How healthcare entrepreneurship enhances ecosystem outcomes: the relationship between venture capital-funded start-ups and county-level health

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Abstract

Purpose – Research has examined how new ventures strengthen local economic outcomes; however, limited research examines health-oriented ventures and their impact on social outcomes, including health outcomes. Increased VC investment in healthcare service start-ups signals more activity toward this end, and the need for further academic inquiry. We examine the relationship between these start-ups and county-level health outcomes, health factors, and hospital utilization.

Design/methodology/approach – Data on start-ups funded via institutional venture capital from PitchBook were merged with US county-level outcomes from the County Health Rankings and Area Health Resources Files for 2010 to 2019. We investigated how the number of VC-funded healthcare service start-ups, as well as a subset defined as innovative, were associated with county-level health measures. We used panel models with two-way fixed effects and Propensity Score Matched (PSM), controlling for demographics and socioeconomic factors.

Findings – Each additional VC-funded healthcare service start-up was related to a significant 0.01 percentage point decrease in diabetes prevalence ($p < 0.01$), a decrease of 1.54 HIV cases per 100,000 population ($p < 0.1$), a

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0.02 percentage point decrease in obesity rates ($p < 0.01$), and a 0.03 percentage point decrease in binge drinking ($p < 0.01$). VC-funded healthcare service start-ups were not related to hospital utilization.

Originality/value – This work expands our understanding of how industry-specific start-ups, in this case healthcare start-ups, relate to positive social outcomes. The results underscore the importance of evidence-based evaluation, the need for expanded outcome measures for VC investment, and the possibilities for integration of healthcare services and entrepreneurship ecosystems.

Keywords Venture capital, Health service start-ups, Propensity score matching, Health outcomes, Entrepreneurship ecosystems

Paper type Research paper

1. Introduction

Privately-held, venture capital-funded healthcare service start-ups are increasing in number and influence around the world to address current challenges of quality, cost, and access to care (Phillips and Garman, 2006). We define VC-funded healthcare service start-ups as privately held firms that are beyond the initial personal and angel funding stage, that entered the marketplace within the last five years (Petkova *et al.*, 2013) and leverage a combination of in-person visits and technology to provide care (e.g., private clinics, outpatient services, and elder and disabled care). They pursue healthcare delivery advancements to improve patient and population health outcomes, better patient experience, and lower healthcare costs. They often operate under more agile conditions relative to more mature health systems or public initiatives; that is, VC-funded healthcare service start-ups are guided by a funding-driven framework that prioritizes speed and flexibility within regulatory guidelines to offer promising and innovative solutions to current cost and quality issues.

Investment by institutional VCs in healthcare service start-ups is growing, revolutionized by tech-related VC funding in healthcare provider operations and services. For example, even in a slowed investment market, healthcare venture capital funds raised $22B in the US in 2022 (Cadieux *et al.*, 2023). These investments are not optional, but necessary, as the USAID's Center for Innovation and Impact (2019) reports a nearly $371 billion annual investment gap in healthcare entrepreneurship must be filled to reach the United Nation's Health Sustainable Development Goals (SDG 3) by 2030. These investments also suggest that VC-funded healthcare service start-ups are related to a broader change in healthcare as a more prominent service option deserving of academic inquiry from the health services and entrepreneurship research community to understand the impact on patient, community health, and broader ecosystem outcomes.

Yet, scholarship on VC-funded healthcare service start-ups remains nascent. Specifically, the factors that lead to health ventures achieving health outcomes are still unclear (e.g. Day *et al.*, 2022). While little is known about the relationship between VC-funded healthcare service start-ups and the subsequent health outcomes of communities in which they operate (WHO, 2019; Veazie *et al.*, 2018; Jain *et al.*, 2019; Offodile *et al.*, 2021), related research has found a positive relationship between physician-owned practice characteristics (e.g. ownership, size) and increased monitoring and screening measures that may lead to reduced avoidable utilization (Kralewski *et al.*, 2015; Shortell *et al.*, 2014). Compared to existing knowledge on physician-owned practices or other healthcare organizations, VC-funded healthcare service start-ups are often characterized as highly innovative and rapidly growing (Kortum and Lerner, 2001). By examining them, we aim to shed light on their role in revolutionizing the impact of entrepreneurial ecosystems to create not only economic benefits but also social outcomes, in our case, related to health outcomes. We examine this phenomenon via quantitative analysis of privately-held venture capital-funded health service start-ups within counties in the United States.

To the best of our knowledge, this study is the first to examine the relationship between VC-funded healthcare service start-ups and county-level health outcomes [1], health factors, and hospital utilization in the United States. This work contributes to the entrepreneurship literature by extending entrepreneurial ecosystem theory to examine health outcomes. Substantial research examines the impact of VC funding on local ecosystems generally,

considering outcomes such as employment, venture, and economic growth (Wurth *et al.*, 2022). However, since VC-funded healthcare service start-ups are solving health problems, exploring the association of these innovations to health outcomes and health factors is also important to consider. In this way, we also contribute to the current health services ecosystem literature to include a more entrepreneurial and innovative lens to better understand relationships between health service start-ups and the health outcomes of the communities they serve.

We offer expanded measures of the traditional outcomes of productive entrepreneurial activity (innovation, survival rates, jobs, etc.) to include measures of social welfare (Neumann, 2021), in this case, health outcomes. In doing so, we contribute evidence for the concept of shared value across the ecosystem, which results from common goals, meaning/measurement, as well as other mutually reinforcing activities (Kramer and Pfitzer, 2016).

We also contribute to the empirical analyses of impact evaluations of entrepreneurship activities, both in using innovative databases and adopting appropriate analytical methods. The use of two-way fixed-effects, control of county-level demographics and socioeconomic factors, and adoption of Propensity Score Matching (PSM) help mitigate the heterogeneity and endogeneity problems that may lead to spurious correlations.

The following provides a brief overview of the entrepreneurship ecosystems and the health service ecosystems literature to serve as an integrated foundation to our understanding of health outcomes within these intersected ecosystems. We then provide our empirical motivation to examine VC-funded healthcare service start-ups, our research methodology, and findings. We find that VC-funded start-ups in healthcare services are associated with small improvements in diabetes, HIV, obesity, and binge drinking rates. The results underscore the importance of evidence-based evaluation and the value of examining economic outcomes and health outcomes within entrepreneurial ecosystems.

2. Literature review

We leverage and extend the burgeoning literature on healthcare service ecosystems alongside established work on entrepreneurship ecosystems to better understand the relationships between venture capital startups and county-level health. In the same way that entrepreneurship ecosystems theory has been used to explain why entrepreneurial ventures have a positive impact on regional economic outcomes, we draw from this theory to examine how healthcare service startups impact regional social outcomes, specifically health outcomes. We specifically analyze the definitions, role of actors, and outcomes in the entrepreneurship ecosystems and healthcare service ecosystems literature and propose an integrated view in Table 1.

2.1 Entrepreneurship and healthcare service ecosystems definitions

While entrepreneurship ecosystems have varied conceptualizations, they are generally viewed to have framework conditions (formal institutions, culture, physical infrastructure and demand), systemic conditions (networks, leadership, finance, talent, knowledge, and support services/intermediaries), outputs (entrepreneurial activity), and outcomes (aggregate value creation) (Stam, 2015; Stam and Spigel, 2016). A regional, geographic, cluster, or "place-based" view is common across studies, which provides a lens for understanding the transformation of regions through entrepreneurial action (Audretsch, 2015; Spigel, 2017; Neck *et al.*, 2004; Mason and Brown, 2014). When coordinated, these conditions, actors, and activities within a region can lead to venture development, growth, and economic development (Stam, 2015; Isenberg and Onyemah, 2016).

The place-based view of entrepreneurship ecosystems, coordinating resources, and aggregate value creation are also included in the definition of healthcare service ecosystems. Health service ecosystems are a subset of service ecosystems, i.e. "relatively self-contained, self-adjusting systems of resource-integrating actors that are connected by shared institutional logics and mutual value creation" (Vargo and Lusch, 2016, *p.* 10–11). The health service ecosystems

	Entrepreneurship ecosystems	Healthcare service ecosystems	Entrepreneurial HC service ecosystems- integrated view
Definition and Analysis Unit	Entrepreneurial ecosystems include framework conditions (formal institutions, culture, physical infrastructure, and demand), systemic conditions (networks, leadership, finance, talent, knowledge, and support services/ intermediaries), outputs (entrepreneurial activity), and outcomes (aggregate value creation) (Stam, 2015; Stam and Spigel, 2016) A regional, geographic, cluster, or "place-based" view is common across studies (Spiegel, 2017; Neck *et al.*, 2004; Mason and Brown, 2014)	Healthcare service ecosystems are a subset of service ecosystems as they are "relatively self-contained, self-adjusting systems of resource-integrating actors that are connected by shared institutional logics and mutual value creation" (Vargo and Lusch, 2016, p. 10–11) A regional view (Carr *et al.*, 2004) is common	• Place-based view • Coordination of resources and actors • Aggregate or shared value creation
Actors	Entrepreneurial ventures keep the ecosystem healthy (Stam, 2015) Resource providers, especially venture capital firms, provide financial resources that support innovation, growth, and economic development (Acs *et al.*, 2017) Other key actors include accelerators and policymakers	Agents in health services ecosystems include service providers and macro-level region/country-level actors (Furst *et al.*, 2021; Brodie *et al.*, 2021) Increased VC investment in healthcare service start-ups relates to a lack of public health investments (Yeager, 2022; Baker and Ivory, 2021), improved efficiencies (Xiao *et al.*, 2023; Yi *et al.*, 2023; Jacobson *et al.*, 2015; Hathaway and Rothwell, 2015), and innovation (Hathaway and Rothwell, 2015; WHO, 2019; Klonoff *et al.*, 2019)	• VC-funded healthcare service start-ups may be associated with the maintenance of the health outcomes of a region • Other actors, including investors, accelerators, and policymakers, are also participants
Outcomes	There is an overall theme of aggregate value creation with empirical evidence of entrepreneurial ventures' impact on economic outcomes There is theoretical (but no empirical) evidence of entrepreneurial ventures' impact on health outcomes (Wurth *et al.*, 2022; Stam, 2015) and social welfare (Neumann, 2021)	There is a focus on co-created value regarding improved quality (reduction in medical errors), safety, clinical outcomes (e.g. target levels, life expectancy), reduced hospitalization, efficiency, and costs (Ciasullo *et al.*, 2017a, b)	• Aggregate or shared value creation may include social welfare, including health outcomes

Source(s): Author's own creation/work

Table 1.
Literature review summary

perspective emphasizes the multi-level and dynamic nature of agents, emergent institutional rules and norms, technological innovations, and value co-creation. One qualitative study that took a regional-based view of the healthcare service entrepreneurial ecosystem in the US explored how entrepreneurship opportunities are created, discovered, and exploited in a region, but did not explicitly link this opportunity view to health outcomes (Carr *et al.*, 2004). Coordination and shared resources across levels (legal, social, political, economic, operational) to provide services and co-created value (Ciasullo *et al.*, 2017a); however, the specific value that is co-created is not empirically examined (as we will discuss more in Section 2.3).

Overall, the view of ecosystems as place-based systems with a group of actors and shared value creation is shared across entrepreneurship ecosystems and healthcare service ecosystems. Our study shares this place-based view and examines the role of key actors (VC-funded healthcare service start-ups) and their outcomes within US counties.

2.2 Actors in entrepreneurship and healthcare service ecosystems

Entrepreneurship ecosystems include "a set of independent actors and factors coordinated in such a way that they enable productive entrepreneurship" (Stam and Spigel, 2016, p. 1). Entrepreneurship ecosystems are by nature dynamic, and actors and institutions are interdependent in that they are influenced by, and in turn influence, their particular entrepreneurship ecosystem (Audretsch and Belitski, 2017; Acs *et al.*, 2017; Feld, 2012; Spigel, 2017). Entrepreneurs are the heart of a successful ecosystem, i.e. the central players and leaders "in keeping the system healthy" (Stam, 2015, p. 2). Resource providers, especially venture capital firms, are also considered to be a key actor because they provide financial resources that support innovation, growth, and economic development (Acs *et al.*, 2017; Mason and Brown, 2014). Many other actors, including accelerators and policymakers, are also involved in entrepreneurial ecosystems, but for the examination of the impact of VC-funded healthcare service start-ups, we focus on the start-ups as the key actor.

Agents in health services ecosystems also include service providers and macro-level region/country-level investors (Furst *et al.*, 2021; Brodie *et al.*, 2021). While investors in healthcare services have traditionally been public or not-for-profit, VC investment in healthcare service start-ups is growing rapidly for several reasons related to financing, efficiencies, and innovation. First, they fill a gap when established health systems and public health investments are not able to meet certain health needs in the current ecosystem (Yeager, 2022; Baker and Ivory, 2021) (e.g. diseases associated with the rapidly aging population, such as Alzheimer's massive investments for service delivery).

Second, VC-funded healthcare service start-ups bring improved efficiency and innovation to the health services sector; indeed, receiving funding is often a signal for an innovative promise (Gondi and Song, 2019). Entrepreneurial practices can increase operational efficiency, leading to cost savings and customer satisfaction (Xiao *et al.*, 2023; Yi *et al.*, 2023; Jacobson *et al.*, 2015; Hathaway and Rothwell, 2015). Innovative models of care, medical advancements, and technologies via new ventures are regularly introduced to the market, which can be critical in improving healthcare quality while containing costs (Hathaway and Rothwell, 2015; WHO, 2019; Klonoff *et al.*, 2019).

To fully understand these benefits and the potential influence of VC funding from an ecosystem perspective, we examine the impact that a concentration of all VC-funded healthcare service start-ups and the concentration of innovative (i.e., patent holding) VC-funded healthcare service start-ups in a region may have on health outcomes of that region.

2.3 Entrepreneurship and healthcare service ecosystems outcomes

Because of the theoretical emphasis on growth, innovation, and economic development in entrepreneurship ecosystems, the vast majority of outcome measures and success are economic (Stam, 2018). Recent studies theorize entrepreneurial activity in a region can also be

linked to social outcomes, including increases in the overall welfare and health of a region (Wurth *et al.*, 2022; Zahra *et al.*, 2014; Kapoor and Lee, 2013). However, to date, there has been limited empirical evidence to support this claim.

Integrating health service ecosystems theory and entrepreneurship ecosystems theory becomes very helpful as we seek to empirically examine these claims. Health service ecosystems generate value via co-creation as health providers combine and recombine novel or renewed resources in partnership with patients and other ecosystem actors (Ciasullo *et al.*, 2017a). Aggregate value creation is particularly important in healthcare, where there are interconnected outcomes from individuals to larger communities, and innovation is often necessary in delivering quality care. However, there has been limited study in the specific value that is co-created. Furthermore, although recent research in healthcare service ecosystems discusses the importance of neighborhoods, counties, and patient communities (Ciasullo *et al.*, 2017b; Rezaei Aghdam *et al.*, 2020), the exclusion of healthcare service ventures from these studies means a lack of clarity into broader outcomes at a higher level in the ecosystem such as the county.

Because the impact of healthcare ventures manifests in different ways, this paper examines a broad range of outcomes from a healthcare services ecosystem perspective: health outcomes (such as self-reported fair or poor health, physically unhealthy days per month, mentally unhealthy days per month, diagnosed diabetes, and diagnosed HIV cases), health factors (such as smoking, obesity, binge/heavy drinking, lack of health insurance, preventable hospital stays, mammography screening, and flu vaccination), and hospital utilization (i.e. total inpatient days, total inpatient days of short-term general hospitals, total outpatient visits, total outpatient visits for short-term general hospitals, and total emergency department visits in short-term general hospitals). We collectively refer to the aforementioned categories as health outcomes to differentiate from the common economic or financial outcomes that are often the focus in entrepreneurship ecosystems.

Summarizing the literature review in Table 1, an integrated view of entrepreneurship ecosystems and healthcare service ecosystems yields three key insights: (1) both perspectives share a place-based view of how coordinated resources and actors provide aggregate or shared value creation; (2) both perspectives emphasize outcomes related to the social welfare of a region; we extend this view to specifically examine health outcomes as social welfare outcomes; and (3) research suggests that empirical research is need to examine the extent to which VC-funded healthcare service start-ups are associated with the maintenance of the health outcomes of a region.

3. Data and methods

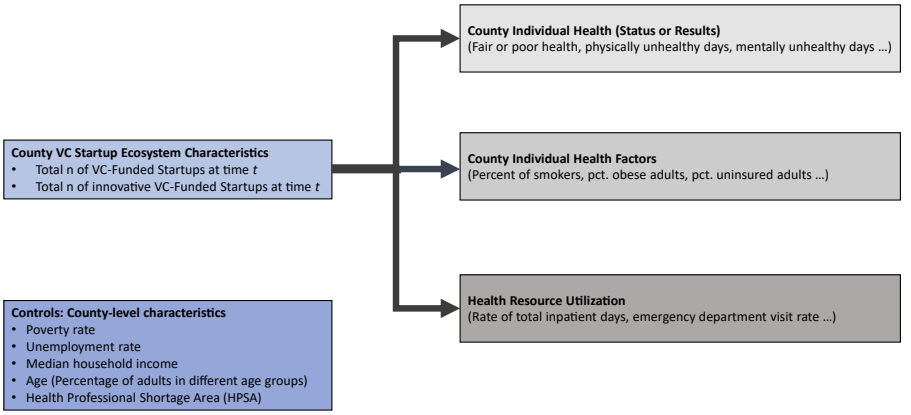
Figure 1 summarizes our approach and variables to examining the influence of VC-funded healthcare service start-ups on the health outcomes of a county.

First, we will review our dependent and independent variables and data sources, followed by empirical models and statistical methods.

3.1 Data and outcome variables

The data is from three sources, including the PitchBook database, County Health Rankings (CHR), and the Area Health Resources Files (AHRF). They were merged based on the year and county locations.

County-level health outcomes and factors came from CHR, a collaboration between the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute. The CHR includes the following five health outcomes that were of interest in this study: the percentage of adults that reported fair or poor health, the average number of physically unhealthy days per month, the average number of mentally unhealthy days per month, the percentage of adults aged 20 and above with diagnosed diabetes, and diagnosed HIV cases for people aged 13 and older per 100,000 population.



Source(s): Author's own creation/work

Figure 1.
Research model associations between county VC startup ecosystem characteristics and health outcomes

The CHR also includes information about additional preventive health factors. We focused on seven factors, including the percentage of current smokers among adults, the percentage of obese adults, the percentage of binge or heavy drinking among adults in the past 30 days, the percentage of the population ages 18 to 64 without health insurance, rate of preventable hospital stays, percentage of annual mammography screening among female Medicare enrollees ages 65–74, and percentage of Medicare enrollees that had an annual flu vaccination.

Hospital utilization data came from AHRF, covering the years 2010–2019. AHRF is a database with more than 6,000 variables for every county in the United States. AHRF aggregates data from more than 50 sources, such as the American Medical Association and the National Center for Health Statistics. We drew five utilization variables from the AHRF, including total inpatient days, total inpatient days of short-term general hospitals, total outpatient visits, total outpatient visits for short-term general hospitals, and total emergency department visits in short-term general hospitals.

The merged full sample had 31,876 observations covering the period from 2010 to 2019, but the sample size for analysis differed for different health outcomes, health factors, and hospital utilization depending on the data availability.

3.1.1 Explanatory variables. The key explanatory variables, the number of VC-funded healthcare service start-ups and the number of innovative VC-funded healthcare service start-ups in a community, are derived from PitchBook. PitchBook is a private company that analyzes venture capital investments and is widely used specifically to examine the performance of entrepreneurial activities in healthcare (Hathaway and Rothwell, 2015; Jain *et al.*, 2019; Rezaei Aghdam *et al.*, 2020; Kassner *et al.*, 2023; Aidis and Schillo, 2017; Asencio *et al.*, 2022).

This study identified 3,899 privately-held VC-funded start-ups in healthcare services in the USA (e.g. clinics, outpatient services, elder and disabled care). Detailed definitions of these start-ups are included in Table A2 in Appendix. These start-ups were founded between January 2010 and December 2020, were all past the seed funding stage, and received institutional VC investments. We created two measures for VC-funded healthcare service start-ups: the number of start-ups and the number of innovative ones in a county in a year. A healthcare service start-up was defined as innovative if it had patents. We lagged the two measures by one year in regression analyses for these start-ups to establish themselves and start providing services and products (Bondurant *et al.*, 2018; Deza *et al.*, 2022). Table 2 lists

Term	Definition/Examples
Venture Capital Funded (VC-funded)	An organization that is beyond the "Seed" or "Series A" rounds of personal, friends and family, and angel funding investment. A single, or multiple, venture capital firms often fund a venture at this stage at a total investment of $3M or more (also referred to as VC-backed)
Healthcare service start-ups	Organizations such as private clinics, outpatient services, and elder and disabled care that entered the marketplace within the last five years and leveraged a combination of in-person visits and technology to provide care
Innovative healthcare service start-ups	healthcare service start-ups that hold patents
Health Outcomes	Self-reported fair/poor health, physically unhealthy days/month, mentally unhealthy days/month, diagnosed diabetes and diagnosed HIV cases
Health Factors	Smoking, obesity, binge/heavy drinking, lack of health insurance, preventable hospital stays, mammography, and flu vaccination
Hospital Utilization	Total inpatient days, inpatient days of short-term general hospitals, outpatient visits, outpatient visits for short-term general hospitals, and emergency department visits in short-term general hospitals

Table 2.
Relevant definitions

Source(s): Author's own creation/work

the definitions of Venture Capital Funded (VC-funded) healthcare service start-ups, health outcomes, health factors, and hospital utilization.

From AHRF, we collected county-level demographics, socioeconomic factors, and health resources as explanatory variables. These included the percentage of people in poverty, unemployment rate, median household income, percentages of the population aged between 15 and 24, between 25 and 44, between 45 and 64, and age 65 and above, and three categories of Health Professional Shortage Area (HPSA) for primary medical care (none of the county; the whole county; and one or more parts of the county designated as a shortage area).

3.2 Validity and reliability of variables

The three databases in our paper (CHR, AHRF, and PitchBook) have a long history, each conducting validity and reliability checks. CHR derives and ranks 34 health measures of nearly all counties in the United States. It makes every effort to provide the most reliable data available and publishes the margins of error (95% confidence intervals). The margins of errors, data sources, methodology, and statistical modeling to assure the quality and comparability of their measures can be found under the technical document and method sections on their website.

The AHRF database collects information from more than 50 reputable organizations and agencies. For example, Health Professional Shortage Area (HPSA) indicators in AHRF are from the Health Resources and Services Administration (HRSA). Inpatient days in AHRF are collected from the American Hospital Association Annual Survey of Hospitals. Age compositions and poverty rates are from the American Community Survey by the US Census Bureau. The unemployment rate in AHRF is from the Bureau of Labor Statistics.

PitchBook was established in 2007 and has a long history of providing market information. They emphasize data reliability and consistent updates and improvements every six hours (https://pitchbook.com/pitchbook-key-differentiators#platform). It uses more than 650,000 web crawlers to scan the internet – capturing relevant financial information from news articles, regulatory filings, websites, press releases and more. The data is then validated according to rigorous quality protocols and verified by Pitchbook quality team members to ensure accuracy and to collect additional hard-to-find details. A recent comparative analysis concluded that it is one of the most accurate databases across general company, founder and funding information (Retterath and Braun, 2020).

Table A9 in the Appendix lists peer-reviewed studies that have used the PitchBook database and the other two databases. These studies are found in reputable journals and organizations such as *JAMA, Health Affairs*, and *Health Services Research*. The adoption of these databases in these studies provides some assurance on the validity and quality of measures used in our paper.

3.3 Statistical analysis

We used linear multivariable panel models with fixed effects and the aforementioned county-level characteristics in Equation (1) .

$$Y_{i,s,t} = \beta d_{i,s,t} + \alpha X_{i,s,t} + C_i + S_{s,t} + T_i + \varepsilon_{i,s,t} \quad (1)$$

Where $Y_{i,s,t}$ is one of the hospital utilization variables, outcome measures, or health factors for county i in state s at year t. In one specification, $d_{i,s,t}$ is the number of VC-backed firms in healthcare services in county i state s in year t. In another specification, $d_{i,s,t}$ is the number of "innovative" new healthcare companies in county i state s in year t. The coefficient β for $d_{i,s,t}$ measures the average impact of healthcare entrepreneurship.

Denote county characteristics as $X_{i,s,t}$. α are their corresponding parameter vectors. C_i is a set of dummy variables for county fixed effects. $S_{s,t}$ are state-year fixed effects (e.g. Massachusetts in 2015). T_i is a set of year dummies. All standard errors are clustered at the county level. The county population is used as the analytic weight. Detailed variable definitions and available years are provided in Table A1 in Appendix.

This model has several advantages. First, the linear model allows coefficient estimates to be directly interpreted as a percentage or rate change and are reliable for measuring average effects (Deza *et al.*, 2022; Gai and Marthinsen, 2019). Second, the dummy variables for county fixed effects (i.e. C_i), state-by-year fixed effects (i.e. $S_{s,t}$) and year-fixed effects (i.e. T_i) are included to control for unobserved time-invariant county characteristics, state-level shocks that changed over time, such as Medicaid expansion and other changes in policies and resources (Bondurant *et al.*, 2018; Deza *et al.*, 2022), and the general trend of healthcare changes over time. We used county population as the analytical weights and clustered standard errors around counties.

Third, Equation (1) follows the exact specification of panel models with two-way fixed effects, controlling both unit and time-fixed effects. It allows for different treatment start times (e.g., states starting the Medicaid expansion in different years or the changing number of VC-backed new healthcare companies in different counties in our study). These models are widely used in social sciences to measure causality and treatment effects, such as labor economics (Autor, 2003), finance (Francis *et al.*, 2014), and health economics (Liu *et al.*, 2017; Gruber and Kleiner, 2012; Gai, 2019).

For example, Bondurant *et al.* (2018) and Deza *et al.* (2022) used the two-way fixed-effects model to study the impact of the number of substance abuse treatment centers and mental healthcare offices in a county on the local crime rates. Frimpong *et al.* (2022) used this model and country-level data to examine the relationship between venture capital healthcare investments and health outcomes, including fertility rate, life expectancy in years, and death rate in 23 EU/EEA countries between 2000 and 2019. The context in these studies is similar to our paper. All focus on the impacts of changing local healthcare resources, including treatment centers, VC healthcare investments, and VC-backed health services, on health outcomes.

Besides the two-way fixed panel model, we further reduce the endogeneity and heteroskedasticity problems using Propensity Score Matching (PSM) methods. The endogeneity and heteroskedasticity issues arise when healthcare service startups choose places where they believe they are most likely to succeed based on favorable local factors (e.g.,

high family income, younger and healthier population, better insurance coverage). Therefore, these same local factors may influence some of our variables of interest (e.g. obesity and diabetes rates), making it challenging to discern relationships.

The PSM methods are widely used to address these problems (Stuart *et al.*, 2014; Gai and Minniti, 2015; Pesko and Robarts, 2017). This approach uses logistic models to predict the probability of a county having a VC-backed health service startup based on county characteristics $X_{i,s,t}$ in equation (1). It then uses the predicted probability, i.e. propensity score, to match each county with a startup (i.e. the treatment group) with the most similar counties without any startup (i.e. the control group). Three PSM methods were used, including nearest neighbor, caliper matching, and kernel matching. The matched sample within each year was then pooled together to create a new panel. We then re-estimated all models in Equation (1) using this new panel.

To test the robustness of our results, we re-estimated our models without county population as the analytical weights. We replaced state-by-year fixed effects with year-fixed effects. Stata 17 MP (StataCorp LP, College Station, TX) and its panel and PSM commands were used for our analysis. Because we were using both firm and county-level variables that were publicly available, our study was exempt from the IRB requirement.

4. Results

Table 3 contains summary statistics of our sample. Counties that did not have a VC-funded healthcare service start-up in a year could have one in the subsequent year, but over 90% of these counties never had any VC-funded healthcare service start-up during our sample period. In contrast, among counties with a start-up in a year, 32.00% had one healthcare service start-up over the sample period; 35.31% had two to five healthcare service start-ups, and 32.69% had more than five healthcare service start-ups. As for innovative healthcare service start-ups, i.e., start-ups with patents, 98.59% of counties without a VC-funded healthcare service start-up in a year never had any innovative healthcare service start-ups during the sample period. Close to 40% of counties with a healthcare service start-up in a year had at least one innovative start-up.

There were significant differences in health-related variables between the two types of counties. Compared to counties with a VC-funded healthcare service start-up in a year, those without a VC-funded start-up had worse health outcomes, including a higher percentage of fair or poor health (18.04% v. 15.56%), more physically unhealthy days (4.03 v. 3.62), and mentally unhealthy days (4.06 v. 3.81), and a higher prevalence of diabetes (11.55% v. 9.56%). The only exception is HIV cases per 100,000 population, where counties without a healthcare service start-up had much lower rates (173.55 v. 365.59).

Counties without a VC-funded healthcare service start-up had more adverse preventive health factors, including higher percentages of smokers (18.78% v. 15.59%, $p < 0.01$), obesity (31.90% v. 27.20%, $p < 0.01$), uninsured adults (17.73% v. 15.54%, $p < 0.01$), more preventable hospital stays among Medicare enrollees (1675.64 v. 1467.00, $p < 0.01$), lower percentages of mammography screening (53.92% v. 56.34%, $p < 0.01$) and flu vaccination (41.39% v. 47.94%, $p < 0.01$) among Medicare enrollees, with the difference statistically significant at the 1% level. The only exception was binge or heavy drinking, where counties without a healthcare service start-up had a lower rate (17.36% v. 18.62%, $p < 0.01$).

With regard to hospital utilization, except for similar short-term general hospital outpatient visits (2.45 v. 2.49, $p = 0.557$), counties without healthcare service start-ups had lower rates in total inpatient days (0.62 v. 0.74, $p < 0.01$), short-term general hospital inpatient days (0.51 v. 0.60, $p < 0.01$), total outpatient visit (2.52 v. 2.71, $p < 0.01$), and emergency department visits (0.40 v. 0.43, $p < 0.01$).

	Entire sample (full sample[a] $n = 31876$) Mean (SD) or no.	Did not have a startup at year t ($n = 29758$) Mean (SD) or no.	Had a startup at year t ($n = 2118$) Mean (SD) or no.	p-value[b]
Total n of VC-funded startups at t, mean (SD)	0.59(3.85%)	0.18(0.84%)	7.67(14.19%)	<0.01
Zero startup at *t*, No. (%)	26990(85.64%)	26990(90.70%)	0(0.00%)	<0.01
One startup at *t*, no. (%)	2438(7.74%)	1876(6.30%)	562(32.00%)	<0.01
Two to five startups at *t*, no. (%)	1362(4.32%)	742(2.49%)	620(35.31%)	<0.01
More than five startups at *t*, no. (%)	724(2.30%)	150(0.50%)	574(32.69%)	<0.01
Total n of innovative VC-funded startups at t, mean (SD)	0.09 0.92%)	0.02(0.18%)	1.36(3.62%)	<0.01
Zero innovative startup at *t*, no. (%)	30384(96.41%)	29338(98.59%)	1046(59.57%)	<0.01
One innovative startup at *t*, no. (%)	693(2.20%)	336(1.13%)	357(20.33%)	<0.01
Two to five innovative startups at *t*, no. (%)	318(1.01%)	82(0.28%)	236(13.44%)	<0.01
More than five innovative startups at *t*, no. (%)	119(0.38%)	2(0.01%)	117(6.66%)	<0.01
Health outcome variables, mean (SD)				
Percent of adults that report fair or poor health	17.89(5.01%)	18.04(5.04%)	15.56(3.65%)	<0.01
Avg. no. of physically unhealthy days per month	4.00(0.76%)	4.03(0.76%)	3.62(0.56%)	<0.01
Avg. no. of mentally unhealthy days per month	4.04(0.71%)	4.06(0.72%)	3.81(0.53%)	<0.01
Percent of adults aged 20 and above with diabetes	11.44(2.89%)	11.55(2.89%)	9.56(2.22%)	<0.01
HIV cases per 100,000 population (age 13 and older)	187.15(228.08%)	173.55(204.66%)	365.59(388.39%)	<0.01
Health factor variables, mean (SD)				
Percent of adults who are current smokers	18.59(4.01%)	18.78(3.96%)	15.59(3.50%)	<0.01
Pct. obese adults (age 20 and older)	31.63(4.90%)	31.90(4.77%)	27.20(4.99%)	<0.01
Pct. adults binge or heavy drinking in last 30 days	17.44(3.39%)	17.36(3.41%)	18.62(2.88%)	<0.01
Pct. uninsured adults (age 18 to 64)	17.60(7.40%)	17.73(7.41%)	15.54(7.05%)	<0.01

(*continued*)

Table 3. Summary statistics of entire sample and sub-samples W/O A VC-funded startups in healthcare services at year *t*

	Entire sample (full sample[a] $n = 31876$) Mean (SD) or no.	Did not have a startup at year t ($n = 29758$) Mean (SD) or no.	Had a startup at year t ($n = 2118$) Mean (SD) or no.	p-value[b]
Preventable hospital stays (medicare enrollees)[c]	1663.43(2464.59%)	1675.64(2486.34%)	1467.00(2074.46%)	<0.01
Pct. mammography screening (medicare)[d]	54.06(12.65%)	53.92(12.69%)	56.34(11.76%)	<0.01
Pct. flu vaccination (medicare enrollees)[e]	41.77(9.90%)	41.39(9.94%)	47.94(6.74%)	<0.01
Hospital utilization variables, mean (SD)				
Rate of total inpatient days per person[f]	0.62(1.22%)	0.62(1.25%)	0.74(0.60%)	<0.01
Short-term general hospital inpatient rate	0.52(0.96%)	0.51(0.98%)	0.60(0.52%)	<0.01
Rate of total outpatient visit per person[g]	2.53(3.38%)	2.52(3.41%)	2.71(2.71%)	<0.01
Short-term general hospital outpatient visit rate	2.45(3.33%)	2.45(3.36%)	2.49(2.59%)	0.557
Emergency department visit rate	0.40(0.58%)	0.40(0.59%)	0.43(0.28%)	<0.01
County-level characteristics, mean (SD)				
Poverty rate	16.24(6.40%)	16.41(6.43)	13.41(5.20)	<0.01
Unemployment rate	6.25(2.91%)	6.28(2.93)	5.76(2.52)	<0.01
Median household income	48284.87(13062.37%)	47438.90(12183.35%)	62617.17(18144.49%)	<0.01
Pct. population between 15 and 24	12.80(3.36%)	12.75(3.38%)	13.61(2.93%)	<0.01
Pct. population between 25 and 44	23.44(3.22%)	23.24(3.08%)	26.83(3.73%)	<0.01
Pct. population between 45 and 64	27.38(3.02%)	27.46(3.02%)	26.13(2.74%)	<0.01
Pct. population 65 and above	17.77(4.65%)	17.96(4.60%)	14.47(4.16%)	<0.01
Health professional shortage area (HPSA), no. (%)				
None of the county designated as shortage	3914(13.84%)	3743(14.00%)	171(11.15%)	<0.01
Whole county designated as shortage	9097(32.17%)	8859(33.13%)	238(15.51%)	<0.01
One or more parts designated as shortage	15263(53.98%)	14138(52.87%)	1125(73.34%)	<0.01
Distribution by year, no. (%)				
Year 2010	3233(10.14%)	3007(10.10%)	226(10.67%)	0.415
Year 2011	3308(10.38%)	2997(10.07%)	311(14.68%)	<0.01
Year 2012	3277(10.28%)	2976(10.00%)	301(14.21%)	<0.01
Year 2013	3152(9.89%)	2987(10.04%)	165(7.79%)	<0.01
Year 2014	3153(9.89%)	2934(9.86%)	219(10.34%)	0.482

Table 3. (*continued*)

	Entire sample (full sample[a] n = 31876) Mean (SD) or no.	Did not have a startup at year t (n = 29758) Mean (SD) or no.	Had a startup at year t (n = 2118) Mean (SD) or no.	p-value[b]
Year 2015	3151(9.89%)	2951(9.92%)	200(9.44%)	0.472
Year 2016	3150(9.88%)	2973(9.99%)	177(8.36%)	<0.01
Year 2017	3150(9.88%)	2952(9.92%)	198(9.35%)	0.384
Year 2018	3151(9.89%)	2975(10.00%)	176(8.31%)	<0.01
Year 2019	3151(9.89%)	3006(10.10%)	145(6.85%)	<0.01

Note(s): [a]Sample size changes depending on the health variables. Reported here is the maximum sample size
[b]p-values from t tests on differences between counties without or with any VC-Funded Startups at year t
[c]Rate of hospital stays for ambulatory-care sensitive conditions per 100,000 Medicare enrollees
[d]Percentage of female Medicare enrollees ages 65–74 that received an annual mammography screening
[e]Percentage of fee-for-service (FFS) Medicare enrollees that had an annual flu vaccination
[f]Total inpatient days of short-term general, short-term non-general, long-term, and Veterans hospitals. Inpatient days are the no. of adult and pediatric days of care, excluding newborn days of care, rendered during the entire reporting period. Neonatal and swing admissions are included
[g]Total outpatient visits for short-term general, short-term non-general, long-term, and Veterans hospitals. It consists of emergency visits, other visits (including clinic and referred visits), and total visits. An outpatient visit is defined as a visit by a patient not lodged in the hospital while receiving medical, dental, or other services. Each visit an outpatient makes to a discrete unit constitutes one visit regardless of the no. of diagnostic and/or therapeutic treatments that the patient receives
Source(s): Author's own creation/work

Table 3.

Counties without these start-ups had less favorable socioeconomic and demographic factors, including higher poverty rates (16.41% v. 13.41%, $p < 0.01$), higher unemployment (6.28% v. 5.76%, $p < 0.01$), lower median income ($47,438.90 v. $62,617.17, $p < 0.01$), and higher percentages of the population age 65 and above (17.96% v. 14.47%, $p < 0.01$). Finally, counties without these start-ups had a higher percentage of the entire county in shortage of primary care (33.13% v. 15.51%, $p < 0.01$).

Table 4 lists the total and annual average number of VC-funded healthcare service start-ups by state. The most popular states are California (65.2 start-ups per year), Texas (32.5 per year), New York (30.1 per year), Florida (23.5 per year), and Massachusetts (16.1 per year).

Table 5 presents the estimated relationship between the number of VC-funded healthcare service start-ups and innovative ones in healthcare services and health-related variables. Figure 2 illustrates the estimated associations.

In the full sample, each additional healthcare service start-up was associated with improvements in three health outcomes, including a 0.01% point decrease in the percentage of people reporting fair or poor health in a county ($p < 0.05$), a 0.02% point decrease in diabetes ($p < 0.01$), and a reduction of 1.47 HIV cases per 100,000 population. The presence of an additional healthcare service start-up was associated with four preventive health factors, including a 0.02% percentage point reduction in current smokers ($p < 0.01$), a 0.03% point decrease in obesity rates ($p < 0.01$), a 0.03% point decrease in binge or heavy drinking ($p < 0.01$) and a reduction of 0.03% point in uninsured adults ($p < 0.05$).

The estimated relationships were larger for innovative start-ups. For example, the decrease in fair or poor health went from 0.01 to 0.06% points. But, innovative healthcare service start-ups were not associated with changes in smoking and insurance. Neither the total number of healthcare service start-ups nor innovative ones were related to changes in hospital utilization.

The last two columns in Table 5 report results based on one-to-one nearest-neighbor PSM samples. To validate the PSM approach, we tested the balancing of independent variables between the matched control and treatment groups. The test results, listed in Table A8 in

State	Total *N*	Avg. *N*	State	Total *N*	Avg. *N*
Alabama	29	2.9	Montana	39	3.9
Alaska	3	0.3	Nebraska	7	0.7
Arizona	82	8.2	Nevada	19	1.9
Arkansas	10	1	New Hampshire	24	2.4
California	652	65.2	New Jersey	17	1.7
Colorado	125	12.5	New Mexico	88	8.8
Connecticut	46	4.6	New York	13	1.3
D.C.	17	1.7	North Carolina	301	30.1
Delaware	15	1.5	North Dakota	103	10.3
Florida	235	23.5	Ohio	2	0.2
Georgia	129	12.9	Oklahoma	101	10.1
Hawaii	12	1.2	Oregon	35	3.5
Idaho	17	1.7	Pennsylvania	38	3.8
Illinois	98	9.8	Rhode Island	118	11.8
Indiana	47	4.7	South Carolina	7	0.7
Iowa	10	1	South Dakota	22	2.2
Kansas	30	3	Tennessee	5	0.5
Kentucky	31	3.1	Texas	106	10.6
Louisiana	36	3.6	Utah	325	32.5
Maine	6	0.6	Vermont	62	6.2
Maryland	67	6.7	Virginia	8	0.8
Massachusetts	161	16.1	Washington	87	8.7
Michigan	58	5.8	West Virginia	71	7.1
Minnesota	61	6.1	Wisconsin	2	0.2
Mississippi	5	0.5	Wyoming	29	2.9
Missouri	29	2.9	Total	3615	361.5

Source(s): Author's own creation/work

Table 4. Distribution of total and average no. of VC-funded startups per year by state

Appendix, confirm that counties with and without a healthcare service startup in the matched samples show no significant differences in their demographics, socioeconomic factors, and primary healthcare. Hence, it is appropriate to use the PSM approach to reduce the heterogeneity in the data.

The last two columns in Table 5 indicate that healthcare service start-ups were no longer associated with improvements in poor or fair health, but they continued to be associated with a 0.01% point decrease in diabetes ($p < 0.01$) and 1.54 HIV cases per 100,000 population ($p < 0.1$). Each additional start-up was significantly associated with two health factors, a 0.02% point reduction in obesity ($p < 0.01$) and a 0.03% point reduction in binge drinking ($p < 0.01$). The four observed relationships were stronger with innovative healthcare service start-ups. Similar to the full sample, these start-ups were not associated with hospital utilization.

As a robustness check, we re-estimated the models based on caliper-matched and kernel-matched samples. In other specifications, county population weights were not used, and state-year fixed effects were replaced by year-fixed effects. County-level fixed effects were included in all models. Results from these samples and specifications are reported in Appendix Tables A3–A7. Significant relationships remained for two health outcomes, including diabetes and HIV, and two health factors, including obesity and binge drinking.

5. Discussion

While VC-funded healthcare service startups may have the potential to revolutionize healthcare through entrepreneurship, there is warranted concern that health ventures, when

	Full sample		Propensity score matched sample	
	Lagged # of startups	Lagged # of innovative startup	Lagged # of startups	Lagged # of innovative startups
Health outcomes as dependent variables				
Percent of adults that report fair or poor health	−0.01** (0.00)	−0.06** (0.03)	−0.00 (0.01)	−0.06 (0.04)
No. of observations	12557	12557	1488	1488
R^2	0.67	0.67	0.72	0.72
Avg. no. of physically unhealthy days per month	0.00* (0.00)	0.00 (0.01)	0.00** (0.00)	−0.00 (0.00)
No. of observations	12557	12557	1488	1488
R^2	0.67	0.67	0.76	0.76
Avg. no. of mentally unhealthy days per month	−0.00* (0.00)	−0.00 (0.00)	−0.00 (0.00)	−0.00 (0.01)
No. of observations	12557	12557	1488	1488
R^2	0.85	0.85	0.85	0.85
Pct. adults aged 20 and above with diabetes	−0.02*** (0.00)	−0.06*** (0.02)	−0.01*** (0.00)	−0.04** (0.02)
No. of observations	18826	18826	2129	2129
R^2	0.22	0.22	0.44	0.44
HIV cases per 100,000 population (age 13 and older)	−1.47** (0.70)	−8.83*** (2.85)	−1.54* (0.80)	−8.40** (3.35)
No. of observations	11807	11807	1656	1656
R^2	0.23	0.24	0.48	0.48
Health factors as dependent variables				
Pct. adults who are current smokers	−0.02*** (0.01)	−0.05 (0.03)	−0.01 (0.01)	−0.05* (0.03)
No. of observations	12557	12557	1488	1488
R^2	0.62	0.62	0.66	0.66
Pct. obese adults (age 20 and older)	−0.03*** (0.01)	−0.10** (0.04)	−0.02*** (0.01)	−0.10*** (0.03)
No. of observations	18827	18827	2129	2129
R^2	0.35	0.35	0.55	0.55
Pct. adults binge or heavy drinking in last 30 days	−0.03*** (0.00)	−0.12*** (0.03)	−0.03*** (0.01)	−0.14*** (0.03)
No. of observations	12557	12557	1488	1488
R^2	0.46	0.46	0.52	0.52
Pct. uninsured adults (age 18 to 64)	−0.03** (0.01)	−0.04 (0.05)	−0.02* (0.01)	−0.05 (0.06)
No. of observations	21969	21969	2477	2477
R^2	0.97	0.97	0.98	0.98
Preventable hospital stays (Medicare enrollees)[a]	−0.86 (3.15)	−2.74 (13.06)	0.10 (3.49)	−8.25 (14.32)
No. of observations	21307	21307	2442	2442
R^2	0.96	0.96	0.98	0.98
Pct. mammography screening (Medicare)[b]	−0.01 (0.01)	−0.05 (0.04)	0.00 (0.01)	−0.01 (0.04)
No. of observations	21530	21530	2451	2451
R^2	0.97	0.97	0.99	0.99
Pct. flu vaccination (Medicare enrollees)[c]	−0.00 (0.01)	−0.01 (0.06)	−0.00 (0.01)	0.02 (0.04)
No. of observations	9374	9374	1086	1086
R^2	0.73	0.73	0.91	0.91

(*continued*)

Table 5.
Relationships between VC-funded startups and health with two-way fixed effects and county population weights

	Full sample		Propensity score matched sample	
	Lagged # of startups	Lagged # of innovative startup	Lagged # of startups	Lagged # of innovative startups
Health resource utilization as dependent variables				
Rate of total inpatient days per person[d]	−0.00 (0.00)	−0.00 (0.00)	−0.00 (0.00)	−0.00 (0.00)
No. of observations	25116	25116	2763	2763
R^2	0.06	0.06	0.34	0.34
Short-term general hospital inpatient rate	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
No. of observations	25116	25116	2763	2763
R^2	0.06	0.06	0.30	0.31
Rate of total outpatient visit per person[e]	0.00 (0.00)	0.01 (0.01)	0.00 (0.00)	0.02 (0.02)
No. of observations	25121	25121	2764	2764
R^2	0.09	0.09	0.27	0.27
Short-term general hospital outpatient visit rate	0.00 (0.00)	0.01 (0.01)	0.00 (0.00)	0.02 (0.02)
No. of observations	25116	25116	2763	2763
R^2	0.08	0.09	0.25	0.25
Emergency department visit rate	0.00* (0.00)	0.00 (0.00)	0.00** (0.00)	0.00* (0.00)
No. of observations	25116	25116	2763	2763
R^2	0.05	0.05	0.23	0.22

Note(s): Standard errors are in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. All models are weighted by county population

The matched sample is from one-to-one nearest neighbor matching

In all models, we included poverty rate, unemployment rate, median household income, percentages of the population between 15 and 24, between 25 and 44, between 45 and 64, 65 and above, Health Professional Shortage Area indicators, county-level fixed effects, and state-year fixed effects. Full results are available from the authors on request

[a]Rate of hospital stays for ambulatory-care sensitive conditions per 100,000 Medicare enrollees

[b]Percentage of female Medicare enrollees ages 65–74 that received an annual mammography screening

[c]Percentage of fee-for-service (FFS) Medicare enrollees that had an annual flu vaccination

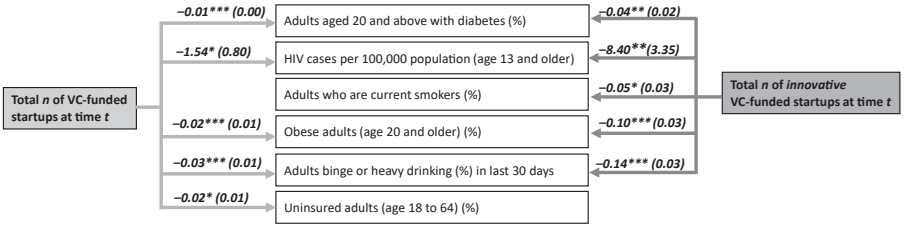
[d]Total inpatient days of short-term general, short-term non-general, long-term, and Veterans hospitals. Inpatient days are the no. of adult and pediatric days of care, excluding newborn days of care, rendered during the entire reporting period. Neonatal and swing admissions are included

[e]Total outpatient visits for short-term general, short-term non-general, long-term, and Veterans hospitals. It consists of emergency visits, other visits (including clinic and referred visits), and total visits. An outpatient visit is defined as a visit by a patient not lodged in the hospital while receiving medical, dental, or other services. Each visit an outpatient makes to a discrete unit constitutes one visit regardless of the no. of diagnostic and/or therapeutic treatments that the patient receives

Source(s): Author's own creation/work

Table 5.

examined individually, may not be achieving the health outcomes that they claim (Day *et al.*, 2022). Furthermore, health services ecosystems, as currently studied, do not always consider the impact of entrepreneurial ventures on social outcomes (e.g. Ciasullo *et al.*, 2017a). However, when we measure their impact on health outcomes at a higher level of aggregation, in this case, the county level, health outcomes may be observable. Thus, our integrated view of entrepreneurship ecosystem theory and healthcare services ecosystem theory both strengthens our empirical understanding of health ventures as well as tests the theory that entrepreneurial ecosystems can impact non-economic outcomes.



Key: *$p < 0.10$; ** $p < 0.05$; ***$P < 0.05$

Note(s): Standard errors are in parentheses
All models are weighted by county population

Source(s): Author's own creation/work

Figure 2.
Associations from propensity score matched sample

The current findings provide empirical support that VC-funded healthcare service start-ups are associated with improved county-level health outcomes. Indeed, our results show that each additional VC-funded healthcare service start-up was associated with a significant 0.01% point decrease in diabetes prevalence, a decrease of 1.54 HIV cases per 100,000 population, a 0.02% point decrease in obesity rates, and a 0.03% point decrease in binge drinking rates at the county level.

While these results are statistically significant, we find relatively limited and small effects of VC-funded healthcare service start-ups on health outcomes. The primary focus on financial returns and a secondary focus on social outcomes in the entrepreneurship ecosystem literature (Wurth *et al.*, 2022; Zahra *et al.*, 2014) and by VCs (Jacobson *et al.*, 2015; Ackerly *et al.*, 2008; Grundy *et al.*, 2017; Freudenberg, 2017) may help to explain these results. While the entrepreneurship ecosystems literature has alluded to social outcomes in recent years, there has been limited measurement. Because entrepreneurial ecosystem stakeholders may not measure such outcomes, it is less likely that ventures focus on achieving them.

Our results also find associations between innovative VC-funded healthcare service start-ups (i.e. those who had patents) and county-level diabetes, HIV, obesity, and binge drinking. These findings had larger coefficient values than the associations between these outcomes and non-innovative start-ups. This finding provides empirical support to previous research that proposed that entrepreneurship ecosystems and health service ecosystems are in part characterized by their focus on technological development and innovation (Neck *et al.*, 2004; Ciasullo *et al.*, 2017b). In particular, we show healthcare outcomes can provide a measure of social welfare benefits that result from concentration of innovative healthcare start-ups. Relatedly, our results help substantiate the growing body of work showcasing entrepreneurial activity toward necessary innovation and adaptation to address new challenges beyond the current actors and systems (Bressan *et al.*, 2021; Kraus *et al.*, 2020).

Another point of inquiry coming from the current study concerns how counties where more innovative VC-funded healthcare service start-ups were located also had more favorable health outcomes and county-level factors such as higher income and lower poverty rate, which could be indicative of heterogeneity among counties and the endogeneity of healthcare service start-up locations. However, we adopted panel models with county-level demographics, socioeconomic factors, HPSA for primary care, county-fixed effects, and state-year fixed effects. Counties with and without a VC-funded start-up were matched using PSM to further alleviate heterogeneity and endogeneity problems. In sum, our robust findings are conservatively suggestive that the increasing investment in VC-funded healthcare service start-ups (particularly innovative ones) does relate to some small improvements in county-level outcomes.

Finally, we found no association between these start-ups (either innovative or not) and hospital utilization rates, which could suggest that a more granular or longitudinal analysis is necessary to better understand the interconnected factors in healthcare ecosystems. The lack of association with hospital utilization could be due to the time horizon of the study and with an extended time horizon, these healthcare service start-ups could have a statistically significant relationship to hospital utilization. This has also traditionally been a challenge for investments in privately held health systems that attempt to demonstrate an impact on hospitalization outcomes (van Gool, 2021). Collectively, these findings and discussion points reveal several implications for practice and policy, as well as limitations and areas for future research that we describe below.

6. Implications for practice and policy

Our results have implications for the interactions between VC-funded healthcare service start-up leaders and VCs as well as for policymakers. Significant relationships for diabetes, HIV, obesity, and drinking, but not in other health outcomes (e.g. percentage of poor or fair health, uninsured adults, and inpatient stays) implies that it may be easier for these start-ups to tell a convincing story of potential market size and profitability to attract VC investments for shorter-term outcomes compared to longer-term outcomes.

Longer-term health outcomes such as poor or fair health and hospital visits may be more difficult to measure or may take more time to show a return on investment. VC fund managers focus strongly on returns for their limited partners, which often have shorter time horizons than patient population outcomes. As reported in a survey, managers of healthcare VC agreed that "financial returns to be their primary concern and that the public health benefit of their investments is of little importance" (Ackerly *et al.*, 2008).

However, this should not dissuade a more recent movement of start-up leaders and VCs from developing patient-centered solutions with longer-term impact horizons. For example, a study of physician-owned practices found that monitoring and screening measures mediate the relationship between practice ownership and avoidable utilization (Kralewski *et al.*, 2015). Similar utilization savings may occur from VC-funded start-ups over time. Term sheets and formal arrangements could include mechanisms for measuring and sharing these saved costs between start-ups and VCs.

We also note a lack of scrutiny from policymakers, public health organizations, and regulatory bodies overseeing many VC-funded healthcare service start-ups and their potential impact on health outcomes (Grundy *et al.*, 2017; Freudenberg, 2017). Although it allows start-ups to quickly bring innovative products and services to the market and attract VC funding, it may diminish their clinical legitimacy among consumers and healthcare professionals (Day *et al.*, 2022).

Policymakers and regulatory leaders could consider initiatives that simultaneously increase healthcare service start-up efficacy (e.g., privacy, security, and truthful clinical claims (Freudenberg, 2017)) and encourage innovation. For example, the "Pay for Success" financing tool is a form of public-private partnership whereby private investors provide initial funding for preventative health and human service interventions to address social determinants of health (Iovan *et al.*, 2018). These initiatives have the benefit of oversight via government collaboration while remaining innovative.

7. Limitations and future research

Limitations to this study include the time horizon as well as accounting for additional venture variables that are not included within Pitchbook, e.g. size, location, and overall database accuracy. These limitations give rise to areas for future research, including understanding processes and non-financial outcomes for entrepreneurship ecosystems.

Time horizon and additional variables. The lack of association with hospital utilization may be explained by the time horizon of the study. We tested our findings by using a two-year lag instead of one, and our findings did not change, providing additional robustness to our results. However, future research could take a longitudinal approach to examine the impact of time on the relationship between healthcare service startups and utilization outcomes. Also, Pitchbook's data in terms of firm size and data on employment history is sporadic and infeasible for imputation. Future research could consider the impact of a venture-funded healthcare service start-up size as a large start-up may be more likely to influence local healthcare than a small one.

Overall database accuracy. Like other venture databases (e.g. Crunchbase and VentureXpert), PitchBook only reports headquarters' locations, but a healthcare service start-up could serve multiple places (e.g. a business that operates clinics in different counties), which could bias our results. As such, future research should examine approaches for a more comprehensive and reliable range of data on VC-funded healthcare service start-ups than is currently available. Also, because of the private nature of VC-funded healthcare service start-ups, it is difficult to validate the accuracy and coverage of the PitchBook database. However, they emphasize their data reliability and consistent updates and improvements every six hours (https://pitchbook.com/pitchbook-key-differentiators#platform). Other data vendors, such as Crunchbase and VentureXpert, provide VC-related data. After examining these other data sources, we find PitchBook data has the most comprehensive coverage of variables. In addition, its wide adoption in healthcare VC analyses, as seen in Appendix Table A9, lends credibility to its data.

A Process View of Entrepreneurship Ecosystems. We proposed an integrated perspective of healthcare service and entrepreneurship ecosystems, which suggests that the conditions (place-based, coordination of resources, and shared value creation) might be integrated. Hence, future research should explore the mechanisms by which VC-funded healthcare service start-ups improve health outcomes and how these mechanisms could differ across various health outcomes and behaviors. By grouping diverse healthcare services in PitchBook with different clinical and operational settings and by analyzing their impacts across a broad category of health outcomes, we estimated the aggregate effects of the VC-funded healthcare service start-ups. Future research could focus on narrower settings and health outcomes. For example, research could collect information on VC-funded clinics of a specific specialty (e.g. dental services) and the related health outcomes (e.g. access to dental care) in their service areas.

Non-Financial Outcomes of Entrepreneurship Ecosystems. Our proposed integrated view of entrepreneurship and healthcare service ecosystems suggests a shared value creation with non-economic outcomes. As such, we suggest that scholars should examine the non-financial outcomes of entrepreneurship. As noted in a recent commentary, "the growth of venture capital and venture capital-backed, early-stage companies (startups) deserves the attention of patients and policymakers because advancements in medicine are no longer exclusively born from providers within the delivery system and increasingly from innovators outside of it (p. 1)" (Gondi and Song, 2019). Entrepreneurship scholars informed by impact investors, academic medical centers, healthcare accelerators, and other ecosystem partners could develop indices to encourage a stronger well-being outcome measurement. In this way, the current study helps move forward conversations on how values and entrepreneurial motivations relate and impact activity (Hueso *et al.*, 2021), how socially oriented entrepreneurial activity may or may not differ from more traditional forms (Santos *et al.*, 2021), and on models that can facilitate shared value across the ecosystem (Kramer and Pfitzer, 2016).

8. Conclusions

To conclude, our results provide empirical evidence that VC-funded start-ups in healthcare services are associated with small improvements in diabetes, HIV, obesity, and binge

drinking rates. To increase the impact of VC-funded healthcare service start-ups, a stronger partnership with established health systems and appropriate public policies may be required to align the financial incentives of VC investors and health objectives. Also, a longer time horizon and more granular and multi-faceted measures will complement the emerging story from the current results.

We hope that our focus on VC-funded healthcare service start-ups encourages additional scholarship of these emerging organizational forms to extend our collective understanding of private health organizations beyond the physician-owned practice to complement public health investments and non-traditional actors in the healthcare ecosystem.

Note

1. The data set used in the current study refers to health outcomes, health factors, and hospital utilization so we follow this nomenclature to be clear about the data used; however, these three categories are also collectively referred to as health outcomes in the related health care literature and we follow that wording in discussing the contribution particularly to delineate from economic outcomes that are common in the entrepreneurship literature.

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Appendix

The supplementary material for this article can be found online.

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