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Key drivers of medical crowdfunding success: a comprehensive analysis of 84,712 projects

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Medical crowdfunding, an emerging form of internet-based financing, has seen immense growth globally in recent years, playing a significant role in supporting vulnerable groups to afford medical expense. In China, the insufficiency of medical insurance to cover all medical expenses, coupled with significant urban-rural disparities, leaves certain households, especially those in impoverished regions, unable to bear unforeseen high healthcare costs. Consequently, there arises a need for medical crowdfunding as a supplementary mechanism to the healthcare insurance system. The performance of existing medical crowdfunding projects, as well as the factors affecting the success rate, however, have been largely been overlooked. This study collects a large dataset from one of China's largest crowdfunding platforms, encompassing 84,712 unique projects, and employs comprehensive analysis on investigating the impact of a variety of factors, including project features and patient characteristics. The results indicate that both project features and patient characteristics significantly affect the performance of medical crowdfunding projects, encompassing aspects like fundraising target amount, patient age, disease type, and geographic location. Notably, donors in China tend to favor projects aiding teenagers, leukemia sufferers, and cancer patients. Additionally, an intriguing observation is that patients in affluent regions are more likely to receive financial support through medical crowdfunding, which reveals the inequity in the geographic distribution of medical crowdfunding. Our research not only contribute to providing a valuable addition to the field of medical crowdfunding, but also provide insightful guidance and practical recommendations for crowdfunding platforms and fundraisers.

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Introduction

Crowdfunding, the practice of gathering financial support from a broad base of individuals, typically in small amounts, has gained significant traction (Zribi, 2022). For instance, Kickstarter has emerged as a prominent crowdfunding platform with an impressive track record of 244,003 successfully funded projects, which have received a total of \$7,486,505,124 in donations (Perry et al., 2009). The global crowdfunding market is projected to exceed a valuation of \$28.77 billion by 2025 (Ren et al., 2020), highlighting its substantial growth and potential as a powerful fundraising mechanism. Crowdfunding is categorized into four types based on the nature of returns offered: reward-based, lending-based, equity-based, and donation-based crowdfunding (Tang et al., 2023). Distinct from the other types, donation-based crowdfunding specifically aims to attract donors to support charitable, research, creative, or personal projects without expecting any financial or non-financial compensation in return (Mejia et al., 2019; Zhao et al., 2022). A key subset of this, medical crowdfunding, involves collecting funds online from numerous individuals to assist those who cannot afford medical expenses (Burtch and Chan, 2019). In 2023, the global healthcare system is facing severe challenges, primarily the steep increase in medical costs, significantly affecting individuals, especially those with low income. It is predicted that medical costs will double in most countries by 2023, often exceeding the 15% medical inflation rate (Asinta, 2022). Alarming, in the United States alone, ~112 million adults struggle with medical expenses (West Health, 2022). In this case, many patients unable to afford treatment often resort to crowdfunding platforms for financial aid. GoFundMe, specializing in donation-based crowdfunding, reveals that more than a third of their projects are specifically focused on healthcare spending, generating more than \$650 million in annual fundraising (Snyder and Cohen, 2019). Despite its growing importance, empirical research on medical crowdfunding remains scarce.

It is worth mentioning that the success rate of medical crowdfunding projects is generally low, with a significant majority of projects failing to achieve their funding targets (Jin, 2019). Specifically, in the UK, the success rate of medical crowdfunding projects stands at 40% (Coutrot et al., 2020). While in China, it drops even further to 10% (Fong et al., 2020). Consequently, the medical industry is actively focused on enhancing the fundraising effectiveness of medical crowdfunding projects, whereas the academic community continues to explore the underlying reasons for their unsatisfactory performance. Although there is a substantial body of research on the key factors for success in non public welfare crowdfunding, such as reward-based crowdfunding, studies focusing on the specific drivers of success in medical crowdfunding are limited (Deng et al., 2022; Shneor and Vik, 2020; Kindler et al., 2019). Especially, Compared with general crowdfunding, medical crowdfunding projects frequently involve more time-sensitive financial requirements, and the lack of success in these projects can result in heightened repercussions, including unfortunate outcomes, such as patient fatalities. However, the applicability of factors deemed influential in general crowdfunding categories, to medical crowdfunding is still under debate (Murdoch et al., 2019). Therefore, further exploration of the determinants specific to medical crowdfunding is crucial to boost crowdfunding effectiveness and ultimately enhance patient outcomes.

It's critical to recognize that the bulk of research on factors influencing the success of medical crowdfunding has primarily focused on developed countries, such as the United States, often overlooking the unique challenges faced by developing regions with low incomes and inadequate healthcare coverage (Kenworthy et al., 2020). In developing regions, low incomes and

inadequate health insurance coverage leave many individuals and families unable to afford high medical costs (Wu and Peng, 2023). As a result, the demand for medical crowdfunding in these regions is becoming increasingly urgent. China, exemplifying a developing country, has witnessed a surge in demand for medical crowdfunding. For example, QFund, one of China's largest medical crowdfunding platforms, has processed a total of 2 billion donation transactions as of 2020, leading the world in terms of donation count on a crowdfunding platform (Yu and Yang, 2014). Although China has achieved universal medical insurance coverage, there are ongoing structural issues, such as high out-of-pocket expenses and uneven distribution of medical resources within the medical insurance system, policies, and management (Wu and Peng, 2023). With the current limitations of China's medical security system, there is a pressing need for comprehensive research into the factors that affect the success of medical crowdfunding, aiming to support patients who are unable to meet high medical expenses through medical insurance alone.

To fill the identified research gaps, our study primarily concentrates on investigating the determinants of success in medical crowdfunding within the context of China. We selected QFund, one of the largest medical crowdfunding platforms in China, as the data source and analyzed 84,712 project datasets. This selection not only provides a substantial volume of case studies but also offers insights into actual donation behaviors in developing countries. We utilized a combined approach of univariate and multivariate analyses to investigate both project-level factors (such as target fundraising amount and posting time) and patient-level factors (including age, disease type, and geographic location), comprehensively assessing the synergistic effects of these multidimensional factors on the ultimate outcomes of crowdfunding projects. Additionally, we established multiple indicators to represent the fundraising outcomes of projects, including fundraising amount, completion rate, number of donors, and average donation amount per donor. This approach allows for a more comprehensive assessment of the varying impacts of different factors on the success of medical crowdfunding projects, thus avoiding partiality. Consequently, this research illuminates the localized practice of medical crowdfunding in China, providing empirical evidence to better understand medical crowdfunding and offering valuable practical guidance to enhance fundraising effectiveness, thereby holding significant practical implications.

Literature review

Donation-based crowdfunding is an innovative online fundraising mechanism, connecting sponsors and donors to support a diverse range of projects. In contrast to other crowdfunding models, donation-based crowdfunding lacks commercial motives and serves as a platform dedicated to supporting social causes, specifically poverty alleviation, children's education, and medical assistance (Lee et al., 2016). Among them, medical crowdfunding has emerged as an innovative solution and fundraising method, mainly to help individuals manage short-term financial pressures caused by medical expenses (Burtch and Chan, 2019), aggregating numerous small contributions to cover healthcare costs (Young and Scheinberg, 2017). Current research in medical crowdfunding focuses on issues of equitable allocation of healthcare resources, ethical concerns, and efficiency (Hou et al., 2022). The fairness in the allocation of healthcare resources is evident in four aspects: the socioeconomic status of fundraisers (van Duynhoven et al., 2019), disparities in information technology capabilities (Kenworthy et al., 2020), potential discrimination faced by fundraisers or patients within the population (Dressler and Kelly, 2018), and

the commercialization aspects of medical crowdfunding (Liberman, 2019). Ethical concerns mainly encompass issues such as the falsification of fundraising information (Zenone and Snyder, 2019), violation of patient privacy (Snyder et al., 2016), and the use of illegal treatment methods (Snyder and Cohen, 2019). The efficiency aspect is primarily concerned with the low completion rates of medical crowdfunding projects or their sub-optimal performance (Solotke et al., 2020). Compared to the extensive research on fairness and ethical concerns, research on the effectiveness of medical crowdfunding appears to be limited. Given this context, exploring the performance issues of medical crowdfunding projects is of great significance, as it can provide valuable insights into enhancing the effectiveness of these fundraising efforts.

Current research in medical crowdfunding examines factors influencing its success across four dimensions: patient characteristics, donor characteristics, crowdfunding platform features, and project features (Hou et al., 2022). The first three dimensions analyze the characteristics of different participant groups and their impact on the outcomes of medical crowdfunding projects. The last dimension focuses on the impact of specific project features and descriptions on fundraising results. A significant portion of existing studies concentrates on factors related to patient characteristics and project features. Patient characteristics encompass a range of factors, such as age (Barcelos and Budge, 2019), geographic location (Burtch et al., 2014), education level (Jin, 2019), family background (Burtch and Chan, 2019), ethnicity (Igra et al., 2021), disease type (Barcelos and Budge, 2019), social networks (Mollick, 2014), personal influence (Carpiano, 2006), interaction skills (Snyder et al., 2017), and personal reputation (Snyder et al., 2017; Wessel et al., 2016). Project features include factors, such as fundraising goals (Mollick, 2014), project duration (Ortiz et al., 2018), project update frequency (Berliner and Kenworthy, 2017), number of photos and videos (Berliner and Kenworthy, 2017), number of comments (Ortiz et al., 2018), number of donors (Peng et al., 2021), text sentiment (van Duynhoven et al., 2019), text topics (Snyder et al., 2017), text credibility (Hou et al., 2022), text narrative style (Berliner and Kenworthy, 2017), and text quality (Wu et al., 2022). These multifaceted dimensions underscore the complexity of factors that contribute to the success of medical crowdfunding campaigns, emphasizing the need for a comprehensive approach in understanding and enhancing their effectiveness.

Previous studies on the effectiveness of medical crowdfunding have relied primarily on qualitative data, such as surveys and interviews (Zhang et al., 2022), with a more limited reliance on quantitative data like donation amounts, project success rates, and other relevant metrics from crowdfunding platforms (Hou et al., 2023). Quantitative data offer the advantage of enabling the measurement and comparison of differences across various medical crowdfunding projects, thereby facilitating the assessment of factors affecting project performance and yielding more objective conclusions. Current research on the performance of medical crowdfunding focuses primarily on developed countries, using data from platforms such as GoFundMe (Berliner and Kenworthy, 2017). However, there is a notable gap in research concerning medical crowdfunding in low-income, developing countries where health insurance coverage is often inadequate (Ba et al., 2020). Despite nearly universal public health insurance coverage for its 1.4 billion people, China, as the largest developing country, still faces scenarios where many patients and their families struggle to afford medical treatment not covered by government insurance (Fang et al., 2019). Therefore, these individuals heavily rely on medical crowdfunding to alleviate their financial burdens. We selected one of China's

largest medical crowdfunding platforms, QFund, to collect a substantial amount of quantitative data (Chen et al., 2022). This approach is intended to enable a more objective analysis of the factors that influence the effectiveness of medical crowdfunding in China, aligning with the current academic interest and scholarly rigor.

In conclusion, this research employs web scraping techniques to gather extensive data from QFund. By focusing on two pivotal dimensions—project features and patient characteristics—this study provides an in-depth analysis of the factors influencing the effectiveness of medical crowdfunding in China. This approach not only offers a detailed understanding of the dynamics at play in Chinese medical crowdfunding but also contributes valuable insights into the broader field of crowdfunding research, especially in the context of developing countries with unique healthcare challenges.

Data and methodology

Data collection and processing. QFund, a crowdfunding platform specifically catering to major illnesses, enables users to create crowdfunding projects to receive donations. Since its establishment in September 2014, QFund has played a pivotal role in assisting 2.53 million families, amassing over 25.50 billion RMB (the official currency of the People's Republic of China) in total donations. A common practice among fundraisers and their supporters involves sharing links to their crowdfunding projects on social media platforms to enhance visibility and attract donations. Sina MicroBlog, a platform similar to X (previously Twitter) boasting 584 million users, stands as a crucial medium for disseminating information about QFund projects. Consequently, URLs linking to a variety of crowdfunding projects on QFund are frequently shared and can be sourced from Sina MicroBlog, demonstrating the integration of social media dynamics in the realm of medical crowdfunding (Wang et al., 2023).

To gather data for our research, we first searched for MicroBlog posts that contained the keyword “Easy Fundraising”. These MicroBlog posts usually contain a public URL link that directs donors to the donation page, as shown in Fig. 1. Subsequently, we extracted all these URL links identified in the MicroBlog search. The final step involved crawling the detailed data of each crowdfunding project. Through this three-step process, we crawled the comprehensive information on 187,050 unique crowdfunding projects initiated between January 1, 2016, and December 31, 2020. This data encompassed various aspects such as the fundraising amount, patient characteristics, and number of donations. Additionally, we collected 189 million individual donation records, including donor ID, donation time, and one-time donation amount, as depicted in Fig. 1. However, it's important to note that not all projects contained complete information, and some were not related to medical crowdfunding. To ensure the integrity and relevance of our data, we implemented specific filtering steps to enhance data quality.

Disease information filtering: Only projects that included specific information about the disease were selected. This step ensures that our research is based specifically on medical crowdfunding projects and allows for disease-specific analysis.

Target amount filtering: We set the target fundraising amount (TFA) to be between RMB 1000 and RMB 500,000. This range helped to filter out projects that were not genuine, such as unauthentic or test projects.

Donor count filtering: Projects that received no donations were excluded. The lack of donations often indicates that a project might have been created for testing purposes rather than for actual fundraising.

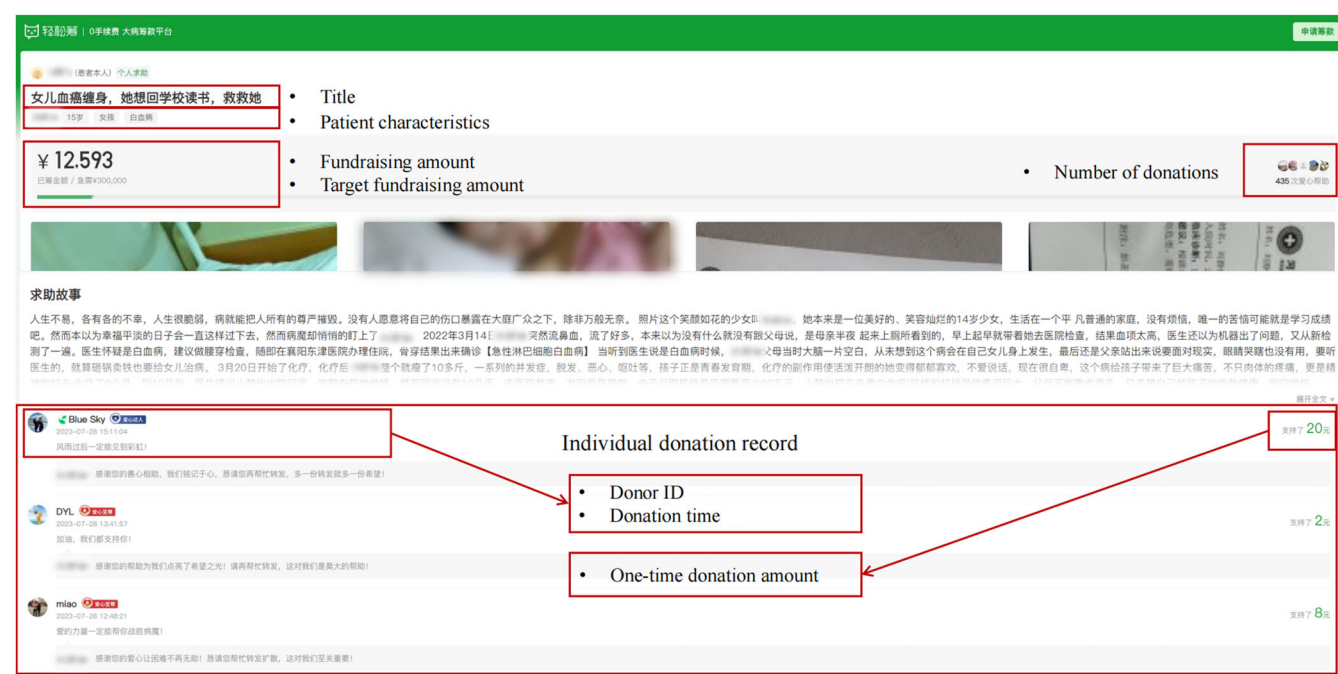


Fig. 1 Data source page on QFund.

Individual donation information filtering: We eliminated projects with incomplete individual donation information, for example, where the sum of one-time donation amounts did not match the total fundraising amount. This step was crucial for maintaining data integrity.

Age screening of patients: The age of patients at the time of the project's initiation was recalculated. We included only those projects where the patients' ages ranged from 0 to 95 years and excluded projects lacking patient age information.

Disease label filtering: Projects were retained if their title and activity description contained disease keywords from a specially constructed disease keyword dictionary. This dictionary was developed using multiple medical knowledge websites, such as <https://www.zhzyw.com/jbdq.html>, <http://jb.qm120.com>, and <http://www.a-hospital.com>.

Geographic location information filtering: Projects lacking provincial information about the patient were excluded. This step is intended to avoid biases that could arise from data lacking provincial information.

Using the seven steps mentioned above, the original data were secondary cleaned, resulting in 84,712 projects. These rigorous filtering steps were instrumental in ensuring that the dataset was comprehensive, reliable, and suitable for a detailed analysis of the factors influencing the success of medical crowdfunding projects in China.

Indicator setting. To assess the fundraising performance of medical crowdfunding projects on QFund, we identified four key indicators: Fundraising Amount, Completion Rate, Number of Donors, and Donation Amount per Donor. These indicators provide a comprehensive view of each project's success and public engagement. These indicators are described in detail as follows:

(1) **Fundraising amount**
Fundraising amount (FA) refers to the total amount ultimately raised by the project, indicating the overall level of public support. The FA for each project is obtained directly from the QFund website.

- (2) **Completion rate**
Completion rate (CR) measures how much of the crowdfunding goal was achieved at the project's conclusion. It's calculated as the ratio of the Fundraising Amount to the Target Fundraising Amount ($CR = FA/TFA$). TFA data is sourced from the QFund website.
- (3) **Number of donors**
Number of donors (ND) signifies the total number of individual donors who contributed to the project, reflecting the project's ability to attract public participation in donations. Determined by counting unique donor IDs from the individual donation records on QFund (see Fig. 1).
- (4) **Donation amount per donor**
Donation amount per donor (DA) represents the average donation made by each donor, reflecting the average level of support provided by donors to the project. It is calculated as the ratio of Fundraising Amount to the Number of Donors ($DA = FA/ND$).

Research methodology. In order to explore the impact on fundraising performance, our investigation centers on two primary categories: project features and patient characteristics. The project features include the TFA and project posting time, while patient characteristics include patient age, disease type, and geographic location. This dual-focused approach allows for a comprehensive understanding of the factors influencing the success of medical crowdfunding. We employed statistical analysis methods, including descriptive statistics and correlation analysis, to observe and compare the values of indicators across different factor values. Given the skewed distributions observed in various indicator categories, the nonparametric Kruskal–Wallis (KW) test method was applied to assess the distributions differences among two or more independent sample categories. Subsequently, employing indicators such as FA as dependent variables, we established the multiple regression model and the negative binomial regression model to analyze the impact of diverse factors on project fundraising performance.

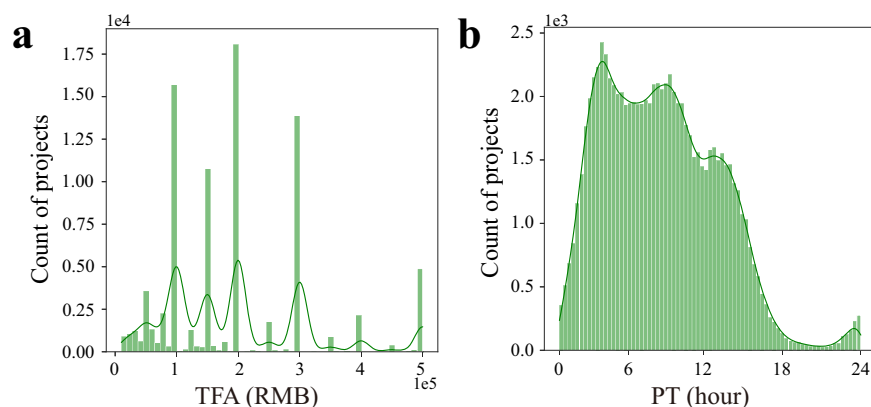


Fig. 2 Distribution of projects. **a** Distribution of target fundraising amount (TFA). **b** Distribution of posting time (PT).

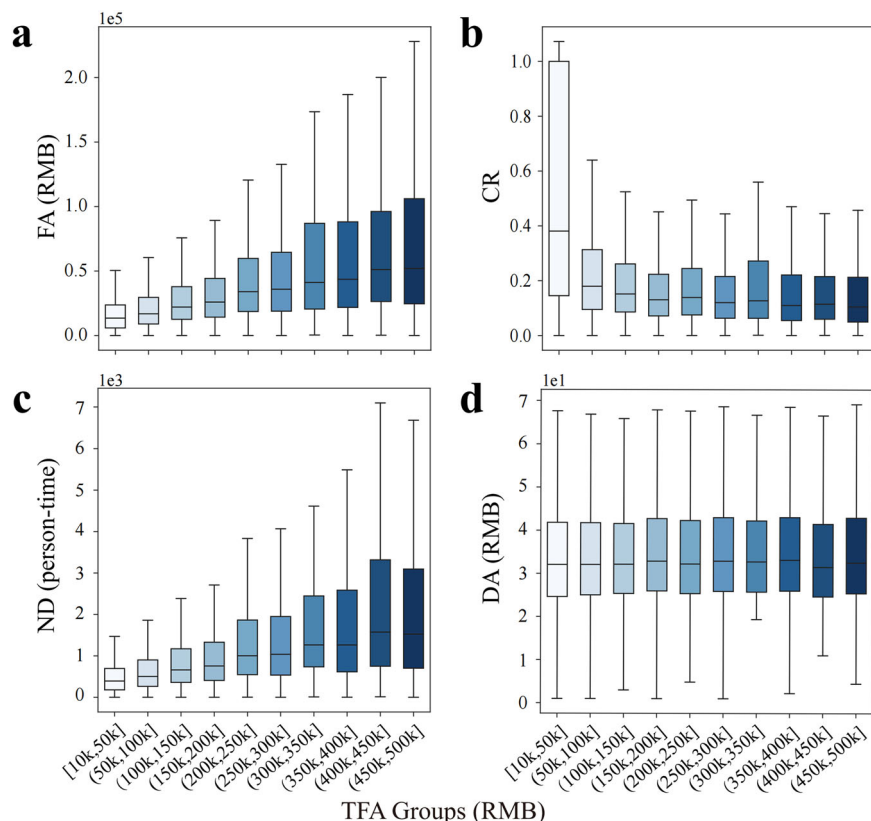


Fig. 3 Differences in fundraising performance indicators across different TFA. **a** Fundraising amount (FA). **b** Completion rate (CR). **c** Number of donors (ND). **d** Donation amount per donor (DA).

Project features analysis

Target fundraising amount. TFA is crucial to the success of crowdfunding projects, as it encapsulates the actual financial requirements needed to cover expenses such as surgical procedures, medications, and medical equipment. Setting an appropriate TFA is essential to guarantee the effectiveness of these projects.

Figure 2a shows the TFA distribution across a dataset comprising 84,712 unique crowdfunding projects. Among these, a significant majority (70.48%) set their TFA below RMB 200,000. It is observed that TFAs often align with milestone thresholds, commonly opting for round figures in increments of RMB 100,000 or RMB 50,000. This trend is evident in the substantial proportion of projects targeting TFAs at RMB 200,000 (21.33%), RMB 100,000 (18.39%), RMB 300,000 (16.37%), and RMB

150,000 (12.5%). For detailed group analysis, these projects were categorized into 10 distinct segments based on their TFA, with each segment spanning a range of RMB 50,000 (refer to Table S1 for details).

The analysis depicted in Fig. 3, along with the correlation analysis presented in Table 1, yields significant insights into the relationships between various factors. The FA exhibits a moderately strong positive correlation with the TFA, as evidenced by a Pearson correlation coefficient of 0.39. Additionally, the ND also demonstrates a positive correlation with TFA, indicated by a correlation coefficient of 0.35. In contrast, the correlation between the DA and TFA is found to be negligible, with a correlation coefficient of 0.02. Notably, there is a negative correlation observed between the CR and TFA, denoted by a correlation coefficient of -0.26 .

Table 1 Variable correlation matrix.																			
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
1 FA	1.00																		
2 CR	0.55	1.00																	
3 ND	0.88	0.47	1.00																
4 DA	0.09	0.10	-0.15	1.00															
5 TFA	0.39	-0.26	0.35	0.02	1.00														
6 PT	0.01	0.03	0.01	0.00	-0.01	1.00													
7 Age	-0.25	-0.17	-0.30	0.16	-0.17	-0.01	1.00												
8 Age ²	-0.25	-0.18	-0.29	0.14	-0.17	-0.01	0.96												
9 B	-0.04	-0.02	-0.03	-0.04	-0.04	0.00	0.09	1.00											
10 F	-0.04	-0.02	-0.01	-0.05	-0.07	0.00	-0.02	-0.11	1.00										
11 K	0.00	0.00	-0.02	0.02	0.05	0.01	-0.08	-0.11	-0.14	-0.08	1.00								
12 L	0.21	0.07	0.20	-0.02	0.24	0.00	-0.27	-0.24	-0.14	-0.08	-0.11	1.00							
13 M	-0.02	0.00	-0.02	0.01	-0.03	0.00	0.02	0.02	-0.11	-0.06	-0.08	-0.08	1.00						
14 Cc	0.07	0.04	0.04	0.08	0.04	0.00	0.05	0.04	-0.39	-0.22	-0.29	-0.36	0.28	1.00					
15 E	0.09	0.06	0.01	0.18	0.06	-0.02	0.01	0.00	-0.02	-0.03	-0.01	0.02	0.02	0.07	1.00				
16 N	-0.02	-0.02	0.00	-0.05	0.00	-0.02	-0.02	-0.02	0.00	0.00	0.01	0.04	-0.02	0.00	-0.14	1.00			
17 NE	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.04	-0.04	-0.01	0.00	0.00	0.04	-0.01	0.01	-0.09	-0.05	1.00		
18 SC	0.01	0.01	0.06	-0.10	0.00	0.01	0.06	0.07	0.03	0.00	-0.02	-0.05	0.01	-0.03	-0.51	-0.25	-0.17	1.00	
19 SW	-0.09	-0.07	-0.09	-0.03	-0.05	0.02	-0.05	-0.05	-0.01	0.03	0.03	0.00	-0.01	-0.03	-0.23	-0.11	-0.08	-0.42	1.00
20 GDPPC	0.17	0.11	0.14	0.09	0.09	0.01	0.05	0.05	-0.02	-0.02	-0.02	0.00	0.03	0.06	0.37	-0.08	-0.14	0.05	-0.29

Posting time. The success of fundraising projects on Sina MicroBlog is largely contingent upon the extent of their reach among users. In this context, the Posting time (PT) plays a critical role in maximizing its visibility and exposure. Thus, PT emerges as a potentially influential factor in determining the performance of medical crowdfunding projects. This consideration suggests that the timing of a project’s launch could significantly impact its ability to attract attention and, consequently, donations.

In this section, we classified PT into four groups (refer to Table S1 for details): 0:00 to 6:00 (early morning), 6:00 to 12:00 (morning), 12:00 to 18:00 (afternoon), and 18:00 to 24:00 (evening). Figure 2b presents the distribution of PTs within our dataset. The data reveals a prominent concentration of PTs during the early morning (37.10%) and morning periods (41.33%). A significant peak occurs at 3:00, accounting for 8.56% of the total projects. However, there is a noticeable decrease in project postings during the afternoon (19.71%), with the volume reaching its nadir in the evening (1.85%). Notably, only 3.75% of all fundraising projects were posted between 16:00 and 23:00. These patterns suggest that fundraisers strategically choose early morning and morning hours to post their projects. This timing aligns with maximizing visibility on Sina MicroBlog, as users are more likely to encounter these projects first thing upon waking up. Such strategic timing indicates an understanding of user behavior on social media platforms and is likely aimed at optimizing user engagement and support for their fundraising efforts.

Reflecting on the insights derived from Fig. 4 and the correlation analysis presented in Table 1, it becomes evident that there are negligible associations between Posting Time (PT) and all evaluated indicators: CR ($r = 0.03$), FA ($r = 0.01$), ND ($r = 0.01$), and DA ($r = 0.00$). The correlation coefficients for each of these relationships are minimal, indicating that PT, within the scope of this study, does not significantly influence these key aspects of crowdfunding project performance.

Patient characteristics analysis

Age. To examine the influence of patient age on fundraising performance, we divided patients into five distinct age groups, as depicted in Fig. 5. These age groups correspond to various life stages, providing a framework to understand how age may impact the success of fundraising efforts. By analyzing the differences in fundraising performance across these age groups, we can gain insight into the extent to which a patient’s age affects the willingness of donors to contribute and the overall effectiveness of the crowdfunding project. This approach allows us to explore whether certain age groups elicit more empathy or support, thereby influencing fundraising performance.

Using the maximum values of each indicator as references, we constructed a bubble chart, as depicted in Fig. 5. The chart illustrates the average performance of different age groups across various indicators. The teenager group showed the highest performance in FA (RMB 56,687) and ND (2091). Conversely, the young adult group outperformed in CR (27.95%), and the elderly group showed the highest performance in DA (RMB 38). Across these indicators, significant disparities emerged among the age groups. The average FA for teenagers was 2.98 times that of the elder group, and their average ND was 3.86 times greater. The CR for the young adults surpassed that of the elderly by 13%. In addition, the elderly group’s DA exceeded that of the other groups. These trends indicate a marked preference for donating to teenagers, alongside a lower success rate for the elderly in medical crowdfunding projects.

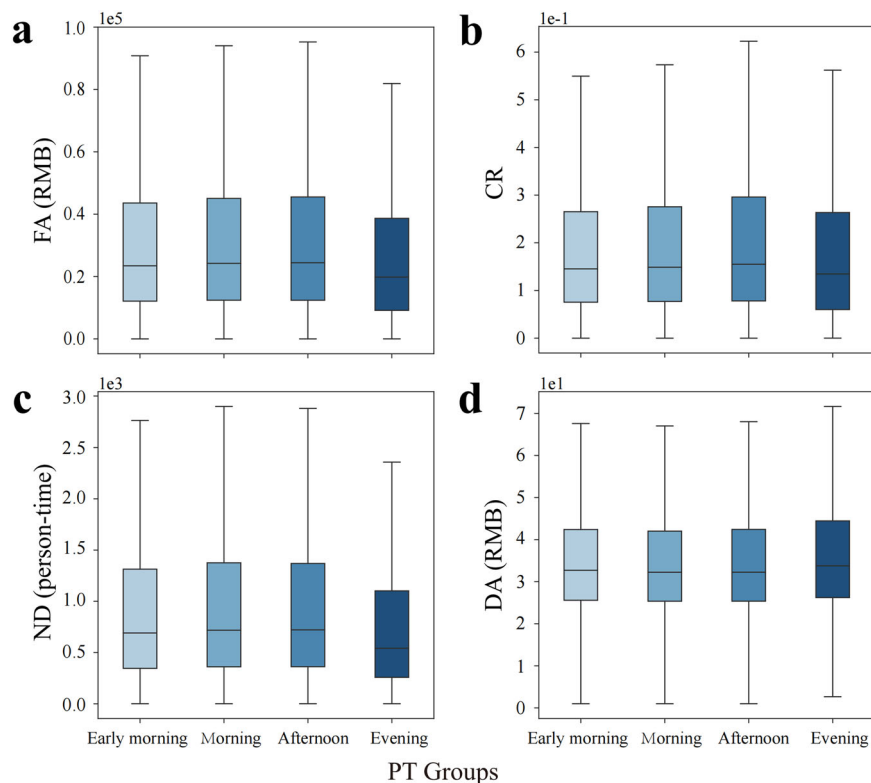


Fig. 4 Differences in fundraising performance indicators across different PTs. **a** FA. **b** CR. **c** ND. **d** DA.

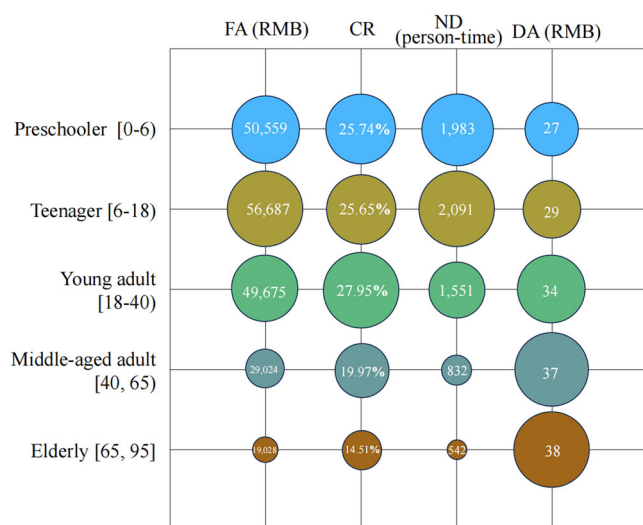


Fig. 5 Average performance across multiple indicators in different patient age groups.

Disease type. The type of disease (DT) constitutes a crucial factor in ascertaining the urgency of a crowdfunding project and the requisite donation amount. We concentrate on assessing the influence of DT on fundraising performance. This analysis involves categorizing diseases, considering elements like disease label and cancer as foundational criteria for this categorization.

Disease label. Analyzing the textual description of project information, we identified 59 unique patient disease labels (DLs). Of these, the five most frequent DLs, as illustrated in Fig. 6, were chosen for a detailed examination of their impact on the

performance of medical crowdfunding projects, with a specific focus on these DLs. Remaining DLs were categorized under “others”.

Comparing the box plots presented in Fig. 6, a notable distinction emerges in the distribution of the four indicators across various groups. The dotted and solid lines in Fig. 6 represent the mean and median values, respectively. Leukemia stands out with higher median values in FA, CR, and ND, and its distribution significantly differs from other disease labels. Brain disease, kidney disease, malignant tumor, fracture, and the “others” category exhibited similar median values in FA, CR, and ND (see Fig. 6). However, variations in their dispersion trends are evident, with distinct differences observed in the DA distribution range (see Fig. 6). In addition, leukemia showed the highest average FA (RMB 65,694), which is 2.23 times the average for fracture (RMB 29,512). Furthermore, its mean CR (27.54%) is 6.57% higher than that of fracture (20.97%). The mean ND for leukemia, at 2095, is more than double that of “others”, which stands at 1035. In terms of DA, the mean value for kidney disease (RMB 37) is RMB 5 higher than that for fracture (RMB 32). Diseases such as kidney disease, malignant tumor, and those in the “others” category show similar performances across multiple indicators, indicating that specific DLs may be key drivers of these discrepancies.

Cancer and non-cancer. Cancer is either a primary or secondary cause of death in 112 countries, and in China, cancer-related deaths are projected to comprise nearly 30% of total deaths (Sung et al., 2021). In addition, cancer crowdfunding projects hold a significant share within medical crowdfunding platforms. To investigate the potential impact of cancer on the fundraising performance, projects were classified into two distinct groups: those associated with cancer and those not, following the disease labels (DLs) specified in the International Classification of

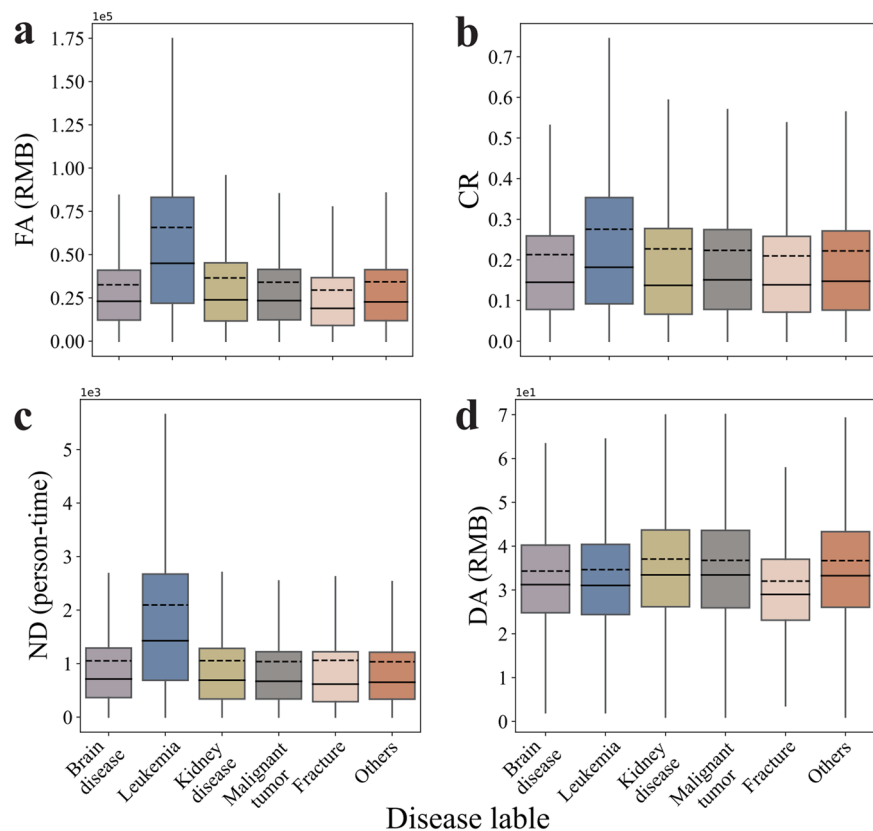


Fig. 6 Indicator manifestations of different disease labels. **a** FA. **b** CR. **c** ND. **d** DA.

Diseases (ICD-10) by the World Health Organization, as detailed in Table S2.

The average values for the four indicators in both cancer and non-cancer projects are visually represented in Table S1. Cancer projects received an additional RMB 6240 compared to non-cancer projects, along with a 2% higher completion rate. Meanwhile, there was a notable difference of 106 donors between the cancer and non-cancer projects. The average donation amount per donor for cancer projects exceeded that for non-cancer projects by more than RMB 3. These findings suggest that cancer-related projects have a greater capacity to attract a larger number of donors who are inclined to contribute higher amounts.

Geographic location. Geographic location (GL) is a critical dimension in crowdfunding research. Existing studies have highlighted regional biases and disparities within crowdfunding (Burtch and Chan, 2019). Despite this, a thorough analysis exploring the impact of GL on fundraising performance in medical crowdfunding projects is yet to be conducted. Consequently, we examine the influence of geographic factors on the four indicators, considering both regional and provincial dimensions.

Geographic region. Medical crowdfunding projects were gathered from 31 provinces, municipalities, and autonomous regions across China. These areas were further classified into six distinct geographic regions (GRs), as illustrated in Fig. 7. This classification reflects the variances in economic development and cultural practices prevalent across these GRs.

East China registers the highest average FA (RMB 44,050), which is 1.61 times higher than that of the Southwest China (RMB 27,438). The average project CR in East China exceeds that

in Southwest China by 6.42%. Additionally, the DA in the East China (RMB 41) surpasses that of the North China by RMB 9. South Central China, meanwhile, exhibits the highest average ND (1235), which is 393 more than in Southwest China. Figure 7 illustrates the kernel density distributions of various indicators across these regions. It is evident that the distribution of FA, CR, and ND in Southwest China shows a higher degree of centralization compared to other regions, with an overall trend significantly lower than in other areas. In contrast, East China displays a more decentralized distribution of FA, CR, and DA. These findings highlight the significant disparities in both the mean values and distributions across different regions for the four indicators, underscoring the profound impact of geographic regions (GRs) on fundraising performance in medical crowdfunding.

Province. The province is a key factor in defining geographic locations (GLs). Therefore, this section focuses on the provincial dimension to thoroughly investigate the influence of GL. East China is one of the most economically promising areas in China, exhibiting the best fundraising performance. Given the significant economic and cultural differences among the provinces in this region, it proves to be highly representative. Consequently, we have chosen the eastern region as the focus of our study.

In terms of FA, Zhejiang boasts the highest mean FA value (RMB 58,571), whereas Jiangxi's mean value is RMB 36,748. In terms of the CR, both Zhejiang and Fujian achieved an average CR of 29%, surpassing Shandong and Jiangxi by 7%. Additionally, Zhejiang's average DA of RMB 49 surpasses others. Fujian leads in the average ND with 1574, significantly outpacing Anhui's donors (952). Figure 8 illustrates the distribution of these four indicators across the provinces. The violin plots for Zhejiang (FA, CR, and DA), and Fujian (FA, CR, and ND) demonstrate marked

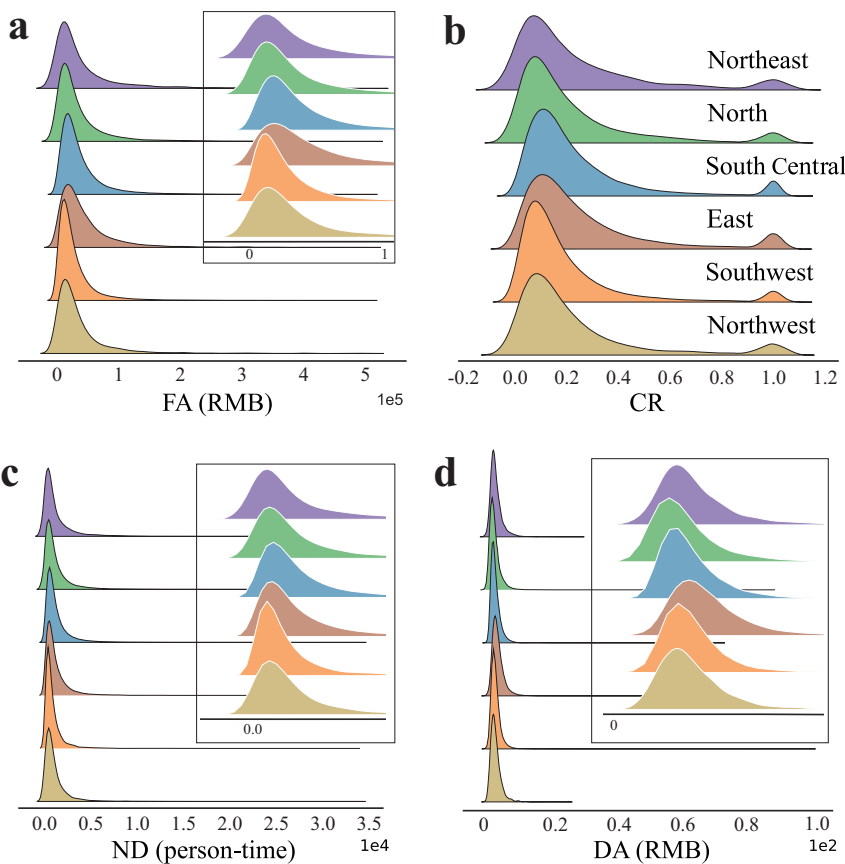


Fig. 7 Ridge maps illustrating the distribution of different indicators for each geographic region. **a** FA. **b** CR. **c** ND. **d** DA.

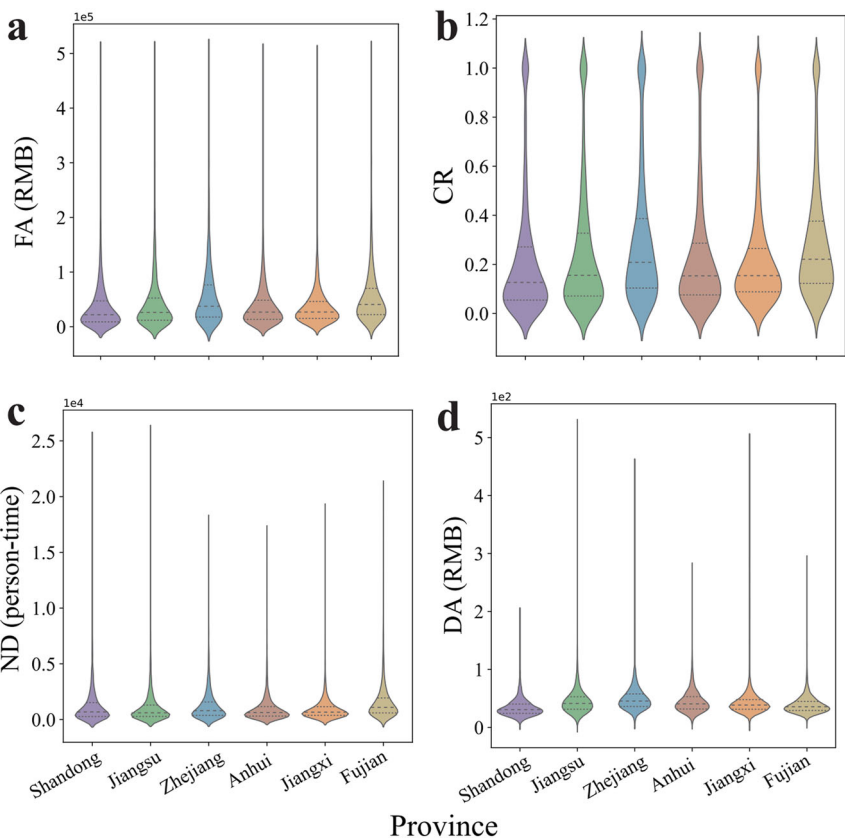


Fig. 8 Violin maps for different provinces in different indicators. **a** FA. **b** CR. **c** ND. **d** DA.

Table 2 Significance test table.									
Group variables		FA		CR		ND		DA	
		Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
TFA		1684.21	<0.001	1684.65	<0.001	1341.69	<0.001	8.55	<0.001
PT		14.26	<0.001	34.77	<0.001	2.73	<0.001	12.28	<0.001
Age		6044.12	<0.001	2950.88	<0.001	8844.55	<0.001	3542.85	<0.001
DT	DL	3060.19	<0.001	368.53	<0.001	3299.68	<0.001	889.77	<0.001
	Cc	437.70	<0.001	177.83	<0.001	98.12	<0.001	894.96	<0.001
GL	GR	2474.45	<0.001	1282.92	<0.001	1852.15	<0.001	4288.23	<0.001
	Province	752.84	<0.001	549.19	<0.001	811.93	<0.001	1275.40	<0.001

morphological compared to other provinces. Zhejiang and Fujian show a more dispersed data distribution, while other provinces exhibit a higher concentration. This pattern indicates that provincial factors may significantly influence the distribution of data across various indicators, highlighting the importance of the provincial dimension in analyzing geographic location influences.

In China, East China is distinguished by its high average level of economic development, while Southwest China has historically required substantial economic support. This economic disparity is reflected in crowdfunding, where projects initiated in East China demonstrate superior fundraising performance compared to those in Southwest China. Furthermore, economically prosperous provinces like Zhejiang and Fujian exhibit enhanced fundraising outcomes, in contrast to the less developed provinces such as Anhui and Jiangxi, which show weaker performance across multiple indicators. This pattern indicates that the fundraising efficacy of medical crowdfunding projects may be closely linked to the economic level of the geographic location. Notably, the disparities in fundraising performance are even more pronounced at the provincial level than those observed between geographic regions.

Significance test of factors

Individual factor significance assessment using the Kruskal–Wallis test. Following a descriptive statistical analysis, five principle factors were identified for in-depth examination of their influence on fundraising performance: TFA, PT, Age, DT, and GL. Skewness tests were conducted on the independent variables, excluding binary ones, revealing slight deviations (refer to Table S4). Given that the absolute skewness values are all less than 1, data transformation or other operations are not necessary at this time. The research progressed by categorizing these five principle factors using the method detailed in the descriptive statistics section. Kruskal–Wallis (KW) tests were performed for four crowdfunding performance indicators (FA, CR, ND, DA) in each group. As shown in Table 2, the outcomes of all KW tests reveal highly significant statistical differences in crowdfunding performance across the different groups. This is evidenced by all *p*-values being below the 0.05 threshold, indicating a statistically significant impact of these core factors on the performance of crowdfunding projects.

Variable significance testing using regression models

Regression model.

- (1) Multiple linear regression model
- Multiple Linear Regression (MLR) serves as a tool to assess the relationship between a dependent (outcome or response) variable and a set of independent (explanatory) variables. The “linear” aspect of MLR implies the assumption that the dependent variable is related to the independent variables through a linear combination. In other words, changes in the independent variables are

expected to linearly influence the dependent variable. MLR allows researchers to not only determine the existence and strength of relationships between variables but also to understand the relative contribution of each independent variable in explaining the variation in the dependent variable. By analyzing the coefficients of the independent variables in the regression equation, researchers can assess which factors have the most significant impact on the outcome variable. The general form of an MLR model can be represented mathematically as follows:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_nX_n + \varepsilon$$

(1)

where *Y* represents dependent variable, *X_i* (*i* = 1, 2, . . . , *n*) are independent variables or explanatory variables, β_0 is the intercept, the predicted value of *Y* when all explanatory variables are 0, β_j (*j* = 1, 2, . . . , *n*) are the parameters of the model, corresponding to each independent variable. These coefficients quantify the change in the dependent variable *Y* for a one-unit change in the respective independent variable *X_i*, assuming all other variables are held constant. ε is the random error term.

- (2) Negative binomial regression model

Negative Binomial Regression (NB) is a statistical technique designed for count data analysis, particularly useful when such data exhibit over-dispersion, meaning the variance exceeds the mean. In an NB model: The dependent variable is count data, representing the number of times an event occurs. Examples include the number of accidents in a year, the number of disease cases in a region, etc. The independent variables can be of any type—either continuous (like age, income) or categorical (like gender, type of treatment). The dependent variable in an NB model is assumed to follow a negative binomial distribution, which is a generalization of the Poisson distribution that allows for a greater variance than the mean. The general form of an NB model can be expressed as:

$$\log(\lambda) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_mX_m + \varepsilon\sigma$$

(2)

where λ is the expected value of *Y*, and $\varepsilon\sigma$ is the disturbance term (Byers et al., 2003).

Compared to the Poisson regression model, NB does not assume equidispersion, a condition where the mean equals the variance. This characteristic enables the NB model to effectively address the discreteness and overdispersion commonly observed in count data, making it more apt for processing discrete count data.

Regression model analysis. In this study, we aim to construct four regression models to explore the relationships between various performance indicators and multiple factors. The dependent variables from Model (1) to Model (4) correspond to FA, CR, ND, and DA, respectively. Notably, the descriptive statistical analysis revealed no linear correlation between age and these four

Table 3 Variable description.

Variable	Name	Description
Fundraising amount	FA	The total amount ultimately raised by the project.
Completion rate	CR	The ratio of fundraising amount to the target fundraising amount.
Number of donors	ND	The number of donors for each project at the conclusion of the project; Integer.
Donation amount per donor	DA	The average amount donated by donors contributing to the project.
Target fundraising amount	TFA	The target fundraising amount for the project.
Posting time	PT	The time of project release, representing specific moments of the day.
Patient's age	Age	The age of patient at the initiation of medical crowdfunding project.
Square of age	Age ²	Square of age.
Brain disease	B	Disease label is brain disease; Bool.
Fracture	F	Disease label is fracture; Bool.
Kidney disease	K	Disease label is kidney disease; Bool.
Leukemia	L	Disease label is leukemia; Bool.
Malignant tumor	M	Disease label is malignant tumor; Bool.
Cancer	Cc	Disease of patient is cancer; Bool.
GDP per capita	GDPPC	GDP per capita in the patient's province between 2016 and 2020.

indicators. Therefore, in the regression models, we included age square as a variable. Furthermore, considering the correlations between the four indicators and the economic levels linked with GL, we included the provincial GDP per capita, corresponding to the patient's location, as a variable in the models. Additional variables are detailed in Tables 3 and 4.

Model (1)

$$FA = \beta_{1,0} + \beta_{1,1}TFA + \beta_{1,2}PT + \beta_{1,3}Age + \beta_{1,4}Age^2 + \beta_{1,5}B + \beta_{1,6}F + \beta_{1,7}K + \beta_{1,8}L + \beta_{1,9}M + \beta_{1,10}Cc + \beta_{1,11}GDPPC + \varepsilon \quad (3)$$

Model (2)

$$CR = \beta_{2,0} + \beta_{2,1}TFA + \beta_{2,2}PT + \beta_{2,3}Age + \beta_{2,4}Age^2 + \beta_{2,5}B + \beta_{2,6}F + \beta_{2,7}K + \beta_{2,8}L + \beta_{2,9}M + \beta_{2,10}Cc + \beta_{2,11}GDPPC + \varepsilon \quad (4)$$

Model (3)

$$\log(\lambda_{ND}) = \beta_{3,0} + \beta_{3,1}TFA + \beta_{3,2}PT + \beta_{3,3}Age + \beta_{3,4}Age^2 + \beta_{3,5}B + \beta_{3,6}F + \beta_{3,7}K + \beta_{3,8}L + \beta_{3,9}M + \beta_{3,10}Cc + \beta_{3,11}GDPPC + \varepsilon\sigma \quad (5)$$

Model (4)

$$DA = \beta_{4,0} + \beta_{4,1}TFA + \beta_{4,2}PT + \beta_{4,3}Age + \beta_{4,4}Age^2 + \beta_{4,5}B + \beta_{4,6}F + \beta_{4,7}K + \beta_{4,8}L + \beta_{4,9}M + \beta_{4,10}Cc + \beta_{4,11}GDPPC + \varepsilon \quad (6)$$

MLR model provides robust estimation of linear relationships between independent and dependent variables, offering clear and intuitive interpretations. Given the continuous nature of the first three variables, we chose the MLR model for Model (1), Model (2), and Model (4). The discrete ND dependent variable has a mean of 1,140.76 and a variance of 2,291,024.07, which does not meet the requirement of equidispersion for Poisson regression. Therefore, we establish a NB model for the dependent variable ND, as in Model (3), where λ_{ND} represents the expected value of ND for a single project.

Robustness checks. We assessed the robustness of the results obtained from models (1) to (4) using various methods, as summarized in Table 5. The methods employed for robustness testing are detailed as follows: Method (1) involved winsorizing the explanatory variables of models (1) to (4) at both the 0.5% and 99.5% tails to mitigate potential biases from outliers. Given

the significant skewness of the dependent variable (refer to Table S4), Method (2) included taking the natural logarithm of the dependent variables, leading to the re-estimation of the regression models using $\ln(FA)$, $\ln(CR)$, and $\ln(DA)$ as dependent variables. Since ND is a discrete variable, Method (3) involved replacing ND with Donation Count (DC) and reconstructing the regression model using a negative binomial regression for robustness checks.

The findings from Method 1 and Method 3 are consistent with those of Models (1) to (4). However, the results from Method 2 revealed discrepancies in the signs of the coefficients for variables such as *PT*, *Age*, and *K* when compared to the results of Models (1) to (4). Despite these discrepancies, the coefficients and significance levels of other variables remained consistent. This variation suggests that *PT* may not have a stable impact on fundraising performance. Notably, the results for *Age*² and *Age* indicate that age has a significant impact on fundraising performance. Although the coefficient for *K*, representing disease type, was unstable, the results for other disease-type variables, such as *B* and *F*, emphasize the significant impact of disease type on fundraising performance. Additionally, the findings for *Cc* and *GDPPC* validate their influence on fundraising performance. These outcomes are in line with our previous experimental findings, thereby affirming the robustness of our conclusions.

Results analysis

Target fundraising amount. The dynamics of setting TFAs in medical crowdfunding projects are multifaceted and can significantly influence donor behavior. Increasing the target amount has the potential to attract more donors and raise higher totals, as it may be perceived that projects with larger targets represent more urgent or critical needs. This perception often motivates people to participate more actively and advocate for causes they perceive as having greater urgency, influenced by social factors and personal identification with the cause. However, higher target amounts also present challenges. They are often associated with lower completion rates, creating an inverse relationship. This phenomenon can be attributed to the fact that higher targets imply a need for substantial or challenging-to-obtain resources. When the target amount is exceedingly high, potential donors might perceive their individual contributions as inconsequential. This perception can lead to a belief that their donations will have minimal impact on achieving the overall goal, consequently diminishing their willingness to contribute. It's also critical to recognize that variations in target amounts typically do not significantly alter individual donation amounts. Donors usually base their contributions on personal financial capabilities and the

Table 4 Regression results.												
Variables	Model(1): MLR(Y=FA)			Model(2): MLR(Y=CR)			Model(3): MLR(Y=ND)			Model(4): MLR(Y=DA)		
	Coefficient	p-value	SE	Coefficient	p-value	SE	Coefficient	p-value	SE	Coefficient	p-value	SE
Constant	4.24 × 10 ³	<0.001	819.77	0.27	<0.001	0.00	6.43	<0.001	0.02	19.11	<0.001	0.36
TFA	0.12	<0.001	0.00	-6.59 × 10 ⁻⁷	<0.001	0.00	2.76 × 10 ⁻⁶	<0.001	0.00	5.04 × 10 ⁻⁶	<0.001	0.00
PT	84.47	0.004	29.69	1.10 × 10 ⁻³	<0.001	0.00	2.10 × 10 ⁻³	0.005	0.00	1.10 × 10 ⁻³	0.933	0.01
Age	-100.64	0.001	31.59	1.60 × 10 ⁻³	<0.001	0.00	-9.10 × 10 ⁻³	<0.001	0.00	0.37	<0.001	0.01
Age ²	-5.37	<0.001	0.39	-5.92 × 10 ⁻⁵	<0.001	0.00	-1.00 × 10 ⁻⁴	<0.001	0.00	-2.60 × 10 ⁻³	<0.001	0.00
DT	1.03 × 10 ³	0.018	438.65	5.10 × 10 ⁻³	0.035	0.00	0.08	<0.001	0.01	-0.98	<0.001	0.19
F	-1.76 × 10 ³	0.005	631.16	-0.03	<0.001	0.00	0.02	0.287	0.02	-2.51	<0.001	0.28
K	-2.88 × 10 ³	<0.001	520.03	7.80 × 10 ⁻³	0.007	0.00	-0.14	<0.001	0.01	2.50	<0.001	0.23
L	1.05 × 10 ⁴	<0.001	549.96	0.07	<0.001	0.00	0.18	<0.001	0.01	-0.75	0.002	0.24
M	-2.09 × 10 ³	0.001	613.18	-0.01	<0.001	0.00	-0.02	0.156	0.02	-1.03	<0.001	0.27
Cc	2.90 × 10 ³	<0.001	382.01	0.01	<0.001	0.00	2.30 × 10 ⁻³	0.812	0.01	2.57	<0.001	0.17
GDPPC	0.36	<0.001	0.01	1.92 × 10 ⁻⁶	<0.001	0.00	8.89 × 10 ⁻⁶	<0.001	0.00	7.64 × 10 ⁻⁵	<0.001	0.00
R ²	0.22			0.15			0.27			0.05		

Table 5 Robustness check.												
Variables	Method (1)			Method (2)			Method (3)					
	FA	CR	ND	DA	ln(FA)	ln(CR)	ln(DA)	DC				
const	4.24 × 10 ^{3***}	0.27*** (<0.001)	6.40*** (<0.001)	19.11*** (<0.001)	9.02*** (<0.001)	-1.91*** (<0.001)	3.04*** (<0.001)	6.47*** (<0.001)				
TFA	0.12***	-6.59 × 10 ^{-7***}	2.76 × 10 ^{-6***}	5.04 × 10 ^{-6***}	2.72 × 10 ^{-6***}	-2.72 × 10 ^{-6***}	1.61 × 10 ^{-7***}	2.73 × 10 ^{-6***}				
PT	84.47*** (0.004)	1.10 × 10 ^{-3***} (<0.001)	2.00 × 10 ^{-3***} (0.007)	1.10 × 10 ⁻³ (0.933)	-1.40 × 10 ^{-3*} (0.099)	4.00 × 10 ⁻⁴ (0.659)	-3.00 × 10 ⁻⁴ (0.299)	2.40 × 10 ^{-3***} (0.001)				
Age	-100.64*** (0.001)	1.60 × 10 ^{-3***} (<0.001)	-8.10 × 10 ^{-3***} (<0.001)	0.37*** (<0.001)	6.40 × 10 ^{-3***} (<0.001)	8.20 × 10 ^{-3***} (<0.001)	0.01*** (<0.001)	-8.50 × 10 ^{-3***} (<0.001)				
Age ²	-5.37*** (<0.001)	-5.92 × 10 ^{-5***} (<0.001)	-1.00 × 10 ^{-4***} (<0.001)	-2.60 × 10 ^{-3***} (<0.001)	-3.00 × 10 ^{-4***} (<0.001)	-3.00 × 10 ^{-4***} (<0.001)	-8.62 × 10 ^{-5***} (<0.001)	-1.00 × 10 ^{-4***} (<0.001)				
DT	1.03 × 10 ^{3**} (0.018)	5.10 × 10 ^{-3**} (0.035)	0.08*** (0.001)	-0.98*** (<0.001)	0.11*** (<0.001)	0.08*** (<0.001)	-0.02*** (<0.001)	0.07*** (<0.001)				
F	-1.76 × 10 ^{3***} (0.005)	-0.03*** (<0.001)	0.02 (0.322)	-2.51*** (<0.001)	-0.13*** (<0.001)	-0.11*** (<0.001)	-0.08*** (<0.001)	0.01 (0.420)				
K	-2.88 × 10 ^{3***} (<0.001)	7.80 × 10 ^{-3***} (0.007)	-0.15*** (<0.001)	2.50*** (<0.001)	-0.09*** (<0.001)	-0.06*** (<0.001)	0.06*** (<0.001)	-0.14*** (<0.001)				
L	1.05 × 10 ^{4***} (<0.001)	0.07*** (<0.001)	0.18*** (<0.001)	-0.75*** (0.002)	0.16*** (<0.001)	0.26*** (<0.001)	-0.02*** (<0.001)	0.19*** (<0.001)				
M	-2.09 × 10 ^{3***} (0.001)	-0.01*** (<0.001)	-0.02 (0.138)	-1.03*** (<0.001)	-0.05*** (0.006)	-0.05*** (0.004)	-0.03*** (<0.001)	-0.02 (0.128)				
Cc	2.90 × 10 ^{3***} (<0.001)	0.01*** (<0.001)	1.60 × 10 ⁻³ (0.865)	2.57*** (<0.001)	0.12*** (<0.001)	0.08*** (<0.001)	0.07*** (<0.001)	2.70 × 10 ⁻³ (0.783)				
GL	0.36*** (<0.001)	1.92 × 10 ^{-6***} (<0.001)	9.16 × 10 ^{-6***} (<0.001)	7.64 × 10 ^{-5***} (<0.001)	1.03 × 10 ^{-5***} (<0.001)	1.02 × 10 ^{-5***} (<0.001)	1.61 × 10 ^{-6***} (<0.001)	8.77 × 10 ^{-6***} (<0.001)				
R-sq	0.22	0.15	0.27	0.05	0.17	0.12	0.07	0.27				

Standard errors are in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01.

degree of resonance they feel with the project's objectives. Thus, while the overall fundraising target may influence the number of donors and the total amount raised, it does not directly affect each donor's contribution amount. Understanding these dynamics is essential for effectively setting and managing fundraising targets in medical crowdfunding projects, balancing the need to convey urgency with the potential for achieving realistic and attainable goals.

Posting time. In the analysis of medical crowdfunding projects' effectiveness, it was noted that the timing of project postings had a negligible impact on various fundraising aspects, including the total amount raised, completion rate, number of donors, and average donation per donor. This observation leads to the inference that factors other than timing are more significant in determining a project's success. The weak correlation between posting timing and donor behavior suggests that factors such as medical condition, storytelling, campaign credibility, and social network reach may be more influential. These factors likely have a greater effect on donor decisions and, therefore, on the overall success of a project. Consequently, researchers in medical crowdfunding should pivot their focus to these more impactful elements. Such a shift will facilitate a deeper, more precise understanding of the key drivers behind fundraising outcomes, providing essential insights for developing effective strategies and best practices to enhance the success rates of medical crowdfunding campaigns.

Age. The analysis demonstrates that patient age significantly impacts fundraising performance. The relationship between age and fundraising outcomes is indicated by the coefficients of age and age squared in the model. Specifically, the indicators CR and DA exhibit an inverted U-shaped relationship with age, with their maximum values occurring at 14 years and 71 years, respectively. In contrast, FA and ND show a declining trend with increasing age. This pattern reflects societal perceptions and biases, particularly regarding elderly patients who often face challenges in attracting widespread attention and assistance due to declining physical functions and possibly lower perceived follow-up value of their treatment. Wang et al. (2023) notes that individuals generally do not vary their contribution amounts significantly, but rather make a binary decision to donate or not. The variations in DA and other indicators among the elderly could thus be linked to the influential role of their social networks, which are characterized by higher donation amounts as highlighted by Huang et al. (2021). While the general inclination to donate to elderly patients is less, those who do contribute tend to donate larger amounts. This results in a scenario where a smaller group of donors, likely close connections or those particularly moved by the cause, make contributions, whereas potential donors of smaller amounts may choose not to participate. This understanding of donor behavior emphasizes the importance of developing targeted strategies in medical crowdfunding, particularly for different age groups, to effectively garner support and resources.

Disease type. The coefficients for certain disease label (DL) variables are significantly non-zero across models (1) through (4). There are marked differences among the coefficients of DL variables, as exemplified by leukemia and kidney disease in model (1). These findings highlight the profound influence of DL on medical crowdfunding projects. DLs can lead to variations in individuals' perceptions of projects, resulting in diverse outcomes across multiple indicators for different DLs. Among the five DL groups analyzed in this study, leukemia demonstrated a heightened ability to garner increased public interest and broader

support. In contrast, kidney disease tended to attract specific demographic groups, enhancing its performance in terms of DA. Furthermore, only a few DLs, such as leukemia, significantly impact fundraising performance. The notable success of leukemia-related fundraising could be attributed to its frequent portrayal in films and news media, making it a more familiar and relatable condition. The coefficients for the cancer variable are significantly positive in model (1), (2), and (4). The fear and concern associated with cancer's low cure rate, high mortality rate, and prevalent occurrence in modern society often elicit strong emotional responses. The extensive news coverage of cancer (Huang et al., 2018) further increases public awareness and empathy for cancer patients. Consequently, this leads to a stark contrast in fundraising performance between cancer-related projects and those associated with other diseases. These insights underline the importance of understanding the impact of disease type on public perception and fundraising outcomes in medical crowdfunding initiatives.

Geographic location. Eastern China, particularly the prosperous province of Zhejiang, demonstrates superior performance across multiple indicators, with the GDP per capita of provinces exhibiting a positive linear relationship with these indicators. Fundraisers in more economically developed regions typically benefit from a higher average economic level within their social networks and a more extensive project-forwarding network, which contributes to enhanced fundraising performance. This phenomenon is underscored by Kim et al. (2018), who note that donors are more inclined to contribute to causes with which they share common references, further reinforcing the trend of donating to local causes. Additionally, residents of affluent areas are generally more capable of providing financial assistance for charitable causes. As a result, crowdfunding projects originating from areas with high economic development levels tend to achieve superior average fundraising performance. This pattern suggests that geographic and economic factors play a crucial role in the success of crowdfunding projects, influencing both the reach and effectiveness of fundraising efforts.

Conclusions and discussion

The evaluation of medical crowdfunding project performance is crucial for enhancing strategic planning and supporting those in need by maximizing assistance from volunteer donors. This study marks a significant shift in focus. Firstly, we move away from developed regions like Europe and the United States to focus on developing countries such as China, where there is a higher demand for medical crowdfunding. Secondly, our approach transcends examining a single dimension; we adopt a more comprehensive methodology by considering the interplay of multiple dimensions and their collective impact on project performance. Our findings offer valuable insights for those investigating medical crowdfunding projects. They provide guidance for crowdfunding platforms and patients, particularly in crafting effective information descriptions for fundraising campaigns. The varied performance of different factors across multiple indicators validates the efficacy of our indicator system. This system not only reflects the multifaceted performance of crowdfunding projects but also contributes valuable supplementary content for future research in the domain of medical crowdfunding. The nuanced understanding of how various factors like patient age, disease type, geographic location, and economic context influence crowdfunding effectiveness can significantly aid platforms and patients in strategizing their campaigns. This comprehensive perspective is essential for optimizing the reach and impact of crowdfunding projects, especially in regions where medical

resources are scarce or expensive, and where crowdfunding can play a pivotal role in healthcare financing.

Target fundraising amount. The impact of the TFA on the performance of medical crowdfunding projects is a significant finding in our research. Consistent with Zhang et al. (2023), we observed that setting higher fundraising goals tends to correlate with lower project completion rates. This suggests that more modest fundraising targets might be perceived as more achievable by donors, thereby encouraging more contributions and increasing the likelihood of a project's success. An intriguing aspect of our findings is that while higher target amounts lead to a decrease in completion rates, they actually result in a greater total amount of funds being raised. This outcome is particularly relevant in the context of medical crowdfunding, where time sensitivity and urgency are paramount. For patients in need of medical assistance, the critical factor is the actual amount of funds raised, rather than the completion rate of the fundraising goal. Given the urgent nature of medical crowdfunding, setting a relatively high but realistic fundraising goal appears to be a strategic approach. Even if the target is not fully met, the campaign can still garner substantial funds, which are vital for ensuring that patients receive uninterrupted necessary treatment due to financial constraints. This insight highlights the importance of balancing the fundraising goal's ambition with practical achievability, considering the unique dynamics of medical crowdfunding and the urgent needs of the beneficiaries.

Posting time. The discovery that there is no significant correlation between the timing of a project's publishing and its performance in medical crowdfunding is a noteworthy finding. It suggests that the success of crowdfunding campaigns is not primarily contingent on the specific moment of project release. Instead, it indicates that other elements of the crowdfunding process play more pivotal roles. This finding implies that the effectiveness of a crowdfunding campaign may hinge more on the strategies employed in promoting and disseminating the project throughout its duration. Consistent and effective communication, outreach efforts, and engagement with potential donors over the course of the fundraising period are likely more influential factors in determining a project's success. Therefore, while the timing of project release should not be disregarded entirely, it need not be a primary focus. Greater emphasis should be placed on other aspects that can significantly impact performance. These may include the project's narrative, the transparency and credibility of the information provided, the strength and reach of the social networks involved, and the ongoing efforts to keep potential donors engaged and informed. This approach underscores the importance of a comprehensive and dynamic strategy in crowdfunding campaigns, especially in the medical domain where the stakes are high. It suggests that a well-planned and executed promotional strategy, coupled with sustained engagement and communication, can be more crucial than the initial timing of the project launch.

Age. The observed disparities in donor behavior towards patients of different ages in medical crowdfunding are indeed significant. Projects catering to teenagers typically secure a higher total fundraising amount, while the average donation amount per donor is greater for campaigns involving elderly individuals. This pattern aligns with Huang's et al. (2021) findings, suggesting that donors' emotional responses, particularly empathy, play a crucial role in their decision-making process. The idea of helping children or teenagers often resonates deeply with donors, potentially because they can relate these young patients to their own

children, invoking a strong compassionate response. Snyder et al. (2017) also highlight a common assumption among donors that young people, especially children, are in dire need of assistance, which can influence their willingness to donate. This perception may lead to a higher number of donations for campaigns involving younger individuals, though each donation might be smaller in amount. Additionally, the trend of differing donor willingness based on patient age is not limited to general medical crowdfunding but extends to specific health issues, as evidenced by Holler et al. (2022). Their research into online crowdfunding for urological cancer patients in the United States corroborates the notion that donor behavior varies significantly with the age of patients. These findings suggest that the age of the patient in crowdfunding campaigns is a crucial factor influencing donor behavior. This understanding can inform the strategies of campaign organizers, who may tailor their approaches based on the patient's age to maximize donor engagement and contributions. It also sheds light on the complex interplay between donor psychology and the demographic characteristics of beneficiaries in the realm of medical crowdfunding.

Disease type. Our research indicates that the type of disease plays a significant role in influencing the fundraising outcomes for patients in medical crowdfunding. Specific diseases like leukemia demonstrate higher fundraising amounts and completion rates, while cancer campaigns attract more donations. This finding contrasts with the conclusions of Kim et al. (2018), who posited that donors are less concerned with the severity of a patient's condition. Additionally, our results diverge from Ba et al. (2021), which suggested a donor preference for supporting campaigns for common and curable diseases. The heightened support for campaigns associated with cancer, despite its severity and complexity, might be attributed to several factors. One plausible explanation is the level of awareness and public sympathy for these conditions. Leukemia, for instance, may garner higher trust due to more effective or widespread publicity. On the other hand, the high prevalence of cancer could elicit greater empathy among donors, as it is a condition with which many are familiar, either personally or through acquaintances. Furthermore, Zhang et al. (2023) have examined the relative visibility of certain diseases in media and public discourse, which may, to a certain extent, elucidate variances in donor behavior towards distinct medical types. Diseases that are more prominently featured in media or have stronger advocacy and awareness campaigns tend to attract more attention and, subsequently, more support on crowdfunding platforms. These observations underscore the complexity of donor motivations and behaviors in medical crowdfunding. They suggest that factors such as disease awareness, public perception, and the perceived severity and treatability of conditions significantly influence fundraising outcomes. Understanding these nuances can help in strategizing more effective crowdfunding campaigns for different medical conditions.

Geographic location. The economic development level of a geographic location exhibits a significant positive correlation with the fundraising performance of medical crowdfunding projects. This trend, where individuals in wealthier areas are more likely to receive donations, challenges the expectation that crowdfunding should promote equitable distribution of assistance to those in need. Our research corroborates the findings of Snyder et al. (2017), which suggest that people in relatively privileged positions often garner more support. To optimize donation outcomes, crowdfunding platforms might consider leveraging geographic advantages in their project promotions. However, it is equally important to focus on patients in economically disadvantaged

areas and those with limited social networks. Addressing the fundraising challenges faced by these groups could entail heightened publicity efforts and other strategic initiatives. This dual approach—highlighting projects from prosperous areas while also bolstering support for underprivileged regions—can help balance the distribution of aid and ensure that crowdfunding fulfills its potential as a tool for equitable assistance.

Future research. This study delves into the intertwined impact of project characteristics and patient demographics on medical crowdfunding, with an analysis of donor behavior and its underlying psychological factors. Understanding the mechanisms and factors driving donor behavior constitutes a pivotal aspect of crowdfunding research (Baber et al., 2022; Fanea-Ivanovici and Baber, 2021; Baah-Peprah, 2023; Baber, 2021), yet the realm of medical crowdfunding, and even donation-based crowdfunding more broadly, suffers from a dearth of relevant studies. Future research on donation-based crowdfunding should prioritize the exploration of psychological and social determinants influencing donor decision-making, as well as the examination of potential synergies between offline and online donation platforms. By harnessing the potential of donation-based crowdfunding, societies can achieve maximal societal and economic benefits, thereby establishing it as a powerful instrument for catalyzing positive social change.

This study is based on China's QFund platform. While the findings reveal the current state of medical crowdfunding in China, these results may not represent the global landscape of medical crowdfunding. Consequently, future research should conduct comparative studies across different platforms and regions to enhance the global applicability of the results. This approach will help identify commonalities and differences in medical crowdfunding across various regions and provide valuable insights for optimizing and formulating policies for global medical crowdfunding platforms.

Additionally, we conducted data processing, which involved removing projects with incomplete information and those that received no donations. This operation enhanced the integrity and reliability of the data, allowing our research to focus on representative medical crowdfunding projects. However, projects that received no donations and those with incomplete information represent two special categories that require further exploration of their fundraising mechanisms and influencing factors. For instance, in the context of medical crowdfunding, projects that did not receive donations may have certain characteristics that hindered funding support, and it remains to be examined whether and to what extent the lack of specific information affects the fundraising amounts of these projects. Future research should delve into these areas to provide a more comprehensive understanding of the dynamics at play.

Moreover, we revealed significant regional disparities in fundraising performance within China and examines the influence of regional economies through the lens of per capita GDP. However, this economic perspective alone may not fully account for the complexities underlying these disparities. Future research should extend the analysis to include other potential contributing factors, such as regional differences in internet access, social media usage, and cultural attitudes towards crowdfunding. These factors are likely to play a crucial role in shaping public engagement and participation in crowdfunding activities. A more comprehensive understanding of these elements will enable the development of more targeted and effective fundraising strategies, which could significantly enhance the success rates and overall efficiency of medical crowdfunding across various regions.

Furthermore, we selected medical crowdfunding projects from 2016 to 2020 to analyze the impact of project features and patient characteristics. However, we did not consider the potential temporal effects on medical crowdfunding projects, such as changes in platform policies, shifts in user behavior, and how other external events might influence fundraising outcomes. Platform policy changes involve modifications to project display interfaces, changes in privacy policies, and various donation methods. Assessing changes in user behavior requires analyzing multiple factors related to the social environment, employing reasonable evaluation methods, and potentially collecting additional data through surveys. The large number of external events necessitates further screening and classification to clarify their occurrence times and affected populations. Understanding the impact of these three categories on medical crowdfunding outcomes is of great significance for research in this field.

Finally, we found that patients from affluent areas or those suffering from specific diseases (such as leukemia and cancer) are more likely to receive donations. This phenomenon raises significant ethical issues regarding the fair distribution of resources and the potential impact on existing healthcare disparities. The risk of exploiting patients' stories for financial gain and the potential for misrepresentation or exaggeration of medical conditions to attract donations further complicate these ethical concerns. Future research should delve deeper into these issues to develop fairer resource distribution mechanisms and avoid exacerbating current medical inequalities.

Management revelation. Our research findings offer valuable insights into the nuances of medical crowdfunding and provide actionable recommendations for both fundraisers and crowdfunding platforms. (1) Setting Reasonable Fundraising Targets: The impact of the fundraising goal on performance underscores the need for fundraisers to balance their actual financial requirements with achievable targets. A well-considered target can optimize fundraising outcomes by being ambitious enough to meet needs while still appearing attainable to potential donors. (2) Guidance from Platforms: Crowdfunding platforms can play a crucial role in advising fundraisers on setting appropriate targets. Providing tools and insights based on data analytics and trends can help fundraisers establish realistic and effective goals. (3) Highlighting Specific Characteristics in Projects: Our observation that projects involving teenagers, cancer, and leukemia patients garner more public support is significant. Fundraisers should be encouraged to effectively communicate these aspects in their project descriptions. Similarly, platforms can emphasize these characteristics in their promotion of projects to stimulate donor interest and empathy. (4) Addressing Geographic Disparities: Recognizing the challenges faced by fundraisers in impoverished areas or those with weaker social networks, crowdfunding platforms should consider implementing targeted support strategies. This could include enhanced visibility for projects from these areas, partnership with local organizations for better outreach, or providing specialized support in crafting compelling narratives. (5) Support for Vulnerable Fundraisers: Platforms have a responsibility to ensure equitable access to crowdfunding benefits. This could involve developing specific features or programs aimed at assisting those with limited resources or social networks. Providing personalized support, mentorship, and resources could help level the playing field for these fundraisers. By implementing these strategies, crowdfunding platforms can not only improve the efficacy of individual campaigns but also contribute to a more equitable and inclusive crowdfunding environment.

Our research highlights the importance of strategic planning, targeted support, and the sensitive handling of projects to maximize their success and impact.

Data availability

The research data, with all privacy information removed, has been submitted as a supplementary file and can also be obtained from the corresponding author upon reasonable request.

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Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

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Additional information

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