

# Current Application Status and Insights of the Ecology of Medical Care Model in Health Services Research: A Scoping Review

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## Abstract:

*Background:* Over the past decade, the ecology of medical care model has gained significant attention from scholars due to its prominent application value. Variations and shifts in the theoretical modeling constructs of this model can serve as indicators of the transformation in healthcare delivery, offering insights into the health needs of the population and the utilization of health services in China. *Objective:* This study aims to integrate and compare research utilizing the ecology of medical care model, describe the current status of such research, and contrast research methodologies and key findings. *Methods:* A comprehensive search was conducted in June 2022 using PubMed, Ovid Medline, Web of Science, Embase, China Biomedical Literature Service System, CNKI, and Wanfang databases. The search covered the period from 1961 to 2022 and was not limited by language. The Joanna Briggs Institute (JBI) methodology manual for scoping review guided the literature screening, information extraction, and descriptive analysis. *Results:* A total of 28 articles met the inclusion criteria, with 22 (78.6%) published after 2010. Most studies employing the ecology of medical care model focused on population health needs, healthcare resource utilization patterns, healthcare-seeking behavior, and disease referrals. Regarding the study population, 11 articles (39.3%) encompassed all age groups, while seven studies (25.0%) targeted specific populations. Four studies were conducted in urban areas of China. Compared to developed countries (regions), developing countries (regions) showed less emphasis on self-seeking help by patients (e.g., over-the-counter medicines, massages). Available ecological models indicated lower rates of patient self-reporting of health issues (symptoms) but higher rates of hospital outpatient and emergency room visits in developing countries (regions). *Conclusion:* The ecology of medical care model and its research methods have undergone significant evolution in the last two decades, maintaining their value as tools for researchers and policymakers to understand healthcare demand and the dynamics between healthcare resource supply and demand. Currently, the application of this model is limited in China, highlighting the need for future studies to utilize it to expose health inequities and unmet health needs in the country. Such research in the field of population medicine will provide evidence to enhance the rational allocation of health resources among the Chinese population.

## Keywords:

Ecology of medical care model  
Health services needs and demand  
Resource allocation  
Health inequities  
Population medicine  
Scoping review

## 1. Introduction

In 1961, White *et al.* [1] systematically introduced the theory of the ecology of medical care, describing the relationship between community health status, healthcare-seeking behavior, and medical and health resources. This groundbreaking theory provided health service researchers with an individual and population-centered perspective. The theoretical model consists of multiple squares of decreasing size, representing different levels of healthcare utilization per 1,000 individuals, such as risk of illness, self-reported disease, individual care, doctor consultation, and hospitalization. It offers a method to calculate the utilization rate of different levels of medical services within a specific period and has been widely and effectively applied globally [2].

Over the past decades, health service researchers in many countries (regions) have used this model to depict local medical resource distribution. By describing the stepwise decrease in health issues, disease conditions, and medical utilization, they have reflected the accessibility, equity, and efficiency of medical and health resources. Equal and fair distribution of healthcare resources and promoting “Universal Health Coverage” (UHC) are among the main challenges of global health today. The concept of UHC, introduced by the WHO, measures health service coverage, quality, and cost to achieve the goal of “health for all.” However, achieving this goal remains a long and arduous task. A study published in *The Lancet* showed that China’s number of doctors per 10,000 population has surpassed Japan and is close to the US, but its UHC index ranks only 58th globally [3]. This indicates a supply-demand contradiction between unmet health needs and limited medical resources in China, and effective evaluation of the healthcare system using the ecology of medical care framework is a key approach to addressing this issue. Research on population medical resource utilization using this framework can describe health issues, disease conditions, and medical service utilization patterns from a population and individual-centered perspective. Differences and changes in the theoretical modeling constructs of the ecology of medical care can reflect shifts in the healthcare model, providing an evidence base for understanding China’s population health needs and health service utilization. This article systematically reviews research and major developments

in population health service utilization using the ecology of medical care model in different countries (regions) since its establishment, aiming to provide insights and references for future research on healthcare service utilization in China using this model.

## 2. Materials and methods

### 2.1. Inclusion and exclusion criteria

Inclusion criteria: Surveys published after 1961 that involve the use of the ecology of medical care model to investigate population medical resource utilization. If multiple publications are found for similar studies in a country (region) during a specific period, only the most comprehensive research paper is considered. Exclusion criteria: (1) Review articles or case studies; (2) Conference papers; (3) Repeatedly published literature; (4) Literature with inaccessible full text; (5) Experimental studies involving animals.

### 2.2. Search strategy

The search was conducted in June 2022 using PubMed, Ovid Medline, Web of Science, Embase (English databases), and CNKI, Wanfang Data, SinoMed (Chinese databases). A combination of subject headings and keywords was adopted, and search strategies were scientifically developed according to the specific requirements of each database to comprehensively and systematically search, screen, and review literature that has applied the ecology of medical care model to conduct health service surveys since 1961.

Based on the preliminary search, the main search terms used were “medical care ecology” and the years between “1961” and “2022.” Taking PubMed as an example of the English database, the search formula was: (“Ecology”[Mesh] OR ecology[tiab]) AND (“Health”[Mesh] OR ((medical care[tiab]) OR (care[tiab]) OR (service[tiab]) OR (medical health[tiab]) OR (health care[tiab]))) NOT (“Animals”[mh] NOT “Humans”[mh])) AND (1961:2022[pdat]) AND ((model[All]) OR (pattern[All]) OR (mode [All]) OR (schema [All])) AND ((medic[title]) OR (health[title]) OR (care[title])) AND (ecolog\*[title]). Taking CNKI as an example of the Chinese database, the search formula was: (SU=‘ecology’+‘ecological’+‘ecological

community') AND (SU='model'+ 'pattern') AND (SU='medical'+ 'health'+ 'hygiene'+ 'care'+ 'service'). The search time limit was from the establishment of the database to June 1, 2022.

### 2.3. Literature screening and data extraction

First, the retrieved literature was imported into EndNote X9 software for sorting and deduplication. Two researchers trained in the Joanna Briggs Institute (JBI) evidence-based methodology strictly followed the inclusion and exclusion criteria, first reading the titles and abstracts of the literature for initial screening, and then further reviewing the full text for secondary screening. When there was a dispute about the screening results, an independent third researcher was invited to make a judgment. An information extraction table was created, which included two parts: (1) basic information, such as researcher name, country (region), literature title, publication year, data source, research type, etc.; (2) research content and methods, such as theoretical framework adopted, research topic, research design, research subjects, research influencing factors, model establishment methods, presentation methods, etc. To form a certain degree of comparability, studies that included specific populations, were historically distant, or had ambiguous definitions were excluded from the comparison of the results, and only studies describing medical care ecology models for all age groups and other age groups were compared.

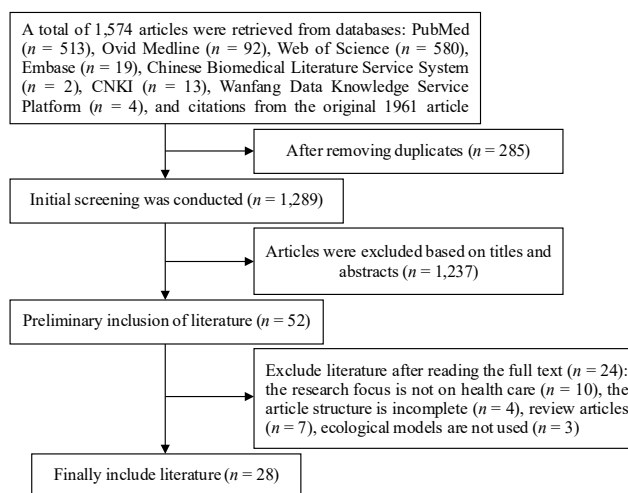
### 2.4. Statistical methods

The content of the information extraction table was imported into SPSS 22.0 statistical software for analysis, and the enumeration data was expressed as relative numbers. Some studies investigated ecological results over half a month, one quarter, or even one year, requiring statistical scientific transformation, which may have some errors. For example, if a study reviewed disease and outpatient treatment issues in the previous two weeks, while the number of inpatient surgeries was in annual units, it would need to be converted to monthly indicators.

## 3. Results

### 3.1. Literature screening results

After initially searching four English databases, three Chinese databases, and citations from the original 1961 literature, a total of 1,574 relevant articles were obtained. After excluding 285 duplicate articles and reviewing titles, abstracts, and full-text secondary screening, 28 articles that met the research requirements were finally included. The literature search process is shown in **Figure 1**.



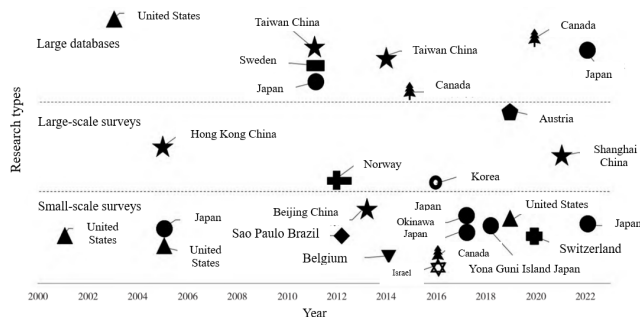
**Figure 1.** Flow chart of literature screening

### 3.2. Basic characteristics of included literature

The 28 articles included in this study were all published between 1961 and 2022, with 22 (78.6%) published after 2010. Regarding the study population, the full age group dominated (11 articles, 39.3%), while seven articles (25.0%) targeted specific populations (such as children and adolescents<sup>[5]</sup>, asthmatic children<sup>[8]</sup>, pregnant women<sup>[11]</sup>, adult women<sup>[16]</sup>, air force pilots<sup>[18]</sup>, family doctors<sup>[19]</sup>, and elderly people<sup>[30]</sup>). From the perspective of the study region, developed countries such as Japan (seven articles) and the United States (five articles) were the main focus, with only five articles (17.9%) conducted in developing countries (regions) or resource-poor areas/rural areas of developed countries (**Table 1**).

The research types of the included studies were divided into three categories based on research methods and sample size: small-scale surveys (sample size <10,000), large-scale surveys (10,000 ≤ sample size ≤ 100,000), and large-scale database analyses (based on large databases, sample size >100,000). It was found

that, excluding the original study from 1961, the included studies were mainly small-scale surveys (14 articles, 51.9%), followed by large-scale database analyses (eight articles, 29.6%), and large-scale surveys (only five articles, 18.5%) (Figure 2).



**Figure 2.** Research types, publication years, and countries (regions) of medical care ecology studies. Note: Small-scale surveys (sample size <10,000), large-scale surveys (10,000 ≤ sample size <100,000), and large-scale database analyses (based on large databases, sample size >100,000). The original study by White *et al.* [1] in 1961 is too far in the past and is not included in the analysis of research types.

In terms of research design, studies before 2010 were mainly small-scale cross-sectional surveys (4/6, 66.7%). However, after 2010, more and more studies were based on large-scale surveys or monitoring databases (11/22, 50.0%) for analysis, forming a framework for the ecology of medical care model. Among them, a study conducted in the United States used longitudinal data to describe and compare the utilization of healthcare services from 2002 to 2016 [24] (Table 1).

### 3.3. Description levels of the ecology of medical care model

Existing studies have used different levels to reflect the utilization of healthcare services in the ecology of medical care model. A review of the included literature found significant variations in the ecological levels of healthcare across different regions and populations. Most studies included levels such as personal symptoms, individual care, outpatient visits, emergency visits, and hospitalizations. Some studies in developed countries included additional dimensions such as oral health care,

family doctor services, and medication (Table 2). For example, Dovey *et al.* [5] in their study on American children and Hansen *et al.* [13] in their Norwegian study, both paid extra attention to whether individuals had received care from a dentist in the past month and whether they had accessed services from a family doctor/general practitioner. Similarly, studies conducted by McAlister *et al.* [26] in Alberta, Canada, and Aoki *et al.* [29] in Japan included additional levels of medication prescribing and drug use. Meanwhile, some studies covered the dimensions of rehabilitation and alternative medicine. For instance, certain studies in developing countries encompassed alternative medical services (such as whether individuals had received acupuncture and herbal treatments [28]).

### 3.4. Comparison of research results related to the ecology of medical care model

Further analysis was conducted on 19 studies that constructed medical care ecology models across all age groups and non-specific adult populations. Among the all-age group, 444 to 862 people per 1,000 reported health issues (symptoms), with 117 to 516 seeking medical treatment at outpatient clinics, ≤ 20 visiting emergency departments, and ≤ 3 being hospitalized in tertiary hospitals. In studies focusing on non-specific adults, the number of people reporting health issues (symptoms) per 1,000 increased from 273 to 939, and the number visiting emergency departments rose from 7 to 122. Notably, there were significant differences in self-reported health issues (symptoms) between the all-age and adult groups, while differences in outpatient medical care and inpatient treatment were not pronounced. Some studies also examined patients' self-help-seeking behavior (such as over-the-counter medications, massage, etc.), finding that 33 to 602 people per 1,000 engaged in such activities. Additionally, all four studies on the healthcare ecology model conducted in China were carried out in urban areas (Table 2).

Table 1. Characteristics of the included 28 studies

No.	Author	Time (year)	Country	Research object	Data source	Sample size	Research question	Research purpose
1	White <i>et al.</i> [1]	1961	United States	Population aged $\geq 16$ years	Data from the United States National Health Survey	11,765	Whether, in the view of consumers, the currently available quantity, quality, and distribution of healthcare are optimal. Who has the responsibility to review these issues and provide data so that reasonable judgments and effective plans can be made based on these data	Through the ecological form of healthcare, estimate the proportion of the “ill” referral population within a relatively short period of one month to quantitatively describe various dimensions of the medical relationship.
2	Green <i>et al.</i> [4]	2001	United States	Full age group	Gallup Organization managed a survey report on healthcare expenditure based on telephone interviews with adults	1,001	Since 1961, significant changes have occurred in the organization and funding of medicine and healthcare, resulting in new forms of technology. Changes in healthcare and health resources may alter the ecology of healthcare	Updated the report by White <i>et al.</i> [1] from 1961 and expanded the initial study to include data on children and other locations and types of healthcare services.
3	Dovey <i>et al.</i> [5]	2003	United States	Children and adolescents <17 years old	Nationally representative data from the 1996 Medical Expenditure Panel Survey	73,532,889	Children have been included in recent studies of healthcare ecology, but have not yet been investigated separately. From the perspective of healthcare ecology, children’s healthcare environment may differ from that of adults. Policymakers need to actively evaluate and adjust to promote children’s healthcare coverage	Describe the proportion of children receiving care in six types of healthcare settings each month and identify characteristics associated with receiving care in these settings.
4	Leung <i>et al.</i> [6]	2005	Hong Kong China	Full age group	2002 Hong Kong Thematic Household Survey	31,762	Determine key utilization distributions, including a comprehensive assessment model of the healthcare ecology and health care in Hong Kong, China, to enable the design, implementation, and evaluation of appropriate policy strategies to maintain equity, efficiency, and quality of care for the population	To better understand resource distribution and healthcare consumption patterns in different geographical, ethnic, and socioeconomic contexts, this study attempts to describe healthcare-seeking behaviors and health service utilization in Hong Kong, China, compared to the United States and the United Kingdom.
5	Fukui <i>et al.</i> [7]	2005	Japan	Full age group	Data collection using a prospective cohort design, questionnaires, and diaries	1,464	No carefully designed studies on patients’ health-seeking behavior for health-related symptoms have been conducted in Japan before, and although there are related reports, they are limited to very small sample sizes	Investigate the health-seeking behavior of Japanese people through a one-month prospective health diary with a nationally representative household panel, and outline the healthcare behavior of Japanese people.
6	Yawn <i>et al.</i> [8]	2005	United States	School-age children (6–17 years old) and young adults (18–44 years old) with self-reported asthma	Case-control study from the 1999 US Medical Expenditure Panel Survey	760	Asthma alters the amount and pattern of healthcare utilization among affected populations. Most studies on asthma healthcare utilization have been conducted in selected insured populations or single locations (such as emergency departments). Asthma is a dynamically sensitive care disease, so it is important to understand the relationships between care across all sites within the entire health service spectrum	The ecology of the medical care model can provide a useful framework to describe the utilization of health services among asthma patients compared to non-asthma patients and identify subgroups with significant gaps in care.

Table 1 (Continued)

No.	Author	Time (year)	Country	Research object	Data source	Sample size	Research question	Research purpose
7	Shao <i>et al.</i> <sup>[9]</sup>	2011	Taiwan	China	Data on 1 million people from the Taiwan National Health Insurance (NHI) research database	1,000,000	There is still a lack of a long-term general healthcare ecology model in Taiwan, China	Utilize a long-established analytical framework, namely the healthcare ecology model, to outline healthcare utilization in Taiwan, China.
8	Ferro <i>et al.</i> <sup>[10]</sup>	2011	Sweden	Sweden	The Census Bureau holds legally updated population registers	243,978	The healthcare ecology model has been used to evaluate healthcare utilization in private and mixed financial systems, but not in publicly funded systems. No previous studies have investigated healthcare utilization in publicly funded systems within a total population study.	Explore the influence of socio-demographic factors on appointments with primary, secondary, and tertiary healthcare doctors in publicly funded healthcare systems.
9	Tokunaga <i>et al.</i> <sup>[11]</sup>	2011	Japan	Japan	Regional study of all perinatal deaths in Tokyo and Miyazaki Prefecture	106,613	Some women require emergency transfer to tertiary medical centers due to serious maternal and child complications. However, the application of ecological models in obstetric care has not yet adopted a population-based approach.	Ecological models can help provide a framework for organizing medical care. This study aims to understand whether ecological models are applicable to perinatal health care in Japan.
10	Roncoletta <i>et al.</i> <sup>[12]</sup>	2012	Sao Paulo	Brazil	Cross-sectional telephone survey data from a sample of the urban population registered with a private Health Maintenance Organization (HMO) in Sao Paulo Brazil.	1,065	Although the national health system has proven successful, especially in immunization and emergency services used by both high-income and low-income populations, nearly 25% of Brazilian citizens are insured through private health plans.	Describe the utilization of primary healthcare, verify the frequency of various symptoms, and determine the role of different sources of healthcare.
11	Hansen <i>et al.</i> <sup>[13]</sup>	2012	Norway	Norway	The sixth Tromsø cross-sectional survey study	12,982	Proper planning and development of healthcare services must be approached from a population perspective. Many countries have studied the annual utilization rate of healthcare services, but few have conducted research related to monthly rates.	This study investigates self-reported symptoms and patterns of healthcare service utilization in Norway based on differences in age and gender.
12	Shao <i>et al.</i> <sup>[14]</sup>	2013	Beijing	China	Cross-sectional survey of healthcare services among the urban population in Beijing in 2012	6,592	Most studies draw attention to developments in several areas of health system reform (HSR), but none attempt to demonstrate progress made in achieving the main goal of HSR, which is affordable, high-quality, and equitable healthcare services.	Quantitative social epidemiological methods were applied to quantify changes in a subset of the Beijing healthcare-seeking population within one month, analyzing the impact of diseases on healthcare-seeking behavior.
13	Vo <i>et al.</i> <sup>[15]</sup>	2014	Belgium	Belgium	Survey on health issues targeting two community populations	537	Focusing on the prevalence of monthly healthcare issues and seeking assistance from different levels of population care is an interesting approach to demonstrate the respective roles of different levels of healthcare. It is reported that such analysis has never been conducted in a sample of the Belgian population.	Based on comparable models and methods, this study analyzed the healthcare ecology of the region.

Table 1 (Continued)

No.	Author	Time (year)	Country	Research object	Data source	Sample size	Research question	Research purpose
14	Chang <i>et al.</i> <sup>[16]</sup>	2014	Taiwan China	Women aged $\geq 18$ years	Claim data from the cohort dataset in the National Health Insurance Research Database of Taiwan China.	418,066	Gynecological care is crucial for women's health. Although most gynecological studies focus on the diagnosis and treatment of diseases, there is limited data on women's utilization of gynecological care.	The utilization of gynecological care by women in 2009 was calculated. This study attempts to determine the utilization rates of outpatient visits, emergency department visits, and gynecological inpatient treatments.
15	Stewart <i>et al.</i> <sup>[17]</sup>	2015	Canada	Population aged $\geq 15$ years	Canadian Community Health Survey, Canadian Census, Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD)	121,801	To provide population-based healthcare needs and utilization in Canada for comparison with other regions.	To present a population-based picture of healthcare needs and utilization across Canada in a highly accessible format for provincial comparisons and comparisons with other international jurisdictions.
16	Gordon <i>et al.</i> <sup>[18]</sup>	2016	Israel	Air Force pilots	Anonymous questionnaire on mandatory healthcare for Israeli Air Force pilots	325	The healthcare ecology model has been used in different populations, but the results vary.	The goal of this study is to apply this model to the population of Israeli Air Force (IAF) pilots.
17	Pimlott <i>et al.</i> <sup>[19]</sup>	2016	Canada	Family Physicians	—	530	Describes the healthcare ecology involving family physicians.	Explains the potential level of involvement that all family physicians may have, and identifies groups that may be lacking in home care and the reasons for it.
18	Kim <i>et al.</i> <sup>[20]</sup>	2016	Korea	Adults aged 18 and over	Korean Health Panel (KHP) data	11,518	Patient care processes are often fragmented, leading to dissatisfaction with the quality of care among patients. Therefore, the reform of the medical service delivery system needs to be emphasized.	Estimates the occurrence of health issues or medical care in various care settings per 1,000 residents within an average of one month, describing the healthcare ecology in Korea.
19	Kaneko <i>et al.</i> <sup>[21]</sup>	2017	Okinawa Japan	People of all age groups	Examination of electronic medical record system, retrospective open cohort study.	1,314	In contrast, on an isolated island with only primary care, the ecology of healthcare is easy to evaluate.	Aims to describe the healthcare ecology of the isolated island of Iheya, and evaluate the gatekeeping function of primary care clinics based on comparisons with previous nationwide surveys.
20	Fukui <i>et al.</i> <sup>[22]</sup>	2017	Japan	People of all age groups	Baseline questionnaire in the form of a health diary.	4,548	Due to the rapid growth of healthcare costs, aging of the population, and low birth rates, Japan's universal healthcare system needs to be reorganized.	Updates a 2003 report on the healthcare ecology of Japan, identifying relevant changes in healthcare patterns.
21	Namiki <i>et al.</i> <sup>[23]</sup>	2018	Yonaguni Island Japan	People of all age groups	Retrospective cohort study conducted at the Yonaguni City Clinic.	1,696	Japan faces the issue of rapid population aging, and the actual supply and demand of medical care under geographical limitations need to be reconsidered in the future.	This study evaluated the healthcare ecology in this region and found that patients have limited access to medical services on an isolated island.
22	Johansen <i>et al.</i> <sup>[24]</sup>	2019	United States	People of all age groups	Medical Expenditure Panel Survey from 2002 to 2016	3,508	Unlike previous studies that assessed certain healthcare policies at the local or state level, investigated their impact on health, or studied the financial consequences (for individuals or society) of legislation, this study examines how U.S. laws affect individual choices in the healthcare system.	This study focuses on long-term changes surrounding the implementation framework of the Patient Protection and Affordable Care Act (ACA).

Table 1 (Continued)

No.	Author	Time (year)	Country	Research object	Data source	Sample size	Research question	Research purpose
23	Hoffmann <i>et al.</i> <sup>[25]</sup>	2019	Austria	Population aged 15 and over	Randomized interview survey	52,058	Investigates the ecological model within the Austrian healthcare system and evaluates changes in care ecology among sociodemographic groups in Austria.	Analyzes the Austrian healthcare system using an ecological care model. A secondary objective of the study is to compare Austrian data with data from other countries.
24	McAlister <i>et al.</i> <sup>[26]</sup>	2020	Canada	Adults aged 18 and over	Retrospective cohort study targeting adults in Alberta	2,660,947	There is a need to refocus attention on the ecology of medical care: understanding where and with whom patients receive professional health advice and treatment is the first step if we want to improve the patient experience.	Defines the ecology of healthcare in Alberta and examines the implementation of five policies across the province by the Ministry of Health and Alberta Health Services from 2003 to 2012.
25	Giezendanner <i>et al.</i> <sup>[27]</sup>	2020	Switzerland	Adults aged 18 and over	Telephone interviews targeting a randomly representative population	1,025	Switzerland's healthcare system forms a relatively decentralized regulatory framework, and there is a lack of independent data on healthcare structure and utilization in Switzerland.	Utilizing the ecology of the healthcare framework, this study evaluates the healthcare-seeking behavior of 1,025 individuals in Switzerland within a 2-month period in 2018, based on a population survey.
26	Xiong <i>et al.</i> <sup>[28]</sup>	2021	Shanghai China	People of all age groups	The Sixth Health Service Survey in Shanghai	23,198	Currently, there is no research describing the framework for the utilization of medical resources in Shanghai.	To better understand the resource distribution and consumption patterns among different ethnic groups and regions with varying levels of economic development, this paper describes healthcare-seeking behavior under the healthcare ecology of Shanghai.
27	Aoki <i>et al.</i> <sup>[29]</sup>	2022	Japan	Population aged 20 and over	A nationwide cross-sectional survey was conducted on a representative sample of the general Japanese adult population.	1,747	The pandemic of COVID-19 has had profound impacts on healthcare utilization, such as social isolation. The overall picture of changes in healthcare utilization remains unclear.	To evaluate healthcare utilization for health-related events among a representative sample of the general population in Japan during the COVID-19 pandemic and compare it with results from before the pandemic in Japan. The relationship between socio-demographic and clinical factors and healthcare utilization during the pandemic was investigated.
28	Kaneko <i>et al.</i> <sup>[30]</sup>	2022	Japan	Elderly people aged 75 and over	A cross-sectional survey targeting all residents aged 75 and over registered in a Japanese city for 1 year.	454,366	Urbanization and aging are global issues faced by healthcare providers. Elderly people experience increased cognitive impairment and decreased daily functioning. However, the healthcare utilization of the oldest elderly remains unclear.	This study aims to describe the healthcare utilization of the oldest elderly compared to younger elderly in the city, using the ecology of a healthcare model.

Note: Health diary refers to a baseline questionnaire completed at the start of the study, followed by continuous recording of any symptoms, daily health-related events, and decisions made for each event over 31 days; “-” indicates not reported in the original literature.



**Table 2.** Comparison of results from 19 ecology of medical care studies in all-age and non-specific populations

Literature source	Participant age	Health issues (symptoms)	Estimated number of individuals per 1,000 residents												
			Individual care			Outpatient medical care					Inpatient treatment				
			Self-help seeking (over-the-counter medications, massage, etc.)	Home care	Remote diagnosis and treatment	Clinic	Hospital	Tertiary hospital	Complementary or alternative medicine (Chinese medicine, etc.)	Emergency care	General hospital (primary and secondary hospitals with inpatient beds)	Tertiary hospital			
Green <i>et al.</i> <sup>[4]</sup>	All age groups	800	327	14	-	217	21	-	65	13	8	<1			
Leung <i>et al.</i> <sup>[6]</sup>	All age groups	567	512	-	-	372	68	-	54	16	7	1			
Fukui <i>et al.</i> <sup>[7]</sup>	All age groups	862	-	3	-	307	88	6	49	10	7	<1			
Shao <i>et al.</i> <sup>[9]</sup>	All age groups	-	-	-	-	329	152	45	67	19	10	3			
Ferro <i>et al.</i> <sup>[10]</sup>	All age groups	-	-	87	-	-	44	-	-	20	12	<1			
Vo <i>et al.</i> <sup>[15]</sup>	All age groups	851	490	-	-	117	-	-	-	-	15	-			
Fuku <i>et al.</i> <sup>[23]</sup>	All age groups	794	-	7	-	265	206	10	-	4	7	-			
Kaneko <i>et al.</i> <sup>[21]</sup>	All age groups	-	-	-	-	360.4	18.4	-	4.1	3.6	<1	-			
Namiki <i>et al.</i> <sup>[23]</sup>	All age groups	-	-	32	-	516	14	-	-	3.8	4.8	-			
Xiong <i>et al.</i> <sup>[28]</sup>	All age groups	444	92	-	-	305	212	-	33	-	7	3			
Kim <i>et al.</i> <sup>[20]</sup>	≥ 18 years old	939	-	-	-	333	101	35	38	7	8	3			
Roncolletta <i>et al.</i> <sup>[12]</sup>	≥ 18 years old	398	311	7	-	292	-	-	22	104	63	1			
Gieciendanner <i>et al.</i> <sup>[27]</sup>	≥ 18 years old	273	193	82	6	-	41	-	4	8	11	3			
McAcister <i>et al.</i> <sup>[26]</sup>	≥ 18 years old	-	602	-	122	332	-	12	22	122	56	-			
Shao <i>et al.</i> <sup>[14]</sup>	≥ 15 years old	295	217	-	-	173	127	-	78	-	15	-			
Stewart <i>et al.</i> <sup>[17]</sup>	≥ 15 years old	560	-	238	-	70	-	-	-	8	-	-			
Hoffmann <i>et al.</i> <sup>[25]</sup>	≥ 15 years old	-	-	-	-	460	78	-	-	-	35	3			
Hansen <i>et al.</i> <sup>[13]</sup>	≥ 30 years old	901	33	-	-	214	91	-	55	-	14	-			
Aoki <i>et al.</i> <sup>[29]</sup>	20~<65 years old	-	-	-	-	113	34	7	104	2	6	<1			
	≥ 65 years old	-	-	-	-	115	46	15	53	3	23	<1			

Note: The consultation situation per 1,000 people in the past 4 weeks aims to estimate the proportion of the ‘‘ill’’ referral population within a relatively short period of 1 month, to quantitatively describe various dimensions of the healthcare relationship. Among them, data from Switzerland <sup>[27]</sup> and Shanghai, China <sup>[28]</sup> were converted from 2 months and 0.5 months, respectively, to 1 month for comparison. Studies conducted on isolated islands in Okinawa, Japan <sup>[21]</sup> and Yonaguni Island <sup>[23]</sup> had a small base, resulting in decimal values in their healthcare ecology research findings. The data studied by Johansen *et al.* <sup>[24]</sup> spanned from 2002 to 2016 and could not be compared, so it is not listed. ‘‘-’’ indicates not reported in the original literature.

A comparison was made between developed and developing countries (regions) regarding research findings on the healthcare ecology framework across all age groups. It was found that compared to developed countries (regions), developing countries (regions) had a lower proportion of self-reported health issues (symptoms). The proportion of visits to primary care physicians was similar to that in developed countries (regions), but the rates of hospital outpatient visits and emergency treatment seeking were higher. Data on individuals seeking medical services was incomplete, but the ratio of self-reported health issues (symptoms) to visits to primary care physicians to non-tertiary hospital inpatient stays in developing countries (regions) was approximately 63:42:1, whereas the ratio in developed countries was 69:27:1 (Figure 3).

Two studies conducted in China across all age groups (one in Hong Kong and the other in Shanghai) were compared with four studies from other countries to analyze differences in the ecology model regarding health issues (symptoms), visits to primary care physicians, and general hospital inpatient levels. These six studies were selected for comparison due to their completeness of data and their ability to represent the three major areas of health issues (symptoms), outpatient medical care, and inpatient treatment. The results showed that studies from the United States, Japan, and Belgium indicated that approximately 27.5% of people seek medical attention

after experiencing health issues, while this proportion was significantly higher in Chinese studies, reaching 67.2% (Figure 4).

### 4. Discussion

This study systematically reviewed research utilizing the ecology of medical care model both domestically and internationally. Since the introduction of the medical ecology model theory in 1961<sup>[1]</sup>, there have been continuous advancements in its application and research methodologies. Based on the publication timeline, the development of the healthcare ecology model can be broadly divided into two stages: the first 40 years

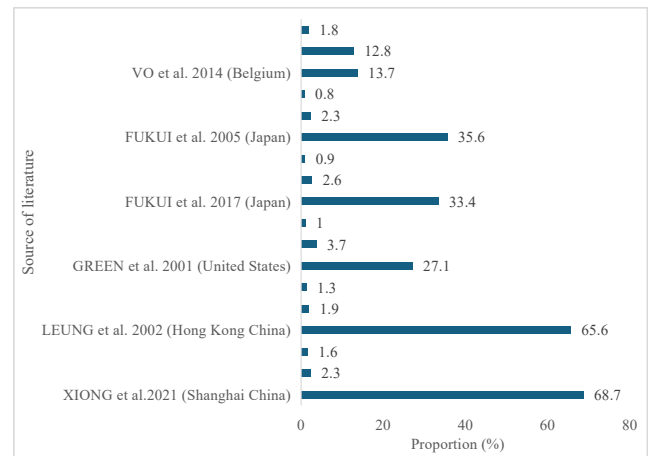
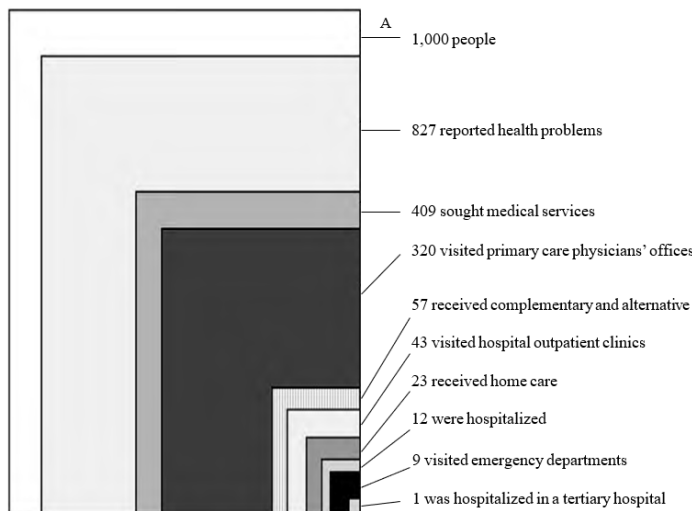


Figure 4. Basic referral status of some studies in all-age groups

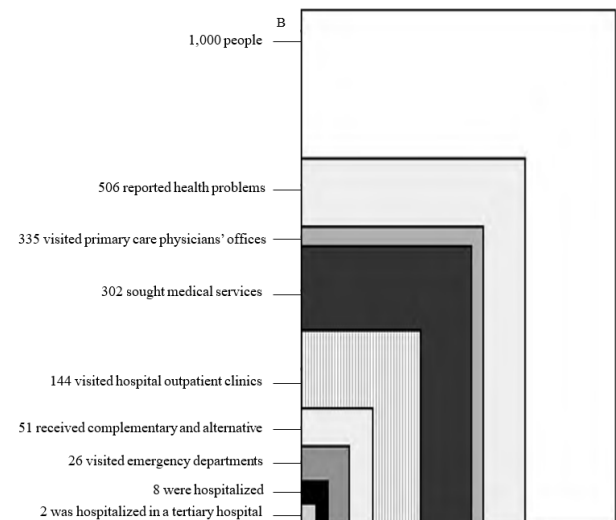


Figure 3. Comparison of the ecology of medical care models results in all-age populations in developed and developing countries (regions) Note: A represents the ecological outcomes of medical care in developed countries (regions), and B represents the ecological outcomes of medical care in developing countries (regions).

represented the initial exploration phase. Although the ecology model played a role in conceptualizing healthcare services in the United States, it was not applied to understand the critical issues of healthcare service disparities. The second stage began after 2001, when Green *et al.* [4] updated the report by White *et al.* [1] from 1961, further refining the framework of the ecology of medical care model. This update incorporated levels reflecting different types of healthcare and increased focus on special populations. Despite the absence of a unified standard for the ecology of medical care model, it describes health issues, disease states, and patterns of healthcare utilization from a population and individual-centered perspective. The model provides a clear visualization of the stratified structure of health needs and health service utilization among different groups, regions, and healthcare systems. This offers researchers and policymakers a comprehensive view of the relationship between healthcare demand and supply. In terms of research design, different methodologies have their respective strengths and weaknesses. Survey data can provide targeted descriptions of the local healthcare ecology. However, surveys often face time constraints, and studies may not establish causal relationships. Additionally, there can be issues such as self-reporting bias, recall bias, and seasonal variations. Some cross-sectional surveys, limited by factors like cost and initial design, may not achieve a sufficiently large sample size, resulting in incomplete coverage of symptoms and health issues. On the other hand, real-world data studies effectively utilize large amounts of dynamic data, saving costs and time, and improving the efficiency of medical and health-related decision-making. However, controlling for biases and data analysis can be more complex in these studies. The model also has certain limitations. For instance, due to the lack of diagnostic data, related studies often cannot capture the overall disease burden, disease severity, continuity of care, and whether patients in need receive appropriate medical services. This limitation highlights the importance of improving data collection and integration to enhance the understanding and application of the ecology of medical care model. Despite these challenges, the model remains a valuable tool for researchers and policymakers to understand and address the complex issues related to healthcare demand

and supply.

There are certain differences in the healthcare system and supply-demand relationships between China and other countries. Previous research conducted in developed cities such as Beijing [14] and Shanghai [28] has shown that in China, approximately 60% of the population seeks medical treatment at clinics for health issues, and the proportion of those who eventually require hospitalization is greater than 1.5%. In Beijing, the hospitalization rate even reaches 5%. However, studies from developed countries (e.g., the United States [4], Japan [7,22], Norway [13]) reveal that these two indicators are roughly 30% and 1%, respectively. In developed countries like Belgium [15] and Canada [26], residents initially seek medical services through home health care, support from pharmacists and physiotherapists, or even online/telephone consultations to address health issues. Referrals are then made by general practitioners, resulting in a lower proportion of hospital visits/emergency department visits. In contrast, due to the absence of a medical referral system and a weaker primary healthcare and referral system in China, hospitals remain the first or only point of contact with the healthcare system for the population. Previous research has also highlighted that China's primary healthcare system is still relatively weak. With the changing disease spectrum and the continuous increase in the number of chronic disease patients, the prevention and management of chronic diseases pose persistent challenges to the Chinese healthcare system [4]. The decreasing trend across different levels in the ecology of medical care model reflects the need for further strengthening the primary healthcare system in China, enhancing referrals between community health service institutions and secondary/tertiary medical institutions to achieve tiered diagnosis and treatment.

The significant decrease across levels in the ecology of medical care model reflects that patients are not always in hospitals, and there is a need for greater attention to patients in the community and outside of hospitals. Although the ecology of medical care model does not have universally applicable standardized levels, changes in model levels reflect shifts in medical paradigms, characteristics of healthcare systems in different countries, and varying relationships between individuals and the healthcare system. Differences in the ecology of

medical care model across regions are closely related to the healthcare system, medical insurance models, and population health needs, and also represent, to some extent, disparities in medical resource allocation.

Research on medical care ecology in China is still not fully developed. Compared to developed countries (regions), studies on the ecology of medical care model in developing countries (regions) lack relevant survey data on home care. Due to the limited number of studies currently available, **Figure 3** is based on existing data and does not account for biases caused by factors such as sample size, study type, and definitional differences. Therefore, further improvement is needed in the future. Analyzing the decreasing proportions across different levels of the ecology of medical care model helps to conceptualize the situation and ratios of healthy populations, sick populations, and those receiving medical care. It reflects how limited medical resources can better meet substantial health needs, which is significant for developing and evaluating health policy objectives.

The ecology of medical care model also provides a new tool for understanding and promoting the implementation of the population medicine concept. The model reveals that patients in hospitals represent only the tip of the iceberg of the population with health needs. More attention should be paid to unmet health needs and the large population with health needs outside of hospitals. The introduction of the population medicine concept also emphasizes an individual and population-centered medical care model that covers the entire chain of “promotion, prevention, diagnosis, control, treatment, and rehabilitation.” The ecology of medical care model can serve as an important research tool for practicing

the population medicine concept in the future, helping researchers and policymakers understand unmet health needs in the population and facilitating the shift from a “disease-centered” to a “health-centered” approach. As more regional and population-specific medical care ecology studies and data become available, the results of the ecology model can be further subdivided based on different definitions, populations, and survey types, enabling continuous improvement and supplementation to fully leverage the model’s potential.

## 5. Conclusion

In summary, the ecology of medical care model and its research methods have continuously evolved over the past 20 years, providing a methodology for understanding the allocation and utilization of medical resources. It remains a valuable tool for researchers and policymakers to comprehend healthcare needs and the supply-demand relationship of medical resources. Currently, the application of the healthcare ecology framework in China is not widespread, and most studies conducted in China focus on more developed urban areas, limiting the use of the ecology of medical care model. In the future, this model can be more widely applied to conduct research in areas such as population medicine, providing an evidence base for improving the rational allocation of health resources in the Chinese population. This article summarizes the research methodology advancements and key findings of this model both domestically and internationally, offering insights and references for future research on healthcare service utilization using this model in China.

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The authors declare no conflict of interest.

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