides acute treatment is often not the institution that provides rehabilitation. Therefore, a patient has, besides a registered residence region, a preceding-

inpatient region where they were admitted before rehabilitation, and a rehabilitation region, and the three may differ. For patients with stroke, decisions regarding inpatient rehabilitation begin during the acute stay, and the likelihood of rehabilitation admission varies among discharging hospitals [7,8]. Where a patient goes is influenced not only by the distance from home and local availability [9,10], but also by the location of the discharging hospital and its referral relationships [11-13]. These findings provide a clear rationale for considering the residence, preceding-inpatient, and rehabilitation regions when estimating rehabilitation demand.

However, the indicators used in regional planning compare only two locations: where patients live and where they received the care in question. Korea's relevance and commitment indices [14-16] and the proportion of patients treated outside their home service area in US studies [3,4] are all of this kind. That is, when applied to rehabilitation, they compare residence with the rehabilitation region only, so where patients were admitted before rehabilitation remains invisible. For example, the proportion of residents who receive rehabilitation outside their region, the out-of-region rehabilitation proportion, combines two different situations: patients who completed the preceding admission in their residence region and moved to another region only for rehabilitation, and patients whose care had already left the region at the preceding admission. The former may point to a shortage of local rehabilitation resources, whereas in the latter, patients have already left the region at the acute stage before rehabilitation; therefore, the implications for regional bed planning differ.

In Korea, the attribution point, the place at which patients are counted, feeds directly into bed allocation under a designated rehabilitation program. Since 2020, the Ministry of Health and Welfare has designated hospitals to provide intensive inpatient rehabilitation after onset of an eligible condition or surgery as rehabilitation medical institutions [17,18]. These designated institutions are re-designated every 3 years, and their number has grown from 45 in the first cycle in 2020 to 71 in the third cycle in 2026 [19,20]. The notice governing the program requires regional bed allocation to take account of rehabilitation demand, including "the number of acute-phase patients related to rehabilitation treatment," and regional balance [17]. Moreover, an annex to the draft amendment published before the third cycle listed proposed bed targets for each region alongside counts of acute-

phase patients [21]. Unlike the indicators above, which compare residence with the rehabilitation region, counts of acute-phase patients capture patients at the stage before rehabilitation. However, neither document states whether these patients were counted as residents of a region or as patients who received acute care there. Planning beds on this basis requires that point to be clear and also requires knowing how far such counts differ from the counts of the same patients at residence or at the rehabilitation institution.

In research, three-location designs do exist. US studies have modeled the choice of post-acute facility using distances from both the patient's residence and the discharging hospital [12,13], and a report by Korea's National Evidence-based Healthcare Collaborating Agency traced whether transfers from acute to subacute care stayed within, moved to a neighboring region, or went to a more distant region relative to an estimated residence [22]. The former examined facility choice; the latter relied on residences inferred from healthcare use and covered a broader population than program users. However, neither compared how regional patient counts changed when the same patients were counted at registered residences, preceding admissions, or rehabilitation institutions. Thus, three-location designs have not yet been incorporated into the regional patient counts.

Therefore, we used Korea's National Health Insurance claims, which cover virtually the entire population, to link the registered residence, preceding-inpatient, and rehabilitation regions of all adults who first used the designated rehabilitation program between March 2020 and December 2024. Our aim was to establish whether patients with out-of-region rehabilitation had their preceding admission in the residence, rehabilitation, or third region, and to compare the regional distribution of the same patients when counted at residence, preceding admission, or rehabilitation institution. For secondary analyses, we classified patients into five patterns of agreement among the three regions and described the differences according to patient group and designation cycle. In doing so, we aimed to empirically show where residence-based estimates of rehabilitation demand can go wrong and provide a basis for resource allocation that considers interregional patient movement.

Methods

Study design and data sources

We conducted a nationwide retrospective observational study using the customized research database of the Korean National Health Insurance Service (NHIS). NHIS records cover beneficiaries of the mandatory National Health Insurance and Medical Aid, the public assistance program for low-income households, and thus almost the entire resident population [23,24].

Annual qualification (eligibility) records provide registered residence, sex, year of birth, and insurance contribution level as a proxy for income [24]. These records were linked to claims and healthcare institution records using pseudonymized individual and institution identifiers. Claims contained dates of care, principal diagnoses, claim form codes, institution types, and the program code S005; institution records provided the locations. When an institution had multiple records, the most recent location records were used. Patient-level data were analyzed in a secure NHIS environment, and only approved aggregate tables were exported. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and the REporting of studies Conducted using Observational Routinely collected health Data (RECORD) extension [25,26].

Designated rehabilitation program

We refer to hospitals designated under the program as designated institutions and to the institution providing rehabilitation as the rehabilitation institution. This study covers the entire first designation cycle and the first 22 months of the second through December 2024. The first cycle began on March 1, 2020 with 26 institutions, followed by 19 additional institutions from January 2021. The second cycle began on March 1, 2023 [15,27,28]. Inpatient claims carry S005 when an admission at a designated institution meets the following program criteria [14]: membership in a specified patient group, admission within the group-specific interval after onset of the condition or surgery, and stay within the covered duration [17]. Patients admitted without S005 were excluded from this study.

Study population

We identified all patients aged 19 years or older with an inpatient claim carrying S005 between March 1, 2020 and December 31, 2024. We also used claims from December 2019 onwards so that inpatient episodes could be constructed and admissions 90 days before the index admission (defined below)

could be identified.

All regional variables were analyzed at the level of Korea's 17 first-level administrative regions (hereafter "regions"): Seoul; six metropolitan cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), which are governed at the same level as provinces; Sejong, a special self-governing city; and nine provinces (Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju). Several cities lie within or beside a province: Seoul is surrounded by Gyeonggi, Gwangju by Jeonnam, Daegu largely by Gyeongbuk, and Daejeon borders Chungnam.

Index episode

Patients were included as the unit of analysis. We constructed inpatient episodes from medical inpatient claims (claim form code 02, excluding dental, traditional Korean medicine, psychiatric, and public health center claims). One episode involved a continuous stay at a single institution. Because long stays are billed monthly, claims from the same institution were combined when the next admission date was no later than the day after the previous discharge date.

For each patient, the first episode containing an S005 claim during the study period was the index rehabilitation episode (hereafter "index episode"); its start date was the index admission date. Merging contiguous claims included care at the institution before the first S005 claim. Therefore, an index episode could begin before the claim or the institution's designation. A total of 155 such episodes began in December 2019. The index admission date determined the lookback period, eligibility record year, age, and designation cycle.

Definition of the three regions

Three regions were defined for each patient. Where the relationships among them are described, they are abbreviated as: R, registered residence region; P, preceding-inpatient region; and H, rehabilitation region.

Registered residence region (R). R was obtained from the NHIS qualification (eligibility) record for the calendar year in which the index episode began; for episodes that began in December 2019, the 2020 record was used.

Preceding-inpatient region (P). We searched for eligible inpatient episodes ending on the index admission date or within the preceding 90 days using the same window for all patients. Ninety days is the longest standard interval from onset of the condition or surgery to program admission; an exception of up to 270 days applies to patients with brain or spinal cord injuries whose acute treatment cannot be completed within that interval [17,20]. Our window applied to discharge rather than onset; therefore, admissions ending shortly before rehabilitation were captured, regardless of when the condition began.

Eligible episodes included admission to any institution other than a long-term care hospital, including an earlier separate stay at the rehabilitation institution. We excluded long-term care hospitals because they provide long-term care rather than acute treatment. The diagnoses did not have to match those of the index episodes. We selected the most recent eligible episode as the preceding admission, and used its institution's region as P.

If a long-term care hospital stay intervened, the earlier eligible admission was selected only if it ended within the window. The interval between discharge and the index admission date was recorded. This definition identifies the most recent eligible admission before rehabilitation, and not a confirmed referral source.

Rehabilitation region (H). H was the region of the rehabilitation institution, that is, the designated institution that provided the index episode, which was obtained by linking the institution identifier to the healthcare institution table. A region was classified as having a designated institution if at least one index episode occurred in an institution located there; Ulsan, Sejong, and Jeonnam had none during the study period [15,28].

Other variables

Age was calculated as the index admission year minus the year of birth and grouped as <40, 40–64, and ≥65 years. Patients were classified as having brain injury, spinal cord injury, musculoskeletal conditions, amputation, or disuse syndrome, the five program groups, or as "other" [17]. The classification first used the Korean Rehabilitation Impairment Category (KRIC) for S005 claims, as

defined in the Korean Rehabilitation Patient Group manual of the Health Insurance Review and Assessment Service [29]: KRIC 01–03 indicated brain injury; 05–07, spinal cord injury; 12, 13, and 15, musculoskeletal conditions; 14 and 17, amputation; and 22, disuse syndrome. If the KRIC was missing or did not correspond to a program group, we applied the prespecified diagnosis code lists to the principal diagnosis of the preceding admission. Patients not classified by either method were assigned to "other."

The insurance contribution level was classified as Medical Aid or as one of five groups, each comprising four consecutive National Health Insurance contribution levels (level 1 being the lowest); missing values were reported as a separate category. Because the levels were assigned across all insured persons, these groups were not quintiles of this cohort.

The designation cycle was defined by the index admission date: cycle 1, before March 1, 2023; and cycle 2, from March 1, 2023 to December 31, 2024. Cycle 1 included the index episodes that began before the first designations took effect on March 1, 2020, and coincided with the COVID-19 pandemic in Korea.

Study measures

Among the patients for whom all three regions were identified, we defined five mutually exclusive and exhaustive patterns (Fig. 1). In pattern 1, all three regions were identical (R=P=H). In pattern 2 the residence and preceding-inpatient regions were the same and the rehabilitation region differed (R=P≠H). In pattern 3 the residence and rehabilitation regions were the same and the preceding-inpatient region differed (R=H≠P). In pattern 4 the preceding-inpatient and rehabilitation regions were the same and both differed from the residence region (P=H≠R). In pattern 5, all three regions differed.

Throughout the paper, "out-of-region rehabilitation" denotes a rehabilitation region different from the registered residence region (H≠R; patterns 2, 4, and 5), and "out-of-region preceding admission" denotes a preceding-inpatient region different from the residence region (P≠R; patterns 3, 4, and 5). The two groups overlapped: patients with patterns 4 and 5 belonged to both groups.

The primary analysis classified the preceding-inpatient region of patients with out-of-region

rehabilitation as the residence region (P=R), rehabilitation region (P=H), or a third region (P≠R and P≠H), nationally and by registered residence region.

For the second aim, we compared the regional counts at three attribution points. An attribution point is the region where a patient is counted: residence, preceding admission, or rehabilitation. Residence-based counts describe residents who used the program, whereas other counts describe users whose preceding admission or rehabilitation took place in that region. Residence was used as a reference.

We compared the residence-based distribution across the 17 regions with the preceding-admission-based distribution among patients for whom all three regions were identified. Comparison with the rehabilitation-based distribution included all patients with identified residence and rehabilitation regions.

Secondary analyses described the five patterns nationally, by patient group, and by designation cycle. We compared the agreement of rehabilitation with preceding admission (H=P) and residence (H=R), overall and among residents of the 14 regions with a designated institution. We also described rehabilitation destinations after out-of-region preceding admissions. Finally, among patients with identified residence and rehabilitation regions, we selected the five residence regions with the most out-of-region rehabilitations and identified their leading rehabilitation destinations. For the same residence regions, we identified the leading destinations for out-of-region preceding admissions among patients with all three regions identified.

Statistical analysis

Categorical variables are summarized as counts and percentages and continuous variables as means, standard deviations, and ranges. Proportions within the subgroups are reported with their numerators and denominators. Percentages are given to one decimal place, and regional shares and the index of dissimilarity are given to two decimal places.

We compared the agreement of rehabilitation with the preceding admission (H=P) and residence (H=R) using McNemar's test because both were measured in the same patients. Differences are reported as percentage points. Regional distributions at different attribution points were compared

using the index of dissimilarity [30]: $D = \frac{1}{2} \Sigma_j |p_j - q_j|$, where p_j and q_j are the percentage shares of region j at the two attribution points, summed across the 17 regions. The index is the minimum percentage of patients who would need to be counted in different regions to ensure that the two aggregate distributions are identical. However, it does not measure individual patient movement. We reported the two indices separately because their analysis populations differed by 493 patients without an identified preceding-inpatient region.

The distribution of the five patterns was compared between the two designation cycles using the chi-square test, with Cramér's V as a measure of the strength of the association. Because the two cycles differed in duration, participating institutions, and patient composition, the differences between them are described but not attributed to the program. All tests were two-sided, and $p<0.05$ was taken as statistically significant.

Patients with unidentified residences or preceding-inpatient regions were excluded from the analyses requiring those regions; missing regions were not imputed. For index episodes beginning before March 1, 2020, part of the 90-day lookback period preceded the available claims; therefore, a preceding admission could have been missed. We summarized the unidentified preceding-inpatient regions by residence region. Rehabilitation regions were known for all patients, allowing out-of-region rehabilitation to be identified despite missing preceding-inpatient regions. Among these patients who underwent out-of-region rehabilitation, we calculated the bounds for the proportion with an out-of-region preceding admission by assuming that all unidentified admissions occurred within the residence region or that all occurred outside it.

Patient-level data processing and statistical tests were performed using SAS Enterprise Guide 7.1 (SAS Institute, Cary, NC, USA) in a secure NHIS analysis environment, and the regional shares and index of dissimilarity were calculated from the exported aggregate tables. Large language models (Claude, Anthropic; ChatGPT, OpenAI; Gemini, Google) were used to assist with drafting and editing the text, as well as writing the code that drew the figures from the exported aggregate tables. The study design, analyses, and interpretation are the authors' own, and the authors have verified and take responsibility for all content.

Ethics approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Korean Medical Association (File number: KMAA 2025-09-01), which waived the requirement for informed consent for this retrospective study of de-identified claims data provided by the NHIS under formal application and approval (Bioethics and Safety Act, Article 16(3)).

Results

Study cohort

All three regions were identified in 36,984 of the 37,480 patients (98.7%; Fig. 2). Residence was identified in 37,477 patients, preceding admission in 36,987, and rehabilitation in all. A total of 493 patients (1.3%) without an identified preceding-inpatient region were distributed across all 17 residence regions, accounting for 0.7–3.6% of the patients in each region. All three patients without a residence region had an identified preceding-inpatient region. Among patients with a preceding admission (n=36,987), the mean interval from discharge to index admission was 2.0 days (standard deviation [SD]: 7.5; range: 0–90).

The characteristics of the study cohort are shown in Table 1. The mean age was 69.7 years (SD: 14.0); 25,320 patients (67.6%) were aged 65 years or older, and 18,520 (49.4%) were men. Brain injury comprised the largest patient group (23,125 patients, 61.7%), followed by musculoskeletal conditions (9,635, 25.7%). Cycle 1 accounted for 19,108 patients (51.0%) and cycle 2 accounted for 18,372 (49.0%).

[Table 1 is to be inserted here]

Preceding admission among patients with out-of-region rehabilitation

Among the 36,984 patients with all three regions identified, 10,870 (29.4%) underwent out-of-region rehabilitation (patterns 2, 4, and 5). All three regions coincided in 22,955 patients (62.1%; pattern 1; Table 2). The preceding admission was outside the residence region for 10,280 patients (27.8%; patterns 3, 4, and 5).

[Table 2 is to be inserted here]

Of the 10,870 patients who underwent out-of-region rehabilitation, 7,121 (65.5%) also had an out-of-region preceding admission. That admission took place in the rehabilitation region for 5,568 patients (51.2% of the 10,870), and in a third region for 1,553 (14.3%) patients. The remaining 3,749 patients (34.5%) had their preceding admission in their residence region (Table 3).

[Table 3 is to be inserted here]

In the larger group with identified residence and rehabilitation regions (37,477 patients), 10,995 (29.3%) patients underwent out-of-region rehabilitation. This included 125 of the 493 patients without an identified preceding-inpatient region. If all 125 had been admitted within their residence region, the proportion of out-of-region rehabilitation preceded by an out-of-region admission would be 64.8% (7,121/10,995); if all had been admitted elsewhere, it would be 65.9% (7,246/10,995).

Variation by residence region

Both the proportion and composition of out-of-region rehabilitation varied widely across the regions of residence (Table 4; Fig. 3). In Ulsan, Sejong, and Jeonnam, which had no designated institutions, all rehabilitation of residents under the program was by definition outside of the region. In the other 14 regions, the proportion of residents rehabilitated outside their region ranged from 3.7% in Daejeon (77/2,072) to 78.5% in Gyeongbuk (1,345/1,714); Jeonbuk, Gyeongbuk, and Gyeongnam had no designated institutions until January 2021.

[Table 4 is to be inserted here]

Among patients with out-of-region rehabilitation, the proportion of patients with an out-of-region preceding admission ranged across the 17 regions from 29.9% in Seoul (592/1,977) to 85.3% in Chungnam (1,077/1,262). Among the residents of the 14 regions with designated institutions who had an out-of-region preceding admission, the proportion rehabilitated within their residence region ranged from 8.8% in Gyeongbuk (108/1,222) to 83.3% in Daejeon (199/239; pattern 3 as a share of patterns 3–5 in Table 4).

Destination regions of out-of-region rehabilitation and preceding admissions

Among the 37,477 patients with residence and rehabilitation regions identified, the five residence regions with the most patients receiving out-of-region rehabilitation were Seoul (1,999), Gyeonggi (1,506), Gyeongbuk (1,357), Jeonnam (1,305), and Chungnam (1,277). These counts exceed those in Table 4 because this population includes the 493 patients without an identified preceding-inpatient region. The leading rehabilitation destinations were Gyeonggi for Seoul residents (1,537; 76.9%), and Seoul for Gyeonggi residents (560; 37.2%) followed by Incheon (454; 30.1%). The leading destinations for Gyeongbuk, Jeonnam, and Chungnam residents were the neighboring metropolitan cities of Daegu (933; 68.8%), Gwangju (857; 65.7%), and Daejeon (771; 60.4%), respectively.

The same destinations accounted for the largest shares of out-of-region preceding admissions among patients with all three regions identified. These were: Gyeonggi for Seoul residents (567/821; 69.1%), Seoul for Gyeonggi residents (1,416/2,044; 69.3%), Daegu for Gyeongbuk residents (855/1,222; 70.0%), Gwangju for Jeonnam residents (739/1,084; 68.2%), and Daejeon for Chungnam residents (563/1,249; 45.1%).

Agreement of the rehabilitation region with the preceding-inpatient and residence regions

Across the 36,984 patients, the rehabilitation region matched the preceding-inpatient region more often than the residence region: 77.1% (28,523 patients; patterns 1 and 4) versus 70.6% (26,114 patients; patterns 1 and 3), a difference of 6.5 percentage points in the same patients ($p<0.001$). As residents of the three regions without a designated institution (n=1,773) could not receive program rehabilitation in their residence region, the comparison was repeated among the 35,211 residents of the other 14 regions, where the proportions were 77.9% (27,436) and 74.2% (26,114), respectively, with a difference of 3.8 percentage points ($p<0.001$).

Among the 10,280 patients whose preceding admission was outside their residence region (patterns 3, 4, and 5), rehabilitation occurred in the region of admission for 5,568 (54.2%), in the residence region for 3,159 (30.7%), and in the third region for 1,553 (15.1%; Table 3).

Patient group and designation cycle

Among patients with out-of-region rehabilitation, the proportion whose preceding admission had been

outside the residence region was 61.2% for brain injury (4,178/6,831), 73.8% for spinal cord injury (629/852), 72.8% for musculoskeletal conditions (1,909/2,623), 73.0% for amputation (27/37), 65.4% for disuse syndrome (200/306), and 80.5% for the "other" group (178/221; Table 5). In pattern 3, rehabilitation in the residence region after an out-of-region preceding admission was most frequent in the spinal cord injury group (17.0%).

[Table 5 is to be inserted here]

The distribution of the five patterns differed between the two designation cycles; however, the association was negligible in magnitude (χ^2=31.57, df=4, p<0.001; Cramér's V=0.029; Table 5). The proportion of out-of-region rehabilitation preceded by an out-of-region admission was 67.4% in cycle 1 (3,770/5,595) and 63.5% in cycle 2 (3,351/5,275).

Regional counts at the three attribution points

The regional shares changed according to attribution points (Table 6; Fig. 4). Among the 36,984 patients with all three regions identified, the index of dissimilarity between the residence-based and preceding-admission-based distributions was 13.91%. When counted at the preceding admission, the shares were larger in Seoul, Daegu, Daejeon, Gwangju, Busan, and Incheon and smaller in the other 11 regions. Seoul's share increased from 12.81% to 19.16% (6.35 percentage points). The next largest change was observed in Gyeongbuk, where the share decreased from 4.63% to 1.47%.

[Table 6 is to be inserted here]

Among the 37,477 patients with residence and rehabilitation regions identified, the index of dissimilarity between residence-based and rehabilitation-based distributions was 16.69%. The rehabilitation-based shares were larger than the residence-based shares in Daejeon (5.65% to 9.64%), Gyeonggi (19.69% to 23.56%), Daegu, Gwangju, Incheon, and Busan. They were smaller in the other 11 regions, including Seoul (12.78% to 10.52%). The three regions without a designated institution accounted for 4.77% of the patients by residence and none by rehabilitation location.

Discussion

This nationwide claims-based study demonstrates that residence-based totals alone cannot fully

capture how patients use care. Approximately three out of ten program users received rehabilitation outside their registered residence region, and two-thirds of them had already left that region at the preceding admission. Rehabilitation coincided with the preceding admission more often than with residence (77.1% vs. 70.6% overall). The regional distribution of the same patients also changed with the attribution point, that is, whether they were counted at their residence, preceding admission, or rehabilitation institution. Therefore, residence-based estimates of demand must be interpreted together with the location of care before rehabilitation.

How the out-of-region rehabilitation proportion should be read is illustrated starkly by Seoul and Chungnam. Their proportions, 41.7% and 48.0%, respectively, were well above the national figure of 29.4%. However, Table 4 shows that among residents with out-of-region rehabilitation, seven in ten in Seoul (70.1%) had their preceding admission within Seoul, whereas in Chungnam, only 14.7% had it within the province. In other words, among those rehabilitated outside their region, most Seoul residents left the region only at the rehabilitation stage, whereas most Chungnam residents had their preceding admission and received rehabilitation outside their residence region. Therefore, an out-of-region rehabilitation proportion cannot be read directly as a local shortage of rehabilitation beds; whether care has already left the region before rehabilitation must be established first. Korean reports use a low relevance index, together with supply-to-demand ratios, to identify regions with insufficient supply [15]; without this distinction, a low index would place Seoul and Chungnam in the same category.

The reverse pathway—rehabilitation in the residence region after a preceding admission elsewhere—also varies by region. As shown in Tables 3 and 4, 30.7% of patients with an out-of-region preceding admission were rehabilitated in their residence region, ranging from 8.8% in Gyeongbuk to 83.3% in Daejeon, among the 14 regions with a designated institution. We also observed greater variation across regions than across the five program groups in the proportion of out-of-region rehabilitation preceded by an out-of-region admission. This proportion ranged from 29.9% in Seoul to 85.3% in Chungnam, compared with 61.2% for brain injury and 73.8% for spinal cord injury across the five groups (Table 5), and the association between the designation cycle and the five patterns was

negligible. This suggests that these patterns are shaped more by regional supply and catchment areas than by the patient mix.

Characterizing out-of-region care properly also requires consideration of the supply side—where catchment areas lie and where designated institutions are located—alongside the region of the preceding admission. For the five residence regions with the most out-of-region rehabilitations, most care was provided in neighboring regions, and the leading destination was the same for rehabilitation and preceding admissions. These links suggest that a single catchment area may be divided by an administrative boundary; therefore, out-of-region care should be assessed along with the supply of services in neighboring regions [31]. Given that the discharging hospital influences where patients go next [7,8,11], and that in Korean stroke care, the choice of rehabilitation institution after discharge is largely left to patients and families [18], where designated institutions are located also matters. Table 6 shows the concentration of designated institutions in large cities. In both cycles, Seoul and the five metropolitan cities other than Ulsan held more than half of them, while Ulsan, Sejong, and Jeonnam had none. This imbalance became more pronounced when the attribution point changed, since Seoul and the five cities accounted for approximately 42% of patients by residence, 56.0% at the preceding admission, and 52.7% at the rehabilitation institution. Therefore, assessing the regional imbalance in resources requires looking at both where institutions are located and how residents move between regions for care.

As these comparisons show, what a regional total represents changes with where patients are counted, and this has important implications for bed allocation. In our data, at least 13.91% of patients would have had to be counted in different regions for the residence-based and preceding-admission-based distributions to coincide, and Seoul's share increased from 12.81% to 19.16%, by 6.35 percentage points, simply by changing the attribution point. Counting at the rehabilitation institution instead, among the 37,477 patients with residence and rehabilitation regions identified, reduced Seoul's share from 12.78% to 10.52%; therefore, even the direction of change depended on where the patients were counted. Korea's governing notice and draft annex for the third designation cycle use acute-phase patient counts in planning regional rehabilitation beds [17,21]. Program users received rehabilitation

more often in the region of their preceding admission than in their residence region. This finding supports the consideration of where inpatient care occurs before rehabilitation when planning for regional rehabilitation beds. However, acute-phase patient counts concern a different population from program users, and neither the notice nor the annex states where those patients were counted. Because the regional shares of the same acute-phase patients may differ according to whether they are counted as residents of a region or as patients treated in its hospitals, any bed target set in proportion to such counts would be directly affected by the attribution point used. Hence, stating which one was used is essential.

Regional health planning and bed allocation should not rely on totals from any single attribution point alone but should make adjustments that reflect the stage of movement, such as the proportion of patients who, after a preceding admission to another region, return to their residence region for rehabilitation or remain in the region of that admission. Likewise, regional statistics should state the population counted and the attribution point, disaggregate out-of-region rehabilitation by preceding-inpatient region, and report the proportion rehabilitated within the residence region after an out-of-region preceding admission.

This study has several limitations that should be considered when interpreting the results. First, the preceding admission was defined as the most recent eligible admission ending within 90 days before the index admission date; therefore, the actual source of referral was not identified. Moreover, 125 out-of-region rehabilitation patients had no identified preceding-inpatient region; whether they are all assigned to their residence region or to other regions, the proportion with an out-of-region preceding admission will remain between 64.8% and 65.9%. Second, claims data lack the clinical and social factors that influence the choice of institution, such as severity, functional status, bed availability, and patient and family preferences. Third, registered residences may differ from actual residences, and the use of administrative regions rather than actual service areas as the unit of analysis may have affected the results [32,33]. For the same reason, our out-of-region rehabilitation proportion of 29.4% is not directly comparable with US estimates based on service areas defined by patterns of care use [3,4,32]. Fourth, cycle 1 coincided with the COVID-19 pandemic and with the expansion from 26 to 45

designated institutions; therefore, differences between cycles cannot be interpreted as program effects. Finally, this study describes the movement of program users and does not directly estimate the total rehabilitation need or the appropriate number of beds in a region.

Despite these limitations, a major strength of this study is that it identified all three regions for 98.7% of patients in a nationwide cohort spanning nearly 5 years, tracing the sequence of care locations for individuals rather than inferring it from aggregate statistics. Where Korean reports have compared residents' use of care with regional rehabilitation supply using indicators such as the relevance index [14,15], this study adds the preceding admission that those indicators leave out, by counting the same program users at the residence, preceding admission, and rehabilitation institution.

Conclusions

This study found that approximately 30% of users of Korea's designated rehabilitation program received rehabilitation outside their registered residence region, and two-thirds of them had already received care in another region at the preceding admission. Therefore, a single indicator, the out-of-region rehabilitation proportion, cannot show how patients actually used care or at which stage care left the region and should not be read on its own as a local shortage of rehabilitation beds.

Because the regional distribution of the same patients changes according to whether they are counted at their residence, preceding admission, or rehabilitation institution, residence-based totals alone are insufficient for regional bed planning. Therefore, regional reports should explicitly state the attribution point and disaggregate out-of-region rehabilitation according to the region of the preceding admission.

Linking residence, preceding admission, and rehabilitation for the same patient offers an analytical framework that fills the gaps left by existing health indicators. This provides a starting point for measuring regional access to rehabilitation and assessing how the continuity of care from acute treatment to recovery phase rehabilitation operates across regions.

List of abbreviations

df: degrees of freedom

H: rehabilitation region

IRB: Institutional Review Board

KRIC: Korean Rehabilitation Impairment Category

NHIS: National Health Insurance Service

P: preceding-inpatient region

pp: percentage points

R: registered residence region

RECORD: REporting of studies Conducted using Observational Routinely collected health Data

SD: standard deviation

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Korean Medical Association (File number: KMAA 2025-09-01), which waived the requirement for informed consent for this retrospective study of de-identified claims data provided by the National Health Insurance Service under formal application and approval (Bioethics and Safety Act, Article 16(3)).

Consent for publication

Not applicable.

Availability of data and materials

The data used in this study were obtained from the National Health Insurance Service (NHIS) under a formal data use agreement and are not publicly available because of legal and institutional restrictions on data sharing. Access is possible through the official application and approval procedures of the NHIS (https://nhiss.nhis.or.kr). The aggregate tables underlying the reported analyses and code lists

used to classify patient groups are available from the corresponding author upon reasonable request.

Competing interests

BW is the director of the IM Rehabilitation Hospital, Cheongju, one of the institutions designated under the program during the study period. The remaining authors declare that they have no competing interests.

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Authors' contributions

YS contributed to conceptualization, methodology, data curation, formal analysis, and writing – original draft. JK contributed to conceptualization, supervision, and writing – review and editing. BW contributed to conceptualization, investigation, and writing – review and editing. SKM contributed to supervision and writing – review and editing. All authors read and approved the final version of the manuscript.

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Tables

Table 1. Characteristics of designated rehabilitation program users with first inpatient claims in 2020–2024 (N=37,480)

Characteristic	n (%) or mean (SD)
Age, years, mean (SD)	69.7 (14.0)
Age group, years	
<40	1,226 (3.3)
40–64	10,934 (29.2)
≥65	25,320 (67.6)
Male sex	18,520 (49.4)
Patient group	
Brain injury	23,125 (61.7)
Spinal cord injury	2,678 (7.1)
Musculoskeletal conditions	9,635 (25.7)
Amputation	100 (0.3)
Disuse syndrome	1,171 (3.1)
Other	771 (2.1)
Insurance contribution group[a]	
Medical Aid	3,853 (10.3)
Group 1 (levels 1–4)	6,601 (17.6)
Group 2 (levels 5–8)	3,341 (8.9)
Group 3 (levels 9–12)	5,099 (13.6)
Group 4 (levels 13–16)	6,432 (17.2)
Group 5 (levels 17–20)	11,622 (31.0)
Missing	532 (1.4)
Designation cycle	
Cycle 1 (index admission before March 2023)	19,108 (51.0)
Cycle 2 (March 2023–December 2024)	18,372 (49.0)

SD, Standard deviation; NHIS, National Health Insurance Service. [a] Insurance contribution level served as a proxy for income. Medical Aid is public assistance for low-income households, whose beneficiaries are shown separately. Five contribution groups were formed by dividing the 20 National Health Insurance contribution levels (level 1 being the lowest) into groups of four consecutive levels. The NHIS assigns these levels to all insured persons; therefore, the groups are not cohort quintiles and are not equal in size within this cohort.

Table 2. Five mutually exclusive patterns of agreement among the residence, preceding-inpatient, and rehabilitation regions

Pattern	Description	Relationship	n (%)
1	All three regions the same	R=P=H	22,955 (62.1)
2	Residence and preceding-inpatient regions the same; rehabilitation region different	R=P≠H	3,749 (10.1)
3	Residence and rehabilitation regions the same; preceding-inpatient region different	R=H≠P	3,159 (8.5)
4	Preceding-inpatient and rehabilitation regions the same; residence region different	P=H≠R	5,568 (15.1)
5	All three regions different	R≠P, P≠H, R≠H	1,553 (4.2)
Total			**36,984 (100.0)**

The table includes patients with all three regions identified (N=36,984). R, Registered residence region; P, Preceding-inpatient region (the region of the most recent eligible inpatient episode ending on the day of admission to the rehabilitation institution or within 90 days before it, excluding long-term care hospital stays); H, Rehabilitation region. Out-of-region rehabilitation comprises patterns 2, 4, and 5, in which the rehabilitation region differs from the registered residence region. The out-of-region preceding admission comprises patterns 3, 4, and 5, in which the preceding-inpatient region differs from the registered residence region. Patients in patterns 4 and 5 belonged to both groups.

Table 3. Preceding admission and rehabilitation regions of patients treated outside their residence region

	n (%)
Patients rehabilitated outside their residence region (n=10,870; patterns 2, 4, and 5), by region of the preceding admission	
Residence region	3,749 (34.5)
Outside the residence region, all	7,121 (65.5)
Outside the residence region: in the rehabilitation region	5,568 (51.2)
Outside the residence region: in a third region	1,553 (14.3)
Patients admitted outside their residence region before rehabilitation (n=10,280; patterns 3, 4, and 5), by region of rehabilitation	
Region of the preceding admission	5,568 (54.2)
Residence region	3,159 (30.7)
Third region	1,553 (15.1)

The table includes patients with all three regions identified (N=36,984). Percentages use the n shown for each part as the denominator. These patterns are defined in Table 2. In the upper part, the third region differed from both the residence and rehabilitation regions. In the lower part, it differed from both the residence and preceding-inpatient regions. Patterns 4 (5,568 patients) and 5 (1,553 patients) belong to both groups and appear in both parts.

Table 4. Five patterns of the three regions by registered residence region

Residence region	Patients with all three regions identified, n	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Out-of-region rehabilitation, n (%)[a]	Preceding admission also outside, n (%)[b]
Seoul	4,739	2,533	1,385	229	504	88	1,977 (41.7)	592 (29.9)
Busan	2,686	2,293	62	220	76	35	173 (6.4)	111 (64.2)
Daegu	2,271	2,103	34	75	43	16	93 (4.1)	59 (63.4)
Incheon	2,566	2,001	124	261	122	58	304 (11.8)	180 (59.2)
Gwangju	1,246	1,101	22	91	26	6	54 (4.3)	32 (59.3)
Daejeon	2,072	1,796	37	199	29	11	77 (3.7)	40 (51.9)
Ulsan*	104	0	48	0	31	25	104 (100.0)	56 (53.8)
Sejong*	373	0	127	0	166	80	373 (100.0)	246 (66.0)
Gyeonggi	7,322	4,660	618	1,173	714	157	1,489 (20.3)	871 (58.5)
Gangwon	1,790	1,183	211	120	177	99	487 (27.2)	276 (56.7)
Chungbuk	2,553	1,841	88	258	255	111	454 (17.8)	366 (80.6)
Chungnam	2,630	1,196	185	172	778	299	1,262 (48.0)	1,077 (85.3)
Jeonbuk	1,727	1,101	164	105	265	92	521 (30.2)	357 (68.5)
Jeonnam*	1,296	0	212	0	890	194	1,296 (100.0)	1,084 (83.6)
Gyeongbuk	1,714	261	231	108	949	165	1,345 (78.5)	1,114 (82.8)
Gyeongnam	1,466	543	185	122	517	99	801 (54.6)	616 (76.9)
Jeju	429	343	16	26	26	18	60 (14.0)	44 (73.3)
Total	**36,984**	**22,955**	**3,749**	**3,159**	**5,568**	**1,553**	**10,870 (29.4)**	**7,121 (65.5)**

The table includes patients with all three regions identified (N=36,984). Patterns follow Table 2: 1, R=P=H; 2, R=P≠H; 3, R=H≠P; 4, P=H≠R; and 5, all three different. The regions follow the order in official Korean statistics: Seoul, the six metropolitan cities, Sejong, and the nine provinces. Chungbuk and Chungnam are the North and South Chungcheong provinces, Jeonbuk and Jeonnam the North and South Jeolla provinces, and Gyeongbuk and Gyeongnam the North and South Gyeongsang provinces. For out-of-region rehabilitation, the preceding admission occurred in the residence region in pattern 2, the rehabilitation region in pattern 4, and the third region in pattern 5 (percentages in Fig. 3b). Among residents with an out-of-region preceding admission (patterns 3–5), the proportion rehabilitated within the residence region was calculated as pattern 3 divided by the sum of patterns 3–5. [a] Out-of-region rehabilitation comprises patterns 2, 4, and 5. The denominator included all patients with all three regions identified in the same row. [b] In patterns 4 and 5, the preceding admission was also outside the residence region. The denominator represents the patients with out-of-region rehabilitation in the same row. *No designated institutions were located in the region during the study period.

693 **Table 5. Five patterns of the three regions by patient group and designation cycle**

	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Total, n	Out-of-region rehabilitation, n	Preceding admission also outside, n (%)
Patient group								
Brain injury	14,299 (62.8)	2,653 (11.7)	1,642 (7.2)	3,292 (14.5)	886 (3.9)	22,772	6,831	4,178 (61.2)
Spinal cord injury	1,337 (50.7)	223 (8.5)	447 (17.0)	436 (16.5)	193 (7.3)	2,636	852	629 (73.8)
Musculoskeletal conditions	6,077 (63.3)	714 (7.4)	902 (9.4)	1,531 (15.9)	378 (3.9)	9,602	2,623	1,909 (72.8)
Amputation	50 (50.5)	10 (10.1)	12 (12.1)	14 (14.1)	13 (13.1)	99	37	27 (73.0)
Disuse syndrome	736 (64.6)	106 (9.3)	98 (8.6)	148 (13.0)	52 (4.6)	1,140	306	200 (65.4)
Other	456 (62.0)	43 (5.9)	58 (7.9)	147 (20.0)	31 (4.2)	735	221	178 (80.5)
Designation cycle[a]								
Cycle 1 (before March 2023)	11,634 (61.9)	1,825 (9.7)	1,559 (8.3)	3,000 (16.0)	770 (4.1)	18,788	5,595	3,770 (67.4)
Cycle 2 (March 2023–December 2024)	11,321 (62.2)	1,924 (10.6)	1,600 (8.8)	2,568 (14.1)	783 (4.3)	18,196	5,275	3,351 (63.5)
Total	**22,955 (62.1)**	**3,749 (10.1)**	**3,159 (8.5)**	**5,568 (15.1)**	**1,553 (4.2)**	**36,984**	**10,870**	**7,121 (65.5)**

694

695 The table includes patients with all three regions identified (N=36,984). Percentages for patterns 1–5 use the
696 row total as the denominator; those in the last column use patients with out-of-region rehabilitation in that row.
697 Patterns follow Table 2: 1, R=P=H; 2, R=P≠H; 3, R=H≠P; 4, P=H≠R; and 5, all three different. Out-of-region
698 rehabilitation comprises patterns 2, 4, and 5, of which patterns 4 and 5 also involve out-of-region preceding
699 admission. [a] The distributions of the five patterns differed between cycles (χ^2=31.57, df=4, p<0.001; Cramér's
700 V=0.029).

Table 6. Regional shares of program users by attribution point, and numbers of designated institutions

	Residence and preceding admission (N=36,984)[a]			Residence and rehabilitation institution (N=37,477)[b]			Institutions[c]
Region	**Residence, n (%)**	**Preceding admission, n (%)**	**Difference, pp**	**Residence, n (%)**	**Rehabilitation institution, n (%)**	**Difference, pp**	**Cycle 1 / 2, n**
Seoul	4,739 (12.81)	7,086 (19.16)	+6.35	4,788 (12.78)	3,944 (10.52)	−2.25	5 / 7
Busan	2,686 (7.26)	2,867 (7.75)	+0.49	2,754 (7.35)	3,218 (8.59)	+1.24	7 / 6
Daegu	2,271 (6.14)	3,216 (8.70)	+2.56	2,294 (6.12)	3,365 (8.98)	+2.86	5 / 5
Incheon	2,566 (6.94)	2,672 (7.22)	+0.29	2,598 (6.93)	3,371 (8.99)	+2.06	2 / 3
Gwangju	1,246 (3.37)	2,014 (5.45)	+2.08	1,258 (3.36)	2,257 (6.02)	+2.67	3 / 3
Daejeon	2,072 (5.60)	2,870 (7.76)	+2.16	2,116 (5.65)	3,614 (9.64)	+4.00	3 / 4
Ulsan*	104 (0.28)	82 (0.22)	−0.06	105 (0.28)	0 (0.00)	−0.28	0 / 0
Sejong*	373 (1.01)	230 (0.62)	−0.39	377 (1.01)	0 (0.00)	−1.01	0 / 0
Gyeonggi	7,322 (19.80)	6,808 (18.41)	−1.39	7,380 (19.69)	8,830 (23.56)	+3.87	10 / 11
Gangwon	1,790 (4.84)	1,670 (4.52)	−0.32	1,856 (4.95)	1,541 (4.11)	−0.84	1 / 1
Chungbuk	2,553 (6.90)	2,199 (5.95)	−0.96	2,586 (6.90)	2,544 (6.79)	−0.11	3 / 4
Chungnam	2,630 (7.11)	1,659 (4.49)	−2.63	2,668 (7.12)	1,808 (4.82)	−2.29	2 / 2
Jeonbuk	1,727 (4.67)	1,443 (3.90)	−0.77	1,740 (4.64)	1,297 (3.46)	−1.18	1 / 1
Jeonnam*	1,296 (3.50)	278 (0.75)	−2.75	1,305 (3.48)	0 (0.00)	−3.48	0 / 0
Gyeongbuk	1,714 (4.63)	545 (1.47)	−3.16	1,733 (4.62)	517 (1.38)	−3.24	1 / 2
Gyeongnam	1,466 (3.96)	949 (2.57)	−1.40	1,480 (3.95)	770 (2.05)	−1.89	1 / 3
Jeju	429 (1.16)	396 (1.07)	−0.09	439 (1.17)	401 (1.07)	−0.10	1 / 1
Total	**36,984 (100.00)**	**36,984 (100.00)**		**37,477 (100.00)**	**37,477 (100.00)**		**45 / 53**

The attribution point is the region in which patients are counted: residence, preceding admission, or rehabilitation institution. The regions follow the order of official Korean statistics (see Table 4). Each comparison counts the same patient at two attribution points, and percentages use that comparison's N. The difference is the preceding-admission-based or rehabilitation-based share minus the residence-based share in percentage points (pp). It was calculated from the counts before rounding and may differ by 0.01 from the difference between the rounded shares.

[a] This comparison includes patients with all three regions identified. The index of dissimilarity was 13.91%, which is the minimum percentage of patients who would need to be counted in different regions to make the aggregate distributions identical.

[b] This comparison includes patients with residence and rehabilitation regions identified, including 493 without an identified preceding-inpatient region. The index is 16.69%.

[c] Institution counts are for cycle 1 / cycle 2. Cycle 1 comprised 45 institutions designated between March 2020 and January 2021 [15]. From March to December 2020, there were 26, with none in Jeonbuk, Gyeongbuk, and Gyeongnam; therefore, the residents of these regions had no local designated institution before January 2021. Cycle 2 comprised 53 institutions designated in March 2023, listed with their designated beds (10,451 in total) in the draft amendment's annex proposing third-cycle bed targets [21]. *No designated institutions were located in the region during the study period.

Figure legends

Fig. 1 Five mutually exclusive patterns of agreement among the residence, preceding-inpatient, and rehabilitation regions.

Each row shows one pattern. X, Y, and Z are arbitrary region labels; matching letters and colors denote the same region. R, registered residence region; P, preceding-inpatient region (the region of the most recent eligible inpatient episode, excluding long-term care hospital stays, ending on the day of

admission to the rehabilitation institution or within the 90 days before it); H, rehabilitation region. Patterns 2, 4, and 5 constitute out-of-region rehabilitation; patterns 3, 4, and 5 constitute an out-of-region preceding admission.

Fig. 2 Identification of the three regions.

The cohort comprised 37,480 patients with a first program inpatient claim. The registered residence region was identified from qualification (eligibility) records for 37,477 patients and the preceding-inpatient region from claims for 36,987 patients. The rehabilitation region was identified from the healthcare institution table for all 37,480 patients. All three regions were identified for 36,984 patients. R, registered residence region; P, preceding-inpatient region; H, rehabilitation region.

Fig. 3 Rehabilitation outside the residence region, by region of residence.

a Percentage of residents with all three regions identified who received rehabilitation outside their residence region. **b** Region of the preceding admission among residents with out-of-region rehabilitation: the residence, rehabilitation, or third region. Numbers within bars are percentages; segments below 5% are not labeled. Regions are ordered, from highest to lowest, by the percentage in panel b whose preceding admission was outside the residence region (rehabilitation region plus third region). The n on the right is the number of residents with out-of-region rehabilitation. *No designated institution was located in the region during the study period.

Fig. 4 Regional shares of program users counted at the residence, preceding admission, and rehabilitation institution.

Each panel compares regional shares of the same patients across the 17 regions. Gray bars show residence-based shares. Blue bars show preceding-admission-based shares in **a** (36,984 patients with all three regions identified) and rehabilitation-based shares in **b** (37,477 patients with residence and rehabilitation regions identified, including 493 without an identified preceding-inpatient region). Values at bar ends are percentages of the panel's analysis population; counts are in Table 6. The index of dissimilarity is 13.91% in **a** and 16.69% in **b**. It is the minimum percentage of patients who would need to be counted in different regions to make the aggregate distributions identical, not a measure of

individual patient movement. The regions follow the order in official Korean statistics (see Table 4).

*No designated institution was located in the region during the study period; its rehabilitation-based share is zero.

Figures (for review only; submitted as separate files)

Fig. 1

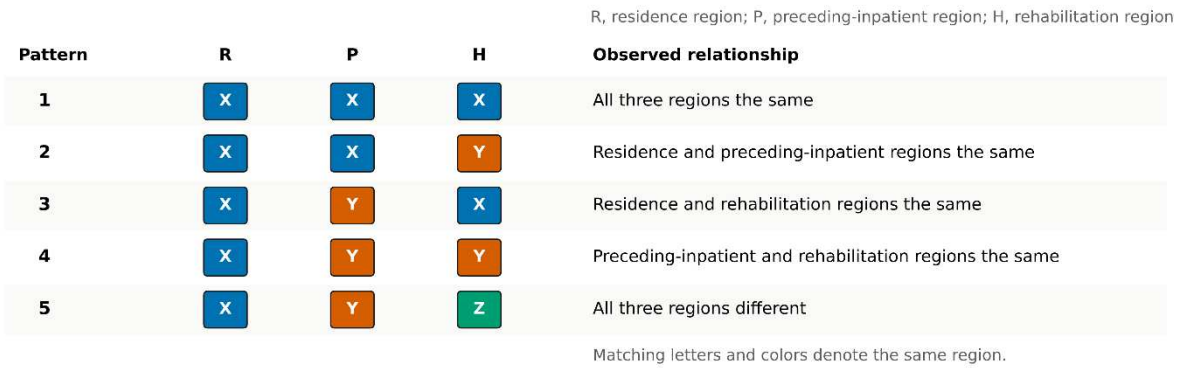
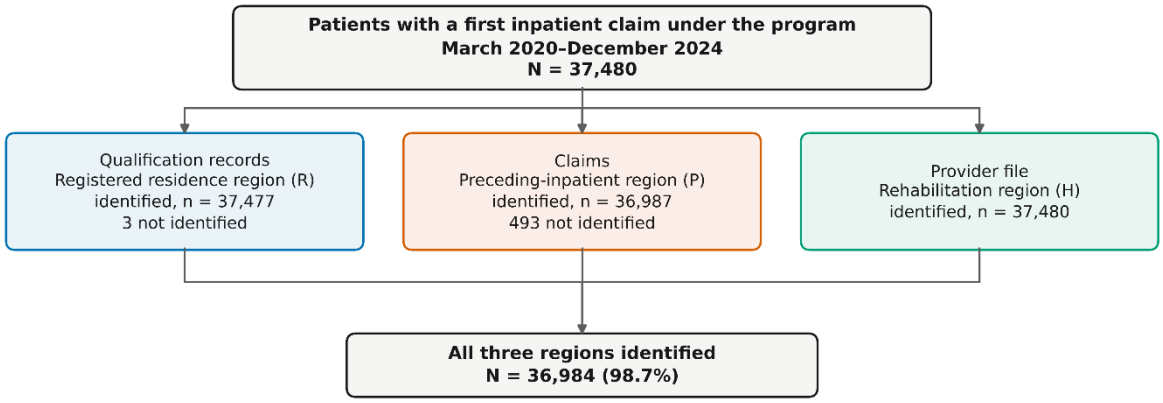
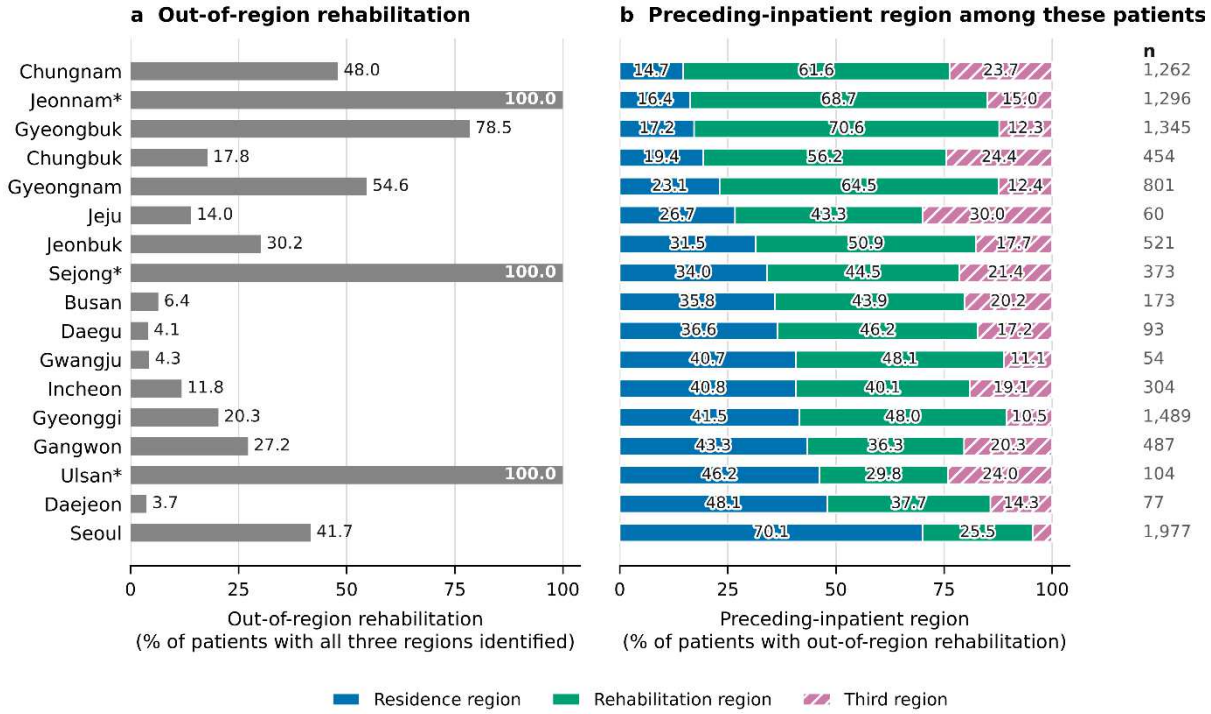


Fig. 2

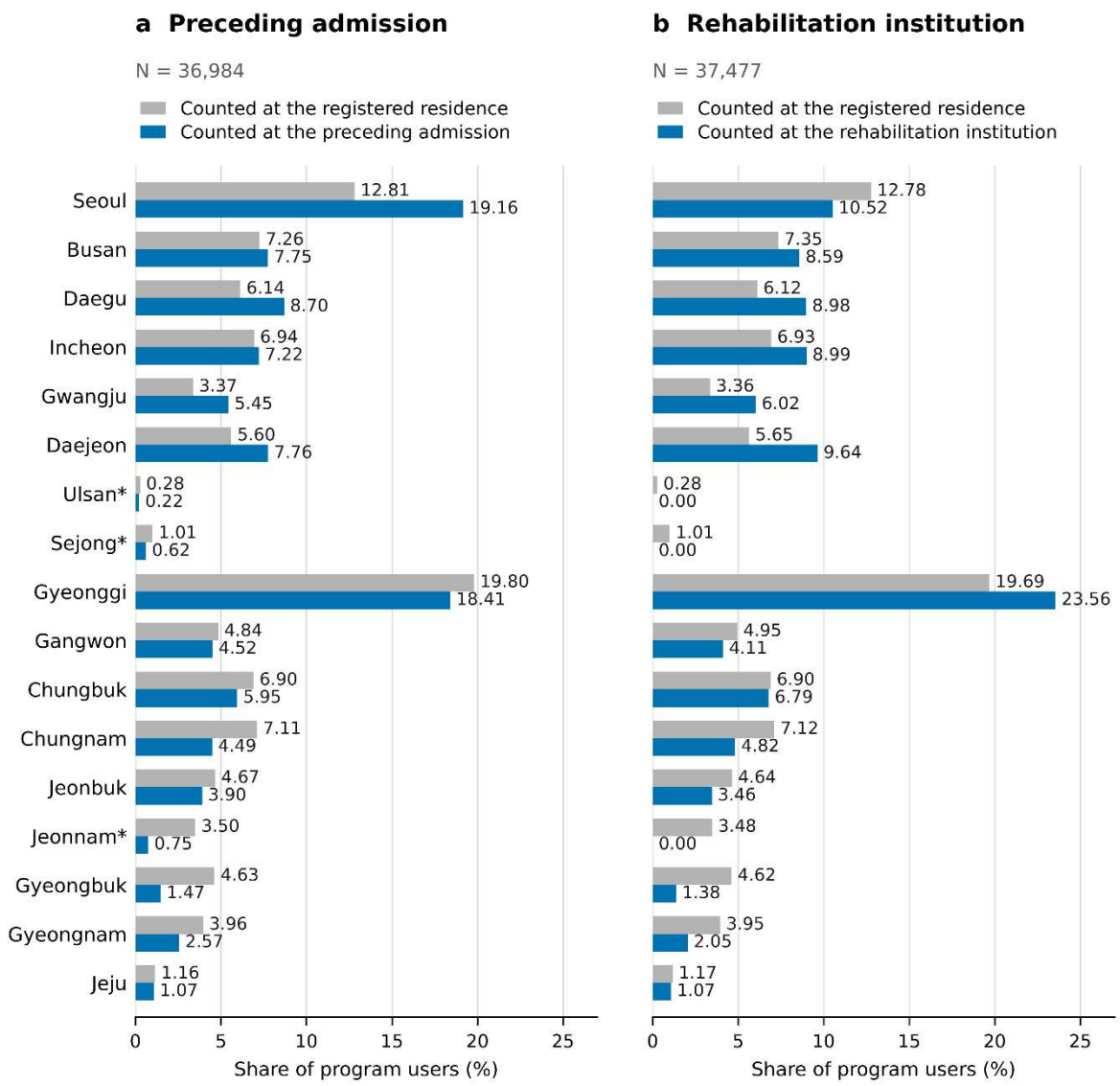


761 **Fig. 3**


a Out-of-region rehabilitation
b Preceding-inpatient region among these patients
n
Chungnam 48.0 14.7 61.6 23.7 1,262
Jeonnam* 100.0 16.4 68.7 15.0 1,296
Gyeongbuk 78.5 17.2 70.6 12.3 1,345
Chungbuk 17.8 19.4 56.2 24.4 454
Gyeongnam 54.6 23.1 64.5 12.4 801
Jeju 14.0 26.7 43.3 30.0 60
Jeonbuk 30.2 31.5 50.9 17.7 521
Sejong* 100.0 34.0 44.5 21.4 373
Busan 6.4 35.8 43.9 20.2 173
Daegu 4.1 36.6 46.2 17.2 93
Gwangju 4.3 40.7 48.1 11.1 54
Incheon 11.8 40.8 40.1 19.1 304
Gyeonggi 20.3 41.5 48.0 10.5 1,489
Gangwon 27.2 43.3 36.3 20.3 487
Ulsan* 100.0 46.2 29.8 24.0 104
Daejeon 3.7 48.1 37.7 14.3 77
Seoul 41.7 70.1 25.5 1,977
0 25 50 75 100
Out-of-region rehabilitation
(% of patients with all three regions identified)
0 25 50 75 100
Preceding-inpatient region
(% of patients with out-of-region rehabilitation)
Residence region
Rehabilitation region
Third region

762

763 **Fig. 4**



Within each panel the same patients are counted in two ways; percentages are of the N of the panel.
* No designated institution was located in the region during the study period.

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