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Permalink

https://escholarship.org/uc/item/3gf1h3r7

Journal

ACR open rheumatology, 4(7)

ISSN

2578-5745

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Publication Date

2022-07-01

DOI

10.1002/acr2.11448

Peer reviewed

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Comparison of Web-Based Advertising and a Social Media Platform as Recruitment Tools for Underserved and Hard-to-Reach Populations in Rheumatology Clinical Research

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Objective. Traditional nondigital methods of participant recruitment for clinical research studies in rheumatology can be costly and inefficient, particularly for recruitment of underserved populations. We aimed to address this need by evaluating two methods of online recruitment to an observational cohort of individuals at risk for rheumatoid arthritis, namely web and Facebook advertisements.

Methods. A 3-month countywide web-based recruitment campaign was conducted consisting of text and image-based advertisements. Similar advertisements were subsequently displayed on Facebook, initially in English for 5 months and later in Spanish for an additional 3 months. Individuals who clicked on advertisements were directed to a website landing page containing study information and could contact study personnel to schedule testing for anti-cyclic citrullinated peptide-3 (CCP3). The primary outcome measure for each campaign was the click-through rate.

Results. During the web campaign, 413,289 advertisement impressions were displayed, resulting in 428 clicks (click-through rate 0.10%) and only one screened participant. During the English Facebook campaign, 724,815 advertisements were displayed with 6765 clicks (click-through rate 0.93%) and 43 screened participants, significantly greater than the web campaign ($P < 0.001$). During the Spanish advertisement campaign, 255,730 Spanish advertisements were displayed, resulting in a click-through rate of 2.09% and 24 screened participants, a significantly higher rate than English advertisements. Of participants recruited through social media, 94% were female and 29.8% were Spanish speakers.

Conclusion. Facebook advertisements were superior to web advertisements for participant recruitment. Spanish Facebook advertisements had a greater click-through rate than English Facebook advertisements. Facebook was an effective recruitment method, particularly for Spanish speakers.

INTRODUCTION

Effective participant recruitment is one of the most difficult problems in clinical research. Up to 50% of studies are terminated early because of inadequate participant accrual (1), with many study locations failing to enroll even a single patient (2). Noninterventional studies can be affected even more severely than studies with therapeutic intent (3), and those involving uncommon diseases may be even more susceptible because of a limited potential population of participants (4). Typical recruitment methods involve coordination with local physicians, printed flyers posted

in public spaces, events such as health fairs, and advertising in printed media. However, these methods tend to be slow, inefficient, poorly targeted, and costly (5). These methods also have limited reach into underserved communities, such as non–English-speaking individuals (6), which contributes to their limited representation in research (7). This is especially true for hard-to-reach populations who are otherwise healthy and not interacting with the health care system or may be in phases of disease in which symptoms are minimal (5).

Rheumatoid arthritis (RA) is a systemic autoimmune disease that affects between 0.5% and 1% of the US adult population (8,9).

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No potential conflicts of interest relevant to this article were reported.

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SIGNIFICANCE & INNOVATION
- Recruitment of underserved and asymptomatic populations in rheumatology clinical research is difficult, costly, and inefficient.
- Facebook advertisements were effective at identifying individuals at risk for rheumatoid arthritis, especially Spanish speakers.
- Social media can be used to improve outreach in hard-to-reach populations.

Anti-citrullinated protein antibodies (ACPAs) appear in most patients with RA several years before the onset of clinically apparent RA (10), and up to 50% of high-titer ACPA-positive individuals develop RA within 3 years (11). Individuals who are ACPA-positive without inflammatory arthritis have been classified as having preclinical RA or pre-RA (11). Several studies attempted to identify risk factors for progression to RA (12) or performed therapeutic interventions to prevent progression to RA (13–15), but this process is still incompletely understood. Many studies of pre-RA focus on first-degree relatives of patients with RA because these individuals have a relative risk of ACPA positivity of approximately twofold to fivefold that of the general population (11,12). However, identifying and recruiting these individuals is time consuming and resource intensive, especially because these individuals may not present to clinical care because they do not yet have inflammatory arthritis.

Some investigators have started to use web-based and social media–based advertising for participant recruitment (16–25). Facebook and other social media platforms have a robust advertising architecture that allows targeting of specific user groups (26). Studies of social media advertising show promising results, but these studies focused primarily on public health measures or common diseases (16–21). Very little information is available on the effectiveness of these advertisements in research of rheumatologic diseases (27,28). In this study, we aimed to evaluate the relative effectiveness of advertising on the web and on Facebook for the recruitment of participants with pre-RA to an observational cohort.
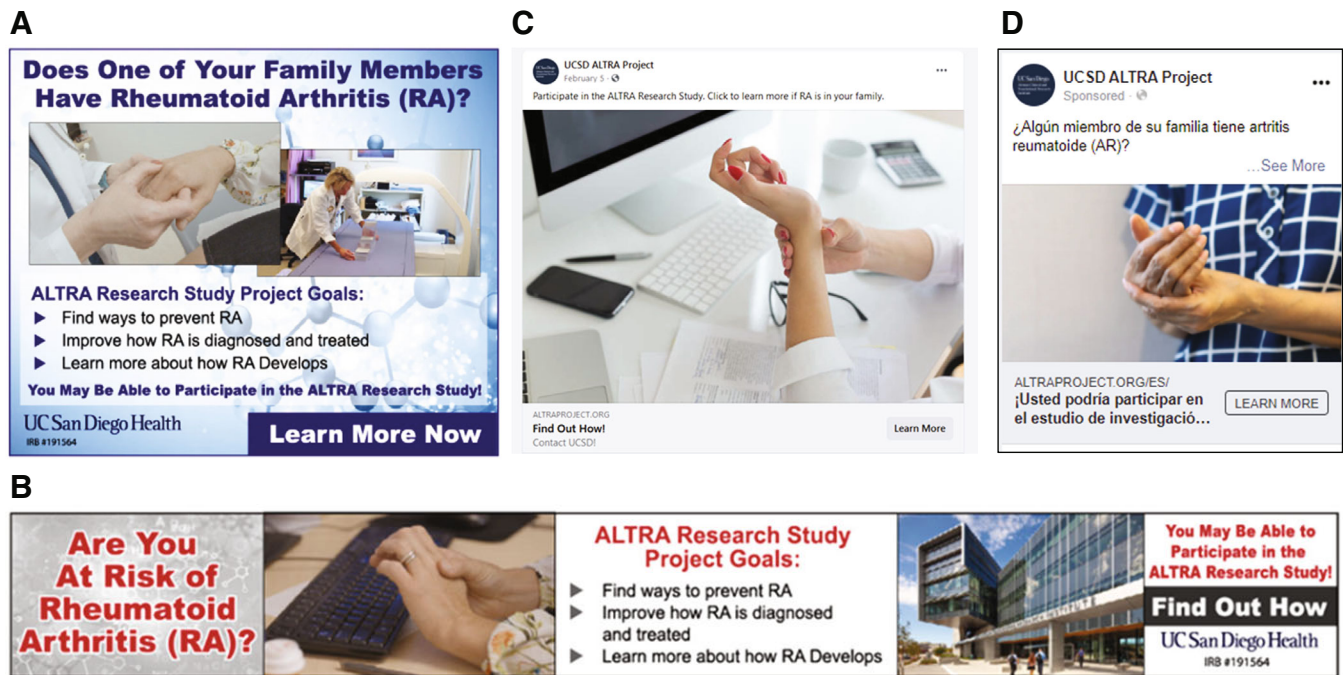
MATERIALS AND METHODS

The Allen Institute of Immunology–University of California, San Diego–University of Colorado Transition to Rheumatoid Arthritis (ALTRA) study is a prospective cohort study of individuals with elevated levels of ACPAs (twofold above upper limit of normal for the anti-cyclic citrullinated peptide-3 (CCP3) antibody test; Inova Diagnostics Inc.) but without clinical evidence of RA (29). Participants were eligible for anti-CCP3 screening if they had at least one first-degree relative with RA. Recruitment for this study was initially limited to methods that included face-to-face patient recruitment from rheumatology clinics, searches of the electronic health records, and paper flyers displayed in public spaces. We continued to use these methods of recruitment alongside the online advertising campaigns.

Advertisements and landing page. We developed several advertisements for use in sequential web-based and Facebook advertising campaigns. The advertisements were 50 to 300 pixels wide and contained an image and brief text description of our targeted population. The advertisements were static without animation or sound and were designed to be easy to read on small and large screens. Six different advertisements were developed for the web campaign, and four advertisements similar to the web advertisements were developed for the Facebook campaign. Two of the Facebook advertisements were designed to be part of an advertisement "carousel," in which they were interspersed between other unrelated advertisements, and two were designed to be standalone advertisements. The four Facebook advertisements were also translated into Spanish when the Spanish advertisement campaign began (see below).

When users clicked on an advertisement, they were directed to a website landing page (Supplementary Figure 1). This page contained detailed information about the ALTRA study and had a button that a user could click to provide their contact information to study personnel. Eligible individuals could then be contacted by study staff for screening. When individuals were contacted by study staff, they would be asked basic demographic questions and subsequently be invited for in-person evaluation, which involved a basic history and ACPA testing using the anti-CCP3 antibody assay. The landing page also had a Spanish-language version, and users that clicked on Spanish advertisements were linked directly to the Spanish landing page. Website development and maintenance was managed by University of Colorado Information Technology.

Advertising campaigns. From October 2020 to December 2020, individuals in San Diego County were shown web-based advertisements displayed in their web browsers and in mobile applications. Advertisements were delivered using a common advertising framework available on numerous websites and applications. Our aim was to identify and recruit first-degree relatives of patients with RA. Figure 1 shows examples of advertisements used in the study. Between 100,000 and 150,000 advertisement impressions were displayed every month for 3 months. Advertisements were targeted primarily using geofencing, a technique that identifies users visiting specific geographic locations (such as physicians' offices), and with search keyword retargeting using keywords such as "arthritis" and "rheumatologist" (Supplementary Table 1). A small number of advertisements were also targeted using website remarketing, in which some individuals who clicked on an advertisement would keep seeing the advertisement again. This allowed individuals who visited the website but did not contact the staff another opportunity to do so.

Figure 1. Examples of advertisements displayed during the study. **A,** A rectangular web advertisement. **B,** A banner web advertisement. **C,** An English Facebook advertisement. **D,** A Spanish Facebook advertisement. ALTRA, Allen Institute of Immunology–University of California, San Diego–University of Colorado Transition to Rheumatoid Arthritis; UC, University of California; UCSD, University of California, San Diego.

To avoid overlap of the two campaigns, all advertising paused for 1 month after completion of the 3-month run of the web campaign. Starting in February 2021, we began a Facebook advertisement campaign targeting Facebook users in San Diego County. In the initial portion of the Facebook campaign, between 100,000 and 180,000 advertisement impressions were displayed monthly for 5 months. Users were targeted primarily through demographics such as age and sex using the proprietary Facebook targeting algorithm. After enough individuals clicked on advertisements, the targeting algorithm developed a profile of users likely to click on an advertisement. We then were able to use lookalike targeting, in which individuals similar to those who already clicked on an advertisement would get advertisements displayed to them. A small number of website remarketing advertisements were displayed during this period as well.

To increase outreach to underserved populations in the San Diego region, we ran English and Spanish advertisements concurrently for 3 months. Spanish advertisements were also targeted initially using demographics similar to those in the English campaign, with lookalike targeting added after a profile of Spanish-speaking users was constructed. The advertising campaigns were managed by ReachLocal, a commercial web and social media advertising company.

Outcome measures and statistical analysis. The primary outcome measure was the advertisement click-through rate for each advertisement campaign, defined as the number of users who clicked on a displayed advertisement divided by the number of advertisement impressions. Subgroup analysis was performed for this outcome measure for each primary targeting method in the web and Facebook campaigns and for English and Spanish advertisements in the Facebook campaign.

Secondary outcome measures included the screen rate, defined as the fraction of those individuals who clicked on an advertisement who were screened for CCP3, cost per click, cost per screened participant, and monthly median screened participant count.

The primary outcome measure and proportional secondary outcome measures were evaluated using the χ^2 test. The monthly median screened participant count before and after the advertisement campaign was evaluated using Fisher's exact test. Mean age was compared using Student's t test, and all other demographic features were evaluated using the χ^2 test. All statistical analysis was done in SPSS version 27 (IBM Corp).

Ethical approval. This study and the ALTRA study were approved by the Institutional Review Boards at the University of Colorado and the University of California, San Diego (UCSD). Participants who clicked on the landing page and expressed interest in the study signed institutional review board–approved informed consent forms prior to a screening visit (history and blood CCP3 test). No identifiable information was retained for individuals who clicked on advertisements but were not screened.

RESULTS

Traditional nondigital recruitment. Traditional nondigital recruitment methods were used from the inception of the ALTRA cohort to the completion of the social media campaign (for 24 months). Sixty-four participants were screened at UCSD through methods other than social media during this time. Seven of these participants subsequently screened positive for anti-CCP3 and enrolled in the study.

Web campaign. For the 3-month duration of the web campaign, 413,289 advertisement impressions were placed. The number of advertisement clicks during this period was 428, corresponding to a click-through rate of 0.10% of displayed advertisements. A total of 279,395 displayed advertisements were targeted by geofencing, and 130,533 were targeted by keyword search retargeting. The click-through rate of advertisements targeted by geofencing was 0.12%, which was significantly higher than the 0.073% rate of keyword search retargeting advertisements ($P < 0.001$). One individual was screened and was anti-CCP3-negative. The cost per click during this period was $2.80, and the cost per screened participant was $1200.

Facebook campaign. During the 5 months of the English-language Facebook campaign, 724,815 advertisement impressions were placed. During this time, 6765 individuals clicked on an advertisement during this period, resulting in a click-through rate of 0.93%, a significantly greater click-through rate than the web campaign ($P < 0.001$) (Figure 2). Of these impressions, 245,488 advertisements were targeted by user demographics and 501,663 advertisements used lookalike targeting. The click-through rate of advertisements targeting user demographics was 1.14%, which was significantly greater than advertisements using lookalike targeting at 0.080% ($P > 0.001$). We screened 43 individuals, and three individuals screened anti-CCP3-positive and enrolled into the study. The cost per click for this campaign was $1.56, and the cost per screened participant was $245.16. The cost per click and cost per screened participant were both significantly lower for the Facebook campaign than the web campaign ($P < 0.001$) (Figure 3). Four individuals enrolled in the study, which was nearly 40% of our total enrollment even though nondigital methods ran for 2 years.

Comparison of English and Spanish Facebook campaigns. Spanish-language advertisements started running immediately after the completion of the 5-month English-only
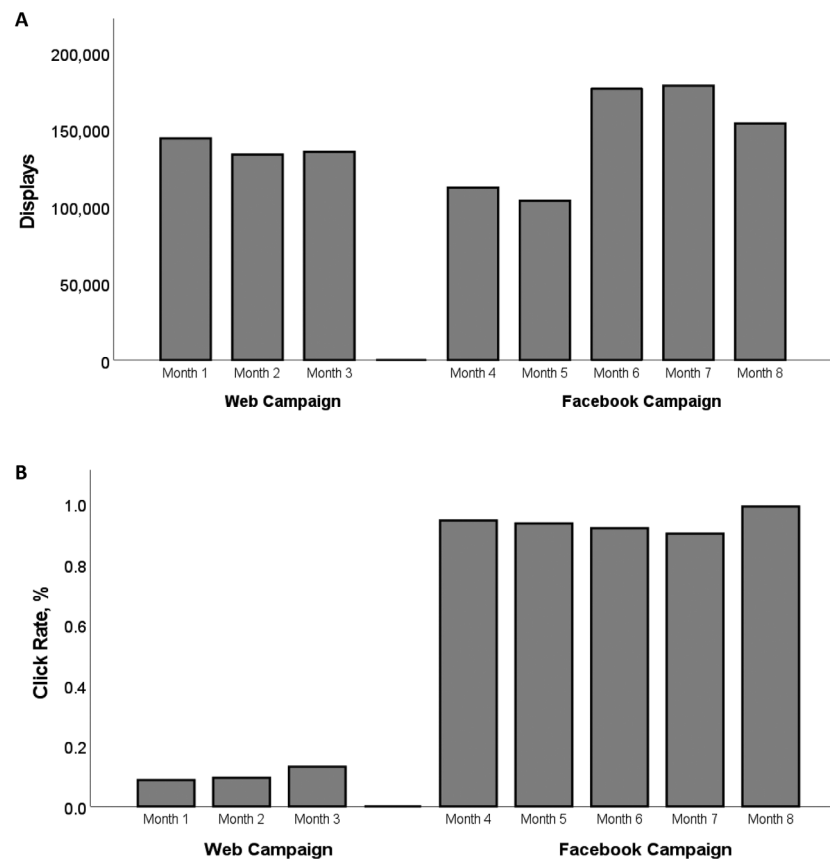
Figure 2. Comparison of web and Facebook advertising campaigns. The web campaign was displayed during months 1 to 3, and the Facebook campaign during months 4 to 8. **A,** Total number of advertisements displayed during web and Facebook campaigns each month. **B,** Click-through rate of advertisements as a percentage of displayed advertisements. The click-through rate for Facebook advertisements was significantly higher than that for web advertisements.

campaign. Spanish advertisements ran for 3 months concurrently with additional English advertisements. During this time period, a total of 154,931 English and 255,730 Spanish advertisement impressions were placed. The click-through rate of English advertisements during these 3 months was 0.94%, and the click-through rate of Spanish advertisements was significantly higher at 2.09% ($P < 0.001$) (Figure 4). We screened 24 individuals, and one individual screened positive and enrolled. The cost per click was $0.67, and the cost per screened participant was $303.92.

Demographics of screened participants. Prior to the start of the Facebook advertising campaign, we screened a median of four (interquartile range [IQR] two to five) participants every month for entry into the study using traditional methods. After the start of the Facebook campaign, the median monthly screened participants, from both traditional and social media methods, increased to 10 (IQR 6-12), which was significantly greater than prior to the start of the campaign ($P = 0.004$) (Figure 5). Of the screened participants during the web and Facebook campaigns, 94% were female and 29.9% were Spanish-speaking. Compared with traditional recruitment methods, participants recruited through social media were older

(mean age 51.1 vs 45.9, $P = 0.014$), more likely to be female (94.0% vs 81.2%, $P = 0.026$), Asian (13.4% vs 3.13%, $P = 0.033$), and Spanish speaking (29.8% vs 9.3%, $P = 0.003$). There were no significant differences between other racial groups, educational attainment, or history of tobacco use (Table 1). There was also no significant difference in the rates of anti-CCP3 positivity ($P = 0.31$). Seventy-seven percent of Spanish-speaking participants screened in the study were recruited during the Spanish-language social media campaign. After deployment of the social media campaign, we were able to successfully fill our ALTRA cohort at UCSD.

DISCUSSION

This study evaluated the utility of social media as a recruitment tool in rheumatologic disease research, particularly for hard-to-reach populations that are asymptomatic or from underserved communities. Social media recruitment methods allowed us to screen a greater number of participants in a shorter time frame than traditional methods of advertising. Although both web and Facebook advertising generated a large number of clicks and website visits, the Facebook campaign
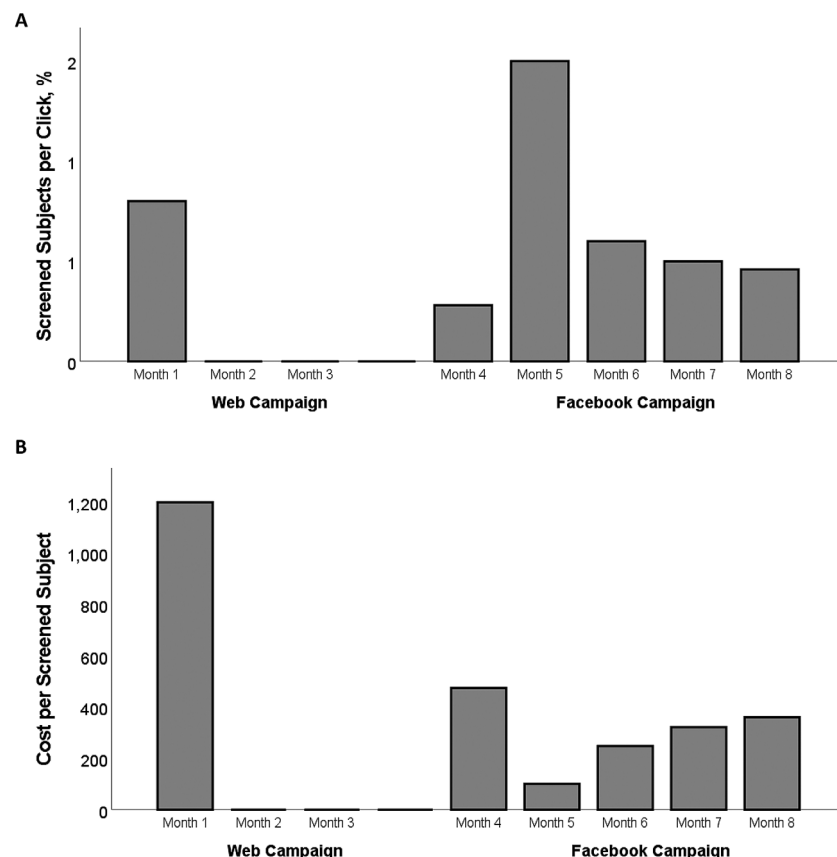
Figure 3. Cost-effectiveness comparison of web and Facebook campaigns. **A,** Screen rate per month, defined as the percentage of advertisement clicks that resulted in a participant screen. **B,** Cost per screened participant for the web and Facebook campaigns. Because of delays between viewing an advertisement and the screening visit, some participants might have clicked on an advertisement in the month before getting screened.
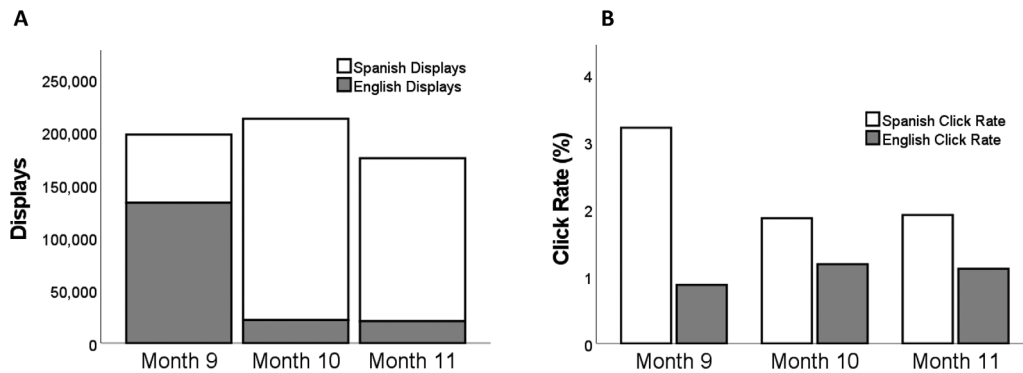
Figure 4. Comparison of English and Spanish Facebook advertisement campaigns. **A,** Number of advertisement displays per month in English and Spanish. **B,** Click-through rate of English and Spanish advertisements as a percentage of advertisements displayed.

was markedly superior in terms of click-through rate, cost-effectiveness, and number of recruited participants. Although the Facebook campaign cost more per advertisement impression, the significantly higher click-through rate resulted in a cost per click that was nearly half of the web campaign and a cost per screened participant of almost one fifth of the web campaign. This difference was even more pronounced for Spanish-speaking participants. The Facebook campaign might have performed better because of more accurate targeting of high-risk populations of a specific sex and age or because individuals were simply more likely to ignore banner advertisements on the web than on Facebook.

Click-through rates in other studies were highly variable, from <0.01% to 3.9% depending on platform and target population (17,20), and are difficult to predict in advance (30). Larger studies with improved metrics are necessary to further evaluate the reason for this difference. Surprisingly, targeting by demographics in the Facebook campaign was more effective than lookalike targeting. This might represent a characteristic of Facebook's profile construction algorithms, or it might be due

to advertising saturation of the highest propensity users. Because of lack of access to Facebook's internal algorithm, the reason for this difference will be difficult to determine, and because the algorithm is constantly being modified, these results may be different in future studies.

We recruited a large number of Spanish-speaking individuals through Spanish-language Facebook advertisements. Spanish-speaking individuals were more than twice as likely to click a Facebook advertisement compared with English speakers, and most of the Spanish-speaking participants in the study were recruited through Facebook advertisements. The percentage of recruited Spanish-speaking participants was greater than the 25% of primary Spanish speakers in San Diego County (31). Facebook advertising is therefore a promising avenue for recruitment of a population that is often underrepresented in clinical studies. Using Facebook for recruitment may allow researchers to bridge the representation gap and assemble cohorts that more closely resemble the general population, increasing study generalizability.

Participants recruited through social media were more likely to be female and were slightly older than participants recruited by traditional methods. This could result from targeting female and middle-aged individuals by the Facebook algorithm because these groups are more likely to develop RA. Most prior studies of Facebook as a recruitment tool focused on younger populations (32). The success of our campaign suggests that Facebook can effectively reach older populations as well. Surprisingly, we did not find any significant differences in the educational attainment of participants recruited through Facebook compared with traditional methods, and both methods were able to reach individuals in every level of educational achievement. This result suggests that social media can reach individuals in diverse social strata.

Our study had several limitations. After a user clicked on a link to enter the website, they were no longer tracked. We therefore could not determine which specific targeting method or advertisement resulted in a participant screen. For this reason, it is also possible that some participants who clicked Spanish Facebook advertisements spoke English as their primary language, or
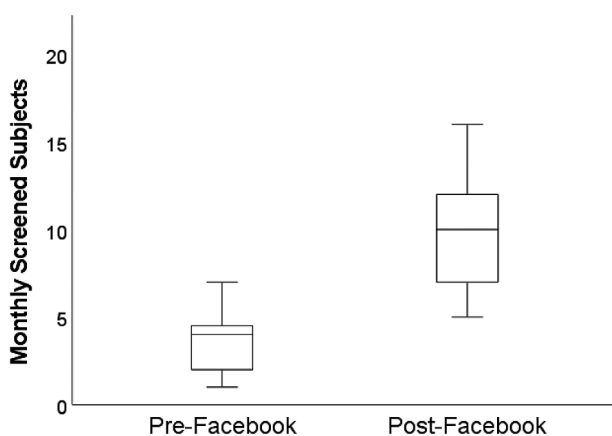
Figure 5. Number of individuals screened per month before and after the start of the Facebook advertising campaign. The median number of individuals increased from four per month prior to the campaign, to a median of 10 per month after the start of the campaign.

Table 1. Demographics of participants recruited through social media and traditional methods

	Social media participants (n = 67)	Non–social media participants (n = 64)	P value
Age, mean (SD)	51.1 (9.7)	45.9 (13.3)	0.014*
Female sex	94.0	81.2	0.026*
Race			
White, non-Hispanic	38.8	50.0	0.197
Any Hispanic	49.2	37.5	0.154
Black	0	6.25	N/A
Asian or Pacific Islander	13.4	3.13	0.033*
Highest level of education			
High school or less	33.3	37.5	0.634
Two-year college degree	23.8	10.7	0.061
Four-year college degree	26.9	33.9	0.410
Graduate degree	15.9	17.9	0.773
Spanish speaking	29.8	9.3	0.003*
History of tobacco use	23.4	25.3	0.605

Note: All values are percentages except age, which is in years.
Abbreviation: N/A, not applicable.
* Significant *P* value.

vice versa, and therefore were not classified appropriately during the screening process. There may have also been individuals who clicked on both web and Facebook advertisements. Second, because the Facebook and web campaigns did not run concurrently, it is possible that external influences related to the time of year might have contributed to differences in campaign effectiveness, though this is less likely because Facebook click-through rates for English remained relatively constant over 8 months. Finally, demographic data were not available for individuals who clicked on a link but did not proceed to screening, so it is unknown if certain demographics were more likely to click an advertisement but not contact study personnel.

In summary, social media advertising, specifically using the Facebook advertising platform, is an effective and cost-effective way to recruit participants to an observational study of pre-RA. Facebook advertising is particularly effective at recruiting underrepresented participants, such as Spanish speakers, although larger studies are required to identify optimal advertisement targeting techniques and the effectiveness of advertisements on other social media platforms. Social media recruitment can be a powerful tool for clinical researchers to fill study cohorts, maximize recruitment cost-efficiency, and expand outreach to underrepresented populations.

ACKNOWLEDGMENTS

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Firestein had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Tsaltskan, Nguyen, Eaglin, Firestein.
Acquisition of data. Tsaltskan, Nguyen, Eaglin, Firestein.
Analysis and interpretation of data. Tsaltskan, Nguyen, Holers, Deane, Firestein.

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