



## ORIGINAL ARTICLE

# Measurement of polydoctoring as a crucial component of fragmentation of care among patients with multimorbidity: Cross-sectional study in Japan

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## Abstract

**Background:** Care fragmentation, characterized by the uncoordinated involvement of multiple healthcare providers, leads to inefficient and ineffective healthcare, posing a significant challenge in managing patients with multimorbidity. In this context, “polydoctoring,” where patients see multiple specialists, emerges as a crucial aspect of care fragmentation. This study seeks to develop an indicator to assess polydoctoring, which can subsequently enhance the management of multimorbidity.

**Methods:** Baseline survey data from the Kawasaki Aging and Wellbeing Project (KAWP) involving independent community-dwelling older adults aged 85–89 were utilized in this cross-sectional study. Polydoctoring measure was defined as the number of regularly visited facilities (RVFs). The association of RVF with the Fragmentation of Care Index (FCI) and the outcome measures of polypharmacy and ambulatory care costs were examined as indicators of care fragmentation.

**Results:** The analysis comprised 968 participants, with an average of 4.70 comorbid chronic conditions; 65.3% of the participants had two or more RVFs, indicating polydoctoring. A significant correlation between RVF and FCI was observed. Modified Poisson regression analyses revealed associations between higher RVF and increased prevalence ratio of polypharmacy. Likewise, a higher RVF was associated with higher outpatient medical costs.

**Conclusions:** RVF was significantly correlated with FCI, polypharmacy, and higher outpatient medical costs. Unlike complex indices, RVF is simple and intuitively comprehensible. Further research is needed to evaluate the impact of care fragmentation on patient outcomes, considering factors such as RVF thresholds, patient multimorbidity, and social support. Understanding the influence of polydoctoring can enhance care quality and efficiency for patients with multimorbidity.

## KEYWORDS

care fragmentation, continuity, multimorbidity, polydoctoring, polypharmacy

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## 1 | INTRODUCTION

Continuity of care constitutes a crucial pillar of primary care.<sup>1</sup> Research showed that receiving care from the same physician throughout a patient's treatment improves interpersonal and longitudinal continuity, leading to better patient health outcomes.<sup>1,2</sup> In contrast, fragmented care can lead to inefficiency and ineffective delivery of healthcare.<sup>3</sup> Fragmented care is defined as adverse effects that occur when multiple healthcare providers are involved in single-patient care, and there is a lack of proper coordination among them.<sup>3</sup> In fact, care fragmentation has been associated with an increase in unnecessary tests, emergency visits, medical costs, and hospitalizations.<sup>4-8</sup>

This issue is particularly prevalent among older adults with multimorbidity, where each chronic condition is often managed by individual specialists, resulting in numerous healthcare providers involved in one patient's care.<sup>9</sup> For instance, a primary care physician may manage hypertension and dyslipidemia, while a cardiologist oversees atrial fibrillation, and an orthopedic surgeon addresses knee osteoarthritis. In Japan, where free access to care, including specialists, is guaranteed, it is common for patients to have a different primary physician for each condition. This phenomenon, known as polydoctoring, is akin to polypharmacy.<sup>10-13</sup> An increase in the number of involved healthcare providers does not directly translate to fragmented care. With appropriate care coordination, effective and efficient team-based care can be achieved, even when numerous healthcare providers are involved. However, it also can be hypothesized that as the number of involved healthcare providers increases, the complexity of care coordination also increases, potentially heightening the risk of care fragmentation. In other words, while polydoctoring is indeed a significant component of care fragmentation, whether it leads to such fragmentation depends on the level of care coordination. Most of the previous research on care fragmentation focuses on single diseases. It is reported that visiting multiple healthcare institutions is associated with polypharmacy, but there are still few studies that have evaluated the impact of polydoctoring in patients with multimorbidity.<sup>14</sup> Understanding the impact of polydoctoring on clinical outcomes is crucial for developing effective management strategies for patients with multimorbidity. It provides guidance to primary care physicians who often face the decision of whether to refer a patient with multimorbidity to a specialist or manage their conditions comprehensively themselves. In order to facilitate research on polydoctor status, it is important to first measure this status accurately.

Existing studies on care fragmentation often use metrics such as the Usual Provider of Care Index (UPC) or the Continuity of Care Index (CCI).<sup>15-17</sup> Some also use the Fragmentation of Care Index (FCI), calculated as  $1 - CCI$ .<sup>18</sup> While these indicators generally exhibit a strong correlation, they capture different aspects of care fragmentation. UPC measures the concentration of care by the usual physician, while CCI and FCI assess the dispersion of care.<sup>19,20</sup> These indicators of care fragmentation assess care fragmentation

by reflecting the proportion of visits managed by a usual provider, including both scheduled visits for chronic conditions and unscheduled visits for acute conditions.<sup>19,21,22</sup> Of course, it is important to determine who should manage acute health conditions in patients with multimorbidity. Given that multimorbidity is defined as the coexistence of multiple chronic diseases, it is crucial to measure polydoctoring by focusing on who manages each of these individual chronic conditions.<sup>23</sup> While existing measures such as FCI and UPC also reflect polydoctoring, they require complex calculations. This complexity can hinder intuitive understanding and pose challenges for directly applying to clinical situations.<sup>20</sup> Therefore, the development of a new indicator is necessary to assess polydoctoring in patients with multimorbidity. This study aimed to create a new indicator of polydoctoring to investigate optimal care in the management of multimorbidity.

## 2 | METHOD

### 2.1 | Study design, data sources, and samples

This study is a cross-sectional analysis using baseline survey data from the Kawasaki Aging and Wellbeing Project (KAWP), which is an ongoing cohort study that focuses on independent older adults in Japan.<sup>24,25</sup> The inclusion criteria for the KAWP were defined as (1) individuals aged 85–89 years who reside in Kawasaki City, (2) community-dwelling, and (3) able to perform activities of daily living (ADL) independently. The study aimed to comprehensively evaluate aging in older adults through face-to-face interviews conducted by healthcare professionals, such as physicians, nurses, pharmacists, and psychologists. These interviews covered various aspects, including medical history, cognitive function assessments, and physical function examinations. In addition, the study integrates medical and long-term care claims databases. Age, sex, drinking history, smoking history, educational background, and Instrumental (IADL) were obtained through a questionnaire and face-to-face interviews. Age was treated as a continuous variable, while sex, drinking history, smoking history, educational background, and independence in IADL were all treated as categorical binary variables. Potential covariates included sex and the number of chronic conditions, which were selected based on their clinical relevance and previous literature.<sup>5,6,14</sup> The number of co-existing chronic conditions was obtained from the face-to-face medical history interview by a physician. Chronic conditions were categorized into the following 18 chronic conditions: cerebrovascular disease, cardiac disease, hypertension, diabetes, dyslipidemia, respiratory disease, gastrointestinal disease, renal disease, prostate disease, thyroid disease, Parkinson's disease, connective tissue disease, eye disease, osteoporosis, arthritis, hyperuricemia, malignancy, and dementia. In the case of medical history being unknown, we treated the corresponding condition as absent. The data for which was unknown accounted for 175 out of 17,424 condition-person instances, which was approximately 1%.

We determined that the impact on the results was minimal. Out of the 1026 participants in the KAWP, those with available claims data and multimorbidity, which is defined as having two or more chronic diseases, were included in the analysis.<sup>23</sup>

We obtained informed consent from all study participants, and data analysis was performed after anonymization. The ethics committee of Keio University School of Medicine (ID: 20160297) approved this study, which was registered in the University Hospital Medical Information Network Clinical Trial Registry as an observational study (ID: UMIN000026053).

## 2.2 | Care fragmentation measures

Several existing studies have addressed the concept of polydoctoring, yet a clear definition has not been established.<sup>10-13,26</sup> Therefore, in this study, we define polydoctoring as a situation where multiple physicians are regularly involved in the care of chronic conditions in a single patient. To measure polydoctoring, we developed a new indicator named Regularly Visited Facilities (RVFs). The RVF was determined based on the number of facilities with three or more monthly claims data per year and an interval of at least 6 months between the first and last claim. This definition was formulated through a consensus among the authors, with consideration given to two factors. First, we considered that patients visit their primary care provider at least three times a year and the maximum prescription period of 90 days in Japan.<sup>27,28</sup> Second, chronic health conditions, by definition, require management and care for at least 6 months.<sup>29,30</sup> Having more than two RVFs indicates polydoctoring, suggesting a high risk of fragmented care.<sup>31,32</sup> RVF was categorized into four groups: 0, 1, 2, and 3 or more. An RVF of 0 implies that patients see no doctor regularly, while an RVF of 1 means that one physician cares for the patient regularly. Two or more RVF indicates polydoctoring. We divided them into 2 and 3 or greater to approximately dichotomize the sample size. In addition, for comparison with other measures of care fragmentation, FCI, which is derived from CCI, was calculated.<sup>16,18</sup> FCI was defined as follows:

$$FCI = 1 - CCI = \frac{n^2 - \sum_i^k n_i^2}{n(n - 1)}$$

Here,  $n$  represents the total number of outpatient visits,  $n_i$  represents the number of visits to each facility  $i$ , and  $k$  represents the number of facilities visited. Instead of counting each day of the visit, we considered the number of months with at least one visit to each facility as the number of visits. This approach was chosen due to the difficulty in distinguishing rehabilitation visits from physician visits in the claims data. In the group with no history of visits to medical facilities, it is unable to calculate FCI. FCI ranges from 0 (all visits to the same facility) to 1 (each visit to a different facility). A higher FCI value indicates greater care fragmentation.<sup>18</sup> FCI was transformed into four categorical variables based on quartiles. 1st quartile indicates the least fragmented care, while 4th quartile indicates the most fragmented care.

## 2.3 | Care fragmentation-related outcomes

To validate RVF, we selected polypharmacy and outpatient medical care costs which are known to be associated with care fragmentation.<sup>14,33-35</sup> Polypharmacy was defined as the regular prescription of six or more medications. The outpatient medical cost was calculated based on the claims data, which encompass consultation fees, medication expenses, laboratory testing, imaging, and rehabilitation cost during a baseline survey year.

## 2.4 | Statistical analysis

To assess the concurrent validity of RVF, we examined its correlation with FCI, an established measure of care fragmentation. The associations of RVF and FCI with polypharmacy as well as outpatient healthcare costs, which are related to care fragmentation, were investigated.<sup>36-39</sup> The group without a history of visits to a medical facility, for which the FCI could not be calculated, was excluded from the analysis utilizing FCI. To evaluate the correlation between RVF and FCI, Kendall's rank correlation coefficient was calculated. We used a binary variable for the occurrence of polypharmacy based on the presence or absence of regular prescriptions for six or more medications. Modified Poisson regression analysis was conducted to analyze the occurrence of polypharmacy, with RVF as the independent variable. For outpatient medical expenses, a log-linear regression was performed after adding a constant of one to the actual expense. Adjusted models were applied, considering sex and the number of chronic conditions. We calculated the Variance Inflation Factor (VIF) in the adjusted model to assess multicollinearity. If the VIF exceeded 5, we considered that there was multicollinearity. All VIFs in the adjusted model were below 5, indicating no multicollinearity was detected. All the statistical analyses were performed using R version 4.3.1 in Rstudio version 2023.06.1, with a significance level of  $\alpha=0.05$ .

## 3 | RESULTS

The descriptive statistics of 968 participants are presented in [Table 1](#). The average number of comorbid chronic conditions was 4.70, with a standard deviation of 2.10. The average number of prescribed medications was 5.49, with a standard deviation of 2.30. The distribution of RVF and FCI is illustrated in [Figure 1](#). Among the participants, 65.3% had two or more RVFs, indicating polydoctoring. In contrast, 5.7% of participants had multiple chronic conditions but did not receive regular care.

[Table 2](#) presents a cross-tabulation of RVF and FCI. The Kendall's tau coefficient for RVF and FCI was 0.583 ( $p < 0.01$ ), indicating a significant correlation between the two measures. [Table 3](#) displays the results of crude and adjusted logistic regression analyses examining the occurrence of polypharmacy. The adjusted model accounted for sex and the number of comorbid chronic conditions as covariates. Both higher RVF and FCI were associated with an increased risk of

TABLE 1 Characteristics of study participants.

<i>n</i>	968
Age (mean (SD))	86.59 (1.38)
Male (%)	487 (50.3)
Education $\geq 12$ years (%)	436 (45.0)
Drinking (%)	388 (40.1)
Smoking (%)	37 (3.8)
IADL independent (%)	835 (86.3)
Chronic conditions (mean (SD))	4.70 (1.78)
RVF (%)	
0	55 (5.7)
1	281 (29.0)
2	292 (30.2)
$\geq 3$	340 (35.1)
FCI (median [IQR])	0.65 [0.49, 0.74]
Prescribed medications (mean (SD))	5.49 (3.65)
Polypharmacy (%)	452 (46.7)
Outpatient medical expense (Japanese Yen, median [IQR])	183,495.00 [106,925.00, 296,050.00]

Abbreviations: FCI, Fragmentation of Care Index; IADL, instrumental activity of daily life; IQR, interquartile range; RVF, regularly visited facilities; SD, standard deviation.

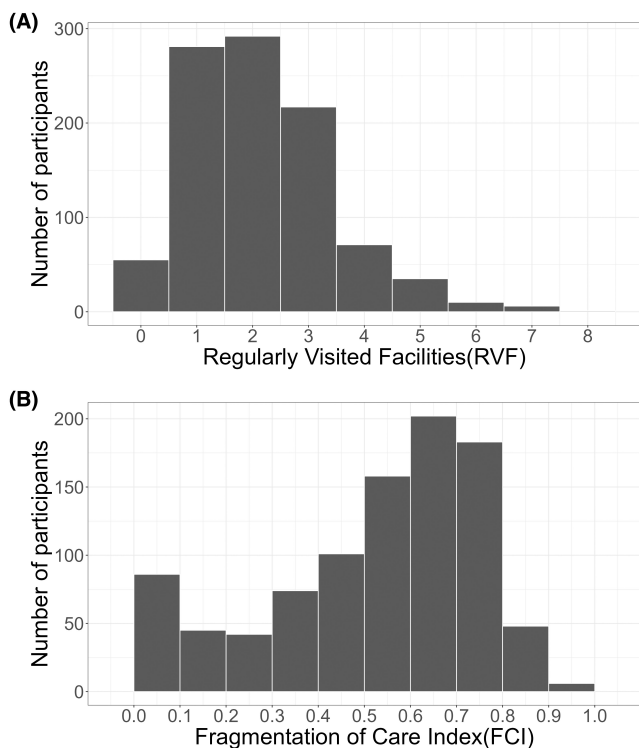


FIGURE 1 Distribution of regularly visited facilities (RVF) and Fragmentation of Care Index (FCI).

polypharmacy. In the group visiting two medical facilities, the prevalence ratio for polypharmacy was 1.19 (95%CI: 0.97–1.45). In the group visiting three or more medical facilities, the prevalence ratio was 1.71 (95%CI: 1.43–2.04).

Table 4 presents the results of crude and adjusted log-linear regression analyses for the outpatient medical cost. Both higher RVF and FCI were associated with higher outpatient costs, indicating a quantity-response relationship. In the adjusted model, an increase in RVF from 1 to 2 corresponds to approximately a 1.5-fold increase in outpatient medical costs. Similarly, an increase in RVF to three results in an approximately 2-fold increase in outpatient costs.

## 4 | DISCUSSION

The study findings revealed a significant correlation between RVF and FCI, as well as associations between RVF and polypharmacy and higher outpatient medical costs. Notably, existing measures of care fragmentation, although assessing different aspects, were reported to be highly correlated.<sup>19,22</sup> RVF represents the number of healthcare facilities where a patient receives regular care, while FCI measures the dispersion of care. A comparison between these measures highlights cases where patients have an RVF of zero, indicating no regular care despite multimorbidity, while FCI indicates variable levels of care dispersion. This disparity can be attributed to the inclusion of visits for acute illnesses in FCI, where even a single acute illness visit significantly affects it, particularly when the total number of visits is low. In contrast, even if a patient visits a new facility due to an acute illness, it will not be counted as RVF unless the patient visits separately for 3 months and there is a more than six-month interval between the first and last visit. Therefore, compared with FCI, RVF is anticipated to be less susceptible to the impact of visits due to acute illnesses. Another difference between FCI and RVF is whether groups with no history of medical visits are excluded from the analysis. It is essential to distinguish the group that has no regular source of care when examining the impact of polydoctoring. When RVF is three or higher, indicating the involvement of multiple healthcare facilities in multimorbidity care, FCI tends to be higher as well. Consequently, RVF is thought to be capable of identifying patients who are not receiving regular care, compared to FCI, and reflecting a high degree of polydoctoring, showing high values in patients with high care dispersion by FCI.

Existing measures, such as FCI, which assess continuity or care fragmentation, often have complex calculations, making them less intuitively understandable and more difficult for clinical application.<sup>20</sup> In contrast, RVF provides a straightforward indication of the number of healthcare facilities regularly involved in the care of patients with multimorbidity, making it intuitively easy to understand and more applicable in a clinical setting. Moreover, it can be easily calculated from claims data, making it applicable to large-scale database studies. However, RVF also has its limitations. First, the concept of polydoctoring in the context of care fragmentation among patients with multimorbidity has not yet been fully established. To the best of our knowledge, this article is the first to propose a definition and measurement method for polydoctoring. It will be essential to further refine the concept and measurement of

**TABLE 2** Cross-tabulation table of RVF and FCI.

	FCI				NA	Total N (%)
	1st	2nd	3rd	4th		
RVF						
0	8	2	7	15	23	55 (5.7)
1	186	56	29	10	0	281 (29)
2	38	152	70	32	0	292 (30.2)
≥3	0	29	131	180	0	340 (35.1)
Total N (%)	232 (24.0)	239 (24.7)	237 (24.5)	237 (24.5)	23 (2.4)	968 (100)

Abbreviations: FCI, Fragmentation of Care Index; N, number; RVF, regularly visited facilities.

**TABLE 3** Modified Poisson regression analyses for the occurrence of polypharmacy.

RVF	Crude		Adjusted		FCI	Crude		Adjusted	
	PR (95%CI)	p value	PR (95%CI)	p value		PR (95%CI)	p value	PR (95%CI)	p value
0	0.11 (0.03–0.43)	<0.01	0.11 (0.03–0.44)	<0.01	1st	Reference	–	Reference	–
1	Reference	–	Reference	–	2nd	1.11 (0.89–1.39)	0.34	1.03 (0.83–1.27)	0.81
2	1.31 (1.06–1.62)	0.01	1.19 (0.97–1.45)	0.10	3rd	1.33 (1.09–1.64)	<0.01	1.20 (0.99–1.46)	0.06
≥3	2.00 (1.67–2.40)	<0.01	1.71 (1.43–2.04)	<0.01	4th	1.59 (1.31–1.93)	<0.01	1.37 (1.14–1.65)	<0.01

Note: Polypharmacy was defined as the regular prescription of six or more medications. In the adjusted model, we accounted for sex and the number of chronic conditions. Number in the analysis, 968 participants with RVF, and 945 participants with FCI.

Abbreviations: CI, confidence interval; FCI, Fragmentation of Care Index; PR, prevalence ratio; RVF, regularly visited facilities.

**TABLE 4** Log-linear regression analysis for outpatient medical costs.

RVI	Crude		Adjusted		FCI	Crude		Adjusted	
	Estimates (95%CI)	p value	Estimates (95%CI)	p value		Estimates (95%CI)	p value	Estimates (95%CI)	p value
0	-5.48 (-5.9 to -5.06)	<0.01	-4.04 (-4.52 to -3.56)	<0.01	1st	Reference	–	Reference	–
1	Reference	–	Reference	–	2nd	0.56 (0.42–0.7)	<0.01	0.59 (0.41–0.77)	<0.01
2	0.52 (0.28–0.76)	<0.01	0.54 (0.24–0.84)	<0.01	3rd	0.82 (0.68–0.96)	<0.01	0.78 (0.6–0.96)	<0.01
≥3	0.96 (0.74–1.18)	<0.01	1.00(0.68–1.32)	<0.01	4th	0.92 (0.78–1.06)	<0.01	0.77 (0.57–0.97)	<0.01

Note: In the adjusted model, we accounted for sex and the number of chronic conditions. Number in the analysis, 968 participants with RVF, and 945 participants with FCI.

Abbreviations: CI, confidence interval; FCI, Fragmentation of Care Index; RVF, regularly visited facilities.

polydoctoring by conducting scoping reviews or through a formal consensus method in the future. Second, it does not account for polydoctoring when a patient visits multiple departments within the same healthcare facility. Although Japan's claim data do not capture the number of specialists involved within a single facility, medical records are typically shared within the facility, enabling the understanding of treatment and prescription details.<sup>40,41</sup> In Japan, sharing medical records between different facilities is uncommon, posing challenges in maintaining informational continuity of care when patients visit multiple facilities. Previous research demonstrated that interhospital care fragmentation during admission is associated with higher mortality.<sup>42</sup> Therefore, compared to visiting multiple facilities, the risk of care fragmentation is lower when patients see multiple specialists within the same facility. Thus, RVF remains a useful indicator of polydoctoring, which is a crucial component of care fragmentation. The third limitation is that RVF only captures the quantitative aspect of care

fragmentation. Effective care coordination, with communication and information exchange among involved doctors, can mitigate care fragmentation even if a patient visits multiple facilities. However, measuring coordination from claims data is challenging.<sup>43</sup> Patient-reported evaluations of care coordination and continuity showed strong correlations with patient health outcomes.<sup>44</sup> Therefore, future research should consider combining RVF with patient-reported care coordination measures to comprehensively evaluate care fragmentation. Finally, our study focuses on independently living older adults aged 85–89 residing in urban areas, and thus its generalizability may be limited. This group, capable of visiting medical facilities on their own, often comes to outpatient clinics, and as such, our study could provide meaningful insights into their care. A validation study is required in other regions and among different age groups of patients in the future.

RVF enables us to investigate the impact of polydoctoring on patient health outcomes. It is important to determine whether

polydoctoring exacerbates or improves hard outcomes, such as mortality. Considering the treatment burden model, polydoctoring can be considered a factor that increases patients' treatment burden.<sup>9,45</sup> However, the effect of polydoctoring on patient outcomes may also depend on the patient's capability. When investigating the threshold of RVF values at which polydoctoring worsens outcomes, the capability of patients, such as their social support, should also be considered. Identifying the impact of polydoctoring on health outcomes can optimize the allocation of care resources to patients with multimorbidity and design more efficient and effective care strategies.

## 5 | CONCLUSION

In summary, we developed a new indicator, RVF, to measure polydoctoring which is a crucial component of care fragmentation in managing multimorbidity. RVF demonstrated a significant correlation with FCI and associations with the occurrence of polypharmacy and higher outpatient medical costs. RVF provides a straightforward and intuitive measure of the number of healthcare facilities regularly involved in the care of patients with multimorbidity. RVF enables the investigation of the impact of polydoctoring on patient outcomes, which is essential for understanding the treatment burden and determining the threshold at which polydoctoring may worsen outcomes.

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## CONFLICT OF INTEREST STATEMENT

All the authors declare no Conflict of Interests for this article.

## ETHICS STATEMENT

This study was approved by the ethics committee of Keio University School of Medicine (ID: 20160297).

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