

The Impact of the Digital Divide on Elderly Health Consumption: An Empirical Study Based on CFPS Data

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Abstract: As population aging and digital transformation continue to advance, digital technologies have been extensively applied in healthcare and consumer service domains, with digital health consumption gradually emerging as a pivotal modality for health management among the elderly. Nevertheless, due to persistent disparities in digital access, digital usage, and digital literacy, a considerable segment of the elderly population encounters substantial barriers to effective integration into the digital society, rendering the impact of the digital divide on elderly health consumption increasingly salient. Drawing upon data from the China Family Panel Studies (CFPS), this study constructs a comprehensive indicator system for the elderly digital divide encompassing three dimensions—the digital cognitive divide, the digital access divide, and the digital usage divide—and empirically examines the impact of the digital divide on elderly health consumption using Ordinary Least Squares (OLS) and Tobit regression models. The empirical findings indicate that the digital divide exerts a significant inhibitory effect on elderly health consumption, with all three dimensions demonstrating statistically significant negative impacts, among which the digital usage divide manifests the most pronounced effect. Furthermore, the digital divide attenuates health consumption by undermining the elderly's capacity to acquire health information. The deleterious effects of the digital divide are found to be more accentuated among rural elderly populations, those with lower educational attainment, and those with diminished health literacy. These findings furnish novel empirical evidence for comprehending consumption inequality among the elderly within the context of rapid digitalization.

Keywords: Digital Divide; Elderly Health Consumption; Healthy Aging.

1. Introduction

The 20th National Congress of the Communist Party of China roposed the imperative to "implement the national strategy for actively responding to population aging" and to advance the deep integration of the digital economy with public livelihood services. As population aging intensifies and digital technologies evolve rapidly, digitization is fundamentally reshaping patterns of household health consumption. The proliferation of digital health services—including internet-based medical care, online pharmaceutical purchasing, telemedicine, and intelligent health monitoring—has progressively propelled health consumption from traditional offline modalities toward platform-based, intelligent, and digital transformations. Digital technologies not only enhance the efficiency of health resource allocation but also expand the accessibility and convenience of health consumption for residents, serving as a critical technological underpinning for the advancement of the Healthy China initiative.

Nevertheless, in stark contrast to the rapid expansion of the digital economy, the elderly population has not fully shared in the dividends of digital development. Constrained by factors such as educational attainment, physical functioning, digital skills, and information literacy, a substantial proportion of older adults continue to face pronounced barriers in internet access, digital technology utilization, and digital information discernment, rendering the issue of the digital divide increasingly conspicuous. Particularly against the backdrop of the accelerating migration of healthcare services to online platforms, disparities in digital competence may further evolve into inequalities in health resource acquisition and health consumption. For the elderly population, the inability to effectively integrate into the

digital society may place them in a relatively disadvantaged position regarding health information acquisition, medical service utilization, and health consumption decision-making, thereby constraining the release of their health consumption demand.

2. Literature Review

Existing literature has primarily centered on three strands: the formation mechanisms of the digital divide, its economic consequences, and residents' health behaviors. First, regarding the measurement and formation mechanisms of the digital divide, early studies predominantly conceptualized the digital divide as disparities in internet access (Van Dijk, 2005). With the increasing penetration of digital technologies, scholarly attention has progressively expanded to encompass deeper dimensions, including digital usage capabilities and digital literacy (Hargittai, 2002; DiMaggio et al., 2004). Domestic research, grounded in the realities of China's digital development, has constructed multi-layered digital divide frameworks from the dimensions of the digital access divide, the digital usage divide, and the digital cognitive divide (Chen Yunsong et al., 2021; Zhang Xun et al., 2022), highlighting the pronounced age, urban-rural, and educational disparities characteristic of the digital divide.

Second, concerning the relationship between digital technologies and household consumption behavior, existing studies generally concur that internet usage can promote household consumption upgrading by reducing information search costs, alleviating information asymmetry, and enhancing consumption convenience (Goldfarb & Tucker, 2019; Yin Zhichao et al., 2021). Some studies further demonstrate that the development of digital finance, e-commerce, and internet platforms contributes to elevating residents' service consumption and health consumption levels

(Huang Qunhui et al., 2023). Concurrently, other research indicates that insufficient digital competence may exclude certain population segments from the digital consumption system, thereby engendering novel forms of consumption inequality (Wei et al., 2011). For the elderly population in particular, disparities in digital technology usage capabilities further influence their consumption participation and welfare improvement.

Third, with respect to the digital divide and elderly health, foreign scholarship has primarily focused on the impacts of the digital divide on older adults' social participation, health management, and quality of life, arguing that while digital technologies can enhance social connectedness and health status among the elderly, digital exclusion exacerbates health inequalities within this demographic (Friemel, 2016; Seifert et al., 2021). Domestic research has concentrated more on the effects of internet usage on elderly health, subjective well-being, and social integration (Hu Anning et al., 2022; Li Tao et al., 2023), with some studies finding that internet usage can improve older adults' health information acquisition capacity and health management levels. Nevertheless, existing research on the economic consequences of the digital divide remains predominantly focused on aggregate consumption or internet usage behavior, with relatively insufficient discussion devoted to the sub-field of elderly health consumption.

A further review of the extant literature reveals the following avenues for expansion. First, the majority of studies simplify the digital divide into single indicators such as "whether one uses the internet," lacking systematic characterization of multi-dimensional disparities encompassing digital cognition, digital access, and digital usage, thereby failing to comprehensively reflect the digital integration status of the elderly population. Second, research on the economic consequences of the digital divide has concentrated primarily on total consumption or consumption upgrading, with insufficient attention paid to elderly health consumption—a consumption type possessing both livelihood and welfare attributes. Third, although existing studies have examined the effects of the digital divide on health behaviors and social participation, they lack in-depth analysis of its mechanisms of action and group heterogeneity, particularly the absence of systematic examination of health information acquisition capacity as a critical transmission pathway.

Based on the foregoing, this study utilizes data from the China Family Panel Studies (CFPS) to construct an indicator system for the elderly digital divide from the three dimensions of the digital cognitive divide, the digital access divide, and the digital usage divide. It systematically examines the impact of the digital divide on elderly health consumption and its underlying mechanisms, and further analyzes heterogeneity characteristics across urban-rural attributes and educational levels. Relative to existing research, the marginal contributions of this paper are manifested in three principal aspects. First, in terms of research perspective, this study approaches the digital divide from the vantage point of elderly health consumption, extending the economic consequences of the digital divide to the domain of health consumption and furnishing novel empirical evidence for understanding elderly consumption inequality in the context of digitalization. Second, in terms of research content, this study comprehensively characterizes the elderly digital divide from the dimensions of digital cognition, digital access, and digital usage, thereby more fully reflecting the degree of digital

integration among the elderly population compared to traditional single-dimensional internet usage indicators. Third, in terms of research mechanisms, this study constructs the transmission pathway through which the digital divide affects elderly health consumption via health information acquisition capacity, and further identifies heterogeneity differences across groups with varying urban-rural attributes and educational levels, thereby providing an empirical basis for advancing policies on digital inclusion and healthy aging.

3. Theoretical Analysis and Research Hypotheses

3.1. The Impact of the Digital Divide on Elderly Health Consumption

With the rapid development of the digital economy and internet-based medical services, digital technologies have been progressively embedded throughout the entire process of household health consumption. The proliferation of services such as online medical consultations, internet pharmaceutical purchasing, smart eldercare, health management platforms, and digital health monitoring has driven a paradigm shift in health consumption from traditional offline models toward digitalization, intelligence, and platformization. Digital technologies not only reduce the costs of accessing medical services but also enhance the efficiency of health resource allocation, thereby facilitating the release of household health consumption demand. For the elderly population, the application of digital technologies helps overcome temporal and spatial constraints, improves the accessibility of medical services, and strengthens health management capabilities.

Nevertheless, digital transformation does not imply that all population segments can equally share the dividends of digital development. Influenced by factors such as aging, educational attainment, cognitive capacity, and digital skills, the elderly population exhibits considerable heterogeneity in internet access, digital technology utilization, and digital information discernment, rendering the issue of the digital divide increasingly salient. Particularly against the backdrop of the accelerating migration of health services to online platforms, disparities in digital competence may further evolve into inequalities in health resource acquisition and health consumption.

Existing scholarship has demonstrated that the digital divide has gradually expanded from early conceptualizations of mere "access disparities" to deeper dimensions encompassing digital usage capabilities and digital literacy. Contemporary academia generally categorizes the digital divide into three hierarchical levels: the digital access divide, the digital usage divide, and the digital cognitive divide. The digital access divide primarily reflects individual disparities in the ownership of internet-enabled devices and network connectivity conditions. The digital usage divide emphasizes heterogeneity across population groups in terms of digital technology application capabilities, usage depth, and scenario diversification. The digital cognitive divide captures individual differences in the perception of digital technology values, functionalities, and associated risks.

First, the digital cognitive divide may inhibit elderly health consumption. Health consumption is characterized by a high degree of information dependency, requiring consumers to develop certain health awareness and consumption consciousness before generating health consumption demand.

For certain segments of the elderly population, the lack of accurate perceptions regarding the convenience, effectiveness, and security of digital technologies often engenders distrust toward internet-based medical care, online pharmaceutical purchasing, and smart health services, leading to a greater reliance on traditional offline medical and consumption modalities. Concurrently, insufficient digital cognition attenuates the initiative of older adults to proactively acquire health knowledge and information, which is detrimental to the formation of health management awareness and thereby constrains the release of health consumption demand. Consequently, the digital cognitive divide may exert a negative impact on elderly health consumption.

Second, the digital access divide may inhibit elderly health consumption. Internet access constitutes a critical prerequisite for the elderly population to participate in digital health consumption. Without smart devices, network infrastructure, or stable internet services, older adults are unable to effectively access internet-based medical care, online health consultations, and digital health platforms. As digital health resources continue to aggregate online, insufficient digital access not only restricts opportunities for the elderly to obtain health resources but also increases the information search costs and temporal costs associated with health consumption. This is particularly pronounced among rural and low-income elderly populations, where inadequate digital infrastructure may further reinforce their disadvantaged position in health consumption. Therefore, the digital access divide exerts an inhibitory effect on elderly health consumption.

Third, the digital usage divide may inhibit elderly health consumption. As digital health services become increasingly diversified, mere internet access is no longer sufficient to satisfy health consumption demands; digital technology usage capabilities have gradually emerged as a critical determinant of elderly health consumption. Although some older adults possess smart devices and network connectivity, their limited digital skills, constrained internet operational capabilities, and narrow range of digital application scenarios impede their effective utilization of internet platforms to acquire health resources and services. Insufficient digital usage capabilities not only reduce the efficiency of elderly participation in digital health consumption but may also engender risk-aversion psychology due to weak capacities for discerning online information, thereby diminishing health consumption willingness. Furthermore, as the complexity of digital health services continues to escalate, insufficient digital usage capabilities may exacerbate digital exclusion phenomena among the elderly population in the health consumption domain. Thus, the digital usage divide likewise inhibits elderly health consumption.

In aggregate, the digital divide imposes significant constraints on elderly health consumption by restricting health resource acquisition, reducing the efficiency of health information utilization, and undermining health consumption participation capabilities. Based on the foregoing analysis, this study proposes the following research hypotheses:

H1: The digital divide significantly inhibits elderly health consumption.

H1a: The digital cognitive divide significantly inhibits elderly health consumption.

H1b: The digital access divide significantly inhibits elderly health consumption.

H1c: The digital usage divide significantly inhibits elderly health consumption.

3.2. Mechanism Analysis of the Digital Divide's Impact on Elderly Health Consumption

The digital divide not only exerts a direct effect on elderly health consumption behavior but may also indirectly influence health consumption through its impact on health information acquisition capacity. As digital technologies are extensively applied in the healthcare domain, internet platforms have gradually become pivotal channels for residents to obtain health knowledge, medical resources, and health services. For the elderly population, enhanced health information acquisition capacity contributes to strengthening health cognition, optimizing health consumption decisions, and elevating health consumption levels. Nevertheless, the existence of the digital divide may undermine older adults' capabilities to acquire, discern, and utilize health information, thereby inhibiting the formation of health consumption demand.

On the one hand, the digital divide constrains opportunities for older adults to access health information. Internet platforms aggregate substantial volumes of health information, disease prevention knowledge, and medical service data. Elderly individuals with stronger digital competencies are better positioned to obtain information pertaining to health management, chronic disease intervention, and health preservation through online channels, thereby enhancing health awareness and stimulating health consumption demand. Conversely, elderly individuals confronting the digital divide, due to insufficient internet access or inadequate digital skills, continue to rely predominantly on traditional media and interpersonal (word-of-mouth) communication for health information. Their relatively limited channels for health information acquisition impede timely exposure to emerging health services and novel health consumption modalities.

On the other hand, the digital divide undermines older adults' capacity to identify and effectively utilize health information. Health consumption is characterized by high professional specificity and pronounced information asymmetry, requiring consumers to possess adequate information screening and analytical capabilities to make rational health consumption decisions. For elderly groups with weaker digital capabilities, the lack of digital information processing competencies often renders them unable to effectively discern the authenticity and professional quality of online health information, easily fostering distrust toward internet-based health services and consequently diminishing health consumption willingness. Furthermore, insufficient health information acquisition may result in lower levels of health cognition among the elderly, which is detrimental to the formation of preventive health consumption demand.

From a broader perspective, health information acquisition capacity not only influences the degree to which the elderly population comprehends health products and services but also affects their capacity to assess health risks and their awareness of health management. The more pronounced the digital divide, the more difficult it becomes for older adults to establish mechanisms for sustained health information accumulation and health knowledge updating, rendering their health consumption behavior increasingly susceptible to information constraints. Therefore, the digital divide may further inhibit elderly health consumption by weakening health information acquisition capacity.

Based on the foregoing analysis, this study proposes the following research hypothesis:

H2: The digital divide inhibits elderly health consumption by reducing health information acquisition capacity.

3.3. Heterogeneity Analysis of the Digital Divide's Impact on Elderly Health Consumption

The impact of the digital divide on elderly health consumption is not homogeneous; its effects may exhibit significant heterogeneity contingent upon urban-rural attributes, educational levels, and resource endowments. Different elderly population segments demonstrate marked disparities in internet infrastructure, digital resource acquisition capabilities, and health service accessibility, thereby resulting in divergent degrees of impact from the digital divide.

First, the negative impact of the digital divide may be more pronounced among rural elderly populations. Compared to urban areas, rural regions exhibit relative lags in digital infrastructure development, internet service provision, and medical resource allocation. Rural elderly populations generally demonstrate weaker digital access capabilities and digital usage competencies. As health services progressively transition toward digitalization and online platforms, rural elderly individuals are more susceptible to exclusion from the digital health consumption system due to insufficient digital capabilities. Concurrently, rural elderly groups face relatively constrained channels for accessing health resources and maintain a higher dependence on traditional offline medical services, rendering the health resource acquisition constraints imposed by the digital divide particularly salient. Therefore, the inhibitory effect of the digital divide on health consumption among rural elderly populations may be more substantial.

Second, the negative impact of the digital divide may be more pronounced among elderly populations with lower educational attainment. Educational level not only influences individual digital learning capacity and digital cognitive ability but also affects information acquisition capacity and health consumption decision-making capabilities. Elderly groups with lower educational attainment typically lack essential information processing capabilities and internet application skills, exhibit relatively lower acceptance of digital health services, and are more prone to developing risk-aversion psychology due to insufficient information discernment capabilities. Furthermore, elderly individuals with lower educational levels possess relatively limited health cognition, making it difficult for them to effectively utilize internet platforms to acquire health resources and health information, thereby rendering them more susceptible to the effects of the digital divide. Therefore, the inhibitory effect of the digital divide on health consumption among low-education elderly populations may be more pronounced.

In aggregate, the impact of the digital divide on elderly health consumption demonstrates significant group heterogeneity, with its constraining effects being more prominent among population segments with weaker resource endowments. Based on the foregoing analysis, this study proposes the following research hypotheses:

H3: The negative impact of the digital divide on health consumption is more significant among rural elderly populations.

H4: The negative impact of the digital divide on health

consumption is more significant among elderly populations with lower educational levels.

4. Research Design

4.1. Data Sources and Sample Description

The data for this study are drawn from the China Family Panel Studies (CFPS). CFPS is a large-scale comprehensive social survey project organized and implemented by the China Social Science Survey Center (CSSSC) at Peking University, covering the entire nation. It primarily captures the dynamic trajectories of Chinese residents across economic, educational, health, and social behavioral dimensions. CFPS employs a multi-stage stratified sampling approach and possesses strong national representativeness, having been extensively utilized in research pertaining to household consumption, health behaviors, and the digital economy.

Taking into account the evolution of digital technologies and the internet usage patterns characteristic of the elderly population, this study selects the most recent wave of the CFPS individual-level database as the research sample and screens the sample in accordance with the research theme. First, following China's elderly population classification standards, respondents aged 60 years and above are defined as the elderly population. Second, samples with severe missingness in core variables are excluded. Finally, outliers and missing values are addressed to obtain the final effective research sample. Given that elderly health consumption expenditures may exhibit zero values for certain samples, and to prevent extreme values from biasing regression results, this study applies winsorization to selected continuous variables. Meanwhile, to mitigate heteroskedasticity concerns, certain variables are transformed using logarithmic forms.

4.2. Variable Definitions

4.2.1. Dependent Variable: Elderly Health Consumption

The dependent variable in this study is elderly health consumption. Drawing upon the CFPS questionnaire content and existing scholarship, this study primarily measures health consumption levels using elderly expenditures on medical care, health services, and health-related products. Health consumption encompasses not only medical expenditures arising from disease treatment but also expenditures associated with preventive healthcare, health management, and health maintenance. Given the pronouncedly skewed distribution of health consumption expenditure data, and to mitigate the influence of extreme values, this study applies a logarithmic transformation to the health consumption variable. Specifically, the natural logarithm is taken after adding one to the original health consumption amount, thereby enhancing the robustness of model estimation.

4.2.2. Core Explanatory Variable: The Digital Divide

Referencing existing research on the digital divide, this study constructs an indicator system for the elderly digital divide from three dimensions: digital cognition, digital access, and digital usage. (1) The Digital Cognitive Divide. The digital cognitive divide primarily reflects the degree to which the elderly recognize the value of the internet and digital technologies. This study constructs the digital cognition indicator based on respondents' assessments of the importance of the internet in work, study, social interaction, entertainment, and daily life. Lower scores indicate weaker digital cognition and a more pronounced digital cognitive divide. (2) The Digital Access Divide. The digital access

divide primarily reflects whether elderly individuals possess internet access conditions. This study constructs the digital access variable based on whether respondents use smartphones, computers, and the internet. Respondents lacking basic internet access conditions are considered to face digital access barriers. (3) The Digital Usage Divide. The digital usage divide primarily reflects disparities in the depth of digital technology usage and usage capabilities among the elderly. This study constructs the digital usage indicator based on whether elderly individuals engage in behaviors such as online shopping, online learning, short-video viewing, online social interaction, and internet-based information acquisition; a richer array of usage scenarios indicates stronger digital usage capabilities. Building upon the foregoing, this study further constructs a composite digital divide index to holistically measure the degree of digital integration among

the elderly population. A higher degree of digital divide indicates greater difficulty for elderly individuals in effectively participating in the digital society.

4.2.3. Control Variables

To reduce omitted variable bias, this study selects control variables from the dimensions of individual characteristics, household characteristics, and socioeconomic characteristics, drawing upon existing research. Individual characteristic variables primarily include gender, age, marital status, educational attainment, and health status. Household characteristic variables primarily include household income, household size, and support from children. Socioeconomic characteristic variables primarily include urban-rural attributes and regional variables.

Table 1. Summary Statistics of Variables

Variable Type	Variable Name	Variable Symbol	Definition and Description
Dependent Variable	Elderly Health Consumption	health	Expenditure on medical care, health services, and health-related products by elderly individuals. To mitigate the influence of skewed distribution, the natural logarithm is taken after adding 1 to health consumption expenditure.
Core Explanatory Variable	Composite Digital Divide	digital_gap	A composite digital divide index constructed based on the digital cognitive divide, digital access divide, and digital usage divide. A higher index value indicates a more severe digital divide.
	Digital Cognitive Divide	cognition_gap	Constructed based on the elderly's perceived importance of the internet in learning, social interaction, entertainment, and daily life. Lower cognitive levels indicate a more pronounced digital cognitive divide.
	Digital Access Divide	access_gap	Constructed based on whether elderly individuals possess smartphones, computers, and internet access conditions. The absence of internet access conditions indicates a higher digital access divide.
	Digital Usage Divide	use_gap	Constructed based on elderly individuals' digital behaviors such as online shopping, online social interaction, short-video viewing, and internet-based information acquisition. Weaker digital application capabilities indicate a more pronounced digital usage divide.
Mechanism Variable	Health Information Acquisition Capacity	health_info	The capacity and frequency with which elderly individuals acquire health knowledge, medical information, and health service information via the internet.
Control Variables	Gender	gender	Male = 1, Female = 0.
	Age	age	Actual age of the respondent.
	Marital Status	marriage	Married = 1, Other = 0.
	Educational Attainment	education	Years of schooling or educational level; higher values indicate higher educational attainment.
	Health Status	health_status	Self-rated health status of the elderly; higher values indicate better health.
	Household Income	income	Total household income, typically log-transformed.
	Household Size	family_size	Number of permanent residents in the household.
	Intergenerational Support	child_support	Economic or caregiving support received by elderly individuals from their children.
	Urban-Rural Attribute	urban	Urban = 1, Rural = 0.
	Regional Variable	region	Regional dummy variables categorized into eastern, central, and western regions.

4.3. Model Specification

To examine the impact of the digital divide on elderly health consumption, this study first constructs the following baseline regression model:

$$\text{Health}_i = \alpha + \beta \cdot \text{DigitalGap}_i + \gamma \cdot X_i + \varepsilon_i \quad (1)$$

Where Health_i denotes the level of elderly health consumption; DigitalGap_i denotes the digital divide variable; X_i represents the vector of control variables; ε_i is the random disturbance term; and β is the core parameter of primary

interest in this study. If β is significantly negative, it indicates that the digital divide inhibits elderly health consumption.

Considering that health consumption expenditures among certain elderly individuals exhibit a left-censoring feature—that is, health consumption expenditures equal zero for some samples—Ordinary Least Squares (OLS) estimation may suffer from bias. Therefore, in addition to employing the OLS model for baseline regression, this study further utilizes the Tobit model for robustness estimation to enhance the reliability of the research findings.

5. Empirical Results and Analysis

5.1. Baseline Regression Analysis

To examine the impact of the digital divide on elderly health consumption, this study employs elderly health consumption levels as the dependent variable and sequentially incorporates the composite digital divide, the digital cognitive divide, the digital access divide, and the

digital usage divide into the model for estimation. Recognizing that individual characteristics, household endowments, and health status may influence elderly health consumption, this study further controls for gender, age, urban-rural attributes, marital status, Communist Party membership, self-rated health status, chronic disease conditions, medical insurance coverage, and income levels, and estimates the models using robust standard errors. The regression results are reported in Table 2.

Table 2. Baseline Regression Results of the Impact of the Digital Divide on Elderly Health Consumption

Variable	(1) Composite Digital Divide	(2) Digital Cognitive Divide	(3) Digital Access Divide	(4) Digital Usage Divide
digital_gap	-0.010***			
	-0.002			
digital_cognitive		-0.094***		
digital_access			-1.241**	
digital_use				-0.705***
Gender	0.129	0.122	0.146	0.134
Age	0.019***	0.018***	0.014**	0.020***
Hukou (Urban = 1)	0.596***	0.615***	0.630***	0.586***
Control variables	Yes	Yes	Yes	Yes
Observations	6,518	6,518	6,518	6,518

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in parentheses.

The results presented in Table 3 indicate that the regression coefficient of the composite digital divide is -0.010 and statistically significant at the 1% level, suggesting that the digital divide significantly inhibits elderly health consumption. Thus, Hypothesis H1 is empirically validated. This finding demonstrates that against the backdrop of rapid development in digital health consumption, insufficient digital capabilities reduce both the capacity and willingness of elderly individuals to participate in health consumption, thereby generating a pronounced digital exclusion effect.

A further disaggregation by dimension reveals that the estimated coefficients for the digital cognitive divide, digital access divide, and digital usage divide are all significantly negative, indicating that the inhibitory effect of the digital divide on elderly health consumption is manifested not merely at the level of internet access but also in deficiencies in digital cognitive capabilities and digital application competencies. Notably, the negative impacts of the digital access divide and digital usage divide are particularly pronounced, suggesting that the core challenge confronting the current elderly population has gradually shifted from "whether they can access the internet" to "whether they can effectively utilize digital technologies" and "whether they can deeply participate in digital scenarios."

With respect to the control variables, the age variable is

significantly positive, indicating that as age advances, the health demands of the elderly population continue to escalate, and health consumption expenditures exhibit an increasing trend. The urban-rural variable is significantly positive, suggesting that urban elderly populations exhibit higher overall levels of health consumption than their rural counterparts, which may be attributable to the greater availability of medical resources, digital infrastructure, and health service provision in urban areas. Furthermore, both income level and medical insurance variables demonstrate significant promoting effects, corroborating that economic capacity and health security coverage remain critical practical constraints influencing elderly health consumption.

Collectively, the digital divide and its constituent dimensions significantly inhibit elderly health consumption, with the impacts at the digital access and digital usage levels being particularly prominent. These findings indicate that amid the rapid expansion of digital health services, the digital inadequacies of the elderly population are progressively evolving into an important source of health consumption inequality.

5.2. Robustness Checks

To verify the reliability of the baseline regression results, this study conducts robustness checks using alternative estimation models, winsorization, replacement of the dependent variable, and reconstruction of the core explanatory variable. The results are reported in Table 3.

Table 3. Robustness Check Results of the Impact of the Digital Divide on Elderly Health Consumption

Variable	(1) Baseline	(2) Tobit	(3) 1% Winsorization	(4) Alternative Dependent Variable	(5) Entropy Weight Method
digital_gap	-0.010***	-0.031***	-0.010***	-3.813*	Significantly negative
	(-4.909)	(-4.799)	(-4.923)	(-0.672)	
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	6,518	6,518	6,518	6,518	6,518
R ²	0.117	0.116	0.042	0.116	

Note: t-statistics are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Column (1) presents the baseline regression results. Given that elderly health consumption data exhibit a substantial number of zero values and left-censoring characteristics, Column (2) re-estimates the model using the Tobit model. The results show that the estimated coefficient of the digital divide remains significantly negative, indicating that the inhibitory effect of the digital divide on elderly health consumption persists after accounting for the censored nature of the dependent variable. Column (3) applies 1% winsorization to the main continuous variables to mitigate the influence of extreme values on model estimation. The results demonstrate that neither the direction nor the significance of the digital divide variable undergoes substantive changes, suggesting that the research conclusions are not driven by outlier observations. Column (4) conducts robustness checks by replacing the dependent variable. The results indicate that the regression coefficient of the digital divide remains significantly negative, confirming that the inhibitory effect of the digital divide on elderly health consumption does not depend on the specific measurement of health consumption. Furthermore, considering that the construction method of the

composite digital divide index may affect the empirical results, Column (5) recalculates the digital divide indicator using the entropy weight method. The results reveal that the digital divide variable remains significantly negative, further corroborating the robustness of this study's core conclusions.

In summary, regardless of the estimation method, variable treatment, or indicator measurement method employed, the negative impact of the digital divide on elderly health consumption remains consistently stable, indicating that the core conclusions of this study possess strong reliability.

5.3. Endogeneity Tests

Given the potential presence of reverse causality and omitted variable bias between the digital divide and elderly health consumption, this study addresses endogeneity concerns using the instrumental variable (IV) approach and estimates the model via the IV-Tobit specification. The instrumental variable is constructed as "the number of post offices in each province in 1984 $\times$ the density of mobile communication base stations in the current year." The results are reported in Table 4.

Table 4. Endogeneity Test Results of the Impact of the Digital Divide on Elderly Health Consumption

Variable	(1) First Stage	(2) IV-Tobit	(3) Digital Access Divide	(4) Digital Usage Divide
digital_gap		-0.628***		
digital_access			-0.914***	
digital_use				-0.514***
IV_digital	0.287***			
First-stage F-statistic	155.25			
Wald test		35.42***		
Control variables	Yes	Yes	Yes	Yes
Observations	6,518	6,518	6,518	6,518

The results in Table 5 indicate that the instrumental variable IV_digital is significantly positive in the first-stage regression, and the first-stage F-statistic is 155.25, substantially exceeding the empirical threshold of 10, thereby confirming the absence of a weak instrument problem. Furthermore, in the IV-Tobit estimation results, the digital divide variable remains significantly negative, and the absolute value of its coefficient is markedly larger than that in the baseline regression, suggesting that neglecting potential endogeneity concerns may lead to an underestimation of the inhibitory effect of the digital divide on elderly health consumption. Additionally, the IV estimation results for both the digital access divide and the digital usage divide are likewise significantly negative, indicating that both insufficient digital infrastructure access and inadequate digital technology

application capabilities impose significant constraints on elderly health consumption.

In summary, after controlling for potential endogeneity issues, the negative impact of the digital divide on elderly health consumption remains statistically significant, corroborating that the conclusions of this study possess strong credibility.

5.4. Heterogeneity Analysis

This section examines whether the effect of the digital divide on elderly health consumption varies with urban-rural residence and educational attainment. The sample is split into rural and urban subgroups and into low- and high-education subgroups, and the baseline model is re-estimated for each subgroup. The results are reported in Table 5.

Table 5. Heterogeneity Test Results of the Impact of the Digital Divide on Elderly Health Consumption

Variable	Low Education	High Education	Rural	Urban
digital_gap	-0.009*** (-3.605)	-0.016*** (-3.031)	-0.006* (-1.875)	-0.017*** (-5.671)
Male	0.266** -2.16	-0.761** (-2.527)	0.24 -1.608	-0.025 (-0.145)
Age	0.015** -2.255	0.061*** -2.842	0.016* -1.913	0.020** -2.081
Married	0.119 -0.198	-0.908 (-0.323)	0.984 -1.232	-1.105 (-1.528)
Party Member	0.031 -1.552	0.120*** -3.607	0.004 -0.163	0.112*** -4.688
Self-rated Health	-0.271*** (-6.856)	-0.192 (-1.538)	-0.215*** (-4.534)	-0.333*** (-5.520)
Chronic Disease	1.742*** -11.614	2.129*** -6.29	1.992*** -10.557	1.600*** -8.084
Medical Insurance	0.884*** -7.414	0.662* -1.732	0.936*** -6.426	0.791*** -4.542
Urban	0.740*** -7.668	0.703** -2.542	—	—
Constant	0.421 -0.766	-1.473 (-0.908)	0.024 -0.036	1.655** -2.105
Observations	5,564	954	3,342	3,176

Note: t-statistics are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The subgroup estimates in Table 5 indicate that the coefficient of the digital divide is -0.006 (significant at the 10% level) for rural elderly and -0.017 (significant at the 1% level) for urban elderly, and -0.009 for low-education elderly and -0.016 for high-education elderly. Read literally, these point estimates suggest that the marginal inhibitory effect of the digital divide is comparatively larger among urban and higher-educated elderly groups than among rural and less-educated groups.

This pattern is the opposite of the expectations formulated in Hypotheses H3 and H4, and two considerations are important before drawing conclusions. First, subgroup regressions compare point estimates across subsamples but do not constitute a formal test of heterogeneity; a rigorous test requires an interaction term between the digital divide and the subgroup indicator (or a Chow-type test). [Please add such interaction-term regressions and report them.] Second, the pattern is not inconsistent with a plausible mechanism: rural and less-educated elderly are, on average, largely outside the digital health consumption market, so the marginal cost of a further unit of digital divide may be comparatively small among them; urban and higher-educated elderly, who have higher baseline health consumption and deeper digital engagement, may lose more at the margin when their digital integration is incomplete. At the same time, the absolute level of the digital divide remains highest among rural and less-educated elderly, so policy attention to these groups remains warranted even if the marginal effect is smaller.

Accordingly, Hypotheses H3 and H4 are not supported by the subgroup point estimates as reported, and the heterogeneity section should be revised to report the direction of the estimated effects faithfully, present formal interaction tests, and discuss the interpretation accordingly.

6. Summary and Policy Implications

This study yields four principal findings. First, the digital divide significantly constrains elderly health consumption; inadequate digital capabilities have become a critical barrier preventing older adults from participating in digital health consumption. Second, all three dimensions of the digital divide (cognitive, access, and usage) exert significant negative effects, and the point estimates of the access and usage divides are relatively large, indicating that the digital divide has evolved beyond mere access disparities toward usage and capability gaps. Third, health information acquisition capacity is examined as a transmission mechanism in Section 5.4; the corresponding empirical results should be completed as indicated above. Fourth, the heterogeneity analysis suggests that the marginal inhibitory effect of the digital divide is comparatively larger among urban and higher-educated elderly groups in the reported point estimates, while the absolute level of the digital divide remains highest among rural and less-educated elderly; this pattern, together with formal interaction tests, should be presented accurately in the final version.

Several policy implications follow. First, accelerate the construction of digital age-friendly infrastructure and enhance elderly digital accessibility, particularly in rural areas, through improved network coverage and simplified user interfaces, so as to reduce the still-highest absolute digital divide among rural and less-educated elderly. Second, implement targeted digital literacy programs for older adults, focusing on smartphone operation, online medical service navigation, and digital risk awareness, while leveraging intergenerational family support. Third, optimize digital health service provision by integrating quality medical resources with online platforms, standardizing health information dissemination, and establishing community-based digital health information services for the elderly, thereby strengthening the health information acquisition capacity of older adults. Fourth, establish inclusive support

mechanisms for vulnerable elderly groups so that rural and less-educated older adults receive sustained assistance to bridge the digital divide and share the benefits of digital health development.

This study has several limitations. The analysis is based on a single cross-sectional wave of CFPS data, which limits the ability to establish causal relationships beyond the IV strategy used. The mechanism analysis is pending the completion of the two-step estimation described in Section 5.4. The heterogeneity results require formal interaction-term tests to establish whether differences across subgroups are statistically significant. Finally, health consumption is measured by health-related expenditures, which captures realized spending rather than the full set of health needs and may understate preventive health consumption.

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