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Spatially Exploring the Intersection of Socio-Economic Status and Canadian Cancer-Related Medical Crowdfunding Campaigns

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Abstract

Objectives: Medical crowdfunding is a rapidly growing practice where individuals leverage social networks to raise money for health-related needs. This practice has allowed many to access health care and avoid medical debt but has also raised a number of ethical concerns. A dominant criticism of this practice is that it is likely to increase inequities in access to healthcare if persons from relatively wealthy backgrounds, media connections, tech savvy, and educational attainments are best positioned to use and succeed with crowdfunding. To date this concern has been largely speculative and not supported by data. Our objective in this paper is to assess this concern using socio-economic data and information from crowdfunding campaigns.

Setting: To assess this concern, we present an exploratory spatial analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents.

Participants: Four datasets were used: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries.

Results: Our exploratory spatial analysis demonstrates that use of crowdfunding for cancer-related needs in Canada corresponds with high income, home ownership, and high educational attainment. Campaigns were also commonly located near city centres.

Conclusions: These findings support speculative concerns that those in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs. This study was not able to determine whether other socio-economic dimensions such as race, gender, ethnicity, nationality, and linguistic fluency are also correlated with use of medical crowdfunding. Thus, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding campaigning to explore these other socio-economic variables and campaigns for needs unrelated to cancer.

Strengths and Limitations of this Study

Developed large dataset of crowdfunding data

Presents methods for analyzing datasets of crowdfunding campaign information

Links data on crowdfunding campaigns to data on income, home ownership, and education levels

Unable to determine whether race, gender, ethnicity, nationality, or linguistic fluency impact use of crowdfunding

Introduction

Individuals and groups have increasingly turned to online social networking and social media platforms to fundraise. This practice has come to be popularly known as crowdfunding. In particular, charitable crowdfunding has developed as a means for individuals or small groups to finance their personal needs. Entrepreneurs created online crowdfunding platforms to mediate interactions between campaigners and donors. These platforms host campaigns, including text, images, and video, facilitate outreach to potential donors via social media, and process donations.

The crowdfunding platform GoFundMe dominates the charitable crowdfunding sector. Before it recently acquired YouCaring, the second largest social crowdfunding platform, it controlled 90% of the charitable crowdfunding business in the United States (US) and 80% globally [1,2]. Launched in 2010, US\$ 5 billion has been raised via GoFundMe to date and this platform supports a community consisting of more than 50 million donors and users [1]. Campaigns for health-related purposes comprise the largest proportion of fundraisers hosted by GoFundMe [2,3]. These medical crowdfunding campaigns are thought to be used to pay for essential services for those lacking comprehensive medical insurance, elective procedures not covered by insurance, and unproven or experimental medical treatments. They are also used to pay for indirect needs related to receiving medical care, including travel to receive care, compensation for time off from work, and payments for medical equipment [3]. The use of crowdfunding platforms for medical purposes is expected to continue to grow and thus have a substantial impact on how individuals access health-related care [3,4].

Successful medical crowdfunders can benefit greatly from being better able to obtain health-related support via crowdfunding. However, this practice has also been the target of considerable criticism. These concerns include worries about fraudulent campaigns, loss of medical privacy, and encouraging the privatization of healthcare [3,4]. Arguably the most common and serious critique of medical crowdfunding is that it will exacerbate existing inequities in who is ultimately able to (financially) access health care. While differential access to health care is shaped by each community's

health and social care system, insurance coverage, and demographics, in general those in positions of socio-economic privilege, even in universal health systems, have relatively better access to health-related care than their less privileged compatriots. Medical crowdfunding could exacerbate this problem, it is argued, if crowdfunding serves to reward recipients according to their popularity, extent of social networks, technological capabilities, or media savvy rather than need [5]. For example, Young and Scheinberg [4 p. 1623] flag the “potential for unfairly advantaging those with the means to engage with online tools and tap into large social networks, which may lead to an underrepresentation of cases with the greatest need in which patients lack the tools to coordinate effective crowdfunding campaigns.” Similarly, critics express that medical crowdfunding is likely to reinforce existing inequalities in class and power [6] and reward those with social connections to wealthy persons, media connections, and the educational attainments needed to communicate effectively online [7].

Importantly, criticism that medical crowdfunding mostly benefits those who are socio-economically advantaged is largely speculative and not empirically supported. Quantitative studies of medical crowdfunding are scarce due to the challenges of compiling, organizing, and analyzing data and those studies that have been conducted using crowdfunding datasets have not addressed the issue of equitable access to care. Here we present an exploratory analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents that is connected to a selection of demographic information from the 2016 Canadian Census to explore the relationship between campaign use and socio-economic status. We captured this medical crowdfunding dataset using an automated data crawling program and machine learning techniques. We specifically examine crowdfunding campaigns for cancer-related care as existing research has already documented the commonality of such campaigns in Canada [8,9,10], and we contrast these campaigns against geo-demographic trends using an exploratory spatial data analysis (ESDA) approach. ESDA facilitates the investigation of prior assumptions and guides the identification of spatial patterns [11,12]. We use these patterns to raise important new research questions about medical crowdfunding in the discussion.

Materials and Methods

We utilized four datasets in this exploratory analysis: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries.

We compiled a medical crowdfunding dataset by creating an automated web crawling algorithm. To do this we developed a Python based automated web crawler that scraped a major crowdfunding platform looking for key words or strings of words – in this case, the keyword ‘cancer.’ The search took place on June 11, 2016 and was classified – meaning that borderline terms were flagged for the user who would then read the site and determine if it should be included. After relevant campaigns were identified, we used a SQL database server to store the site in HTML form for further analysis. Once the full HTML files from each campaign were retrieved, the pages were then parsed to remove HTML tags. Further cleaning and labeling took place using a machine learning algorithm designed to find and include any missing information or attributes of the campaigns related to cancer. The final records were stored in a Redis database for access by simple query for analysis. The dataset used in this study contains 1788 records from May 2012 to June 2016 pertaining to cancer-related campaigns created by Canadians.

Aggregate dissemination areas (ADAs) are a new census product released by Statistics Canada as part of the 2016 Canadian Census. Delineation of ADAs considers boundaries of previous census products, including existing census divisions, census metropolitan areas, and census tracts [13]. Forward sortation areas (FSAs) are administrative boundaries determined by Canada Post [14]. They are alphanumerically represented by “the first three characters in a Canadian postal code” [14]. The records contained in our crowdfunding dataset described above have an FSA attribute. This geographic data unit enables ESDA. Boundaries of ADAs and FSAs were obtained from Statistics Canada [15].

Socio-economic status and its correlation with an individual's health or ability to obtain treatments have been previously assessed at a FSA level [16,17,18], which is why we opted to explore socio-economic status indicators. Variables related to income, education, and housing were chosen and

obtained using the University of Toronto's Canadian Census Analyser at the ADA level (see Table 1 for exact variables obtained) [19]. Further data pre-processing and transformations were required in order to link socio-economic data to FSAs due to current data limitations.

** insert Table 1 here **

Profile and boundary datasets for FSAs are unavailable for the Statistics Canada 2016 Census data. In lieu of the FSAs, we computed the weighted average of socio-economic variables based on the percent of spatial overlap between ADAs and FSAs. To prepare for this conversion, ADAs were spatially joined with data retrieved from the 2016 Census Profile. Each FSA is also joined with respective campaign frequencies (see Figure 1 for the high-level description of conversion procedure utilized to add socio-economic data at ADA-level to FSA-level). Once the relationship matrix was generated from the function `GenerateWeights`, it was then retrieved and used to calculate weighted averages of socio-economic variables contained in each intersecting ADA. These weighted socio-economic variables were appended to each respective FSA.

** insert Figure 1 here **

Using ArcMap from the ArcGIS suite (version 10.5), quintiles were created using natural breaks. The data were categorized as quintiles as we trusted that five classes would be sufficient to showcase meaningful differences while minimizing complexity of visual results. These quintiles were used in cartographic representations to support ESDA tasks. Visual comparisons at regional and provincial levels were then conducted with regards to income, education, and housing ownership. The creation of these quintiles allowed project correspondents to examine the data for geographic trends. These cartographic products enabled the significance of these socio-economic variables to be gauged for medical crowdfunding.

Campaigns for each FSA were counted, and these frequencies were assigned to their respective boundaries. These FSAs were subsequently linked with ADAs that feature census variables from the 2016 Canadian Census. These variables consisted of income, number of persons who have completed post-secondary education, and home ownership. These linkages were informed by research conducted by Rogers [20] in which these variables were shown to be commonly associated with vulnerability with regard to health and healthcare. To link these datasets, the variables were weighted based on the percent of areal overlap each ADA shares with each FSA. The resulting weighted attributes were then divided into quintiles using a method similar to Sothorn et al. [21]. Resulting quintiles were then visualized in an interactive cartographic display, or web map, enabling geographic comparisons to be made. This map can be viewed at: <https://www.crowdfundingforhealth.org/chrpexplorer>. Figure 2 describes the process for users of CHRP to explore the ESDA results. Figure 3 shows an image of the web map interface.

** insert Figure 2 here **

** insert Figure 3 here **

Patient and Public Involvement

As the information analyzed in this study was publicly available, patients were not recruited for or actively involved in this study.

Results

Our exploratory analysis utilizes socio-economic variables that have been linked with FSAs. These include a layer of campaign counts per FSA, income, education, and housing (see Figures 4, 5, 6, & 7 for screen captures).

** insert Figure 4 here **

** insert Figure 5 here **

** insert Figure 6 here **

** insert Figure 7 here **

In addition to the web map, a table was generated that showed the proportion of crowdfunding campaigns that belong in each quintile for each socio-economic variable (see Tables 2, 3, 4, & 5).

** insert Table 2 here **

** insert Table 3 here **

** insert Table 4 here **

** insert Table 5 here **

It is important to note that only 176 FSAs out of the 1620 FSAs in Canada contained at least one crowdfunding campaign, with the population of these FSAs representing approximately 5% of the national total. A separate table shows the distribution of the crowdfunding campaigns between each Canadian province and territory and the average value of each socio-economic variable within each administrative division (see Table 6).

** insert Table 6 here **

The average income of crowdfunding campaigners in this dataset is within middle to high level FSAs, with 65.49% of campaigns being located in FSAs within the three highest quintiles in the income category (see Table 3). These higher income levels are matched by higher rates of home ownership among these campaigners, with housing ownership values being larger in the middle quintile (see Table 5). This group also tends to be well educated, with education values tending toward the higher quintiles (see Table 4).

Collectively, our ESDA shows that use of cancer-related medical crowdfunding is occurring unevenly across the country relative to population distribution. For example, Canadians' cancer-related

crowdfunding campaigns were also commonly located in close proximity to city centres (see Figure 3). Provincial differences in campaign use also exist. Campaigns were more commonly posted in the provinces of Ontario and British Columbia and less so in the Atlantic provinces. There is a noticeable density of campaigns in the prairie provinces of Alberta and Saskatchewan.

Discussion

Our ESDA-based findings support existing concerns that persons in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs – in this case care related to cancer. Individuals in the highest income FSAs were found to be the heaviest users of medical crowdfunding for cancer-related campaigns, as were individuals in FSAs with high rates of home ownership. These ESDA-based interpretations support the idea that wealthier individuals are more likely to see crowdfunding as a way to draw together financial resources from elsewhere to meet their health needs. We also observed that individuals in FSAs with higher rates of education turned more frequently to medical crowdfunding. This ESDA-based interpretation supports existing claims that individuals who are better educated, more familiar with online technologies, and better able to express themselves online are more likely to take advantage of crowdfunding to address health-related needs. The positive correlation between the amount raised in a campaign and number of times the campaign was shared supports the speculation that social capital and tech-savviness are important constituents of crowdfunding campaign success.

Our exploration of geo-demographic trends regarding Canadians' use of cancer-related crowdfunding shows that this is a highly urban phenomenon. This is somewhat counterintuitive considering the extensive health service gaps in rural Canadian communities that drive some residents to consider alternative ways to access necessary care [22], such as crowdfunding for the costs of private treatment or to relocate to an urban centre. Research regarding a potential urban-rural divide in crowdfunding use is very limited and so it is difficult to know why there can be proportionately less use in rural areas. This may be due to limited access to technology or lower levels of education in rural

Canadian communities [23,24]. Alternatively, it may be due to the strong voluntary and informal care sectors that 'tight-knit' rural communities are so well known for that would lead to residents pulling together to support those in need [22,25], which would lessen the need for drawing on disparate social networks via crowdfunding. It is important to note, however, that our ESDA approach means that we cannot conclusively state that our analysis documents a clear urban-rural divide. This is due in part to the large aggregations of FSAs as well as the sparse population of Nunavut that can both over- and under-estimate socio-economic variables. We thus flag this as an important issue for future medical crowdfunding research.

While our interpretations of the ESDA results support the general concern that medical crowdfunding will tend to exacerbate socio-economic inequities in access to health-related care, only certain dimensions of this critique were explored here. For example, while we found positive correlations between cancer-related crowdfunding and wealth and education levels, we were not able to explore whether other dimensions of socio-economic privilege are positively correlated. These dimensions include race, gender, ethnicity, nationality, and linguistic fluency, all of which are factors that lead to inequities in health status [26,27]. This leads us to make three important points. First, we acknowledge that it is possible that only certain dimensions of socio-economic privilege correlate with using crowdfunding to address health-related needs, and that some or all of those not explored here do not shape medical crowdfunding use in the ways documented here. Second, and because of this, it is important to explicitly state that this exploratory analysis supports the hypothesis of a more general correlation but does not provide direct evidence supporting every dimension of this correlation. And third, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding use in general or for cancer-related campaigns in order to assist with developing a more robust understanding of any interrelationships.

Limitations

Only the first three digits of postal codes were included in the dataset of crowdfunding campaigns, which were then linked to FSAs. FSAs are smaller in urban areas and may be geographically vast in rural areas.

Linking ADAs to FSAs could result in broad generalizations and aggregation errors and lead to ecological fallacies. This implies that findings from our study are limited, as only broad claims can be stated. The aforementioned generalizations could be less impacted in urban areas with smaller FSAs comparatively to rural areas. While this has implications for our results, the impact may be reduced considering that as of 2011, over 80% of Canada's population lives in urban environments [28].

We acknowledge that a medical crowdfunding campaign recipient may be different from campaign's creator. This necessitates further research with regard to the issues explored in this analysis because campaigners may reside in or report different FSAs than the individual or family in need of financial assistance. Further to this, postal codes are self-reported by campaign creators, which allows typos and misstate to be made. Nothing can be done to address this as a limitation beyond acknowledging our awareness of the potential for errors to exist in postal code reporting.

FSAs encoded in the campaign entries dictated the primary level of aggregation for our study, thus necessitating us to limit selection of socio-economic variables. If spatial and non-spatial attributes were improved, more socio-economic status variables could be involved, such as sex or immigration status. This would aid in obtaining more robust results. Another limitation encountered was the fact that the census profiles at the FSA-level were unavailable due to accuracy issues (Statistics Canada, 2018) [29]. To substitute, a methodology to link and weight the chosen socio-economic variables from the ADA-level to FSA-level had to be developed.

As our dataset was acquired for a snapshot in time, we acknowledge that campaigns have been instantiated at different times and have been underway for varying durations. These comparisons may impact results because the campaign duration captured in the current dataset may not be representative of the overall success of the campaign. Future work may look to compare individual campaigns that have either been run for the same length of time or have completed their respective lifecycles on major crowdfunding platforms.

294 Conclusions

295 The findings reported here provide the first data-informed support for more speculative concerns that
296 charitable crowdfunding will tend to advantage relatively socio-economically privileged individuals.
297 While supporters of medical crowdfunding point to its potential to help people access necessary health
298 care and avoid debt or even medical bankruptcy, this paper demonstrates that this potential is not
299 distributed equitably across society. While these findings do not eliminate the advantages of medical
300 crowdfunding, they show its limits in serving as a systematic and fair solution to structural deficiencies in
301 health systems. Additional research, including using the methods described here, would help to
302 demonstrate whether these findings are reproduced for other socio-economic factors, in countries other
303 than Canada, and for health needs beyond cancer.

305 Contributorship Statement

306 AvD, AL, and RM contributed to developing the methods, conducting the analysis, and writing
307 the manuscript. JS and VAC contributed to method design, securing project funding, and writing
308 the manuscript. PCW contributed to data acquisition and writing the manuscript. NS contributed
309 to method design and writing the manuscript.

311 Competing Interests

312 We declare no competing interests.

314 Funding

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Data Sharing Statement

All crowdfunding data is available from the authors on request.

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397 **Tables**

Variable	Data Obtained
Population and dwelling counts	Population, 2016
Income (Total Sex / Total)	Income statistics in 2015 for the population aged 15 years and over in private households - 100% data / Number of after-tax income recipients aged 15 years and over in private households - 100% data / Median after-tax income in 2015 among recipients (\$)
Education (Total Sex / Total)	Highest certificate, diploma or degree for the population aged 15 years and over in private households - 25% sample data / Postsecondary certificate, diploma or degree
Housing (Total Sex / Total)	Private households by tenure - 25% sample data / Owner

398 **Table 1. Variables Obtained from 2016 Census Profiles for Aggregate Dissemination Areas.**
399 Retrieved from the Canadian Census Analyser, University of Toronto

Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 5	114	64.77%	247	13.81%
6 - 17	36	20.45%	337	18.85%
18 - 41	16	9.09%	402	22.48%
42 - 76	6	3.41%	362	20.25%
77 - 138	4	2.27%	440	24.61%
Total	176	100.00%	1788	100.00%

401 **Table 2. Frequency of Campaigns per FSA. Proportion of Campaigns belonging to each Quintile.**

Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
\$0.00 - \$12699.19	3	1.70%	104	5.82%
\$12699.19 - \$28556.91	54	30.68%	513	28.69%
\$28556.91 - \$33333.84	63	35.80%	449	25.11%
\$33333.84 - \$38980.26	45	25.57%	593	33.17%
\$38980.26 - \$51498.11	11	6.25%	129	7.21%
Total	176	100.00%	1788	100.00%

403 **Table 3. Income, Median After-Tax (2015). Proportion of Campaigns belonging to each Quintile.**

Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1397	12	6.82%	159	8.89%
13979 - 2980	41	23.30%	308	17.23%
2980 - 4156	72	40.91%	755	42.23%
4156 - 6087	46	26.14%	524	29.31%
6087 - 10046	5	2.84%	42	2.35%
Total	176	100.00%	1788	100.00%

Table 4. Education, Post-Secondary. Proportion of Campaigns belonging to each Quintile.

Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1393	17	9.66%	180	10.07%
1393 - 2429	38	21.59%	283	15.83%
2429 - 3218	68	38.64%	711	39.77%
3218 - 4579	48	27.27%	571	31.94%
4579 - 7121	5	2.84%	43	2.40%
Total	176	100.00%	1788	100.00%

Table 5. Housing, Owner. Proportion of Campaigns belonging to each Quintile.

Province/ Territory	Number of FSAs	Number of Campaigns	Percentage (FSA)	Percentage (Campaigns)	Population	Income, Median After-Tax (Average)	Education, Post- Secondary (Average)	Housing, Owner (Average)
British Columbia	32	401	18.18%	22.43%	268112	\$28,716.63	3728	2599
Alberta	21	310	11.93%	17.34%	203643	\$36,012.35	3393	2846
Saskatchewan	14	85	7.95%	4.75%	138065	\$34,795.72	3613	3194
Manitoba	9	66	5.11%	3.69%	83126	\$31,275.32	3211	3032
Ontario	47	576	26.70%	32.21%	436637	\$31,865.32	3942	3105
Quebec	18	139	10.23%	7.77%	158832	\$30,057.44	3923	2675
New Brunswick	12	55	6.82%	3.08%	75339	\$26,745.83	2287	2310
Nova Scotia	9	69	5.11%	3.86%	73961	\$31,392.79	3908	2425
Prince Edward Island	2	25	1.14%	1.40%	15301	\$27,888.67	2984	2582
Newfoundland & Labrador	9	53	5.11%	2.96%	69103	\$26,503.28	2868	2809
Yukon	1	5	0.57%	0.28%	16962	\$41,664.80	3278	2599
Northwest Territories	1	3	0.57%	0.17%	823	\$51,498.11	415	228
Nunavut	1	1	0.57%	0.06%	3	\$63.72	0	0
Total	176	1788	100.00%	100.00%	1539908	\$30,652.31	2889	2339

Table 6. Number of Campaigns, Population, and Socio-economic Values per Province.

Figure Legends

Figure 1: High-Level Description of Conversion Procedure Utilized to add Socio-Economic Data at ADA-Level to FSA-Level. This figure denotes the methodology employed to associate socio-economic data at the ADA-level with the crowdfunding data collected at the FSA-level.

Figure 2: Sample Interaction Sequence to Support Adding Context to Campaign Markers in the Interactive Web Mapping Tool. This figure provides a set of sample instructions to users of the CHRP web map to better understand the datasets displayed.

Figure 3: Screen Capture of Web Map Application (Main Page). This figure shows the home page of the CHRP. The data shown in this figure denotes the locations of all crowdfunding campaigns involved with this study. Basic information associated with each of the campaigns can be viewed here.

Figure 4: Screen Capture of Web Map Application (with the Exploratory layer of Frequency Counts of Campaigns per FSA Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is number of crowdfunding campaigns per forward sortation area.

Figure 5: Screen Capture of Web Map Application (with the Exploratory layer of Income (Median, After-Tax, 2015) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is income (median, after-tax, 2015). The income data was obtained from the 2016 Canadian Census at the ADA-level.

Figure 6: Screen Capture of Web Map Application (with Exploratory layer of Education (Number of People with a Post-Secondary Education) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is education (number of individuals that identify as having post-secondary education). The education data was obtained from the 2016 Canadian Census at the ADA-level.

Figure 7: Screen Capture of Web Map Application (with the Exploratory layer of Housing (Number of People that own homes) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The dataset of interest here is housing (number of individuals that own homes). The housing data was obtained from the 2016 Canadian Census at the ADA-level.

```
Algorithm GenerateWeights(ADA dataset, FSA dataset)
begin
  a = Number of FSA, b = Number of ADA
  Initialize relationship matrix of size a rows by b columns
  For each i ∈ {FSA1...FSAa}:
    Select all from ADA that intersect with FSAi
    For each j ∈ {intersecting ADA retrieved in selection}:
      Calculate percent area that ADAj occupies in FSAi
      Add weight to matrix at the position corresponding with the respective FSA
        and ADA IDs.
    Store relationship matrix as CSV for reuse
end
```

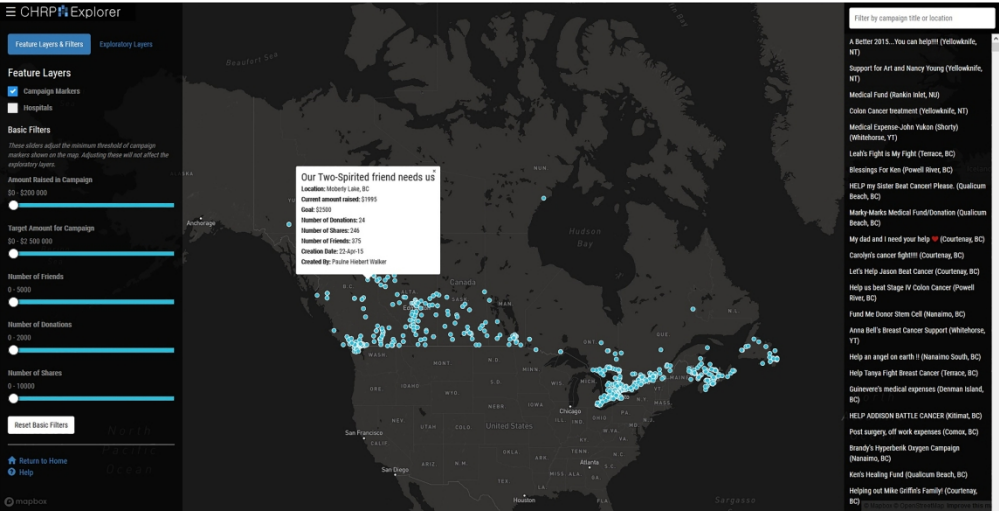
165x74mm (220 x 220 DPI)

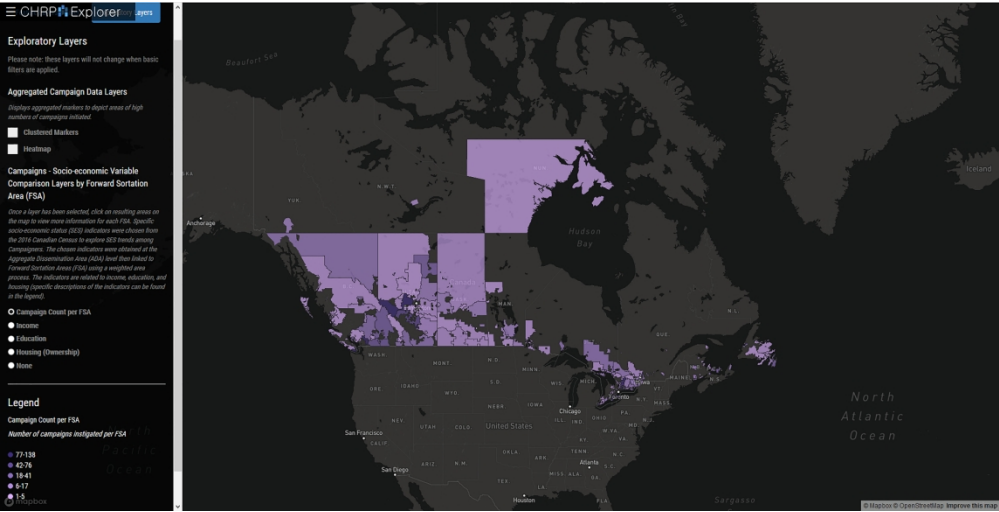
The User:

1. Views the "CHRP Explorer" web mapping application
2. Clicks and drags the map to populate the campaign list sidebar
3. Clicks on campaign markers or hovers over sidebar listings to learn more about individual Canadian medical crowdfunding campaigns
4. Uses the basic filters slider to filter campaigns to have at least \$10,000 raised, more than 300 friends, and at least 100 donations
5. Clicks the "Exploratory" tab to change the panel contents
6. Selects "Income" under the "Campaign - Socioeconomic Variable Comparison Layers by Forward sortation area" section
7. Zooms into a geographic area of interest and clicks on a coloured area to view the median income average for that FSA the campaign is associated with

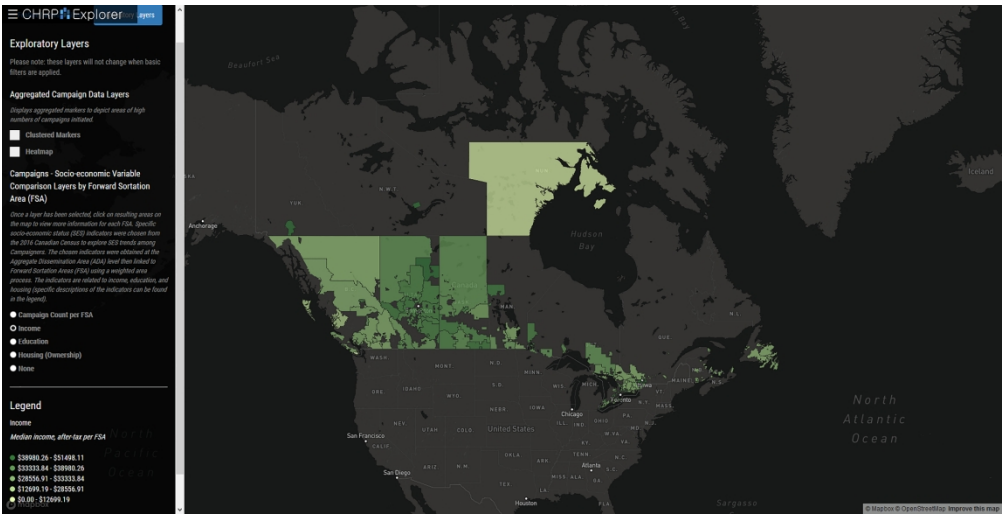
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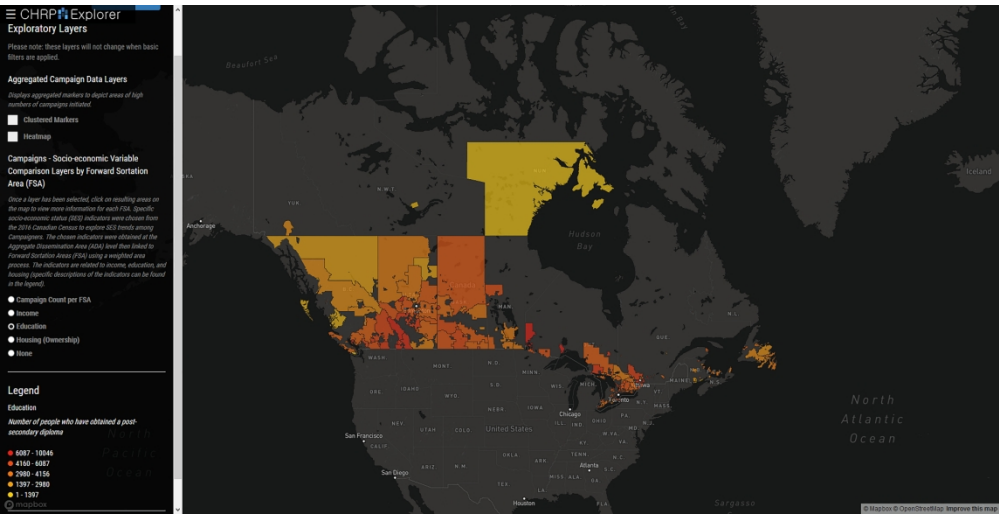




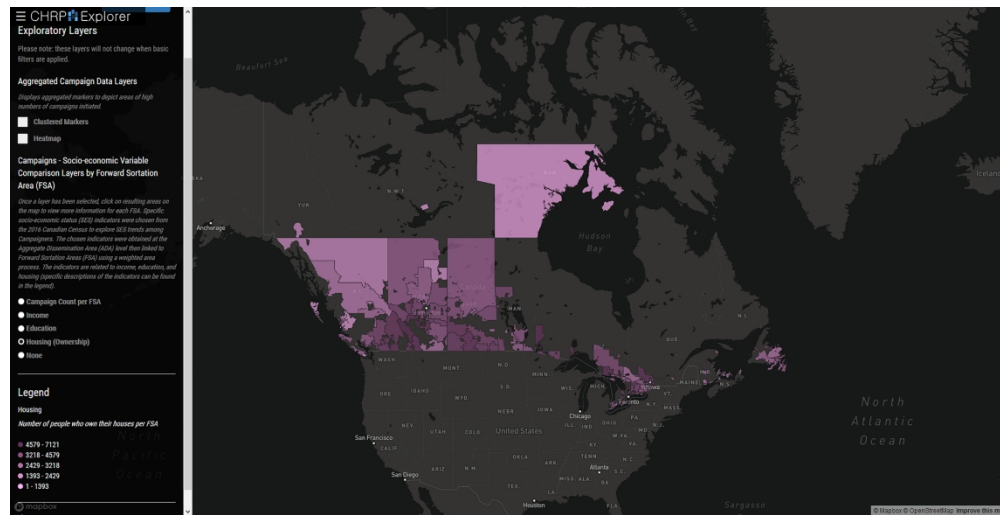
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229x116mm (220 x 220 DPI)



228x116mm (220 x 220 DPI)



230x117mm (220 x 220 DPI)

Standards for Reporting Qualitative Research (SRQR)*

<http://www.equator-network.org/reporting-guidelines/srqr/>

Page/line no(s).

Title and abstract

Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	p. 1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	p. 2

Introduction

Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	p. 4
Purpose or research question - Purpose of the study and specific objectives or questions	p. 4

Methods

Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	pp. 5-7
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	N/A
Context - Setting/site and salient contextual factors; rationale**	pp. 5-7
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	pp. 5-7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	N/A
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	pp. 5-7

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	pp. 5-7
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	pp. 5-7
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	Pp. 5-7
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	Pp. 5-7
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Pp. 5-7

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	pp. 7-9
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	pp. 7-9

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	pp. 9-10
Limitations - Trustworthiness and limitations of findings	pp. 10-11

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	p. 12
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	p. 13

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:

O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388

For peer review only

BMJ Open

Spatially Exploring the Intersection of Socio-Economic Status and Canadian Cancer-Related Medical Crowdfunding Campaigns

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Keywords:	Crowdfunding, Equity, Spatial Analysis

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Abstract

Objectives: Medical crowdfunding is a rapidly growing practice where individuals leverage social networks to raise money for health-related needs. This practice has allowed many to access health care and avoid medical debt but has also raised a number of ethical concerns. A dominant criticism of this practice is that it is likely to increase inequities in access to healthcare if persons from relatively wealthy backgrounds, media connections, tech savvy, and educational attainments are best positioned to use and succeed with crowdfunding. However, limited data has been published to support this claim. Our objective in this paper is to assess this concern using socio-economic data and information from crowdfunding campaigns.

Setting: To assess this concern, we present an exploratory spatial analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents.

Participants: Four datasets were used: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries.

Results: Our exploratory spatial analysis demonstrates that use of crowdfunding for cancer-related needs in Canada corresponds with high income, home ownership, and high educational attainment. Campaigns were also commonly located near city centres.

Conclusions: These findings support concerns that those in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs. This study was not able to determine whether other socio-economic dimensions such as race, gender, ethnicity, nationality, and linguistic fluency are also correlated with use of medical crowdfunding. Thus, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding campaigning to explore these other socio-economic variables and campaigns for needs unrelated to cancer.

Strengths and Limitations of this Study

Developed large dataset of crowdfunding data

Presents methods for analyzing datasets of crowdfunding campaign information

Links data on crowdfunding campaigns to data on income, home ownership, and education levels

Unable to determine whether race, gender, ethnicity, nationality, or linguistic fluency impact use of crowdfunding

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65 Introduction

66 Individuals and groups have increasingly turned to online social networking and social media platforms to
67 fundraise. This practice has come to be popularly known as crowdfunding. In particular, charitable
68 crowdfunding, as opposed to entrepreneurial fundraising intended to raise money for businesses, has
69 developed as a means for individuals or small groups to finance their personal needs. These platforms
70 host campaigns, including text, images, and video, facilitate outreach to potential donors via social media,
71 and process donations.

72 The crowdfunding platform GoFundMe dominates the charitable crowdfunding sector. Before it
73 recently acquired YouCaring, the second largest social crowdfunding platform, it controlled 90% of the
74 charitable crowdfunding business in the United States (US) and 80% globally [1,2]. Launched in 2010,
75 US\$ 5 billion has been raised via GoFundMe to date and this platform supports a community consisting
76 of more than 50 million donors and users [1]. Campaigns for health-related purposes comprise the largest
77 proportion of fundraisers hosted by GoFundMe [2,3]. These medical crowdfunding campaigns are
78 thought to be used to pay for essential services for those lacking comprehensive medical insurance,
79 elective procedures not covered by insurance, and unproven or experimental medical treatments. They are
80 also used to pay for indirect needs related to receiving medical care, including travel to receive care,
81 compensation for time off from work, and payments for medical equipment [3]. The use of crowdfunding
82 platforms for medical purposes is expected to continue to grow and thus have a substantial impact on how
83 individuals access health-related care [3,4].

84 Successful medical crowdfunders can benefit greatly from being better able to obtain health-
85 related support via crowdfunding. However, this practice has also been the target of considerable
86 criticism. These concerns include worries about fraudulent campaigns, loss of medical privacy, and
87 encouraging the privatization of healthcare [3,4]. Arguably the most common and serious critique of
88 medical crowdfunding is that it will exacerbate existing inequities in who is ultimately able to
89 (financially) access health care. While differential access to health care is shaped by each community's

health and social care system, insurance coverage, and demographics, in general those in positions of socio-economic privilege, even in universal health systems, have relatively better access to health-related care than their less privileged compatriots. Medical crowdfunding could exacerbate this problem, it is argued, if crowdfunding serves to reward recipients according to their popularity, extent of social networks, technological capabilities, or media savvy rather than need [5]. For example, Young and Scheinberg [4 p. 1623] flag the “potential for unfairly advantaging those with the means to engage with online tools and tap into large social networks, which may lead to an underrepresentation of cases with the greatest need in which patients lack the tools to coordinate effective crowdfunding campaigns.” Similarly, critics express that medical crowdfunding is likely to reinforce existing inequalities in class and power [6] and reward those with social connections to wealthy persons, media connections, and the educational attainments needed to communicate effectively online [7]. Others note that placing the distribution of medical funds in the hands of private crowdfunding platforms has problematic effects, as when these companies prohibit fundraisers for certain services and procedures such as abortion or promote and donate to specific fundraisers (as in the case of the parents of Charlie Gard fundraising for an unproven medical treatment) [8,9,10].

Empirical support for the criticism that medical crowdfunding mostly benefits those who are socio-economically advantaged is thus far limited. Lukk, Schneiderhan, and Soares reviewed 319 crowdfunding campaigns by Canadians for services related to education and healthcare [11]. They found that older and visible minority Canadians were relatively less successful in these campaigns. Berliner and Kenworthy examined 200 medical crowdfunding campaigns and found correlations between success in meeting medical crowdfunding goals and the inclusion of photos and videos, campaign updates, and interactions including comments, social media shares, and ‘liking’ a campaign [12]. A review of 850 campaigns for services related to organ transplantation found that campaigns with positive emotional sentiment tend to be relatively successful [13]. An analysis of 410 crowdfunding campaigns for medical transition and gender affirming surgeries and treatments demonstrated that campaigners that are young,

white, and transgender men raise more than others in this area but that campaigns for medical transition perform less well than medical crowdfunding campaigns generally [14].

Here we present an exploratory analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents that is connected to a selection of demographic information from the 2016 Canadian Census to explore the relationship between campaign use and socio-economic status. We captured this medical crowdfunding dataset using an automated data crawling program and machine learning techniques. We specifically examine crowdfunding campaigns for cancer-related care as existing research has already documented the commonality of such campaigns in Canada [15,16,17], and we contrast these campaigns against geo-demographic trends using an exploratory spatial data analysis (ESDA) approach. ESDA facilitates the investigation of prior assumptions and guides the identification of spatial patterns [18,19]. We use these patterns to raise important new research questions about medical crowdfunding in the discussion.

Materials and Methods

We utilized four datasets in this exploratory analysis: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries. In consultation with the Simon Fraser University Research Ethics Board we determined that ethics approval was not required for this project under locally relevant Tri-Council policy (article 2.2) as the data being collected and used was publicly accessible with no reasonable expectation of privacy given the nature of crowdfunding as an activity [20]. While not required by local research ethics regulations, we have chosen not to publish any identifiable details from the scraped campaigns in the interest of the privacy of campaign recipients.

We compiled a medical crowdfunding dataset by creating an automated web crawling algorithm. To do this we developed a Python based automated web crawler that scraped the GoFundMe platform looking for key words or strings of words – in this case, the keyword ‘cancer’ – and postal codes

identifying campaigns as originating within Canada. The search took place on June 11, 2006. Any ambiguous posts were read by the researchers to determine if they fit the classification and should be included. After relevant campaigns were identified, we used a SQL database server to store the site in HTML form for further analysis. Once the full HTML files from each campaign were retrieved, the pages were then parsed to remove HTML tags. Further cleaning and labeling took place using a machine learning algorithm designed to find and include any missing information or attributes of the campaigns related to cancer. From this process campaigns not listed in the 'medical' category were excluded. The final records were stored in a Redis database for access by simple query for analysis. The dataset used in this study contains 1788 records from May 2012 to June 2016 pertaining to cancer-related campaigns created by Canadians.

Aggregate dissemination areas (ADAs) are a new census product released by Statistics Canada as part of the 2016 Canadian Census. Delineation of ADAs considers boundaries of previous census products, including existing census divisions, census metropolitan areas, and census tracts [21]. Forward sortation areas (FSAs) are administrative boundaries determined by Canada Post [22]. They are alphanumerically represented by "the first three characters in a Canadian postal code" [22]. The records contained in our crowdfunding dataset described above have an FSA attribute. This geographic data unit enables ESDA. Boundaries of ADAs and FSAs were obtained from Statistics Canada [23].

Socio-economic status and its correlation with an individual's health or ability to obtain treatments have been previously assessed at a FSA level [24,25,26], which is why we opted to explore socio-economic status indicators. Variables related to income, education, and housing were chosen and obtained using the University of Toronto's Canadian Census Analyser at the ADA level (see Table 1 for exact variables obtained) [27]. Further data pre-processing and transformations were required in order to link socio-economic data to FSAs due to current data limitations.

** insert Table 1 here **

165
166 Profile and boundary datasets for FSAs are unavailable for the Statistics Canada 2016 Census
167 data. In lieu of the FSAs, we computed the weighted average of socio-economic variables based on the
168 percent of spatial overlap between ADAs and FSAs. To prepare for this conversion, ADAs were spatially
169 joined with data retrieved from the 2016 Census Profile. Each FSA is also joined with respective
170 campaign frequencies (see Figure 1 for the high-level description of conversion procedure utilized to add
171 socio-economic data at ADA-level to FSA-level). Once the relationship matrix was generated from the
172 function `GenerateWeights`, it was then retrieved and used to calculate weighted averages of socio-
173 economic variables contained in each intersecting ADA. These weighted socio-economic variables were
174 appended to each respective FSA.

175 ** insert Figure 1 here **
176

177 Using ArcMap from the ArcGIS suite (version 10.5), quintiles were created using natural breaks.
178 The data were categorized as quintiles as we trusted that five classes would be sufficient to showcase
179 meaningful differences while minimizing complexity of visual results. These quintiles were used in
180 cartographic representations to support ESDA tasks. Visual comparisons at regional and provincial levels
181 were then conducted with regards to income, education, and housing ownership. The creation of these
182 quintiles allowed project correspondents to examine the data for geographic trends. These cartographic
183 products enabled the significance of these socio-economic variables to be gauged for medical
184 crowdfunding.

185 Campaigns for each FSA were counted, and these frequencies were assigned to their respective
186 boundaries. These FSAs were subsequently linked with ADAs that feature census variables from the 2016
187 Canadian Census. These variables consisted of income, number of persons who have completed post-
188 secondary education, and home ownership. These linkages were informed by research conducted by
189 Rogers [28] in which these variables were shown to be commonly associated with vulnerability with

regard to health and healthcare. To link these datasets, the variables were weighted based on the percent of areal overlap each ADA shares with each FSA. The resulting weighted attributes were then divided into quintiles using a method similar to Sothorn et al. [29]. Resulting quintiles were then visualized in an interactive cartographic display, or web map, enabling geographic comparisons to be made. This map can be viewed at: <https://www.crowdfundingforhealth.org/chrpexplorer>. Figure 2 describes the process for users of CHRP to explore the ESDA results. Figure 3 shows an image of the web map interface.

** insert Figure 2 here **

** insert Figure 3 here **

Patient and Public Involvement

As the information analyzed in this study was publicly available, patients were not recruited for or actively involved in this study.

Results

Our exploratory analysis utilizes socio-economic variables that have been linked with FSAs. These include a layer of campaign counts per FSA, income, education, and housing (see Figures 4, 5, 6, & 7 for screen captures).

** insert Figure 4 here **

** insert Figure 5 here **

** insert Figure 6 here **

** insert Figure 7 here **

In addition to the web map, a table was generated that showed the proportion of crowdfunding campaigns that belong in each quintile for each socio-economic variable (see Tables 2, 3, 4, & 5).

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** insert Table 2 here **

** insert Table 3 here **

** insert Table 4 here **

** insert Table 5 here **

It is important to note that only 176 FSAs out of the 1620 FSAs in Canada contained at least one crowdfunding campaign, with the population of these FSAs representing approximately 5% of the national total. A separate table shows the distribution of the crowdfunding campaigns between each Canadian province and territory and the average value of each socio-economic variable within each administrative division (see Table 6).

** insert Table 6 here **

The average income of crowdfunding campaigners in this dataset is within middle to high level FSAs, with 65.49% of campaigns being located in FSAs within the three highest quintiles in the income category (see Table 3). These higher income levels are matched by higher rates of home ownership among these campaigners, with housing ownership values being larger in the middle quintile (see Table 5). This group also tends to be well educated, with education values tending toward the higher quintiles (see Table 4).

Collectively, our ESDA shows that use of cancer-related medical crowdfunding is occurring unevenly across the country relative to population distribution. For example, Canadians' cancer-related crowdfunding campaigns were also commonly located in close proximity to city centres (see Figure 3). Provincial differences in campaign use also exist. Campaigns were more commonly posted in the provinces of Ontario and British Columbia and less so in the Atlantic provinces. There is a noticeable density of campaigns in the prairie provinces of Alberta and Saskatchewan.

Discussion

Our ESDA-based findings support existing concerns that persons in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs – in this case care related to cancer. Individuals in the highest income FSAs were found to be the heaviest users of medical crowdfunding for cancer-related campaigns, as were individuals in FSAs with high rates of home ownership. These ESDA-based interpretations support the idea that wealthier individuals are more likely to see crowdfunding as a way to draw together financial resources from elsewhere to meet their health needs. We also observed that individuals in FSAs with higher rates of education turned more frequently to medical crowdfunding. This ESDA-based interpretation supports existing claims that individuals who are better educated, more familiar with online technologies, and better able to express themselves online are more likely to take advantage of crowdfunding to address health-related needs. The positive correlation between the amount raised in a campaign and number of times the campaign was shared supports the speculation that social capital and tech-savviness are important constituents of crowdfunding campaign success.

Our exploration of geo-demographic trends regarding Canadians' use of cancer-related crowdfunding shows that this is a highly urban phenomenon. This is somewhat counterintuitive considering the extensive health service gaps in rural Canadian communities that drive some residents to consider alternative ways to access necessary care [30], such as crowdfunding for the costs of private treatment or to relocate to an urban centre. Research regarding a potential urban-rural divide in crowdfunding use is very limited and so it is difficult to know why there can be proportionately less use in rural areas. This may be due to limited access to technology or lower levels of education in rural Canadian communities [31,32]. Alternatively, it may be due to the strong voluntary and informal care sectors that 'tight-knit' rural communities are so well known for that would lead to residents pulling together to support those in need [30,33], which would lessen the need for drawing on disparate social networks via crowdfunding. It is important to note, however, that our ESDA approach means that we

cannot conclusively state that our analysis documents a clear urban-rural divide. This is due in part to the large aggregations of FSAs as well as the sparse population of Nunavut that can both over- and under-estimate socio-economic variables. We thus flag this as an important issue for future medical crowdfunding research. Furthermore, factors distinctive to the Canadian cultural, geographic, and healthcare context may mean that these specific results are not applicable elsewhere. These factors include widespread access to basic cancer care through the Canadian single payer health system, cultural differences in charitable giving, and the geographically disparate nature of Canadian communities. These differences may be less acute in European communities with greater access to public health insurance and greater in the US and other countries with more limited public provision of care but requires additional investigation in other settings.

While our interpretations of the ESDA results support the general concern that medical crowdfunding will tend to exacerbate socio-economic inequities in access to health-related care, only certain dimensions of this critique were explored here. For example, while we found positive correlations between cancer-related crowdfunding and wealth and education levels, we were not able to explore whether other dimensions of socio-economic privilege are positively correlated. These dimensions include race, gender, ethnicity, nationality, and linguistic fluency, all of which are factors that lead to inequities in health status [34,35]. This leads us to make three important points. First, we acknowledge that it is possible that only certain dimensions of socio-economic privilege correlate with using crowdfunding to address health-related needs, and that some or all of those not explored here do not shape medical crowdfunding use in the ways documented here. Second, and because of this, it is important to explicitly state that this exploratory analysis supports the hypothesis of a more general correlation but does not provide direct evidence supporting every dimension of this correlation. And third, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding use in general or for cancer-related campaigns in order to assist with developing a more robust understanding of any interrelationships.

Limitations

Only the first three digits of postal codes were included in the dataset of crowdfunding campaigns, which were then linked to FSAs. FSAs are smaller in urban areas and may be geographically vast in rural areas. Linking ADAs to FSAs could result in broad generalizations and aggregation errors and lead to ecological fallacies. This implies that findings from our study are limited, as only broad claims can be stated. The aforementioned generalizations could be less impacted in urban areas with smaller FSAs comparatively to rural areas. While this has implications for our results, the impact may be reduced considering that as of 2011, over 80% of Canada's population lives in urban environments [36].

We acknowledge that a medical crowdfunding campaign recipient may be different from campaign's creator. This necessitates further research with regard to the issues explored in this analysis because campaigners may reside in or report different FSAs than the individual or family in need of financial assistance. Further to this, postal codes are self-reported by campaign creators, which allows typos and mistakes to be made. Nothing can be done to address this as a limitation beyond acknowledging our awareness of the potential for errors to exist in postal code reporting. Campaigners may also have moved to an urban centre in order to access care, thus introducing an urban bias into our sample.

FSAs encoded in the campaign entries dictated the primary level of aggregation for our study, thus necessitating us to limit selection of socio-economic variables. If spatial and non-spatial attributes were improved, more socio-economic status variables could be involved, such as sex or immigration status. This would aid in obtaining more robust results. Another limitation encountered was the fact that the census profiles at the FSA-level were unavailable due to accuracy issues (Statistics Canada, 2018) [37]. To substitute, a methodology to link and weight the chosen socio-economic variables from the ADA-level to FSA-level had to be developed.

As our dataset was acquired for a snapshot in time, we acknowledge that campaigns have been instantiated at different times and have been underway for varying durations. These comparisons may impact results because the campaign duration captured in the current dataset may not be representative of the overall success of the campaign. For example, less successful campaigns may be deleted more quickly

than more successful campaigns, more successful campaigns may not be removed at all, or less technologically adept individuals may not think to delete completed campaigns. Future work may look to compare individual campaigns that have either been run for the same length of time or have completed their respective lifecycles on major crowdfunding platforms.

Conclusions

The findings reported here support concerns that charitable crowdfunding will tend to advantage relatively socio-economically privileged individuals. While supporters of medical crowdfunding point to its potential to help people access necessary health care and avoid debt or even medical bankruptcy, this paper demonstrates that this potential is not distributed equitably across society. While these findings do not eliminate the advantages of medical crowdfunding, they show its limits in serving as a systematic and fair solution to structural deficiencies in health systems. Additional research, including using the methods described here, would help to demonstrate whether these findings are reproduced for other socio-economic factors, in countries other than Canada, and for health needs beyond cancer.

Contributorship Statement

AvD, AL, and RM contributed to developing the methods, conducting the analysis, and writing the manuscript. JS and VAC contributed to method design, securing project funding, and writing the manuscript. PCW contributed to data acquisition and writing the manuscript. NS contributed to method design and writing the manuscript.

Competing Interests

340 We declare no competing interests.

341

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347 Data Sharing Statement

348 All crowdfunding data is available from the authors on request.

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Tables

Variable	Data Obtained
Population and dwelling counts	Population, 2016
Income (Total Sex / Total)	Income statistics in 2015 for the population aged 15 years and over in private households - 100% data / Number of after-tax income recipients aged 15 years and over in private households - 100% data / Median after-tax income in 2015 among recipients (\$)
Education (Total Sex / Total)	Highest certificate, diploma or degree for the population aged 15 years and over in private households - 25% sample data / Postsecondary certificate, diploma or degree
Housing (Total Sex / Total)	Private households by tenure - 25% sample data / Owner

Table 1. Variables Obtained from 2016 Census Profiles for Aggregate Dissemination Areas.
Retrieved from the Canadian Census Analyser, University of Toronto

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 5	114	64.77%	247	13.81%
6 - 17	36	20.45%	337	18.85%
18 - 41	16	9.09%	402	22.48%
42 - 76	6	3.41%	362	20.25%
77 - 138	4	2.27%	440	24.61%
Total	176	100.00%	1788	100.00%

Table 2. Frequency of Campaigns per FSA. Proportion of Campaigns belonging to each Quintile.

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
\$0.00 - \$12699.19	3	1.70%	104	5.82%
\$12699.19 - \$28556.91	54	30.68%	513	28.69%
\$28556.91 - \$33333.84	63	35.80%	449	25.11%
\$33333.84 - \$38980.26	45	25.57%	593	33.17%
\$38980.26 - \$51498.11	11	6.25%	129	7.21%
Total	176	100.00%	1788	100.00%

Table 3. Income, Median After-Tax (2015). Proportion of Campaigns belonging to each Quintile.

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1397	12	6.82%	159	8.89%
1397 - 2980	41	23.30%	308	17.23%
2980 - 4156	72	40.91%	755	42.23%
4156 - 6087	46	26.14%	524	29.31%
6087 - 10046	5	2.84%	42	2.35%
Total	176	100.00%	1788	100.00%

Table 4. Education, Post-Secondary. Proportion of Campaigns belonging to each Quintile.

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1393	17	9.66%	180	10.07%
1393 - 2429	38	21.59%	283	15.83%
2429 - 3218	68	38.64%	711	39.77%
3218 - 4579	48	27.27%	571	31.94%
4579 - 7121	5	2.84%	43	2.40%
Total	176	100.00%	1788	100.00%

Table 5. Housing, Owner. Proportion of Campaigns belonging to each Quintile.

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Province/ Territory	Number of FSAs	Number of Campaigns	Percentage (FSA)	Percentage (Campaigns)	Population	Income, Median After-Tax (Average)	Education, Post- Secondary (Average)	Housing, Owner (Average)
Alberta	21	310	11.93%	17.34%	203643	\$36,012.35	3393	2846
British Columbia	32	401	18.18%	22.43%	268112	\$28,716.63	3728	2599
Manitoba	9	66	5.11%	3.69%	83126	\$31,275.32	3211	3032
New Brunswick	12	55	6.82%	3.08%	75339	\$26,745.83	2287	2310
Newfoundland & Labrador	9	53	5.11%	2.96%	69103	\$26,503.28	2868	2809
Northwest Territories	1	3	0.57%	0.17%	823	\$51,498.11	415	228
Nova Scotia	9	69	5.11%	3.86%	73961	\$31,392.79	3908	2425
Nunavut	1	1	0.57%	0.06%	3	\$63.72	0	0
Ontario	47	576	26.70%	32.21%	436637	\$31,865.32	3942	3105
Prince Edward Island	2	25	1.14%	1.40%	15301	\$27,888.67	2984	2582
Quebec	18	139	10.23%	7.77%	158832	\$30,057.44	3923	2675
Saskatchewan	14	85	7.95%	4.75%	138065	\$34,795.72	3613	3194
Yukon	1	5	0.57%	0.28%	16962	\$41,664.80	3278	2599
Total	176	1788	100.00%	100.00%	1539908	\$30,652.31	2889	2339

446 Table 6. Number of Campaigns, Population, and Socio-economic Values per Province.

Figure Legends

Figure 1: High-Level Description of Conversion Procedure Utilized to add Socio-Economic Data at ADA-Level to FSA-Level. This figure denotes the methodology employed to associate socio-economic data at the ADA-level with the crowdfunding data collected at the FSA-level.

Figure 2: Sample Interaction Sequence to Support Adding Context to Campaign Markers in the Interactive Web Mapping Tool. This figure provides a set of sample instructions to users of the CHRP web map to better understand the datasets displayed.

Figure 3: Screen Capture of Web Map Application (Main Page). This figure shows the home page of the CHRP. The data shown in this figure denotes the locations of all crowdfunding campaigns involved with this study. Basic information associated with each of the campaigns can be viewed here.

Figure 4: Screen Capture of Web Map Application (with the Exploratory layer of Frequency Counts of Campaigns per FSA Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is number of crowdfunding campaigns per forward sortation area.

Figure 5: Screen Capture of Web Map Application (with the Exploratory layer of Income (Median, After-Tax, 2015) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is income (median, after-tax, 2015). The income data was obtained from the 2016 Canadian Census at the ADA-level.

Figure 6: Screen Capture of Web Map Application (with Exploratory layer of Education (Number of People with a Post-Secondary Education) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is education (number of individuals that identify as having post-secondary education). The education data was obtained from the 2016 Canadian Census at the ADA-level.

Figure 7: Screen Capture of Web Map Application (with the Exploratory layer of Housing (Number of People that own homes) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The dataset of interest here is housing (number of individuals that own homes). The housing data was obtained from the 2016 Canadian Census at the ADA-level.

```
Algorithm GenerateWeights(ADA dataset, FSA dataset)
begin
  a = Number of FSA, b = Number of ADA
  Initialize relationship matrix of size a rows by b columns
  For each i ∈ {FSA1...FSAa}:
    Select all from ADA that intersect with FSAi
    For each j ∈ {intersecting ADA retrieved in selection}:
      Calculate percent area that ADAj occupies in FSAi
      Add weight to matrix at the position corresponding with the respective FSA
        and ADA IDs.
    Store relationship matrix as CSV for reuse
end
```

165x74mm (220 x 220 DPI)

The User:

1. Views the "CHRP Explorer" web mapping application
2. Clicks and drags the map to populate the campaign list sidebar
3. Clicks on campaign markers or hovers over sidebar listings to learn more about individual Canadian medical crowdfunding campaigns
4. Uses the basic filters slider to filter campaigns to have at least \$10,000 raised, more than 300 friends, and at least 100 donations
5. Clicks the "Exploratory" tab to change the panel contents
6. Selects "Income" under the "Campaign - Socioeconomic Variable Comparison Layers by Forward sortation area" section
7. Zooms into a geographic area of interest and clicks on a coloured area to view the median income average for that FSA the campaign is associated with

164x63mm (220 x 220 DPI)

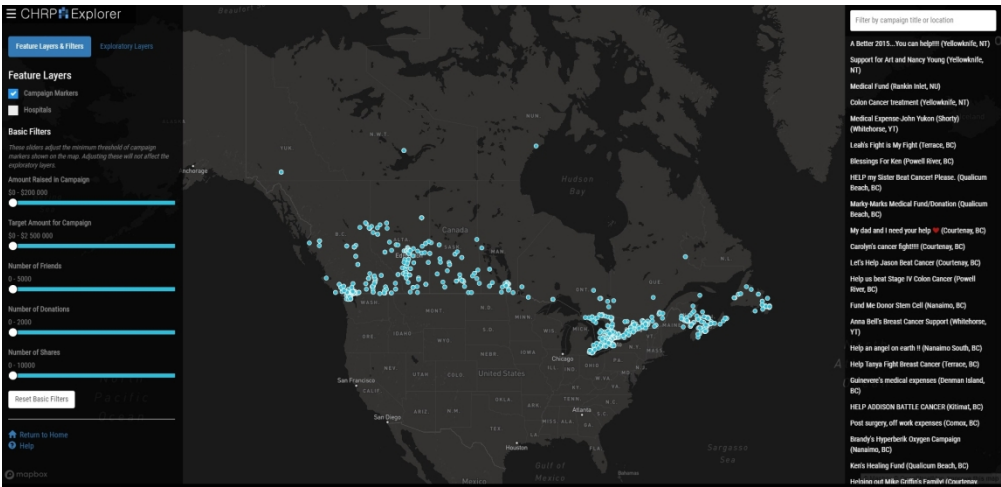


Figure 3

169x81mm (288 x 288 DPI)

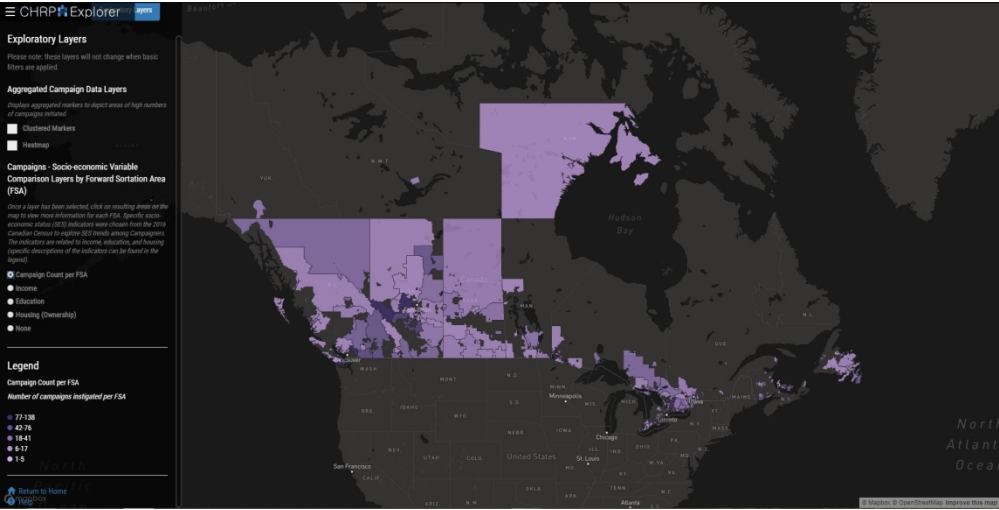


Figure 4

169x85mm (288 x 288 DPI)

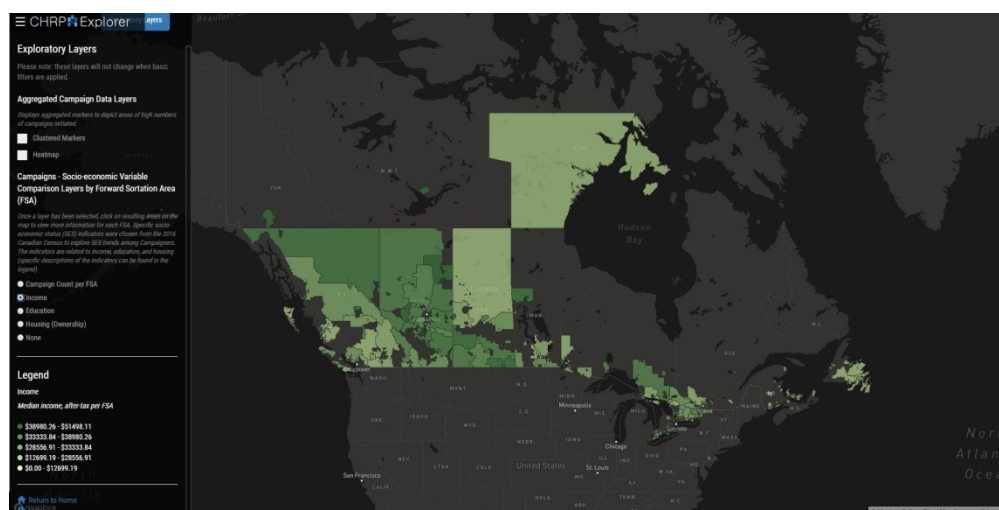


Figure 5

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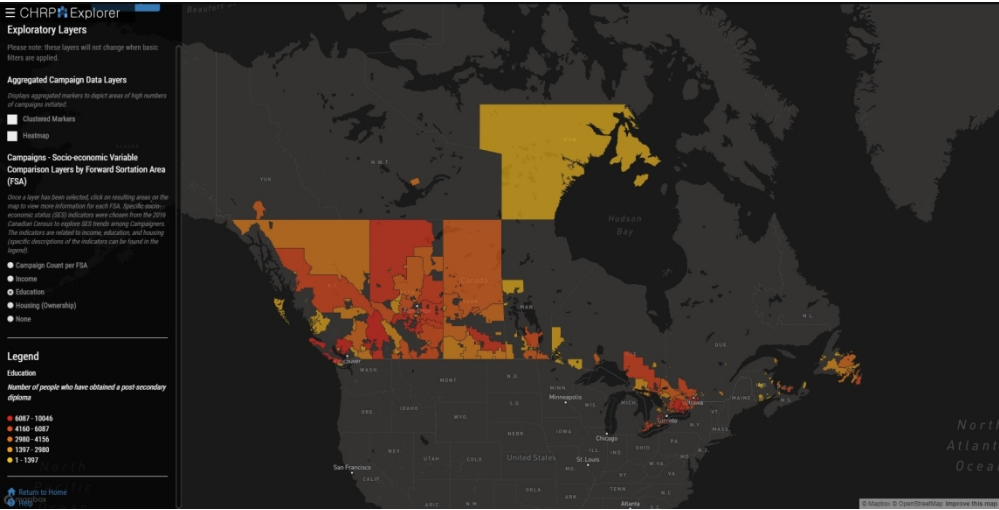


Figure 6

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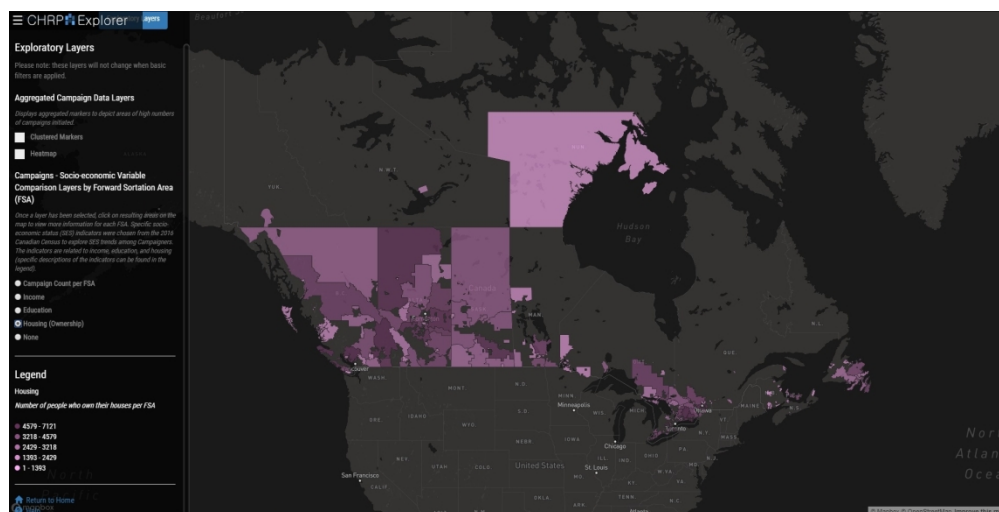


Figure 7

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Standards for Reporting Qualitative Research (SRQR)*

<http://www.equator-network.org/reporting-guidelines/srqr/>

Page/line no(s).

Title and abstract

Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	p. 1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	p. 2

Introduction

Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	p. 4
Purpose or research question - Purpose of the study and specific objectives or questions	p. 4

Methods

Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	pp. 5-7
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	N/A
Context - Setting/site and salient contextual factors; rationale**	pp. 5-7
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	pp. 5-7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	N/A
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	pp. 5-7

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	pp. 5-7
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	pp. 5-7
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	Pp. 5-7
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	Pp. 5-7
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Pp. 5-7

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	pp. 7-9
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	pp. 7-9

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	pp. 9-10
Limitations - Trustworthiness and limitations of findings	pp. 10-11

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	p. 12
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	p. 13

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:

O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388

For peer review only

BMJ Open

Spatially Exploring the Intersection of Socio-Economic Status and Canadian Cancer-Related Medical Crowdfunding Campaigns

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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Ethics, Health policy
Keywords:	Crowdfunding, Equity, Spatial Analysis

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Abstract

Objectives: Medical crowdfunding is a rapidly growing practice where individuals leverage social networks to raise money for health-related needs. This practice has allowed many to access health care and avoid medical debt but has also raised a number of ethical concerns. A dominant criticism of this practice is that it is likely to increase inequities in access to healthcare if persons from relatively wealthy backgrounds, media connections, tech savvy, and educational attainments are best positioned to use and succeed with crowdfunding. However, limited data has been published to support this claim. Our objective in this paper is to assess this concern using socio-economic data and information from crowdfunding campaigns.

Setting: To assess this concern, we present an exploratory spatial analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents.

Participants: Four datasets were used: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries.

Results: Our exploratory spatial analysis demonstrates that use of crowdfunding for cancer-related needs in Canada corresponds with high income, home ownership, and high educational attainment. Campaigns were also commonly located near city centres.

Conclusions: These findings support concerns that those in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs. This study was not able to determine whether other socio-economic dimensions such as race, gender, ethnicity, nationality, and linguistic fluency are also correlated with use of medical crowdfunding. Thus, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding campaigning to explore these other socio-economic variables and campaigns for needs unrelated to cancer.

Strengths and Limitations of this Study

Developed large dataset of crowdfunding data

Presents methods for analyzing datasets of crowdfunding campaign information

Links data on crowdfunding campaigns to data on income, home ownership, and education levels

Unable to determine whether race, gender, ethnicity, nationality, or linguistic fluency impact use of crowdfunding

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65 Introduction

66 Individuals and groups have increasingly turned to online social networking and social media
67 platforms to fundraise. This practice has come to be popularly known as crowdfunding. In
68 particular, charitable crowdfunding, as opposed to entrepreneurial fundraising intended to raise
69 money for businesses, has developed as a means for individuals or small groups to finance their
70 personal needs. These platforms host campaigns, including text, images, and video, facilitate
71 outreach to potential donors via social media, and process donations.

72 The crowdfunding platform GoFundMe dominates the charitable crowdfunding sector.
73 Before it recently acquired YouCaring, the second largest social crowdfunding platform, it
74 controlled 90% of the charitable crowdfunding business in the United States (US) and 80%
75 globally [1,2]. Launched in 2010, US\$ 5 billion has been raised via GoFundMe to date and this
76 platform supports a community consisting of more than 50 million donors and users [1].
77 Campaigns for health-related purposes comprise the largest proportion of fundraisers hosted by
78 GoFundMe [2,3]. These medical crowdfunding campaigns are thought to be used to pay for
79 essential services for those lacking comprehensive medical insurance, elective procedures not
80 covered by insurance, and unproven or experimental medical treatments. They are also used to
81 pay for indirect needs related to receiving medical care, including travel to receive care,
82 compensation for time off from work, and payments for medical equipment [3]. The use of
83 crowdfunding platforms for medical purposes is expected to continue to grow and thus have a
84 substantial impact on how individuals access health-related care [3,4].

85 Successful medical crowdfunders can benefit greatly from being better able to obtain
86 health-related support via crowdfunding. However, this practice has also been the target of
87 considerable criticism. These concerns include worries about fraudulent campaigns, loss of

medical privacy, and encouraging the privatization of healthcare [3,4]. Arguably the most common and serious critique of medical crowdfunding is that it will exacerbate existing inequities in who is ultimately able to (financially) access health care. While differential access to health care is shaped by each community's health and social care system, insurance coverage, and demographics, in general those in positions of socio-economic privilege, even in universal health systems, have relatively better access to health-related care than their less privileged compatriots. Medical crowdfunding could exacerbate this problem, it is argued, if crowdfunding serves to reward recipients according to their popularity, extent of social networks, technological capabilities, or media savvy rather than need [5]. For example, Young and Scheinberg [4 p. 1623] flag the "potential for unfairly advantaging those with the means to engage with online tools and tap into large social networks, which may lead to an underrepresentation of cases with the greatest need in which patients lack the tools to coordinate effective crowdfunding campaigns." Similarly, critics express that medical crowdfunding is likely to reinforce existing inequalities in class and power [6] and reward those with social connections to wealthy persons, media connections, and the educational attainments needed to communicate effectively online [7]. Others note that placing the distribution of medical funds in the hands of private crowdfunding platforms has problematic effects, as when these companies prohibit fundraisers for certain services and procedures such as abortion or promote and donate to specific fundraisers (as in the case of the parents of Charlie Gard fundraising for an unproven medical treatment) [8,9,10].

Empirical support for the criticism that medical crowdfunding mostly benefits those who are socio-economically advantaged is thus far limited. Lukk, Schneiderhan, and Soares reviewed 319 crowdfunding campaigns by Canadians for services related to education and healthcare [11].

They found that older and visible minority Canadians were relatively less successful in these campaigns. Berliner and Kenworthy examined 200 medical crowdfunding campaigns and found correlations between success in meeting medical crowdfunding goals and the inclusion of photos and videos, campaign updates, and interactions including comments, social media shares, and ‘liking’ a campaign [12]. A review of 850 campaigns for services related to organ transplantation found that campaigns with positive emotional sentiment tend to be relatively successful [13]. An analysis of 410 crowdfunding campaigns for medical transition and gender affirming surgeries and treatments demonstrated that campaigners that are young, are white, and transgender men raise more than others in this area but that campaigns for medical transition perform less well than medical crowdfunding campaigns generally [14].

Here we present an exploratory analysis of a new dataset of crowdfunding campaigns for cancer-related care by Canadian residents that is connected to a selection of demographic information from the 2016 Canadian Census to explore the relationship between campaign use and socio-economic status. We captured this medical crowdfunding dataset using an automated data crawling program and machine learning techniques. We specifically examine crowdfunding campaigns for cancer-related care as existing research has already documented the commonality of such campaigns in Canada [15,16,17], and we contrast these campaigns against geo-demographic trends using an exploratory spatial data analysis (ESDA) approach. ESDA facilitates the investigation of prior assumptions and guides the identification of spatial patterns [18,19]. We use these patterns to raise important new research questions about medical crowdfunding in the discussion.

Materials and Methods

We utilized four datasets in this exploratory analysis: 1) a medical crowdfunding dataset that included cancer-related campaigns posted by Canadians; 2) the 2016 Census Profile for aggregate dissemination areas; 3) aggregate dissemination area boundaries; and 4) forward sortation area boundaries. In consultation with the Simon Fraser University Research Ethics Board we determined that ethics approval was not required for this project under the locally relevant Tri-Council policy (article 2.2) as the data being collected and used was publicly accessible with no reasonable expectation of privacy given the nature of crowdfunding as an activity [20]. While not required by local research ethics regulations, we have chosen not to publish any identifiable details from the scraped campaigns in the interest of the privacy of campaign recipients.

We compiled a medical crowdfunding dataset by creating an automated web crawling algorithm. To do this we developed a Python based automated web crawler that scraped the GoFundMe platform looking for key words or strings of words – in this case, the keyword ‘cancer’ – and postal codes identifying campaigns as originating within Canada. We chose the key term ‘cancer’ as it is a higher order concept that captures many subtypes. Furthermore, it is a term that will be more familiar and more likely to be used by crowdfunders and donors than subtype names. Our goal was to capture a large selection of cancer-related campaigns rather than an exhaustive sample of such campaigns, making the higher order term well suited to our aims.

The search took place on June 11, 2016. Any ambiguous posts were read by the researchers to determine if they fit the classification and should be included. After relevant campaigns were identified, we used a SQL database server to store the site in HTML form for further analysis. Once the full HTML files from each campaign were retrieved, the pages were then parsed to remove HTML tags. Further cleaning and labeling took place using a machine

learning algorithm designed to find and include any missing information or attributes of the campaigns related to cancer. Through this process, campaigns not listed in the ‘medical’ category were excluded and the main campaign content attributes were extracted and irrelevant content (e.g., footers) were removed. The final records were stored in a Redis database for access by simple query for analysis. The dataset used in this study contains 1788 records from May 2012 to June 2016 pertaining to cancer-related campaigns created by Canadians.

Aggregate dissemination areas (ADAs) are a new census product released by Statistics Canada as part of the 2016 Canadian Census. Delineation of ADAs considers boundaries of previous census products, including existing census divisions, census metropolitan areas, and census tracts [21]. Forward sortation areas (FSAs) are administrative boundaries determined by Canada Post [22]. They are alphanumerically represented by “the first three characters in a Canadian postal code” [22]. The records contained in our crowdfunding dataset described above have an FSA attribute. This geographic data unit enables ESDA. Boundaries of ADAs and FSAs were obtained from Statistics Canada [23].

Socio-economic status and its correlation with an individual's health or ability to obtain treatments have been previously assessed at a FSA level [24,25,26], which is why we opted to explore socio-economic status indicators. Variables related to income, education, and housing were chosen and obtained using the University of Toronto’s Canadian Census Analyser at the ADA level (see Table 1 for exact variables obtained) [27]. Further data pre-processing and transformations were required in order to link socio-economic data to FSAs due to current data limitations.

** insert Table 1 here **

Profile and boundary datasets for FSAs are unavailable for the Statistics Canada 2016 Census data. In lieu of the FSAs, we computed the weighted average of socio-economic variables based on the percent of spatial overlap between ADAs and FSAs. To prepare for this conversion, ADAs were spatially joined with data retrieved from the 2016 Census Profile. Each FSA is also joined with respective campaign frequencies (see Figure 1 for the high-level description of conversion procedure utilized to add socio-economic data at ADA-level to FSA-level). Once the relationship matrix was generated from the function `GenerateWeights`, it was then retrieved and used to calculate weighted averages of socio-economic variables contained in each intersecting ADA. These weighted socio-economic variables were appended to each respective FSA.

** insert Figure 1 here **

Using ArcMap from the ArcGIS suite (version 10.5), quintiles were created using natural breaks. The data were categorized as quintiles as we trusted that five classes would be sufficient to showcase meaningful differences while minimizing complexity of visual results. These quintiles were used in cartographic representations to support ESDA tasks. Visual comparisons at regional and provincial levels were then conducted with regards to income, education, and housing ownership. The creation of these quintiles allowed project correspondents to examine the data for geographic trends. These cartographic products enabled the significance of these socio-economic variables to be gauged for medical crowdfunding.

Campaigns for each FSA were counted, and these frequencies were assigned to their respective boundaries. These FSAs were subsequently linked with ADAs that feature census

variables from the 2016 Canadian Census. These variables consisted of income, number of persons who have completed post-secondary education, and home ownership. These linkages were informed by research conducted by Rogers [28] in which these variables were shown to be commonly associated with vulnerability with regard to health and healthcare. To link these datasets, the variables were weighted based on the percent of areal overlap each ADA shares with each FSA. The resulting weighted attributes were then divided into quintiles using a method similar to Sothorn et al. [29]. Resulting quintiles were then visualized in an interactive cartographic display, or web map, enabling geographic comparisons to be made. This map can be viewed at: <https://www.crowdfundingforhealth.org/chrpexplorer>. Figure 2 describes the process for users of CHRP to explore the ESDA results. Figure 3 shows an image of the web map interface.

** insert Figure 2 here **

** insert Figure 3 here **

Patient and Public Involvement

As the information analyzed in this study was publicly available, patients were not recruited for or actively involved in this study. Patients and the public were not involved in the design or planning of the study.

Results

Our exploratory analysis utilizes socio-economic variables that have been linked with FSAs.

These include a layer of campaign counts per FSA, income, education, and housing (see Figures 4, 5, 6, & 7 for screen captures).

** insert Figure 4 here **

** insert Figure 5 here **

** insert Figure 6 here **

** insert Figure 7 here **

In addition to the web map, a table was generated that showed the proportion of crowdfunding campaigns that belong in each quintile for each socio-economic variable (see Tables 2, 3, 4, & 5).

** insert Table 2 here **

** insert Table 3 here **

** insert Table 4 here **

** insert Table 5 here **

It is important to note that only 176 FSAs out of the 1620 FSAs in Canada contained at least one crowdfunding campaign, with the population of these FSAs representing approximately 5% of the national total. A separate table shows the distribution of the crowdfunding campaigns between each Canadian province and territory and the average value of each socio-economic variable within each administrative division (see Table 6).

** insert Table 6 here **

The average income of crowdfunding campaigners in this dataset is within middle to high level FSAs, with 65.49% of campaigns located in FSAs within the three highest quintiles in the income category (see Table 3). These higher income levels are matched by higher rates of home ownership among these campaigners, with housing ownership values being larger in the middle quintile (see Table 5). This group also tends to be well educated, with education values tending toward the higher quintiles (see Table 4).

Collectively, our ESDA shows that use of cancer-related medical crowdfunding is occurring unevenly across the country relative to population distribution. For example, Canadians' cancer-related crowdfunding campaigns were also commonly located near city centres (see Figure 3). Provincial differences in campaign use also exist. Campaigns were more commonly posted in the provinces of Ontario and British Columbia and less so in the Atlantic provinces. There is a noticeable density of campaigns in the prairie provinces of Alberta and Saskatchewan.

Discussion

Our ESDA-based findings support existing concerns that persons in positions of relative socio-economic privilege disproportionately utilize crowdfunding to address health-related needs – in this case care related to cancer. Individuals in the highest income FSAs were found to be the heaviest users of medical crowdfunding for cancer-related campaigns, as were individuals in FSAs with high rates of home ownership. These ESDA-based interpretations support the idea that wealthier individuals are more likely to see crowdfunding as a way to draw together

financial resources from elsewhere to meet their health needs. We also observed that individuals in FSAs with higher rates of education turned more frequently to medical crowdfunding. This ESDA-based interpretation supports existing claims that individuals who are better educated, more familiar with online technologies, and better able to express themselves online are more likely to take advantage of crowdfunding to address health-related needs. The positive correlation between the amount raised in a campaign and number of times the campaign was shared supports the speculation that social capital and tech-savviness are important constituents of crowdfunding campaign success.

Our exploration of geo-demographic trends regarding Canadians' use of cancer-related crowdfunding shows that this is a highly urban phenomenon. This is somewhat counterintuitive considering the extensive health service gaps in rural Canadian communities that drive some residents to consider alternative ways to access necessary care [30], such as crowdfunding for the costs of private treatment or to relocate to an urban centre. Research regarding a potential urban-rural divide in crowdfunding use is very limited and so it is difficult to know why there can be proportionately less use in rural areas. This may be due to limited access to technology or lower levels of education in rural Canadian communities [31,32]. Alternatively, it may be due to strong voluntary and informal care sectors in 'tight-knit' rural communities that would lead to residents pulling together to support those in need [30,33], which would lessen the need for drawing on disparate social networks via crowdfunding. It is important to note, however, that our ESDA approach means that we cannot conclusively state that our analysis documents a clear urban-rural divide. This is due in part to the large aggregations of FSAs as well as the sparse population of Nunavut that can both over- and under-estimate socio-economic variables. We thus flag this as an important issue for future medical crowdfunding research. Furthermore, factors distinctive to

the Canadian cultural, geographic, and healthcare context may mean that these specific results are not applicable elsewhere. These factors include widespread access to basic cancer care through the Canadian single payer health system, cultural differences in charitable giving, and the geographically disparate nature of Canadian communities. These differences may be less acute in European communities with greater access to public health insurance and greater in the US and other countries with more limited public provision of care but requires additional investigation in other settings.

While our interpretations of the ESDA results support the general concern that medical crowdfunding will tend to exacerbate socio-economic inequities in access to health-related care, only certain dimensions of this critique were explored here. For example, while we found positive correlations between cancer-related crowdfunding and wealth and education levels, we were not able to explore whether other dimensions of socio-economic privilege are positively correlated. These dimensions include race, gender, ethnicity, nationality, and linguistic fluency, all of which are factors that lead to inequities in health status [34,35]. This leads us to make three important points. First, we acknowledge that it is possible that only certain dimensions of socio-economic privilege correlate with using crowdfunding to address health-related needs, and that some or all of those not explored here do not shape medical crowdfunding use in the ways documented here. Second, and because of this, it is important to explicitly state that this exploratory analysis supports the hypothesis of a more general correlation but does not provide direct evidence supporting every dimension of this correlation. And third, we call for further research to explore the relationship between socio-economic variables and medical crowdfunding use in general or for cancer-related campaigns in order to assist with developing a more robust understanding of any interrelationships.

315 *Limitations*

316 Only the first three digits of postal codes were included in the dataset of crowdfunding
317 campaigns, which were then linked to FSAs. FSAs are smaller in urban areas and may be
318 geographically vast in rural areas. Linking ADAs to FSAs could result in broad generalizations
319 and aggregation errors and lead to ecological fallacies. This implies that findings from our study
320 are limited, as only broad claims can be stated. The aforementioned generalizations could be less
321 impacted in urban areas with smaller FSAs comparatively to rural areas. While this has
322 implications for our results, the impact may be reduced considering that as of 2011, over 80% of
323 Canada's population lives in urban environments [36].

324 We acknowledge that a medical crowdfunding campaign recipient may be different from
325 campaign's creator. This necessitates further research with regard to the issues explored in this
326 analysis because campaigners may reside in or report different FSAs than the individual or
327 family in need of financial assistance. Further to this, postal codes are self-reported by campaign
328 creators, which allows mistakes to be made. Nothing can be done to address this as a limitation
329 beyond acknowledging our awareness of the potential for errors to exist in postal code reporting.
330 Campaigners may also have moved to an urban centre in order to access care, thus introducing
331 an urban bias into our sample.

332 FSAs encoded in the campaign entries dictated the primary level of aggregation for our
333 study, thus necessitating us to limit selection of socio-economic variables. If spatial and non-
334 spatial attributes were improved, more socio-economic status variables could be involved, such
335 as sex or immigration status. This would aid in obtaining more robust results. Another limitation
336 encountered was the fact that the census profiles at the FSA-level were unavailable due to

accuracy issues (Statistics Canada, 2018) [37]. To substitute, a methodology to link and weight the chosen socio-economic variables from the ADA-level to FSA-level had to be developed.

At the time this analysis was conducted, the Census profile for the FSA level was not published. To handle this, we selected the SES variables from the ADA level. Performing an intersection operation between FSAs and ADAs, SES variables were added to FSAs based on the percentage of area shared. By taking the weighted average of SES variables from the ADAs that intersect with each FSA, values such as those for shown for Nunavut are impacted by the error accumulation from this procedure, where populations are sparse. Likewise, if there were any issues with values in the ADA-level SES data, these will propagate to the weighted SES variables linked to the FSAs. This means that data issues from the ADA Census profile product or low populations contribute to and exacerbate errors. The Nunavut values are correct with respect to this method applied. This is a systematic limitation that is exaggerated by the sparse population of Nunavut and affects all data reported in the tables at varying degrees.

As our dataset was acquired for a snapshot in time, we acknowledge that campaigns have been instantiated at different times and have been underway for varying durations. These comparisons may impact results because the campaign duration captured in the current dataset may not be representative of the overall success of the campaign. For example, less successful campaigns may be deleted more quickly than more successful campaigns, more successful campaigns may not be removed at all, or less technologically adept individuals may not think to delete completed campaigns. Future work may look to compare individual campaigns that have either been run for the same length of time or have completed their respective lifecycles on major crowdfunding platforms.

Conclusions

The findings reported here support concerns that charitable crowdfunding will tend to advantage relatively socio-economically privileged individuals. While supporters of medical crowdfunding point to its potential to help people access necessary health care and avoid debt or even medical bankruptcy, this paper demonstrates that this potential is not distributed equitably across society. While medical crowdfunding still benefits many, these findings show its limits in serving as a systematic and fair solution to structural deficiencies in health systems. Additional research, including using the methods described here, would help to demonstrate whether these findings are reproduced for other socio-economic factors, in countries other than Canada, and for health needs beyond cancer.

Contributorship Statement

AvD, AL, and RM contributed to developing the methods, conducting the analysis, and writing the manuscript. JS and VAC contributed to method design, securing project funding, and writing the manuscript. PCW contributed to data acquisition and writing the manuscript. NS contributed to method design and writing the manuscript.

Competing Interests

We declare no competing interests.

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Data Sharing Statement

All crowdfunding data is available from the authors on request.

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473 **Tables**

Variable	Data Obtained
Population and dwelling counts	Population, 2016
Income (Total Sex / Total)	Income statistics in 2015 for the population aged 15 years and over in private households - 100% data / Number of after-tax income recipients aged 15 years and over in private households - 100% data / Median after-tax income in 2015 among recipients (\$)
Education (Total Sex / Total)	Highest certificate, diploma or degree for the population aged 15 years and over in private households - 25% sample data / Postsecondary certificate, diploma or degree
Housing (Total Sex / Total)	Private households by tenure - 25% sample data / Owner

474 **Table 1. Variables Obtained from 2016 Census Profiles for Aggregate Dissemination Areas.**

475 Retrieved from the Canadian Census Analyser, University of Toronto

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 5	114	64.77%	247	13.81%
6 - 17	36	20.45%	337	18.85%
18 - 41	16	9.09%	402	22.48%
42 - 76	6	3.41%	362	20.25%
77 - 138	4	2.27%	440	24.61%
Total	176	100.00%	1788	100.00%

477 **Table 2. Frequency of Campaigns per FSA. Proportion of Campaigns belonging to each Quintile.**

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
\$0.00 - \$12699.19	3	1.70%	104	5.82%
\$12699.19 - \$28556.91	54	30.68%	513	28.69%
\$28556.91 - \$33333.84	63	35.80%	449	25.11%
\$33333.84 - \$38980.26	45	25.57%	593	33.17%
\$38980.26 - \$51498.11	11	6.25%	129	7.21%
Total	176	100.00%	1788	100.00%

479 **Table 3. Income, Median After-Tax (2015). Proportion of Campaigns belonging to each Quintile.**

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1397	12	6.82%	159	8.89%
1397 - 2980	41	23.30%	308	17.23%
2980 - 4156	72	40.91%	755	42.23%
4156 - 6087	46	26.14%	524	29.31%
6087 - 10046	5	2.84%	42	2.35%
Total	176	100.00%	1788	100.00%

Table 4. Education, Post-Secondary. Proportion of Campaigns belonging to each Quintile.

Income Quintile	Number of FSA	Percentage (FSA)	Number of Campaigns	Percentage (Campaigns)
1 - 1393	17	9.66%	180	10.07%
1393 - 2429	38	21.59%	283	15.83%
2429 - 3218	68	38.64%	711	39.77%
3218 - 4579	48	27.27%	571	31.94%
4579 - 7121	5	2.84%	43	2.40%
Total	176	100.00%	1788	100.00%

Table 5. Housing, Owner. Proportion of Campaigns belonging to each Quintile.

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Province/ Territory	Number of FSAs	Number of Campaigns	Percentage (FSA)	Percentage (Campaigns)	Population	Income, Median After-Tax (Average)	Education, Post- Secondary (Average)	Housing, Owner (Average)
Alberta	21	310	11.93%	17.34%	203643	\$36,012.35	3393	2846
British Columbia	32	401	18.18%	22.43%	268112	\$28,716.63	3728	2599
Manitoba	9	66	5.11%	3.69%	83126	\$31,275.32	3211	3032
New Brunswick	12	55	6.82%	3.08%	75339	\$26,745.83	2287	2310
Newfoundland & Labrador	9	53	5.11%	2.96%	69103	\$26,503.28	2868	2809
Northwest Territories	1	3	0.57%	0.17%	823	\$51,498.11	415	228
Nova Scotia	9	69	5.11%	3.86%	73961	\$31,392.79	3908	2425
Nunavut	1	1	0.57%	0.06%	3	\$63.72	0	0
Ontario	47	576	26.70%	32.21%	436637	\$31,865.32	3942	3105
Prince Edward Island	2	25	1.14%	1.40%	15301	\$27,888.67	2984	2582
Quebec	18	139	10.23%	7.77%	158832	\$30,057.44	3923	2675
Saskatchewan	14	85	7.95%	4.75%	138065	\$34,795.72	3613	3194
Yukon	1	5	0.57%	0.28%	16962	\$41,664.80	3278	2599
Total	176	1788	100.00%	100.00%	1539908	\$30,652.31	2889	2339

484 Table 6. Number of Campaigns, Population, and Socio-economic Values per Province.

Figure Legends

Figure 1: High-Level Description of Conversion Procedure Utilized to add Socio-Economic Data at ADA-Level to FSA-Level. This figure denotes the methodology employed to associate socio-economic data at the ADA-level with the crowdfunding data collected at the FSA-level.

Figure 2: Sample Interaction Sequence to Support Adding Context to Campaign Markers in the Interactive Web Mapping Tool. This figure provides a set of sample instructions to users of the CHRP web map to better understand the datasets displayed.

Figure 3: Screen Capture of Web Map Application (Main Page). This figure shows the home page of the CHRP. The data shown in this figure denotes the locations of all crowdfunding campaigns involved with this study. Basic information associated with each of the campaigns can be viewed here. Permission has been granted to reproduce this image and it is not under copyright.

Figure 4: Screen Capture of Web Map Application (with the Exploratory layer of Frequency Counts of Campaigns per FSA Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is number of crowdfunding campaigns per forward sortation area. Permission has been granted to reproduce this image and it is not under copyright.

Figure 5: Screen Capture of Web Map Application (with the Exploratory layer of Income (Median, After-Tax, 2015) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is income (median, after-tax, 2015). The income data was obtained from the 2016 Canadian Census at the ADA-level. Permission has been granted to reproduce this image and it is not under copyright.

Figure 6: Screen Capture of Web Map Application (with Exploratory layer of Education (Number of People with a Post-Secondary Education) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The variable of interest here is education (number of individuals that identify as having post-secondary education). The education data was obtained from the 2016 Canadian Census at the ADA-level. Permission has been granted to reproduce this image and it is not under copyright.

Figure 7: Screen Capture of Web Map Application (with the Exploratory layer of Housing (Number of People that own homes) Displayed). This figure shows the CHRP displaying one of its exploratory layers. The dataset of interest here is housing (number of individuals that own homes). The housing data was obtained from the 2016 Canadian Census at the ADA-level. Permission has been granted to reproduce this image and it is not under copyright.


```
Algorithm GenerateWeights(ADA dataset, FSA dataset)
begin
  a = Number of FSA, b = Number of ADA
  Initialize relationship matrix of size a rows by b columns
  For each i ∈ {FSA1...FSAa}:
    Select all from ADA that intersect with FSAi
    For each j ∈ {intersecting ADA retrieved in selection}:
      Calculate percent area that ADAj occupies in FSAi
      Add weight to matrix at the position corresponding with the respective FSA
        and ADA IDs.
    Store relationship matrix as CSV for reuse
end
```

165x74mm (220 x 220 DPI)

- The User:
1. Views the "CHRP Explorer" web mapping application
 2. Clicks and drags the map to populate the campaign list sidebar
 3. Clicks on campaign markers or hovers over sidebar listings to learn more about individual Canadian medical crowdfunding campaigns
 4. Uses the basic filters slider to filter campaigns to have at least \$10,000 raised, more than 300 friends, and at least 100 donations
 5. Clicks the "Exploratory" tab to change the panel contents
 6. Selects "Income" under the "Campaign - Socioeconomic Variable Comparison Layers by Forward sortation area" section
 7. Zooms into a geographic area of interest and clicks on a coloured area to view the median income average for that FSA the campaign is associated with

164x63mm (220 x 220 DPI)

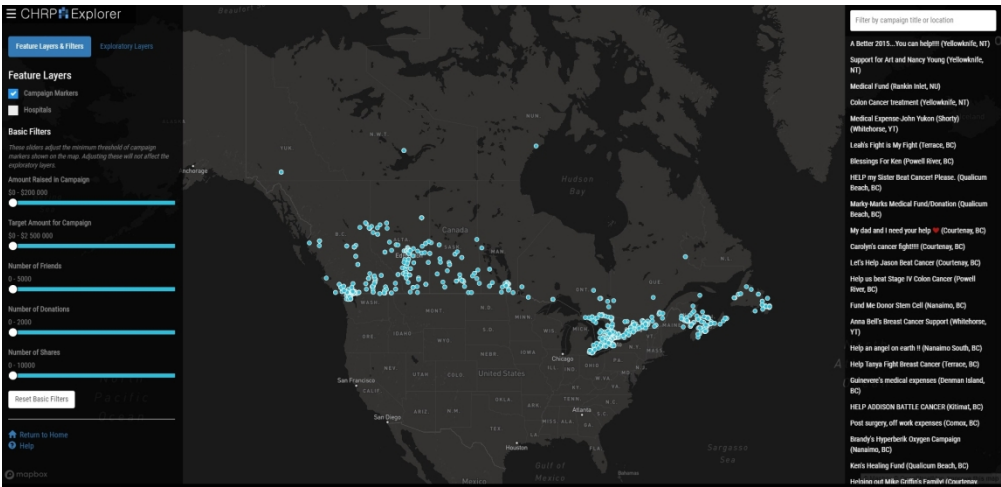


Figure 3

169x81mm (288 x 288 DPI)

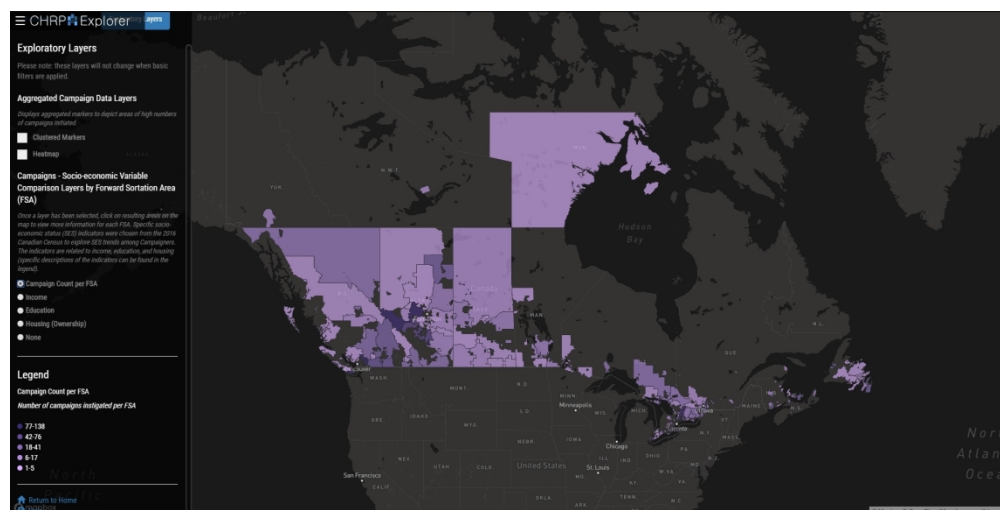


Figure 4

169x85mm (288 x 288 DPI)

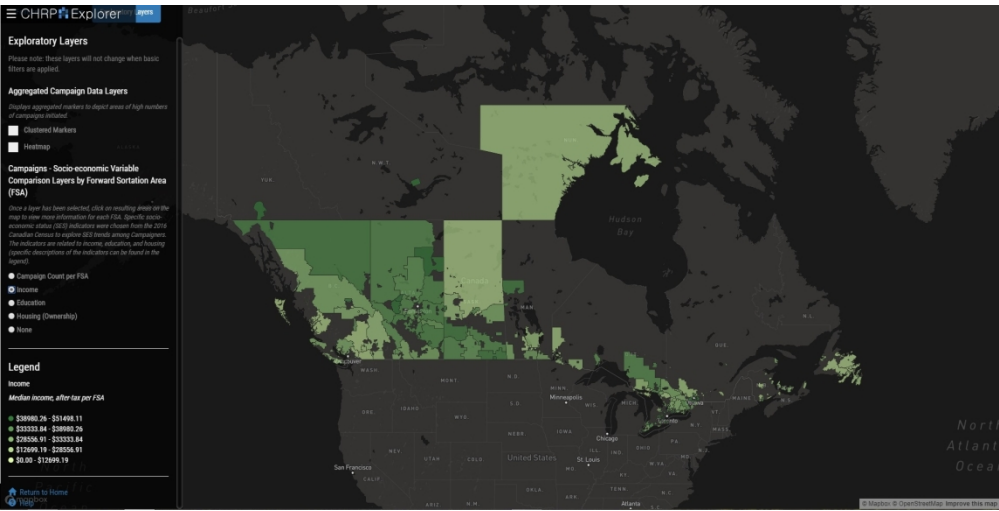


Figure 5

169x85mm (288 x 288 DPI)

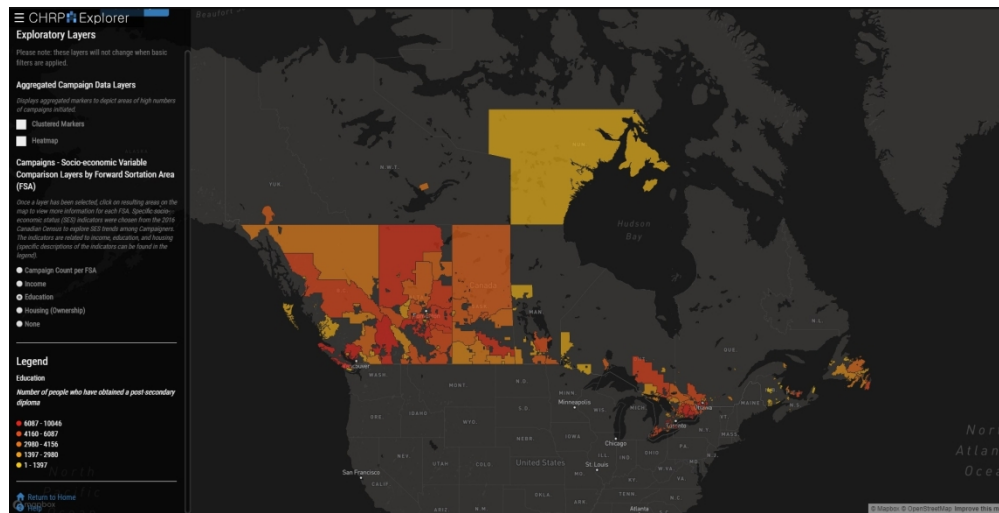


Figure 6

169x85mm (288 x 288 DPI)

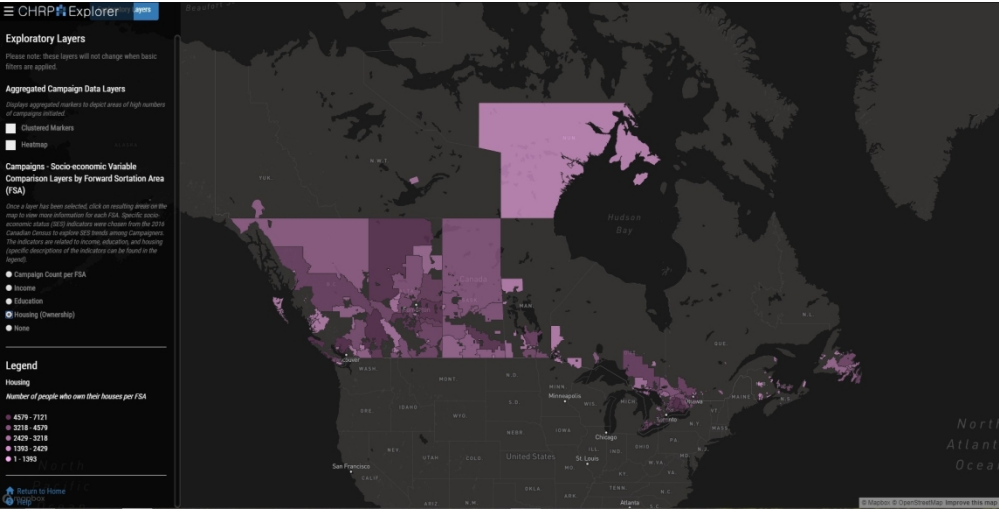


Figure 7

168x85mm (288 x 288 DPI)

Standards for Reporting Qualitative Research (SRQR)*

<http://www.equator-network.org/reporting-guidelines/srqr/>

Page/line no(s).

Title and abstract

Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	p. 1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	p. 2

Introduction

Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	p. 4
Purpose or research question - Purpose of the study and specific objectives or questions	p. 4

Methods

Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	pp. 5-7
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	N/A
Context - Setting/site and salient contextual factors; rationale**	pp. 5-7
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	pp. 5-7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	N/A
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	pp. 5-7

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	pp. 5-7
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	pp. 5-7
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	Pp. 5-7
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	Pp. 5-7
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Pp. 5-7

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	pp. 7-9
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	pp. 7-9

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	pp. 9-10
Limitations - Trustworthiness and limitations of findings	pp. 10-11

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	p. 12
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	p. 13

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

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**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:
O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388

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