

Community-based primary care and inpatient costs and length of stay in Henan, China: retrospective cohort study of 5.9 million older adults

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Abstract

Background

Community-based primary care is a cornerstone for managing chronic disease in ageing populations, but whether prior enrolment is associated with resource use during subsequent admissions is not well established. We examined whether enrolment in China's National Essential Public Health Services (NEPHS) elderly health management programme before admission was associated with inpatient costs and length of stay among older adults.

Methods

We conducted a retrospective cohort study (2019–2024) linking public hospital discharge records, the NEPHS elderly health management registry, and patient identifier files from Henan Province, China. Adults aged 65 years or older with at least one inpatient admission were eligible. The exposure was NEPHS enrolment recorded before the index admission, with management duration categorised as 3 years or less, 4 to 9 years, or 10 years or more. Outcomes were total inpatient costs (log scale) and length of stay, estimated by multivariable linear regression and compared with inverse probability of treatment weighting, overlap weighting, propensity score matching, and within-person fixed effects contrasts. The Charlson Comorbidity Index (CCI) was examined as a candidate clinical pathway.

Results

Of 19,425,809 admissions among 5,938,289 patients, 10,377,454 occurred after NEPHS enrolment (mean [SD] age, 73.15 [6.13] years) and 9,048,355 among patients not enrolled (74.89 [7.30] years). In the primary adjusted model, enrolment was associated with 9.9% lower total inpatient costs (95% CI -10.1% to -9.8%) and a 0.68 day shorter length of stay (95% CI -0.70 to -0.66). Weighted and matched estimates were consistent in direction; within-person estimates were smaller (2.6% lower cost). Concurrent CCI accounted for 32.7% of the cost association and 26.9% of the length-of-stay association. Associations were larger with longer management duration and among patients aged 85 years or older, those with a CCI of 3 or greater, and admissions covered by the New Rural Cooperative Medical Scheme.

Conclusions

Prior NEPHS enrolment was associated with lower per-admission inpatient costs and shorter length of stay, with larger differences among patients with greater comorbidity burden. These are observational associations; prospective or quasi-experimental studies are needed before causal or resource allocation

Introduction

Population ageing and multimorbidity present substantial challenges for health systems delivering long-term care for older adults [1]. The World Health Organization's framework for integrated care emphasises person-centred assessment, longitudinal management, and coordinated pathways in primary care for older adults with complex needs [1, 2]. A stronger primary care orientation is generally associated with better population outcomes, though the evidence base remains heterogeneous and context dependent [3, 4]. Most of this literature examines whether primary care prevents avoidable admissions, improves mortality, or aids chronic disease control [5]. Multimorbidity and frailty are well-established drivers of hospital use, though evidence on length of stay is less consistent [6, 7]. For health systems building scalable community-based programmes, a critical unresolved question is whether prior enrolment in community-based primary care is associated with lower inpatient resource use when older adults are admitted.

China combines one of the world's largest older populations with a national policy platform for community-based primary care. By the end of 2025, China had 223.65 million people aged 65 years or older, representing 15.9% of the national population [8, 9]. Launched in 2009, the National Essential Public Health Services (NEPHS) programme delivers a nationally specific package of public health and individual health management services free of charge through township health centres and community health service centres [10–15]. Nationally, 141.36 million people aged 65 years or older received health management through primary health care institutions in 2024, approximately 64% of that age group [16]. Henan is a populous central province with substantial urban-rural diversity that implements NEPHS within this national framework. Previous research in rural Henan found that use of NEPHS elderly health management services varied by income and access-related factors despite free provision [17]. Existing evaluations of NEPHS have largely examined hypertension control, chronic disease management, and service utilisation, with cost outcomes generally confined to drug or service costs within primary care facilities [15, 18–20]. Few have linked large-scale inpatient administrative records, examined resource use conditional on admission, or separated within-person from population-level contrasts, and many treat comorbidity burden as a baseline confounder rather than as a candidate clinical pathway.

Using province-wide linked public hospital records from Henan, we examined whether NEPHS enrolment before admission was associated with total inpatient costs and length of stay among adults aged 65 years or older admitted between 2019 and 2024, and whether associations varied by management duration and across clinical, insurance-defined, and regional subgroups.

Methods

Data Sources

We conducted a retrospective cohort study using province-wide public hospital inpatient discharge records for older adults admitted in Henan Province, China, between 2019 and 2024. Three data sources were linked. First, standardised inpatient discharge front-page summaries, the standard discharge abstract of the inpatient medical record, submitted to provincial health authorities by inpatient

institutions across Henan; 2231 institutions reported during 2019–2024, and the 883 at the secondary level or above accounted for 94.5% of admissions among adults 65 years or older. Second, the NEPHS elderly health management information system, maintained by the Henan Provincial Health Commission, which provided recorded enrolment dates. Third, patient identifier files, which linked the first two sources through pseudonymized identity codes derived from national resident identity card numbers. Linked records included demographic characteristics, admission and discharge dates, International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) diagnoses, procedure codes, itemised charges, insurance type, region, enrolment status, costs, and length of stay (Fig. 1).

The NEPHS elderly health management programme is a statutory service provided free of charge to residents 65 years or older, comprising an annual health examination, health risk assessment, health guidance, and health-record updating; those with recorded hypertension or type 2 diabetes also receive protocolized chronic-disease follow-up [14, 15]. The unit of analysis was the inpatient admission; patient identifiers were used for linkage, clustering of standard errors, prior-admission comorbidity measures, and within-person analyses. Reporting follows the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) guideline; the completed checklist is provided in eTable 11 [21]. The study was approved by the Research, New Technology and New Service Ethics Committee of Fuwai Central China Cardiovascular Hospital (approval number [2025] Ethics Review No. 25), which waived the requirement for informed consent because the analysis used pre-existing, deidentified administrative records.

Study Population

The eligible linked cohort included 21,545,177 inpatient admissions among 6,650,335 patients aged 65 years or older. We excluded 459,048 admissions with records outside 2019 to 2024, missing sex, invalid length of stay (0 days or less, or more than 365 days), missing or invalid total costs (0 yuan or less), or more than 30 admissions per patient-year, a threshold applied to truncate extreme values in the admission-frequency distribution. This left 21,086,129 admissions among 6,591,380 patients. After further excluding 1,660,320 admissions with missing core covariates, the primary complete-covariate cohort included 19,425,809 admissions among 5,938,289 patients (Fig. 1).

Conceptual Framework

Our conceptual framework (eFigure 1) treats recorded NEPHS enrolment as an implemented primary care exposure rather than a randomly assigned intervention, acting on inpatient resource use through earlier identification and sustained control of chronic conditions, which shape the comorbidity burden recorded at admission [2, 15]. The Charlson Comorbidity Index (CCI) at admission is therefore treated as a candidate intermediate clinical state rather than a baseline confounder, and the primary model excludes CCI [22].

Exposures and Outcomes

Admissions were classified as enrolled if the patient held an enrolment record dated before the admission date. This lagged definition was intended to reduce reverse-causality bias from enrolments triggered by the admission itself; a concurrent-enrolment definition was assessed in sensitivity analyses. The registry records entry into managed status but not disenrolment, so enrolment is an absorbing state and within-person change occurs only from non-enrolled to enrolled. Management duration, the elapsed time between initial NEPHS enrolment and the admission date, was categorised as 3 years or less, 4 to 9 years, or 10 years or more, with non-enrolled admissions as the reference category.

The primary outcomes were total inpatient costs and length of stay. Total costs were the charges recorded on the discharge summary, irrespective of payer and not restricted to the out-of-pocket component, in nominal Chinese yuan, analysed on the natural logarithmic scale due to right-skewed distributions. Log-cost coefficients were transformed to approximate percentage differences as $100 \times (\exp[\text{coefficient}] - 1)$. Length of stay was measured in days and analysed as a continuous outcome.

Covariates

Core measured confounders selected a priori were age group (65–74, 75–84, and 85 years or older), sex (male, female), marital status (married, widowed, other), insurance type (Urban Employee Basic Medical Insurance [UEBMI], Urban-Rural Resident Basic Medical Insurance [URBMI], New Rural Cooperative Medical Scheme [NRCMS], self-pay, and other), geographic region (central, eastern, western, northern, and southern Henan), admission year, and admission quarter (first through fourth). Although NRCMS has been formally integrated into a unified urban-rural resident scheme, the label persists in discharge coding and was interpreted as indicating rural resident coverage. Comorbidity burden was measured with the CCI, a weighted summary of chronic conditions derived from ICD-10 diagnoses in which higher scores indicate greater burden, calculated with the Quan algorithm and standard Charlson weights and categorised as 0, 1 to 2, and 3 or greater [22]. Surgical admission (yes, no) was identified from surgery-related procedure or charge information, and principal diagnosis category (circulatory, respiratory, digestive, nervous, injury and musculoskeletal, neoplasm, endocrine, other) was mapped from ICD-10 chapters for clinical-adjustment and exploratory analyses.

Statistical Analysis

We used complementary approaches to separate the population-level association from design-balanced and within-person contrasts. Standard errors were clustered at the patient level. For the population-level contrast, we estimated three multivariable linear regression models. Model 1 (primary) adjusted for age group, sex, marital status, insurance type, geographic region, admission year, and admission quarter, the latter two accounting for secular changes in prices, payment policies, and case mix. Model 1 was designated primary because CCI, principal diagnosis category, and surgical admission could lie on the pathway between primary care and inpatient resource use. Model 2 added CCI to assess attenuation

compatible with a comorbidity pathway, and Model 3 further added principal diagnosis category and surgical admission.

For design-balanced contrasts, we estimated a propensity score for NEPHS enrolment using continuous age, sex, marital status, insurance type, geographic region, admission year, and admission quarter. We implemented stabilized inverse probability of treatment weighting (IPTW) and overlap weighting in the full complete-covariate cohort, and propensity score matching at the patient level as 1:1 nearest-neighbour matching without replacement on the logit of the propensity score, with exact matching on admission year and a caliper of 0.05 standard deviations [23–25]. Balance was assessed using standardised mean differences (SMDs), with an absolute SMD below 0.10 considered adequate.

For the within-person contrast, we fitted individual fixed-effects models among patients whose NEPHS enrolment status changed across admissions, including patient fixed effects and calendar-period controls. These models control for time-invariant patient characteristics but apply only to patients whose status changed. We did not interpret the fixed-effects estimate as superior to the population-level or design-balanced estimates; it was used to assess the extent to which time-invariant unmeasured differences might account for between-person associations.

We evaluated comorbidity as a candidate pathway using change-in-coefficient attenuation and mediation decomposition under the Imai, Keele, and Tingley framework with quasi-Bayesian simulation, with concurrent CCI as the primary candidate mediator and prior-admission and secondary-diagnosis-only CCI as conservative specifications [26]. Mediation results were interpreted as pathway evidence rather than proof of mechanism. Management duration was modelled using the categorical groups defined above; because these cut points are not clinically established, restricted cubic splines were also fitted as a specification check that does not depend on the categorisation (eFigure 5). Subgroup heterogeneity was assessed by age group, CCI category, insurance type, and geographic region using interaction terms.

The primary population-level and design-balanced analyses used the full complete-covariate cohort of 19,425,809 admissions among 5,938,289 patients. Prior-admission CCI analyses were restricted to admissions with an earlier inpatient admission recorded within the study window. Individual fixed-effects analyses were restricted to the 297,179 patients whose enrolment status changed across admissions, contributing 1,777,499 admissions. Mediation decomposition was conducted in the analytic subset containing the variables required for the decomposition. Sample sizes for each analysis are reported in the corresponding eTables.

Prespecified sensitivity analyses included alternative (concurrent) exposure definitions, exclusion of 2020, period-specific analyses, exclusion of flagged or Z-code admissions, cost trimming, patient-level mean outcomes, restriction to single-admission patients, individual fixed effects, and E-values for unmeasured confounding [27]. All analyses were conducted using R version 4.5.0 (R Foundation for Statistical Computing) and Python version 3.8.

Results

Cohort Baseline Characteristics

The complete-covariate cohort included 19,425,809 admissions among 5,938,289 patients aged 65 years or older (Fig. 1). Of these admissions, 10,377,454 occurred after NEPHS enrolment and 9,048,355 occurred among patients not enrolled before admission. Baseline characteristics differed between groups (Table 1). The largest imbalance was admission year (SMD, 0.667), with 3,389,529 enrolled (32.7%) and 1,138,015 non-enrolled admissions (12.6%) in 2024; insurance type also differed (SMD, 0.341). Compared with non-enrolled admissions, enrolled admissions involved younger patients (mean [SD] age, 73.15 [6.13] vs 74.89 [7.30] years) with a lower recorded comorbidity burden (mean [SD] CCI, 1.56 [1.57] vs 1.91 [1.82]), a lower median inpatient cost (5373.51 vs 6191.21 CNY), and a shorter mean length of stay (8.92 vs 10.22 days) (Table 1).

Table 1
Baseline Characteristics by NEPHS Enrolment Status

Characteristic	Not enrolled	NEPHS enrolled	SMD
No. of admissions	9,048,355	10,377,454	—
Admission year	—	—	0.667
2019	1,459,745 (16.1)	672,174 (6.5)	—
2020	1,539,861 (17.0)	867,707 (8.4)	—
2021	1,704,135 (18.8)	1,153,712 (11.1)	—
2022	1,603,251 (17.7)	1,532,085 (14.8)	—
2023	1,603,348 (17.7)	2,762,247 (26.6)	—
2024	1,138,015 (12.6)	3,389,529 (32.7)	—
Age, mean (SD)	74.89 (7.30)	73.15 (6.13)	0.258
Female sex, n (%)	4,072,047 (45.0)	5,396,799 (52.0)	0.140
Insurance type	—	—	0.341
UEBMI	2,594,491 (28.7)	1,863,879 (18.0)	—
URBMI	2,086,937 (23.1)	3,793,426 (36.6)	—
NRCMS	2,697,101 (29.8)	2,842,616 (27.4)	—
Self-pay	700,457 (7.7)	722,112 (7.0)	—
Other	969,369 (10.7)	1,155,421 (11.1)	—
Region	—	—	0.199
Central	1,597,851 (17.7)	1,973,754 (19.0)	—
East	1,892,925 (20.9)	2,406,292 (23.2)	—
West	1,297,582 (14.3)	849,830 (8.2)	—
North	1,731,940 (19.1)	2,204,147 (21.2)	—
South	2,528,057 (27.9)	2,943,431 (28.4)	—
Charlson comorbidity index, mean (SD)	1.91 (1.82)	1.56 (1.57)	0.204

Values are No. (%) unless otherwise indicated. SD indicates standard deviation; IQR, interquartile range; SMD, standardised mean difference; CCI, Charlson Comorbidity Index; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban-Rural Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme. Costs were right-skewed; median (IQR) values are shown. Mean (SD) values are reported in eTable 1. Model estimates used log-transformed cost.

Characteristic	Not enrolled	NEPHS enrolled	SMD
CCI category	—	—	0.173
CCI = 0	2,016,360 (22.3)	2,824,176 (27.2)	—
CCI = 1–2	4,660,268 (51.5)	5,524,377 (53.2)	—
CCI ≥ 3	2,371,727 (26.2)	2,028,901 (19.6)	—
Principal diagnosis category	—	—	0.250
Circulatory	2,924,628 (32.3)	3,526,308 (34.0)	—
Respiratory	1,092,062 (12.1)	1,026,445 (9.9)	—
Digestive	683,284 (7.6)	842,084 (8.1)	—
Eye and ear	371,610 (4.1)	688,502 (6.6)	—
Injury and musculoskeletal	405,778 (4.5)	616,777 (5.9)	—
Other (11 categories)	2,390,586 (26.4)	2,716,241 (26.2)	—
Surgical admission, n (%)	2,362,983 (26.1)	3,009,578 (29.0)	0.065
Total inpatient cost (CNY), median (IQR) ¹	6191.21 (3781.86–11555.39)	5373.51 (3460.17–9535.19)	—
Length of stay (days), mean (SD)	10.22 (10.31)	8.92 (8.18)	0.139
Values are No. (%) unless otherwise indicated. SD indicates standard deviation; IQR, interquartile range; SMD, standardised mean difference; CCI, Charlson Comorbidity Index; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban-Rural Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme. Costs were right-skewed; median (IQR) values are shown. Mean (SD) values are reported in eTable 1. Model estimates used log-transformed cost.			

Associations With Inpatient Costs and Length of Stay

In Model 1, NEPHS enrolment before admission was associated with lower total inpatient costs (log-cost coefficient, -0.105; 95% CI, -0.106 to -0.103; $P < .001$), corresponding to approximately 9.9% lower costs (95% CI, -10.1% to -9.8%), and with a shorter length of stay (coefficient, -0.679 days; 95% CI, -0.697 to -0.661; $P < .001$) (Fig. 2; eTable 2). After IPTW and overlap weighting, all covariates had absolute SMDs of 0.015 or less, and the estimated cost differences were - 9.9% and - 10.1%, respectively. Matching balanced admission year exactly but left residual imbalance in insurance type (SMD, 0.149) and restricted the sample to 3,782,666 admissions; the matched cost difference was - 12.5%, and - 8.8% when CCI was added to the propensity model. Length-of-stay differences ranged from - 0.405 to -0.675 days across these specifications (eTables 3 and 4 and eFigure 2).

The within-person fixed-effects analysis included 1,777,499 admissions among 297,179 patients whose enrolment status changed. NEPHS enrolment was associated with an estimated 2.6% lower total costs

(log-cost coefficient, -0.027; 95% CI, -0.034 to -0.019) and a 0.274-day shorter stay (95% CI, -0.341 to -0.206) (eTables 3 and 10 and eFigure 6).

Comorbidity Burden as a Candidate Pathway

Adjustment for concurrent CCI attenuated the estimated associations (Fig. 3A; eTable 2 and eFigure 3). For log total costs, the coefficient was -0.133 (95% CI, -0.134 to -0.131) unadjusted, -0.105 after adjustment for the primary covariates, -0.071 after adding concurrent CCI, and -0.059 after further adjustment for principal diagnosis category and surgical admission; for length of stay, the corresponding coefficients were -1.294, -0.679, -0.511, and -0.492 days. In the mediation decomposition, concurrent CCI accounted for an estimated 32.7% of the cost association and 26.9% of the length-of-stay association; proportions were smaller under the conservative specifications (19.1% and 9.9% using prior-admission CCI; 25.2% and 13.6% using secondary diagnoses only) (eTables 5 and 6).

Associations by Management Duration

Associations increased across management duration categories (Fig. 3B). Compared with non-enrolled admissions, management for 3 years or less was associated with an estimated 8.1% lower cost (log-cost coefficient, -0.085; 95% CI, -0.087 to -0.083) and a 0.553-day shorter stay (95% CI, -0.576 to -0.531); for 4 to 9 years with a 9.8% lower cost and a 0.677-day shorter stay; and for 10 years or more with an 11.5% lower cost (-0.123; 95% CI, -0.125 to -0.120) and a 0.784-day shorter stay (95% CI, -0.805 to -0.762). Spline analyses suggested a nonlinear association for both outcomes (eFigure 5).

Subgroup Heterogeneity

Associations differed by age group (Fig. 4; eTable 9 and eFigure 4). The estimated cost difference was -9.1% at ages 65 to 74 years, -10.4% at 75 to 84 years, and -13.4% at 85 years or older (P for interaction < .001); corresponding length-of-stay differences were -0.539, -0.768, and -1.321 days. By comorbidity, the cost difference was -3.9% at a CCI of 0, -8.4% at 1 to 2, and -9.0% at 3 or greater (P for interaction < .001). By insurance type, it was largest among NRCMS-covered admissions (-12.5%) and smallest among self-pay admissions (-6.3%; P for interaction < .001). Regional estimates differed without a consistent geographic pattern across both outcomes (eTable 9).

Sensitivity Analyses

The direction of associations was unchanged across prespecified sensitivity analyses (eTable 7 and eFigure 7). Excluding 2020 yielded an estimated 9.8% lower cost and a 0.647-day shorter stay; restricting to 2024 yielded a 6.8% lower cost and a 0.462-day shorter stay (eTable 8). The E-value was 1.46 for the primary cost association and 3.36 for length of stay. In exploratory analyses stratified by principal diagnosis, the cost association was reversed among neoplasm admissions (eTable 9).

Discussion

In this province-wide cohort study, prior enrolment in the NEPHS elderly health management programme was associated with lower inpatient costs and a shorter length of stay per admission. Weighted contrasts aligned closely with the primary adjusted estimates, whereas within-person fixed-effects estimates were more conservative. The weighting analyses balanced measured covariates closely, whereas matching restricted the sample and left residual imbalance in insurance type, the dimension with the largest subgroup heterogeneity. The attenuation from -12.5% to -8.8% when CCI entered the propensity model parallels the attenuation from Model 1 to Model 2. Patients whose enrolment status changed had more admissions per patient and differed from those whose status did not, so those estimates apply to a distinct subgroup. Together, the contrasts indicate that the population-level association reflects both a within-person component and residual between-person selection.

Our findings address a critical gap in the primary care literature. Although strong primary care systems are widely theorized to improve chronic disease management and lower avoidable hospital use [1, 3, 4, 12], empirical evidence on their association with inpatient resource use remains mixed [5]. Previous evaluations of NEPHS have largely relied on survey data, disease-specific cohorts, or programme-level variation [13, 15, 18–20]. Recent linked-record studies show how primary care and hospital data can examine care pathways in routine health systems [28, 29]. Our study addresses a narrower operational question: among older adults who are admitted, is prior community-based primary care associated with lower per-admission resource intensity? Separating population-level, design-balanced, and within-person contrasts matters because routine programmes are implemented through policy but realized through local delivery, documentation, and patient engagement rather than random assignment.

The comorbidity findings are clinically plausible but require careful framing. Attenuation after adding CCI is compatible with comorbidity burden contributing to part of the association; the secondary-diagnosis-only specification reduces, but does not eliminate, concern that this pattern is driven mechanically by the principal diagnosis of the index admission, while prior-admission CCI provides a more conservative, temporally preceding specification. Mediation decomposition rests on assumptions that cannot be verified in these data (eg, no unmeasured confounding) [26]. Costs and length of stay are the resource-use outcomes of direct interest to payers but are not measures of care quality: shorter stays can reflect better coordination, whereas premature discharge can worsen outcomes or shift care to other settings [30]. Because our data lacked post-discharge information such as readmission, mortality, or discharge destination, shorter length of stay cannot be interpreted as improved care.

Residual selection remains the central identification limitation. Recorded enrolment marks entry into managed status rather than verified receipt of services and is not randomly assigned; it can differ by local implementation, access, documentation, and patient engagement. Enrolled and non-enrolled admissions differed materially by admission year, insurance type, age group, and recorded comorbidity. Regression, weighting, and matching improve comparability on measured characteristics but cannot remove unmeasured differences in health-seeking behaviour, family support, care access, or local delivery quality [23]. Fixed-effects models address time-invariant characteristics but apply only to patients whose enrolment status changed [31]. The E-value of 1.46 indicates that the cost association

could be explained by an unmeasured confounder of modest strength, whereas the E-value of 3.36 indicates the length-of-stay association is less vulnerable. These estimates should be read as complementary contrasts that bound the observational evidence rather than as competing estimates of a single causal effect.

The subgroup patterns are informative for care delivery rather than financial conclusions. The strongest associations were among patients aged 85 years or older and those with a CCI of 3 or greater, suggesting that community-based primary care may be most beneficial for patients with the greatest comorbidity burden. The stronger cost association among NRCMS-covered admissions may have equity implications for a rural insurance group, but the smaller self-pay associations caution against a broad claim that all disadvantaged groups benefit more [13, 17]. Three implications follow for practice and policy. First, because the programme alters neither insurance benefits nor hospital payment, any operational gain must arise through the care pathway, placing emphasis on service content rather than financing. Second, the gradient across management duration suggests that retention, rather than one-time registration, is the dimension most likely to matter. Third, performance assessment may need to extend beyond registration coverage to effective contact, documented follow-up, and management quality, with prospective evaluation targeted at high-comorbidity and rural-insured older adults [2, 9].

Limitations

Beyond the identification issues discussed above, several limitations apply. Administrative coding and the CCI do not capture disease severity, functional status, frailty, or social support, and recorded charges may reflect secular price and payment changes despite calendar-period adjustment. The data contained no vital-status variable, so mortality could be neither adjusted for nor examined. Records came from public hospitals in a single province rather than all care settings, and complete-case restriction may affect representativeness.

Conclusions

In this cohort study of older adults admitted to public hospitals in Henan, prior enrolment in the NEPHS elderly health management programme was associated with lower per-admission inpatient costs and shorter length of stay, with stronger associations among patients aged 85 years or older and those with a higher comorbidity burden. These findings remain observational. Prospective or quasi-experimental studies incorporating richer clinical and quality-of-care outcomes are needed before drawing causal inferences or making resource-allocation decisions.

Declarations

Ethics approval and consent to participate

This study was approved by the Research, New Technology and New Service Ethics Committee of Fuwai Central China Cardiovascular Hospital (approval number [2025] Ethics Review No. 25). The same

committee waived the requirement for informed consent to participate, because the study was a retrospective analysis of pre-existing, deidentified administrative records and involved no contact with participants and no intervention. All methods were carried out in accordance with relevant guidelines and regulations, including the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

JD and ZW contributed equally as co-first authors. JD, ZW, and LH conceived and designed the study. JD, ZW, DX, HW, ZG, QZ, ND, TJ, TC, YS, and RL acquired, analysed, or interpreted the data. JD and ZW drafted the manuscript. DX, HW, SG, ZG, QZ, ND, TJ, TC, YS, ZM, RL, and LH critically reviewed the manuscript for important intellectual content. ZW and DX did the statistical analysis. LH obtained funding. HW, ND, TJ, TC, and RL provided administrative, technical, or material support. RL and LH supervised the study. ZW had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. RL is the guarantor, accepts full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish. All authors read and approved the final manuscript.

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Data Availability

The individual-level hospital discharge and NEPHS registry data used in this study are owned by the Health Commission of Henan Province and cannot be shared publicly owing to data governance regulations and patient privacy requirements under Chinese data protection law. Aggregate summary statistics, covariate balance diagnostics, and analysis code are available from the corresponding authors upon reasonable request. Requests for data access should be directed to the Grassroots Health Department, Health Commission of Henan Province.

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Figures

Figure 1. Data linkage, cohort construction, and exposure timing

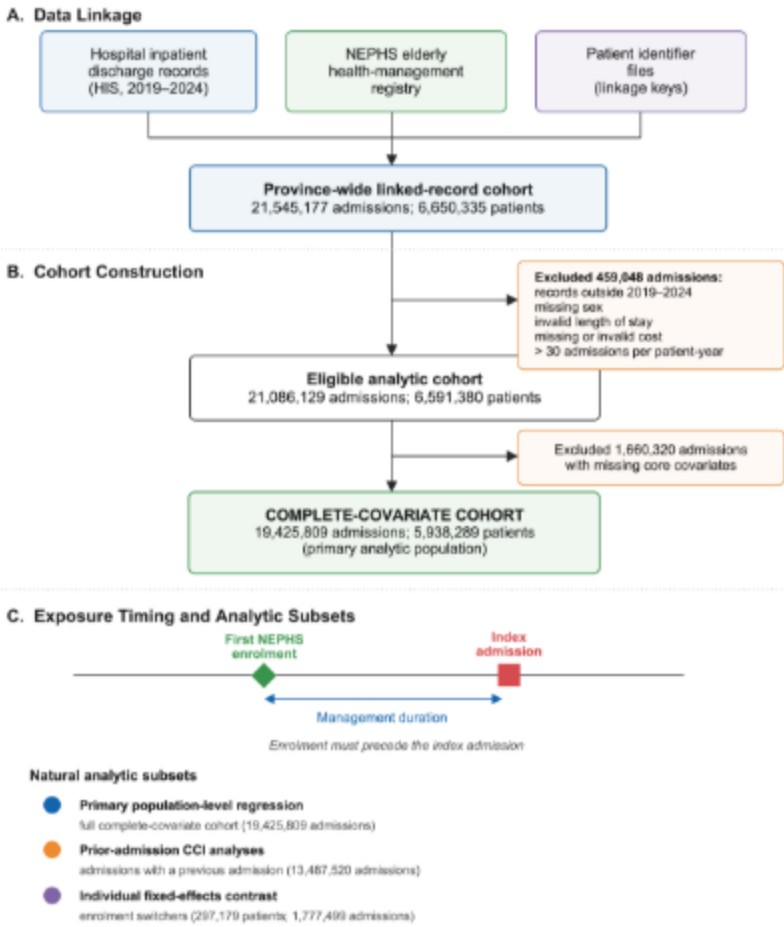


Figure 1

Data Linkage, Cohort Construction, and Exposure Timing

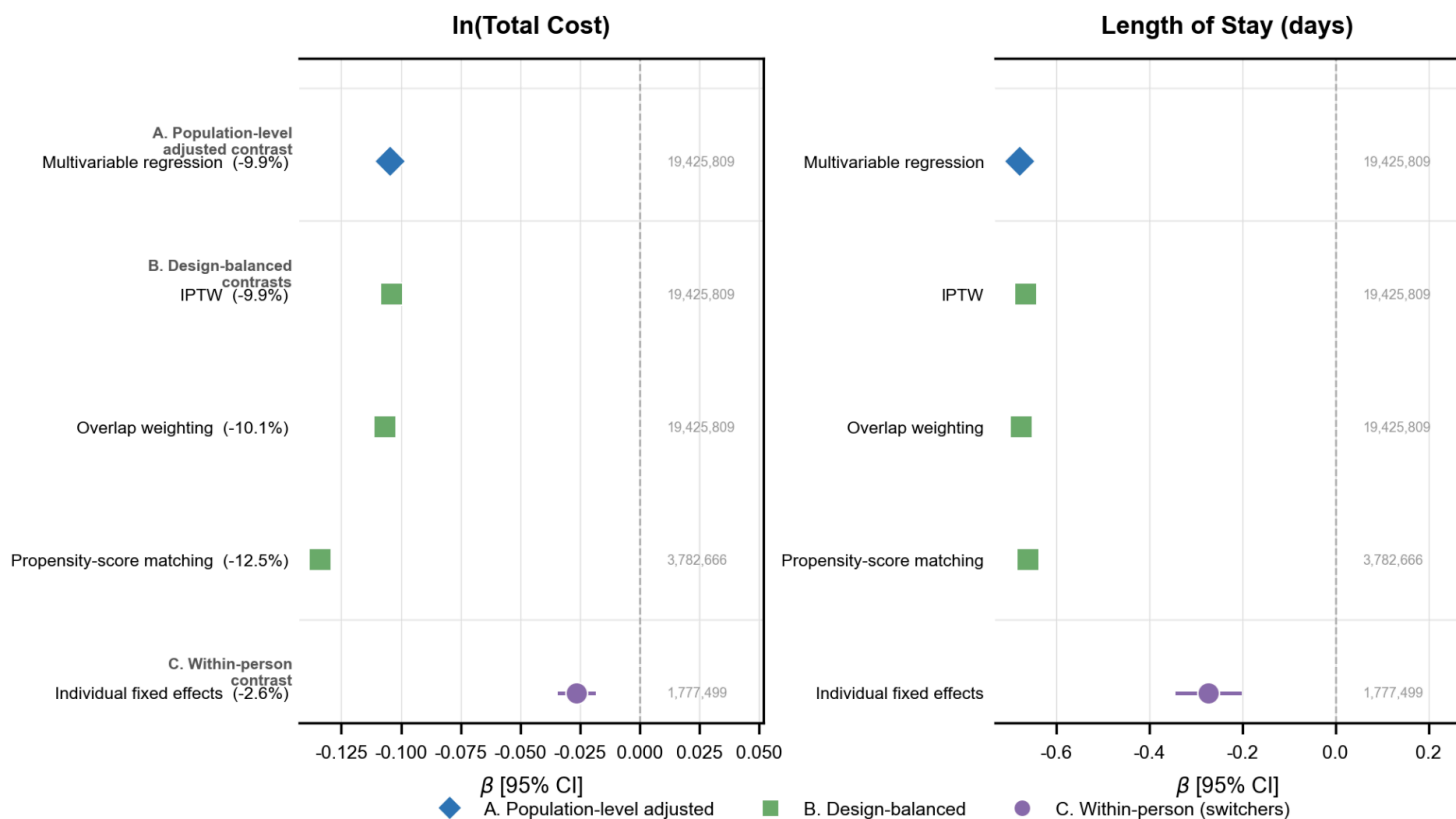


Figure 2

Associations Between NEPHS Enrolment and Inpatient Resource Use Across Analytic Contrasts

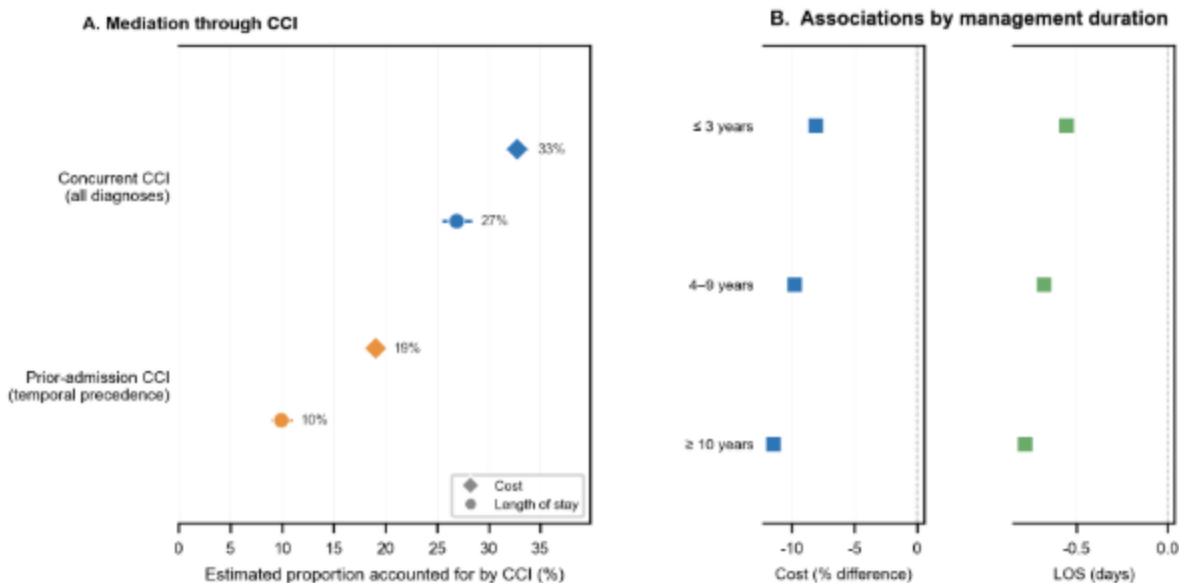


Figure 3

Comorbidity Pathway and Associations by Management Duration

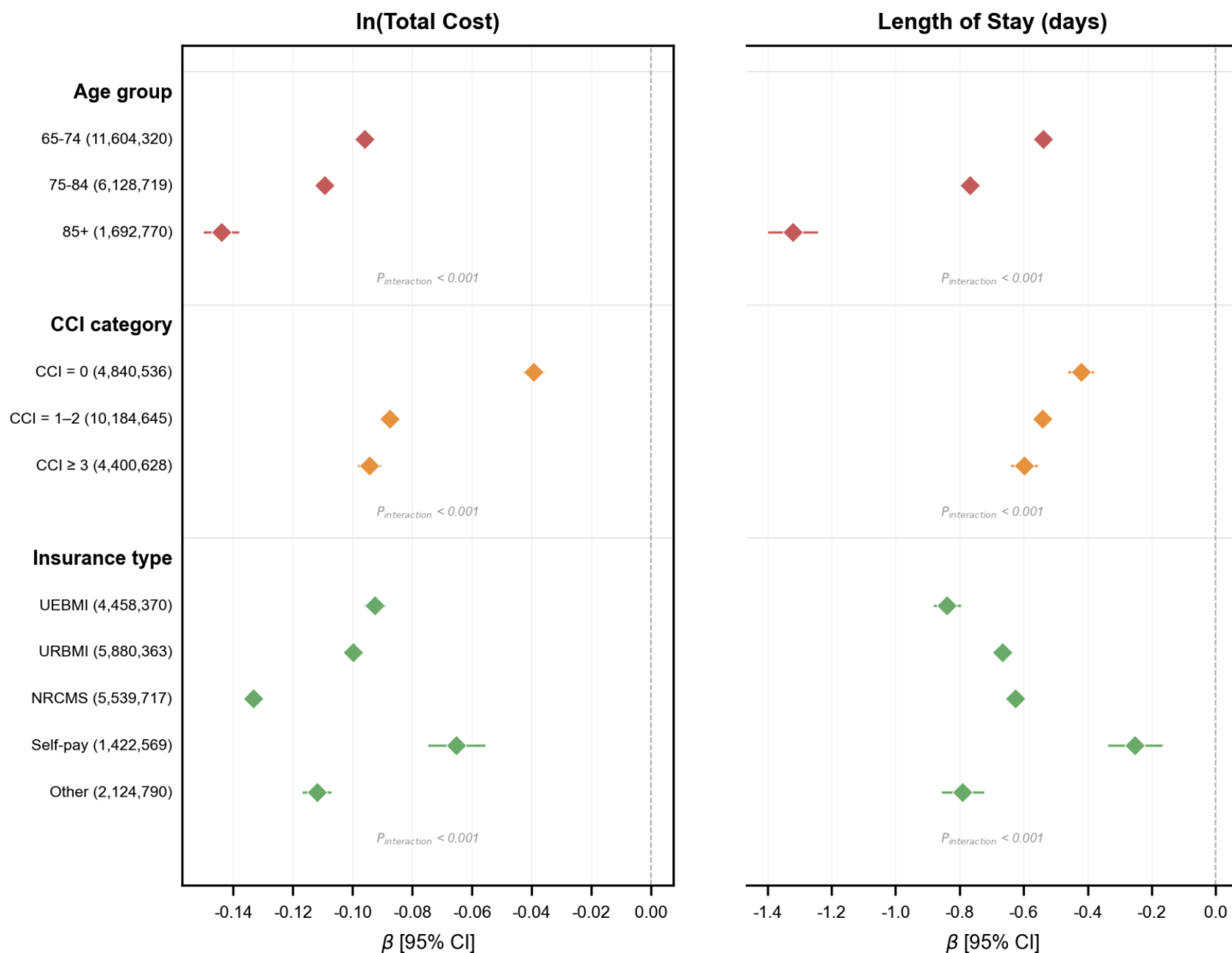


Figure 4

Subgroup Heterogeneity in Associations With Inpatient Cost and Length of Stay

Supplementary Files

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