Joint international consensus statement on crowdsourcing challenge contests in health and medicine: results of a modified Delphi process

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ABSTRACT

Objectives To develop a consensus statement to provide advice on designing, implementing and evaluating crowdsourcing challenge contests in public health and medical contexts.

Design Modified Delphi using three rounds of survey questionnaires and one consensus workshop.

Setting Uganda for face-to-face consensus activities, global for online survey questionnaires.

Participants A multidisciplinary expert panel was convened at a consensus-development conference in Uganda and included 21 researchers with experience leading challenge contests, five public health sector workers, and nine Ugandan end users. An online survey was sent to 140 corresponding authors of previously published articles that had used crowdsourcing methods.

Results A subgroup of expert panel members developed the initial statement and survey. We received responses from 120 (85.7%) survey participants, which were presented at an in-person workshop of all 21 panel members. Panelists discussed each of the sections, revised the statement, and participated in a second round of the survey questionnaire. Based on this second survey round, we held detailed discussions of each subsection with workshop participants and further revised the consensus statement. We then conducted the third round of the questionnaire among the 21 expert panelists and used the results to finalize the statement. This iterative process resulted in 23 final statement items, all with greater than 80% consensus. Statement items are organised into the seven stages of a challenge contest, including the following: considering the appropriateness, organising a community steering committee, promoting the contest, assessing contributions, recognising contributors, sharing ideas and evaluating the contest (COPARSE).

Conclusions There is high agreement among crowdsourcing experts and stakeholders on the design and implementation of crowdsourcing challenge contests. The COPARSE consensus statement can be used to organise crowdsourcing challenge contests, improve the rigour and reproducibility of crowdsourcing research and enable large-scale collaboration.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Recruitment for the first round of survey questionnaire included 140 lead authors of crowdsourcing manuscripts.
⇒ Two additional rounds of surveys were completed by a multidisciplinary expert panel to obtain from a broad range of stakeholders with expertise in leading crowdsourcing challenge contests.
⇒ A combination of in-person and digital methods were used for discussion and voting on consensus items.
⇒ The study is limited by an absence of in-depth interviews to develop the initial statement items and potential recency bias.

INTRODUCTION

COVID-19 continues to test governments and healthcare providers around the world. In response, crowdsourced projects have created new forms of personal protective equipment,1 developed participatory citizen-science apps for contact tracing,2 and organised mutual aid organisations.3–5 Crowdsourcing is the process of having a group, including experts and non-experts, solve a problem and then share solutions with the public.6 Crowdsourcing has been used to inform WHO policy,7 develop machine learning algorithms,8 and identify innovative health services.9

Crowdsourcing is increasingly being used to find innovative, stakeholder-engaged solutions to challenging medical and public health problems.10–12 The effectiveness of crowdsourced health solutions has been demonstrated in randomised clinical trials,10 and social science research has also demonstrated the power of crowdsourcing to increase the engagement of stakeholders in health problem-solving, resulting in solutions that are more effective at addressing local
contexts and community concerns. For example, a crowdsourcing approach has been previously been used to engage communities disproportionately impacted by the HIV epidemic to help develop creative, culturally-appropriate messaging on HIV cure research. Additionally, crowdsourcing approaches have been found to be highly effective for engaging marginalised lay populations in HIV cure research, and for engaging youth in developing effective youth-friendly HIV self-testing promotion strategies.

An array of crowdsourcing approaches have been used by health and scientific research organisations, including the National Academies of Sciences, Engineering and Medicine, the National Institutes of Health Research Office of Behavioral and Social Science Research, and The Lancet Healthy Cities Commission. While there are many ways to implement crowdsourcing approaches, one common approach is in the form of challenge contests (also called open calls, innovation challenges, prize inducement contests). Challenge contests typically involve a call for community solutions in response to a specified problem; contributions are evaluated to identify exceptional ideas, with finalists being awarded prizes and their ideas disseminated for implementation. The goals of challenge contests can vary; for instance, a systematic review of challenge contests found that process-oriented contests focused on mass engagement, while outcome-oriented contests focused on producing high-quality outputs.

Despite the growing interest in and value of crowdsourcing challenge contests, there are few resources available to inform the design, implementation and evaluation of crowdsourcing contests related to health and medicine. The Special Programme for Research and Training in Tropical Disease (TDR) ‘Practical Guide on Crowdsourcing in Health and Health Research’ is the single most comprehensive guidance. However, this guide did not include a systematic review of the evidence in makings its recommendations, nor did it include a consensus statement. Robust consensus guidance may help to mitigate potential risks of inconsistent application of crowdsourcing methodology, as well as help to establish greater trust in the use of challenge contests as an innovative approach to health research among both health researchers and public stakeholders. Consensus guidance can also help to enhance the rigour and reproducibility of crowdsourcing challenge contests. Given that the heterogeneous nature of crowdsourcing stifles comparisons, consensus guidance may be important for encouraging health researchers to implement this approach across a wider array of challenging problems in need of stakeholder-driven solutions. In order to provide rigorous guidance to assist healthcare professionals, policymakers and citizen scientists in applying a crowdsourcing approach, a multidisciplinary group of international experts reviewed evidence on crowdsourcing in health and medicine to develop a consensus statement. The goal of this paper is to describe our consensus development process and present the final statement as a tool for informing crowdsourcing approaches to health and medical research.

METHODS

Study design

We followed recommendations on guideline development from the Guideline International Network. Development of the final consensus statement proceeded through a modified Delphi process, which proceeded through four stages: (1) convening of an expert panel to initiate the consensus development process; (2) initial statement development and first round of survey questionnaires; (3) an in-person workshop with expert panel members and a second round of survey questionnaires; (4) a third round of survey questionnaires and finalisation of the consensus statement items. These stages are described in detail below.

Patient involvement

Patients were not involved in the design, conduct, reporting or dissemination plans of our research.

Expert panel recruitment

To initiate the consensus development process, we convened a panel of experts at a consensus development conference in Uganda. The conference was convened by PA (conference director), jointly with the following partner organisations: TDR Social Innovation in Health Initiative (SIHI), Makerere University, University of Malawi, University of Philippines Manila, Universidad Icesi, Centro Internacional de Entrenamiento e Investigaciones Medicas, Pan American Health Organization, Social Entrepreneurship to Spur Health and the Bertha Center for Social Innovation and Entrepreneurship at the University of Cape Town. The meeting received organisational support from Fondation Merieux. The conference director and cochair (JT) and partner organisations appointed a multidisciplinary expert panel of internationally recognised academics representing several scientific disciplines, including internal medicine, public health, health policy, social innovation, social entrepreneurship, psychology and primary care. The panel included individuals from each of the five TDR SIHI hubs. These individuals all have experience leading health-related challenge contests in local, regional and global settings. In addition, we invited five individuals from the Ugandan public sector (innovations, consumer organisation, clinical health services, education, science and technology, public health) and nine Ugandan potential users.

The members of the expert panel had voting rights for the entirety of the consensus development process. They were selected because of expertise about crowdsourcing challenge contests and relevant publications. Each of the SIHI hubs used their own criteria to decide who should join the expert panel. Criteria included leadership in organising challenge contests on health, participation in
TDR SIHI activities related to open calls and open innovation, and participation in other committees related to crowdsourcing. One independent, non-voting member (EK) with previous experience in Delphi methodology administered questionnaires for the modified Delphi process.

**Modified Delphi consensus development**

Building on the evidence from our group’s previous systematic review of crowdsourcing in health and medicine, and previous guidelines, a subgroup of expert panel members developed an initial statement and set of recommendations. An online survey questionnaire was developed using the initial statement following our review of existing guidelines (online supplemental material 1). Second, we sent a link to the survey (hosted on Sojump, an online survey platform) to 140 corresponding authors of previously published articles that had used crowdsourcing methods. The survey included sections on considering, organising, promoting, assessing, recognising, sharing and evaluating crowdsourcing challenges. Throughout the survey, participants were presented with a series of statements pertaining to specific elements in the ideal design and implementation of each stage of a crowdsourcing challenge contest, including what processes, goals and considerations should be part of a crowdsourcing activity. The participants were asked for their level of agreement with each statement (strongly agree, agree, neutral, disagree and strongly disagree) and given the choice to amend or make comments. Note that at this stage of consensus development, the term crowdsourcing rather than the more specific format of crowdsourcing challenge contests was used throughout the questionnaire, in order to capture participants’ views on crowdsourcing as a method more broadly (thus potentially encompassing other forms of crowdsourcing, such as hackathons). Participants were assured that their responses were confidential and only used for the purposes of the consensus statement development. Electronic informed consent in lieu of written consent was obtained from all online survey participants. Third, we presented the survey results to the expert panel at a workshop. This in-person workshop, sponsored by TDR SIHI, was held in Uganda from 8 to 11 October 2019. Participants of the workshop included all 21 members of the expert panel. As proceedings of the workshop are a matter of public record, the names and affiliations of panel members are available from the workshop report and are summarised in table 1. Participants discussed each of the sections, revised the statements, and finished the second round of the survey questionnaire.

At this stage of consensus development, survey participants were asked to consider their responses in relation to the specific crowdsourcing approach of challenge contests. Written informed consent for survey participation was obtained from all 21 workshop participants. Fourth, we held detailed discussions of each subsection with workshop participants (online supplemental material 2) and revised the consensus statement accordingly. Then we conducted the third round of the questionnaire among the 21 expert panelists. Finally, we summarised the results of the final questionnaire.

**Consensus statement definitions**

A supermajority consensus rule was pre-specified. Specifically, all statements that had agreement rates of 80% or higher were included in the final consensus statement. Individual statement items were iteratively revised to maximise agreement across the three rounds of questionnaire. The degree of consensus for each statement was graded as follows: grade U was classified as unanimous (100%) agreement; grade A was 90%–99% agreement; and grade B was 80%–89% agreement.

**RESULTS**

The first round of survey questionnaires (online survey) received 120 responses (response rate 85.7%). The first questionnaire included 35 items, including four items on sociodemographic characteristics. All 21 members of the expert panel participated in the second round survey questionnaire at the in-person workshop. After the workshop, the third round of survey questionnaire was completed by 19 of the 21 expert panel members (response rate 90%). In total, over the three rounds of questionnaires and in-person workshop, first round survey participants and the expert panel eliminated 12 items that were redundant or unnecessary. The iterative process resulted in 23 final consensus statement items, all with greater than 80% consensus. This final consensus statement on crowdsourcing challenge contests is presented in table 2. Note that for the sake of brevity, the general term ‘crowdsourcing’ is used throughout the consensus statement rather than the more specific phrase ‘crowdsourcing challenge contests’. Table 2 also indicates the grade received for each statement item. Seven of the final 23 items achieved unanimous agreement; 15 achieved grade A agreement and 1 (item 6a) achieved grade B agreement.

The 23 final items are organised by the seven stages of implementing a crowdsourcing challenge contest, which are summarised in figure 1. Here, we briefly describe the seven stages. Detailed descriptions are available (online supplemental material 3).

**CONSENSUS STATEMENT**

**Considering the appropriateness of challenge contests**

Considering whether a challenge contest is an appropriate method for solving a problem is an important first step. Challenge contests are prize challenges where the appropriate method for solving a problem is an important first step. Challenge contests are prize challenges where a call is issued by contest organisers, and solutions and ideas are then solicited from the public. Other forms of crowdsourcing include hackathons and online collaboration systems. Challenge contests, hackathons, and online...
collaboration systems differ from one another in terms of the amount of time, resources, and processes required to implement each. Researchers considering whether to use crowdsourcing should consider which method would be the most effective and feasible based on the local setting. Table 3 shows unique aspects of each of these methods.

**Organising a community steering committee**

If a challenge contest is deemed to be the most suitable crowdsourcing method for the local context, a steering committee should be organised. The steering committee often includes local community members, health professionals, community-based organisation leaders and private sector leaders. Importantly, efforts should be made to recruit committee members from diverse fields to provide an array of different perspectives. Including individuals with direct, personal experience with the problem, such as patients or at-risk groups, on the steering committee is essential. The steering committee plays an important leadership role throughout the contest, including deciding the structure and purpose of the contest, outlining the rules and requirements for entries, developing a call for contributions, and establishing the prize structure.

**Promoting the challenge contest**

Many people are unfamiliar with challenge contests and will need a clear description of the purpose, expectations and rules. Although there are many private companies that organise challenge contests, a simple website may be sufficient to communicate with potential challenge participants.

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**Table 1 Members of the expert panel/consensus workshop**

<table>
<thead>
<tr>
<th>Name</th>
<th>Expertise</th>
<th>Position</th>
<th>Affiliation</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phyllis Awor</td>
<td>Maternal and child health, HIV/AIDS</td>
<td>SIHI Uganda lead, research fellow</td>
<td>Makere University</td>
<td>Uganda</td>
</tr>
<tr>
<td>Donny Ndazima</td>
<td>Respiratory infections</td>
<td>Strategy and partnerships manager</td>
<td>Makere University</td>
<td>Uganda</td>
</tr>
<tr>
<td>Maxencia Nabiryo</td>
<td>Maternal and child health</td>
<td>Project officer</td>
<td>Makere University</td>
<td>Uganda</td>
</tr>
<tr>
<td>Emmanuela Oppong</td>
<td>Biomedical engineering</td>
<td>TDR intern</td>
<td>Makere University</td>
<td>Uganda</td>
</tr>
<tr>
<td>Noel Juban</td>
<td>Clinical epidemiology, antibiotics</td>
<td>SIHI Philippines lead, professor</td>
<td>University of Philippines Manila</td>
<td>Philippines</td>
</tr>
<tr>
<td>Jana Deborah Mier</td>
<td>Municipal health</td>
<td>Project manager</td>
<td>University of Philippines Manila</td>
<td>Philippines</td>
</tr>
<tr>
<td>Jean Francis Barcena</td>
<td>Media, communications</td>
<td>SIHI communications officer</td>
<td>University of Philippines Manila</td>
<td>Philippines</td>
</tr>
<tr>
<td>Arturo Ongkeko</td>
<td>Mobile health, health information management</td>
<td>SIHI network facilitator</td>
<td>University of Philippines Manila</td>
<td>Philippines</td>
</tr>
<tr>
<td>Don Mathanga</td>
<td>Infectious disease epidemiology</td>
<td>SIHI Malawi lead, associate professor</td>
<td>University of Malawi</td>
<td>Malawi</td>
</tr>
<tr>
<td>Barwani Msiska</td>
<td>Reproductive health, adolescent health</td>
<td>Project manager</td>
<td>University of Malawi</td>
<td>Malawi</td>
</tr>
<tr>
<td>Ruth Mputeni</td>
<td>Media, communications</td>
<td>Communications coordinator</td>
<td>University of Malawi</td>
<td>Malawi</td>
</tr>
<tr>
<td>Diana Castro-Arroyave</td>
<td>Diseases of poverty, HIV, and hepatitis B</td>
<td>SIHI Latin and Central America lead</td>
<td>CIDEIM</td>
<td>Colombia</td>
</tr>
<tr>
<td>Maria Isabel Echavarria</td>
<td>Capacity building, implementation</td>
<td>IR training and M&amp;E coordinator</td>
<td>CIDEIM</td>
<td>Colombia</td>
</tr>
<tr>
<td>Joseph Tucker</td>
<td>Crowdsourcing, infectious diseases</td>
<td>SESH, SIHI China lead, associate professor</td>
<td>SESH, LSHTM, UNC</td>
<td>China, UK, USA</td>
</tr>
<tr>
<td>Weiming Tang</td>
<td>HIV, STDs, crowdsourcing</td>
<td>SESH manager</td>
<td>SESH</td>
<td>China</td>
</tr>
<tr>
<td>Shufang Wei</td>
<td>Social media, website development</td>
<td>Communications director</td>
<td>SESH</td>
<td>China</td>
</tr>
<tr>
<td>Huanyu Bao</td>
<td>Challenge contest implementation</td>
<td>Implementation officer</td>
<td>SESH</td>
<td>China</td>
</tr>
<tr>
<td>Eneyi Kpokiri</td>
<td>Clinical pharmacy, challenge contests</td>
<td>Research fellow</td>
<td>LSHTM</td>
<td>UK</td>
</tr>
<tr>
<td>Tiarney Ritchwood</td>
<td>Family medicine, community health</td>
<td>Assistant professor</td>
<td>Duke University</td>
<td>USA</td>
</tr>
<tr>
<td>Katusha de Villiers</td>
<td>Health delivery, financial management</td>
<td>Manager</td>
<td>Bertha Center, University of Cape Town</td>
<td>South Africa</td>
</tr>
<tr>
<td>Uche Amazigo</td>
<td>Parasitology, onchocerciasis, sustainability of social innovations</td>
<td>Technical advisor, fellow of the Nigerian Academy of Science</td>
<td>Pan-African Community Initiative on Education and Health</td>
<td>Nigeria</td>
</tr>
</tbody>
</table>

LSHTM, London School of Hygiene and Tropical Medicine; SESH, Social Entrepreneurship to Spur Health; SIHI, Social Innovation in Health Initiative; STD, sexually transmitted disease; TDR, Special Programme for Research and Training in Tropical Disease; UNC, University of North Carolina.
Table 2  Considering the appropriateness, organising a community steering committee, promoting the contest, assessing contributions, recognising contributors, sharing ideas and evaluating the contest: final consensus statement on crowdsourcing challenge contests in health and health research, and the consensus grade achieved by each item

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
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<tbody>
<tr>
<td><strong>Stage 1. Considering crowdsourcing in health and health research</strong></td>
<td></td>
</tr>
<tr>
<td>1a</td>
<td>Before starting a project, the organisers should consider the benefits and risks of crowdsourcing in order to understand if this is an appropriate method.</td>
</tr>
<tr>
<td>1b</td>
<td>Crowdsourcing may be particularly useful in settings in which there are diverse networks (eg, groups, professional societies, social media movements, in-person teams) to solicit contributions.</td>
</tr>
<tr>
<td>1c</td>
<td>Crowdsourcing organisers should consider whether they are asking for something that would be feasible for an individual layperson to develop.</td>
</tr>
<tr>
<td>1d</td>
<td>Crowdsourcing organisers should ensure that they have selected an appropriate activity, based on feedback from community members and other stakeholders.</td>
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<tr>
<td><strong>Stage 2. Organising crowdsourcing activities</strong></td>
<td></td>
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<tr>
<td>2a</td>
<td>Before starting a project, the organisers should establish a steering committee to develop the call for entries, decide the format of submissions, and provide details.</td>
</tr>
<tr>
<td>2b</td>
<td>The steering committee should include people from different disciplines, including the following: (1) people who are living with disease, community leaders, civil society leaders, or other community stakeholders. (2) Key opinion leaders and network leaders who can help to distribute the contest. (3) If focused on local implementation, a member of the government or public sector. (4) If focused on research, a leader of research studies. (5) In some cases, funders as non-voting observers. (6) In some cases, private sector leaders as non-voting observers</td>
</tr>
<tr>
<td>2c</td>
<td>The steering committee should work together to promote the crowdsourcing activity, finalise the judging process, develop a finalist recognition plan, finalise the prize structure, and develop a sharing plan.</td>
</tr>
<tr>
<td><strong>Stage 3. Promoting crowdsourcing activities</strong></td>
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<tr>
<td>3a</td>
<td>A crowdsourcing activity should build trust in the activity in a way that is appropriate to the local context (eg, in-person activities).</td>
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<tr>
<td>3b</td>
<td>A crowdsourcing activity should be promoted through social media platforms with an acknowledgement of the limitations of social media (ie, limitations on who will view and respond to social media calls).</td>
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<tr>
<td>3c</td>
<td>A crowdsourcing activity should be inclusive and allow contributions from diverse individuals.</td>
</tr>
<tr>
<td>3d</td>
<td>A crowdsourcing activity should be promoted with groups and networks of interest identified by the steering committee. Accommodation for participation of people with disability should be considered based on the purpose of the crowdsourcing activity.</td>
</tr>
<tr>
<td>3e</td>
<td>A crowdsourcing activity should have a clear deadline. If needed, the steering committee can extend the deadline, but this should be updated in a clear way and allow for revision for those who already submitted.</td>
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<tr>
<td><strong>Stage 4. Assessing crowdsourced contributions</strong></td>
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<tr>
<td>4a</td>
<td>The judges should provide feedback on contributions independent of each other.</td>
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<tr>
<td>4b</td>
<td>Criteria for selecting judges are similar to the criteria for selecting steering committee members (see above), with the additional requirement of having sufficient time to undertake judging.</td>
</tr>
<tr>
<td>4c</td>
<td>The contest organisers should first assess eligibility and then provide eligible contributions to judges for them to evaluate.</td>
</tr>
<tr>
<td>4d</td>
<td>Judges should recuse themselves from evaluating entries where there is a potential conflict of interest.</td>
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<tr>
<td><strong>Stage 5. Recognising crowdsourcing activities</strong></td>
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<tr>
<td>5a</td>
<td>Steering committee will make the final selection of finalists and respective prizes based on the prespecified criteria.</td>
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<tr>
<td>5b</td>
<td>Personalised announcement first: after deciding the final selection but before making a public announcement, all participants should be contacted about the decision regarding their submission.</td>
</tr>
<tr>
<td>5c</td>
<td>Crowdsourcing organisers should clearly explain how finalists were selected.</td>
</tr>
<tr>
<td><strong>Stage 6. Sharing contributions from crowdsourcing activities</strong></td>
<td></td>
</tr>
<tr>
<td>6a</td>
<td>Providing open access resources, images and templates related to the outputs from a crowdsourcing activity is important.</td>
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<tr>
<td>6b</td>
<td>When possible and after permission has been obtained from participants, seek permission from finalists to use their ideas and distribute them widely.</td>
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Table 2 Continued

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
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<tbody>
<tr>
<td>Stage 7. Evaluating crowdsourcing through research</td>
<td></td>
</tr>
<tr>
<td>7a</td>
<td>Research on crowdsourcing is important to demonstrate the value of crowdsourcing in health and health research.</td>
</tr>
<tr>
<td>7b</td>
<td>A crowdsourcing activity can be evaluated by using qualitative, quantitative, or mixed methods research.</td>
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</table>

contest participants. The website should contain all information related to the challenge contest, including an overview of objectives, timeline, guidelines for contributions, criteria for judging, prizes and frequently asked questions. Infographics and short videos can help make the challenge contest more accessible to a general audience, allowing participation to move beyond expert audiences to engage the public. Challenge contests should include in-person events when possible. One study found that participants were twice as likely to learn about challenge contests through in-person events compared with social media.35

Assessing contributions

The steering committee will need to consider how contributions will be received and judged. For some topics, receiving contributions exclusively online may be the best approach. For example, an online receiving platform would be the most efficient choice for a challenge contest seeking video contributions, as videos can be readily uploaded and submitted from any location with internet access. Text-based contributions can also be easily collected using an online submission form. However, it is important to note that limiting the receiving platform to online contributions may exclude some participants. In-person events in partnership with local organisations can provide alternative ways to receive offline contributions. Once all contributions are collected, a panel of judges will evaluate them to determine finalists. The judging panel often consists of a mix of experts, laypersons and members of the contest organising committee. Judges who have a potential conflict of interest should recuse themselves from reviewing contributions.

The quality of crowdsourcing contributions can vary broadly, resulting in both low and high-quality contributions.34 It is thus recommended to conduct an initial eligibility screening of all contributions in order to remove invalid, incomplete or duplicate entries before forwarding to the judges. When there is a smaller number of contributions, panel judging can then occur after this initial screening. If a contest receives a large number of contributions (eg, more than 10 contributions per judge), the judging process can be conducted in three phases: eligibility screening, crowd judging and panel judging. In phase one, two independent judges examine contributions based on prespecified criteria. Invalid, incomplete or duplicate contributions are deleted and do not advance to the next judging round. In phase two (crowd judging), a group of laypersons evaluates the eligible contributions using an evaluation rubric. Each contribution is reviewed by three independent judges. Only those contributions that are deemed exceptional (eg, mean score of 7/10 or greater) will then proceed to the final round of panel judging. A panel of experts and non-experts individually evaluates each contribution forwarded from the previous round of crowd judging. A panel of experts and non-experts individually evaluates each contribution forwarded from the previous round of crowd judging. Once the evaluations have been received, the steering committee reviews all evaluations to rank order the scores and identify the finalists. Judges should be thanked for their assistance and notified when an announcement of the finalists will be made.

Recognising contributors

Recognition in the context of a challenge contest can be difficult given that organisers bring together experts, non-experts and many other individuals who have different training and expectations. However, this is an important component for sustaining challenge contests. The first stage in recognising individuals is to establish clear expectations for all those who contribute. Among judges and steering committee members, this typically involves mentioning that their contributions are done on a voluntary basis when they are invited. The amount of time required of judges and steering committee members varies but is usually less than 4 hours total. Among contributors, the amount of time required to create a submission should be commensurate with the prize structure.

Figure 1 The seven stages of a challenge contest, adapted from WHO/Special Programme for Research and Training in Tropical Disease guidelines.12
In instances where there is uncertainty, asking individuals who submit entries to estimate the total time spent creating the submission may be helpful. Finalists may be recognised through public announcements using various platforms, including organisational websites, social media platforms, online public fora and in-person events. While more attention is given to finalists, it is important to acknowledge the efforts of all people who submitted entries. There are many ways to do this, including sending emails notifying contributors of the outcome or thanking them for their efforts on an open platform. Written feedback on contributions may be shared with selected contributors. Public announcements should be timely, occurring shortly after the conclusion of a contest. Terms such as ‘winner’ and ‘loser’ are often avoided to acknowledge the hard work of all contest contributors and encourage future participation.

Sharing and implementing ideas

One of the most important stages of community-engaged research projects is the process of sharing results beyond scientific audiences. The main aim of the dissemination stage is to share ideas generated through the contest and implement selected ideas where appropriate. Challenge contest dissemination depends on the context and the audience. There are several reasons to widely share selected contest contributions. First, since crowdsourcing involves soliciting outputs from a group, sharing allows organisers to give back to the group who made the project possible. Second, crowdsourcing projects are often supported by public funds, enrol local participants, and are sanctioned by local public authorities. Despite the strong rationale for sharing, there are also many factors that may limit wide sharing. Contest participants may be appropriately concerned that sharing their contribution could pose risks, such as inadvertent disclosure of private information (eg, sexual orientation). In terms of research, scientists may be concerned with disseminating materials that interfere with blinding in randomised controlled trials (RCTs). The risks of sharing contributions need to be carefully considered and addressed during contest planning.

Evaluating challenge contests

Crowdsourcing challenge contests can be evaluated in many ways, including quantitative and qualitative approaches. Quantitative studies can examine the crowdsourcing activity itself and may include the number and quality of contributions, the number of website views and related social media metrics. Such evaluations can be used to determine the overall reach and level of participation in a challenge contest, which can further indicate the interest of stakeholders in addressing the health problem targeted by the contest. Observational studies can provide useful information about challenge contests such as the acceptability of the challenge contest for relevant stakeholders, the impact on related participant behaviours and motivations for participation. This can provide insights on the extent to which a crowdsourcing activity was successful at engaging a diverse array of stakeholders in ways that are meaningful to them. This may be particularly important for studies seeking to engage populations whose perspectives are often excluded from the production of health research knowledge—for example, individuals with low levels of education and youth. RCTs are used to assess the effectiveness of crowdsourcing interventions compared with interventions developed using other methods. For example, one study evaluated an online, peer support intervention and found that crowdsourced social interactions enhanced user engagement and decreased rates of depression compared with online expressive writing. While considered to be the gold standard evaluation method, RCTs are often time and resource intensive. Qualitative evaluation can synthesise themes identified in the text of contributions or provide more context on implementation.

DISCUSSION

We developed a consensus statement, considering the appropriateness, organising a community steering committee, promoting the contest, assessing contributions, recognising contributors, sharing ideas and evaluating the contest (COPARSE), on crowdsourcing challenge contests in health and health research. COPARSE brought together data from a systematic
review and meta-analysis, existing global guidelines on crowdsourcing, and structured feedback from experts and end-users using a modified Delphi methodology. The consensus statement provides a harmonised framework to enhance crowdsourcing challenge policy, implementation and research. First, the statement provides a structure for policymakers to organise open calls for suggestions about health policy. Second, both the shorter consensus statement and the longer implementation considerations provide a range of practical suggestions for implementers using challenge contests in the field. Finally, researchers may find COPARSE useful in developing studies to evaluate the process or outcomes of crowdsourcing studies.

COPARSE represents a novel approach to solidifying expert advice on the design, implementation and evaluation of challenge contests. Based on the results of our literature review, published literature on crowdsourcing is limited to methodological descriptions. Although there have been published reviews on crowdsourcing, the heterogeneity of recommendations has precluded consensus development. COPARSE extends the scope of TDR’s Practical Guide on Crowdsourcing in Health and Health Research by developing a consensus statement with extensive feedback from clinical and public health experts, as well as implementers with experience using crowdsourcing. Our consensus statement helps to refine the practice of crowdsourcing in health and medical research based on a convergence of expert and non-expert review. Establishing consensus on crowdsourcing challenge contest procedures through the input of experts with direct crowdsourcing experience may help to further legitimise and encourage the use of this approach in solving complex health and medical problems.

COPARSE expands the literature by including diverse voices from around the world, using a modified Delphi method, and focusing on challenge contests. However, there are some methodological limitations to this study that should be considered. First, we did not use in-depth interviews at the start of the process to inform survey development. However, the survey was informed by a thorough review of the existing literature. Second, the in-person workshop was also conducted over 2 days, which may introduce recency bias among workshop participants whose responses were used to develop COPARSE. Third, while the workshop was attended by a diverse range of participants with highly relevant expertise, participation was ultimately limited to 21 individuals. An iterative procedure over a longer time horizon, and with a larger group of participants, may allow for a greater diversity of opinions and recommendations for inclusion in future iterations of COPARSE, which we envision as a statement that can be revisited, updated and further refined over time and in response to innovations in the growing field of crowdsourcing for health research.

**CONCLUSION**

Challenge contests are simple, inclusive, and inexpensive ways to solicit community feedback on health and medical problems. COPARSE should not be used as a rigid guidebook, but rather as a set of core principles to inspire further challenge contests. Only through iterative implementation will the science and practice of crowdsourcing for health and medicine improve.

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**Contributors** LH, WT and JT designed and carried out this study. PA convened the consensus-development conference, which was chaired by JT and attended by members of the expert panel, including WT, TR, SW, HB, EK, DM, PA, NJ, DA, YX, EO, RJ and VA contributed to data analysis and writing of the longer supplemental manuscript. VA developed the website associated with the paper. The paper was drafted by LH, with feedback from TR, SD and JT. All coauthors reviewed the paper. JT act as the guarantor.

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**Patient consent for publication** Not applicable.

**Ethics approval** This project was approved by the IRB of Southern Medical University.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. Data are available upon reasonable request. The datasets generated and/or analysed during the study are not publicly available due to participants not having consented to public availability, but are available from the corresponding author on reasonable request: jd.tucker@med.unc.edu.
Supplemental material
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REFERENCES
Supplemental Material 1. Online survey

Crowdsourcing Delphi Survey

About this Study:
As part of the UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) Social Innovation in Health Initiative (SIHI), our team is identifying consensus on crowdsourcing methods to improve health and health research. This a research study organized by Southern Medical University, SESH, and the China SIHI Hub. This survey will take approximately 15 minutes and is divided into the following sections: considering, organizing, promoting, assessing, recognizing, sharing, and evaluating.

What’s involved?
We are reaching you because you have been involved in crowdsourcing related to health or health research. We are updating the “Crowdsourcing Practical Guide” published by TDR in 2018. We believe that your participation will further inspire the further use of crowdsourcing.

If you have questions or concerns, or if you would like to obtain information or offer input, please contact the Southern Medical University IRB Review Board by calling +86-20-87255824. If you have any questions about the research or your participation in the study, feel free to contact Ms. Juan Nie at Juan@seshglobal.org.

If you agree to participate in this study, please put your initial at here ______________
Introduction

For the purposes of this program, we define crowdsourcing according to the TDR, “Crowdsourcing is the process of having a large group, including experts and non-experts, solve a problem and then share the solution with the public.” This includes innovation challenges, open calls, hackathons, and distributed online systems. The purpose of this project is to create guidance on methods for crowdsourcing in health and health research.

1. Socio-demographic Section

This section includes basic socio-demographic information and information about experiences of crowdsourcing.

1a) Name:
1b) Field (drop-down menu, medicine, public health, communications, technology, other):
1c) Have you ever implemented any crowdsourcing activity (include challenge contests, hackathons, etc.)? Y/N
1d) If Y – how many activities have you organized?
1e) Have you ever done any research related to crowdsourcing (include challenge contests, hackathons, etc)?
1f) Y – how many studies have you been involved in?

The next section has a list of items to consider when implementing crowdsourcing.

2. Considering crowdsourcing in health and health research

This section examines the phase of considering crowdsourcing and determining if it is an appropriate method. You will be given a list of statements about this phase and asked to strongly disagree, disagree, neutral, agree, strongly agree.

2a) Before starting a project, the organizers should consider the benefits and risks of crowdsourcing in order to understand if this is an appropriate method.
[strongly agree / agree / neutral / disagree / strongly disagree]

2b) Crowdsourcing may be particularly useful in settings in which there are diverse networks (e.g., groups, professional societies, social media movements, in-person teams) to solicit contributions.
<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2c) Crowdsourcing may be particularly useful in settings where there are strong advocates (people living with the diseases, community organizers, physicians, or others) who champion the cause?</td>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
<tr>
<td>2d) Crowdsourcing organizers should consider whether they are asking for something that would be feasible and realistic for an individual layperson to develop?</td>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
<tr>
<td>2e) Crowdsourcing organizers should ensure that they have selected an appropriate activity (challenge contest versus hackathon or another type), based on the needs and feedback from community members and researchers.</td>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
</tbody>
</table>

### 3. Organizing crowdsourcing activities

This section examines the phase of organizing crowdsourcing activities. You will be given a list of statements about this phase and asked to strongly disagree, disagree, neutral, agree, strongly agree.

3a) Before starting a project, the organizers should establish a steering committee to develop the call for entry and decide which type(s) of messages will be solicited, and provide details.

<table>
<thead>
<tr>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
</tbody>
</table>

3b) The steering committee should include the representatives from civil society groups or advocacy groups related to the issue (e.g., involving people with dengue in a contest about dengue).

<table>
<thead>
<tr>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
</tbody>
</table>

3c) The steering committee should include key opinion leaders and network leaders who can help the steering committee to distribute the contest message widely.

<table>
<thead>
<tr>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
</tbody>
</table>

3d) The steering committee should work together to decide the promotion process, judging process, judging criteria, recognition plan, and prize structure.

<table>
<thead>
<tr>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree / agree / neutral / disagree / strongly disagree</td>
</tr>
</tbody>
</table>
3e) The steering committee should not provide an example of entry that the contest want to solicit in the call for entry in order to increase creativity.

[strongly agree / agree / neutral / disagree / strongly disagree]

4. Promoting crowdsourcing activities (Including designathon and hackathon)

4a) A crowdsourcing activity should be promoted through in-person activities (Events in class rooms/campuses, and in different kinds of community centers)

[strongly agree / agree / neutral / disagree / strongly disagree]

4b) A crowdsourcing activity should be promoted through social media platforms

[strongly agree / agree / neutral / disagree / strongly disagree]

4c) A crowdsourcing activity should be only limited to a specific group of people.

[strongly agree / agree / neutral / disagree / strongly disagree]

4d) A crowdsourcing activity should have a clear deadline. If needed, the steering committee can extend the deadline, but need to be updated timely and clearly

[strongly agree / agree / neutral / disagree / strongly disagree]

5. Assessing crowdsourced contributions

5a) The judges should be independent

[strongly agree / agree / neutral / disagree / strongly disagree]

5b) The judges should be only selected from one specific group of individuals.

[strongly agree / agree / neutral / disagree / strongly disagree]

5c) The contest organizers should direct send out the submitted entries for judging without screening for eligibility.

[strongly agree / agree / neutral / disagree / strongly disagree]

6. Recognizing crowdsourcing activities

6a) Once all entries have been scored, the entries should be ranked base on the score, and the
Community Steering committee will make the final selection for finalists, based on the score of the entries.

[strongly agree / agree / neutral / disagree / strongly disagree]

6b) Personalized announcement first: After deciding the final selection but before making a public announcement, each finalist participant should be contacted about the decision regarding their submission.

[strongly agree / agree / neutral / disagree / strongly disagree]

6c) Clearly explain how finalists were selected, and answer feedbacks from the people who submitted the entries

[strongly agree / agree / neutral / disagree / strongly disagree]

7. Sharing contributions from crowdsourcing activities

7a) The finalists should be shared with national or local agencies, and should be implemented within communities.

[strongly agree / agree / neutral / disagree / strongly disagree]

7b) Providing open access resources, images, and templates related to the outputs from a crowdsourcing activity is important.

[strongly agree / agree / neutral / disagree / strongly disagree]

7c) When possible and after permission has been obtained from participants, use and/or adapt finalist contributions and distribute them widely.

[strongly agree / agree / neutral / disagree / strongly disagree]

8. Evaluating crowdsourcing through research

8a) Research on crowdsourcing is important in order to demonstrate the

[strongly agree / agree / neutral / disagree / strongly disagree]

8b) A crowdsourcing activity can be evaluated by using qualitative, quantitative, or mixed methods research.

[strongly agree / agree / neutral / disagree / strongly disagree]
8c) In some cases, finalists from crowdsourcing activities can be implemented and evaluated in randomized controlled trials.

[strongly agree / agree / neutral / disagree / strongly disagree]

9. Website

To better provide service to people who want to use crowdsourcing to improve health, our team also created a website to provide information for how to conduct crowdsourcing contest. This website also allows researchers to send their quote for helping them to conduct crowdsourcing contest, with free consultation. See a beta version of the website here:

www.crowdsourcingclinic.
Supplemental Material 2. Consensus Workshop Agenda

SOCIAL INNOVATION IN HEALTH INITIATIVE PARTNERS’ WORKSHOP

Oct 8-10, 2019
Speke Resort Munyonyo, Kampala, Uganda

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00-08:15</td>
<td>Self-introductions</td>
<td>All</td>
</tr>
<tr>
<td>08:15-10:45</td>
<td>Updates from each hub (30 min each)</td>
<td>TBD</td>
</tr>
<tr>
<td>10:45-11:00</td>
<td>Tea break</td>
<td></td>
</tr>
<tr>
<td>11:00-12:30</td>
<td>Social innovation in health module – Philippines SIHI Hub</td>
<td>Dr. Noel Juban</td>
</tr>
<tr>
<td>12:30-13:30</td>
<td>Lunch and poster viewing</td>
<td>All</td>
</tr>
</tbody>
</table>
Day 2 (Wednesday, 9 October 2019): Crowdsourcing Part 2 and Joint Proposal

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30-09:00</td>
<td>Breakfast</td>
<td></td>
</tr>
<tr>
<td>09:00-10:15</td>
<td>CC: Steering committee (step 2) and promotion (step 3)</td>
<td>Dr. Joseph Tucker &amp; Dr. Weiming Tang</td>
</tr>
<tr>
<td>10:15-10:30</td>
<td>Tea break</td>
<td></td>
</tr>
<tr>
<td>10:30-12:00</td>
<td>CC: Receive contributions (step 4), recognize people (step 5), share solutions (step 6)</td>
<td>Mrs. Shufang Wei Dr. Tamey Ritchwood Dr. Eneyi Kpokiri</td>
</tr>
<tr>
<td>12:00-13:30</td>
<td>Lunch and Learn: Crowdsourcing skills workshop 1: Infographics and video</td>
<td>Dr. Joseph Tucker</td>
</tr>
<tr>
<td>13:30-15:00</td>
<td>Crowdsourcing wrap-up at each hub: Plans for next steps moving</td>
<td>Small group work</td>
</tr>
<tr>
<td>15:00-15:30</td>
<td>Final Delphi survey</td>
<td>Dr. Weiming Tang</td>
</tr>
</tbody>
</table>

15:30-15:45 Tea break
15:45-16:15 Joint proposal discussion All
16:15-16:30 Tea break All
16:30-18:00 Planning next steps, sharing feedback by topic (e.g., UHC, TDR call)
19:00 Dinner & Entertainment All
## Day 3 (Thursday, 10 October 2019): SIHI Uganda Stakeholders’ Workshop

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
<th>Speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:45-09:30</td>
<td>Keynote on Social Innovation in Health</td>
<td>Ms. Katsha de Villiers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SIHI South Africa</td>
</tr>
<tr>
<td>09:30-10:30</td>
<td>Panel Discussion on the Role of Social Innovation in improving health outcomes in Uganda</td>
<td>SIHI Uganda advisory committee; MoH and Most policy makers; Social Innovator; Researcher/Evaluator</td>
</tr>
<tr>
<td>10:30-11:00</td>
<td>Tea break (poster viewing)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SIHI Network Partners</td>
</tr>
<tr>
<td>11:00-11:15</td>
<td>SIHI Uganda</td>
<td>Dr. Phyllis Awor</td>
</tr>
<tr>
<td>11:15-11:30</td>
<td>SIHI Malawi</td>
<td>Dr. Don Mathanga</td>
</tr>
<tr>
<td>11:30-11:45</td>
<td>SIHI South Africa (UCT Bertha Centre)</td>
<td>Ms. Katsha de Villiers</td>
</tr>
<tr>
<td>11:45-12:00</td>
<td>SIHI Latin America and the Caribbean</td>
<td>Dr. Diana Maria Castro</td>
</tr>
<tr>
<td>12:00-12:15</td>
<td>SIHI Philippines</td>
<td>Dr. Noel Juan</td>
</tr>
<tr>
<td>12:15-12:30</td>
<td>Social Entrepreneurship to Spur Health (SESH)</td>
<td>Dr. Joseph D. Tucker</td>
</tr>
<tr>
<td>12:30-12:50</td>
<td>The Mérieux Foundation</td>
<td>Dr. Valentina Pico</td>
</tr>
<tr>
<td>12:50-13:30</td>
<td>Lunch</td>
<td></td>
</tr>
</tbody>
</table>
### Ugandan Innovation Talks - Innovators and partners

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00-14:15</td>
<td>Governance, Citizenship and Accountability: Community-Centered Development in the Ugandan health Sector</td>
<td>Joshua Greenberg (Progressive Health Partnership)</td>
</tr>
<tr>
<td>14:15-14:30</td>
<td>Bahemuka health Sure: improving health through community action</td>
<td>Sam Mugisha (Platform for the Needy)</td>
</tr>
<tr>
<td>14:30-14:45</td>
<td>Affected or Infected: An exhibition showcasing the history of HIV in Uganda</td>
<td>Ndungu Ruth (The Uganda Academy-Infectious Disease Institute)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:45-15:00</td>
<td>Response Innovation Lab, Uganda</td>
<td>Charlene Cabot (Save the Children)</td>
</tr>
<tr>
<td>15:00-15:15</td>
<td>Building end-to-end technology enabled healthcare: telemedicine, laboratory, pharmacy</td>
<td>Dr. Louis Kamugegeya (The Medical Concierge Group)</td>
</tr>
<tr>
<td>15:15-15:30</td>
<td>The innovative use of mobile portable ultrasound technology to improve antenatal care and prevention of mother to child transmission of HIV services in rural communities in Kigezi region of Southwestern Uganda</td>
<td>Dr. Geoffrey Anguyo (Kigezi Healthcare Foundation)</td>
</tr>
<tr>
<td>15:30-15:45</td>
<td>Obstetric Fistula Social Reintegration</td>
<td>Edmund Okiboko (Uganda Village Project)</td>
</tr>
<tr>
<td>15:45-16:00</td>
<td>From marginalized youth to social entrepreneurs</td>
<td>Nakawuki Stella (Social Innovation Academy)</td>
</tr>
<tr>
<td>16:00-16:15</td>
<td>Promoting patients-provider engagement to increase skilled</td>
<td>Ms. Robina Katirimba (Uganda National Health Consumers' Organization)</td>
</tr>
</tbody>
</table>

Crowdsourcing challenge contests in public health and medicine: Methodological guidance for implementation and research
Background

Traditional approaches to intervention development typically involve experts collaborating with each other to develop programs for members of key populations with limited input from the public. These approaches often lead to interventions that have limited long-term success, low potential for community-level sustainability, and/or have insufficient levels of community engagement. To address these key concerns, researchers have sought more creative approaches to engaging diverse stakeholders in public health research to improve outcomes and strengthen community buy-in. Crowdsourcing, which involves experts and non-experts collaborating to solve a problem and sharing the solution with the public, is garnering increased attention from researchers and policy-makers due to its collaborative nature and engaging methods [1]. This process encourages creativity and innovation because a large group of people can contribute diverse solutions [2].

Crowdsourcing approaches have been used to increase HIV self-testing among sexual minority men [3], map the placement of automated external defibrillators at various locations within a large county in the United States [4], and solicit ideas for interventions aimed at increasing hepatitis testing [5]. Compared to expert-driven approaches to problem-solving, crowdsourcing may have lower costs [6], produce quicker results [7], and lead to transdisciplinary solutions [8]. There are several approaches to crowdsourcing, including open contests, hackathons, open forum, and data extraction from social media platforms; however, we lack consensus in the field regarding the key stages involved in developing, implementing, and evaluating crowdsourcing processes. This lack of consensus hinders crowdsourcing research and programs in a number of ways, including limiting our ability to compare research findings across studies. In this article,
we share suggestions regarding optimal methods for conducting crowdsourcing contests in health and health research.

Stages for conducting a crowdsourcing contest

This section is divided into the steps recommended by the The Special Programme for Research and Training in Tropical Diseases (TDR) practical guide on crowdsourcing in health and health research [1], which include: determining whether crowdsourcing is an appropriate approach, organizing a steering committee for a crowdsourcing contest, engaging the community, receiving and evaluating contest contributions, sharing outputs from crowdsourcing contests, and recognizing contributors.

Stage 1. Considering the appropriateness of challenge contests

Determining which category of crowdsourcing is best suited to answer a particular research question is key to leading a successful contest. While there are no absolute requirements for crowdsourcing, its implementation may be more appropriate when certain conditions are met, including: having the ability to mobilize diverse networks, selecting a topic that can garner support among community advocates, and developing a contest that is feasible and realistic.

Categories of crowdsourcing

There are three major categories of crowdsourcing: contests, hackathons, and online collaboration systems. Contests are competitive processes in which an individual or entity presents a problem to the public to solicit creative approaches to solving the identified problem [9]. In the past, crowdsourcing contests have been used to develop health messages, inform health policy, and enhance medical diagnostics [9]. Hackathons bring together individuals for a
short amount of time with the purpose of furthering a common goal [10]. In healthcare, hackathons have been used to develop medical technologies [11] and design m-health interventions [12]. Online communities act as collaborative systems by allowing individuals to connect via a virtual platform and exchange knowledge and information [13]. Online collaboration systems have been used to develop a mobile application to train volunteers to identify, locate, and respond to people in the community who were experiencing a suspected out-of-hospital cardiac arrest within a 500 m radius of their location, resulting in a reduction of deaths from out-of-hospital cardiac arrest [14].

Contests, hackathons, and online collaboration systems vary by their organization, duration, and prize structure. When determining whether to use crowdsourcing, an individual or group should decide which approach would be the most appropriate considering a project’s goals, resources, and intended outcomes. Table 1 highlights important considerations and distinguishing factors that could assist one in selecting the approach that is best suited to solve a given problem.

Table 1. Contests, Hackathons, and Online Collaboration Systems

<table>
<thead>
<tr>
<th>Method</th>
<th>Definition</th>
<th>Participation Platform</th>
<th>Duration</th>
<th>Prize Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contests</td>
<td>Open prize challenges where a call is issued to the public and then contributions are solicited and evaluated</td>
<td>In-person or online</td>
<td>Longer duration (weeks/months)</td>
<td>Prizes awarded</td>
</tr>
<tr>
<td>Hackathons</td>
<td>Events where a diverse group of individuals are brought together to advance a common goal</td>
<td>Usually in-person</td>
<td>Shorter duration (a few days)</td>
<td>Prizes awarded</td>
</tr>
<tr>
<td>Online Collaboration Systems</td>
<td>Online platforms that allow individuals to exchange and share contributions and ideas</td>
<td>Online</td>
<td>Permanent</td>
<td>Prizes not typically awarded</td>
</tr>
</tbody>
</table>
Engaging diverse networks

Crowdsourcing can be more effective in settings where there is a mechanism to engage diverse networks of individuals to contribute. In this context, “diverse networks” can be broadly defined as individuals with a wide array of economic, social, cultural, and educational backgrounds [8]. Often, crowdsourcing is able to mobilize diverse populations that are under-engaged in research, including ethnic and sexual minorities, and individuals with disabilities. If organizers do not explicitly make efforts to engage members of underrepresented populations, they run the risk of limiting the scope of a crowdsourcing activity. For example, a crowdsourcing contest that is promoted solely through an online platform may limit responses from individuals who do not have internet access. However, if the target population for the contest frequently engages in activities online, then a virtual contest may be most appropriate.

Advocates for the cause

Another factor warranting consideration is whether there are advocates for a cause within a community. Advocates are typically people who have been directly impacted by the issue or who hold a strong interest in the topic. For example, in a crowdsourcing contest focused on HIV, advocates for the cause could include people living with HIV, healthcare providers, clinical research scientists, health policy experts, and those affected individuals. Moreover, contests may achieve higher levels of participation if community members view advocates as personally invested in the cause, particularly when they have tacit knowledge, work experience, or related training.

Crowdsourcing feasibility
A final element to consider is whether the request being made of potential participants by the
crowdsourcing activity is feasible with regard to the targeted crowd’s ability to contribute.
Crowdsourcing activities that solicit text messages, memes, images, and short videos may draw
larger crowds and a higher number of contributions. Additionally, complex and deep learning
algorithms can also be crowdsourced; however, participation will largely be limited to
individuals or groups with highly specialized or technical skills, and would require a prize
structure and governance framework to sufficiently incentivize participation given the demands
of the activity. Lastly, the amount of time needed to participate in the crowdsourcing activity is
another element to consider when assessing whether and what form of crowdsourcing is
appropriate for a given study or program. For some potential participants, the time commitment
may be a limiting factor.

For the remainder of this article, we outline the processes entailed in designing and
implementing crowdsourcing contests. These guidelines are grounded in the expertise and
experience of individuals who have implemented contests to address an array of issues in health
and medicine.

**Stage 2. Organizing a community steering committee**

Upon deciding that a crowdsourcing contest is the best approach to solving a particular problem,
the next stage involves convening a steering committee [1]. The main function of a steering
committee is to provide leadership and guidance for the contest. While contest organizers are
responsible for clarifying the roles and responsibilities of the steering committee and defining
key stakeholders, the steering committee is responsible for establishing the purpose of the contest
and assisting in the creation of a call for contributions. Forming a competent steering committee is a prerequisite for running a successful crowdsourcing contest and there are a number of ways to do this. For example, during a designathon that sought to engage community members in the design of a public health program [15], the following steps were used to select and organize a steering committee: 1) identify organizations that could host the contests (e.g., a non-governmental organization or a university); 2) invite local professionals in public health, communications, design and civil society to serve on the steering committee; 3) hold regular steering committee meetings to discuss the scope, rules, and prize structure of the contest; and 4) widely disseminate the call for contributions to identify potential participants. Despite variation in this process from project to project, the following steps are generally recommended for effectively organizing a crowdsourcing contest steering committee.

**Clarifying roles and responsibilities**

The first step of organizing a steering committee is to identify hosts and partners of the contest. Host organizations need to have diverse networks and some communication capacity to enable coordination [1]. These networks can help distribute the call for contributions and share solutions. Health-focused crowdsourcing contests have been organized by universities, public health agencies, community-based organizations, UN agencies, and private companies. The host organization is typically responsible for the administrative and logistical aspects of the contest, including promoting the call for contributions, contacting venues, and preparing related materials. Partner organizations are not necessary, but can help to identify steering committee members and build momentum.

**Clarify the purpose of the contest**
The steering committee clarifies the purpose and structure of the contest. Contests are often divided into two types: outcome-oriented contests and process-oriented contests. Outcome-oriented contests usually focused on soliciting highly innovative contributions. For instance, in one study, the team used an online, multiphase crowdsourcing contest to solicit ideas regarding the development of machine learning algorithms to segment lung tumors in preparation for radiation therapy thereby addressing the global shortage of expert radiation oncologists [16]. Process-oriented contests are organized to enhance broad community engagement and reach larger numbers of people [2]. One example is CrowdOutAIDS, a participatory online policy project launched by UNAIDS that focused on developing a strategy to better engage youth in decision-making processes related to AIDS. This enabled young people to engage in an open and horizontal process by allowing them to debate issues related to HIV and sexuality [17]. Many contests have an interest in both generating a high-quality outcome and widespread engagement, but understanding the overall aim can help to shape the contest. In addition, clarifying whether the contest will be organized as a research study or an educational/engagement program is important, as research-based contests tend to place emphasis on improving knowledge on a particular topic, whereas other contests are focused on programmatic objectives.

**Identify steering committee members**

The steering committee should be comprised of key stakeholders who: 1) have an interest in the topic of the contest; 2) are local community members, health professionals, community-based organization (CBO) leaders, or private sector leaders [1]; and 3) have breadth and depth of experience in core disciplines or fields of interest. In addition, a steering committee should include individuals of different genders and people from different regions. Input from members
of underrepresented groups is also important in terms of organizing a steering committee [9]. For example, a contest focused on gay men and health behaviors should include gay men and healthcare providers, as well as other stakeholders, including local CBO leaders and researchers. A sample invitation letter for a steering committee is included in Appendix A.

Create a call for contributions

A well-designed call for contributions can attract potential participants and ensure that they understand the purpose and requirements of the contests, which will lead to quality contributions. The host organization typically creates an initial draft call for contributions. This draft is shared with the steering committee for feedback. The steering committee meets on a regular basis to discuss the scope, purpose, rules, and prize structures of the contest [15]. Roles and responsibilities of hosts, partners, and the steering committee are listed in Table 2.

Table 2. Different roles/responsibilities of institutions

<table>
<thead>
<tr>
<th>Roles/responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Host organization</strong></td>
</tr>
<tr>
<td>1. Identify partner organizations</td>
</tr>
<tr>
<td>2. Identify potential steering committee members</td>
</tr>
<tr>
<td>3. Create a first draft call for contributions (including prize structure)</td>
</tr>
<tr>
<td><strong>Partner organizations</strong></td>
</tr>
<tr>
<td>1. Identify potential steering committee members</td>
</tr>
<tr>
<td>2. Disseminate a call for contributions</td>
</tr>
<tr>
<td><strong>Steering committee</strong></td>
</tr>
<tr>
<td>1. Provide leadership and guidance for the contest</td>
</tr>
<tr>
<td>2. Clarify the purpose of the contest and determine the structure of the contest</td>
</tr>
<tr>
<td>3. Provide feedback on the call for contributions;</td>
</tr>
<tr>
<td>4. Finalize the prize structure</td>
</tr>
</tbody>
</table>
A call for contributions first provides an overview of the contest and then clarifies its purpose. It also identifies the target audience of the contest for potential contributors. Detailed guidelines/requirements for contributions can be listed in the call for contributions, such as word limits or video file size limits. Judging criteria should be clearly described in the call for contributions. The timeline of the contest should also be highlighted, and usually includes the deadline for contributions and the date when the results will be announced. Including information on contest prizes is another essential component of a call for contributions, because an appropriate prize structure can motivate individuals to participate. In some cases, frequently asked questions (FAQs) are included in the call for contributions. In most cases, the call for contributions should avoid providing exemplars of contributions to avoid cognitive fixation [1].

Establish the prize structure

Selecting an appropriate prize structure is essential for encouraging participation and achieving outcomes [18]. The steering committee should consider what may motivate potential contributors to participate, what type of support and resources they have, and determine the level of risk associated with contributing to the contest [19]. Process-oriented contests provide a relatively large number of prizes in order to expand engagement and participation. On the other hand, outcome-oriented contests have a smaller number of larger prizes [2]. An official commendation from the contest organizers or an opportunity to receive mentorship can be excellent prizes. Unless there are teams competing for prizes, we recommend that organizers avoid cash prizes [19]. Several studies have shown that intrinsic benefits of participation like mentorship and commendation are highly valued by participants compared to extrinsic benefits like cash prizes [20]. There should also be some flexibility based on the quality of the contributions and the time
invested. For example, a steering committee may decide that two exceptional submissions both receive a first prize award.

**Stage 3. Promoting the challenge contest**

Community engagement can enhance communication, facilitate information exchange, and spur innovation [21-23]. We define engagement as the process of working collaboratively with relevant partners who share common goals and interests [24]. Community engagement is particularly important in crowdsourcing contests, as it facilitates more contributions and may also assist in disseminating the contest results, which could lead to the diffusion of health information among relevant stakeholders. Additionally, engagement provides stakeholders with an opportunity to contribute local wisdom and learn about their own health [25]. It enables the community to have voice and exercise their power, and holds policy makers accountable to meeting the needs of their beneficiaries [26]. When done well, community engagement builds trust between the institutions and the public. At its best, public engagement can spur systemic changes in policy or practice.

**Community engagement messages**

Most people are unfamiliar with crowdsourcing contests and will need a clear description of the purpose, expectations, and rules. Although there are many private companies that organize contests, we generally recommend using a simple website to communicate with potential participants about the contest. The website shows the public all information related to the crowdsourcing contest, including an overview of the contest’s aims, timeline, target group,
guidelines for submissions, criteria for judging, prizes, FAQs, and partners. Infographics and short videos can help move beyond expert audiences to engage the public.

**Visual media**

Infographics are visualizations of data or ideas that convey information to an audience in a manner that can be easily understood [27]. Infographics require less cognitive demand compared to text, expanding the potential audience. Another advantage of infographics is that they can be easily shared within in-person or online networks. Infographics have been shown to improve individual’s knowledge, particularly in low-literacy groups [28]. Examples of video approaches to communicating contest information include a whiteboard time-lapses, filmed interviews with investigators, and short animations, all of which can be effective at reaching a broad audience and drawing attention through a rich visual experience and detailed descriptions. It is easy to share videos on social media, and helps to personalize and contextualize the contest as well as inspire excitement and trust in the legitimacy of the contest. However, it requires more skills to produce and edit a video compared to an infographic.

**Approaches to community engagement**

**In-person events**

Research on challenge contests suggests that in-person events play an important role in engaging the community [29]. A study evaluating a crowdsourcing contest that used both in-person and online promotion showed participants were twice as likely to learn about crowdsourcing contests through in-person events compared to online ones [30]. Disadvantages of in-person events include needing to coordinate with the hosting institutes and to spend more time explaining the
context of the contest for a general audience. Table 3 provides examples of how in-person events could be implemented as engagement strategies for crowdsourcing contests.

Table 3. Several forms of in-person events

<table>
<thead>
<tr>
<th>Event type</th>
<th>Examples</th>
<th>Contest Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planned smaller events</strong></td>
<td>Lab meetings, research conferences, works-in-progress meetings, seminars</td>
<td>Promote the contest in collaboration with a research laboratory meeting</td>
</tr>
<tr>
<td><strong>Planned larger events</strong></td>
<td>Feedback session in a public space, a booth in a public space</td>
<td>Promote the contest at a large football stadium or sporting event</td>
</tr>
<tr>
<td><strong>Locally driven events</strong></td>
<td>Co-creation workshop in coffee bars or other community spaces.</td>
<td>Speed-friending event at a local community-based organization</td>
</tr>
</tbody>
</table>

**Social Media**

Social media can also be used to promote community engagement related to crowdsourcing contests [31, 32]. Well-crafted social media messages can rapidly move through the internet, or go viral, and reach large groups of people. In addition, emails and newsletters can embed images and links to videos, accelerating dissemination of the call for submissions through pre-established networks. Capturing the attention of the audience is key to the effectiveness of health promotion activities. Several research studies, for example, suggest that social media posts with emotionally upbeat titles are more likely to attract readers’ attention [33, 34]. Moreover, including a good quote or story from the local community can make the contest personal and spark curiosity. It is also important to highlight features that differentiate contests from each other to assist potential contributors in deciding whether to participate. For example, the opportunity for commendations and mentorship offered by one contest may be more appealing to
individuals early in their careers or for those seeking to brand their businesses, while a higher cash prize may be more appealing to those with financial motives [18].

Other promotion approaches

Concurrently, inequities built into social media networks must also be considered. People’s access to social media is widely variable. Crowdsourcing contests can make accommodations for people without social media access and those who are less connected by additionally utilizing low-tech participatory approaches [35]. Low-tech ways to promote contests include text messages, radio station announcements, and word-of-mouth promotion through tribal councils and/or other local organizations.

Stage 4. Assessing contributions

Assessing contributions requires careful consideration of an array of factors pertaining to the category of contest, accessibility, and the need to identify exceptional finalists. Below we explore the various platforms for receiving challenge contest contributions and provide guidance on how to implement an effective evaluation process.

Receiving contributions

Challenge contest organizers must consider how contributions to the contest will be received: will contributions be submitted online, offline, or a combination of both? Consider the context of the contest and which options are available to contest contributors. For some contests, receiving in-person contributions may be the most appropriate option. An in-person approach is best when creating a contribution requires little time and inconvenience on the part of participants (e.g., a
contest involving a brief survey of community members’ ideas on how to improve a particular health service). In-person contributions are typically solicited via ‘in the moment’ participation, which can involve either approaching potential contributors directly, or directing contributors to a station where trained facilitators are present to explain the contest, obtain consent, and receive submissions. Figure 1 depicts an example of the latter scenario.

![Figure 1](image)

**Figure 1.** An example of an in-person strategy for receiving crowdsourcing contest contributions. This contest sought community ideas for improving HIV clinical trials. The contest booth was stationed at a public celebration for HIV Cure Research Day. Potential participants approached the booth where a contest facilitator (shown here) explained the contest, obtained written informed consent, and collected contributions in response to the contest prompts. In this case, contest contributions were displayed as they were received in order to prompt reactions and/or additional participation from event attendees as they walked by throughout the event. Small tokens of appreciation (e.g., colorful bags of assorted candies) were offered to anyone who submitted a contribution, helping to attract further interest in the contest booth among event attendees.
Receiving contributions in-person can be a beneficial approach for many reasons, including providing potential contributors with an opportunity to ask questions about the contest and receive answers immediately. Facilitators’ enthusiasm for the contest can also help to encourage a greater number of participants to engage with and contribute to the contest, as well as help build trust in the contest [1]. Additionally, facilitators can help to make the contest more accessible for persons that may otherwise experience barriers to participation; for example, they can explain contest rules, read consent forms, and record contributions for persons with literacy/language challenges or mobility issues. There are, however, some limitations to using an in-person submission platform, primarily in terms of contest resources and reach. Staffing contest submission stations will require an appropriate space and/or event in which to host the station, and facilitators will need to be trained to effectively solicit contributions from potential contributors. Additionally, if the contest is limited to receiving contributions in-person only, the potential pool of contest contributors is subsequently limited to those who happen to be in the vicinity of the contest station or booth.

For some contest topics, receiving contributions exclusively online may be the best approach, particularly when the contest requires a substantial time commitment to create a contribution, or for contests in which the solicited contribution format is most amenable to digital submission. For example, using an online receiving platform would be the most efficient choice for a challenge contest seeking video contributions, as videos can be readily uploaded and submitted from any location with internet access. An additional benefit to receiving contributions online is that recording and sorting contributions can be quickly and easily accomplished. There are,
however, some drawbacks to an exclusively online platform for receiving contributions. While online submission of contributions can make contest participation more accessible for some (e.g. persons with physical disabilities who may otherwise be missed at in-person contribution opportunities), there are still accessibility issues to consider with an online platform. For example, limiting a contest’s receiving platform to only online contributions should be used with caution in regions with lower literacy levels and limited internet availability. According to a World Economic Forum report, over four billion people, mostly in developing countries, do not have Internet access [36]. There are also logistical aspects to consider when receiving contributions through an online platform. While various online channels may be used to reach broad groups of audiences for promoting the contest (e.g. advertisements linking to the contest on websites, social media platforms, newsletters, etc.), it is important to ensure there is only one online contribution receiving platform. To avoid contributions being submitted through multiple online channels (e.g. email, private messaging, etc.), ensure that all contest advertisements provide the same link for uploading contributions and clearly state that contributions should be submitted via this method. Moreover, once the contest has closed and contributions are no longer being accepted, contest organizers will need to close down the online submission form and provide a notice that the deadline for contributions has passed. This is an opportune time to additionally note the timeline for when the contest finalists will be decided and announced.

Given the potential opportunities and drawbacks of in-person and online receiving platforms, it is recommended that crowdsourcing contests include a mix of both online and in-person opportunities to receive contest contributions wherever possible [2]. For example, in-person promotional events may present an opportunity (depending on the contest topic and type of
contributions sought) to physically collect contributions from event attendees. Contest organizers can then add these contributions to those received through the contest’s online receiving platform.

**Organizing received contributions**

Regardless of whether contributions are received in-person or online, one must keep a record of each submission. Maintaining a well-organized database of received contributions is critical not only for the process of reviewing and evaluating individual contributions, but also to obtain an overall assessment of the contest’s effectiveness (e.g. number of contributions, demographics of participants, etc.). Unless a very large number of contributions is anticipated to result from your contest (which will depend on contest type) a simple spreadsheet will suffice to keep track of contributions and their subsequent evaluations. The rigor of this process is important for maintaining the trust of contributors, as well as for ease of tracking contributions and providing evaluations to judges for the evaluation process.

**Evaluating contributions**

Once all contest contributions are collected and the contest deadline has passed, they are then evaluated by a panel of judges to determine the finalists. There are several aspects to consider in the evaluation process.

**Identify contest judges**

Typically volunteers who have expertise or experience in the topic, are directly impacted by the issue, or are otherwise interested could be judges. The judging panel often consists of a mix of experts, laypersons, and members of the contest organizing committee [1]. Potential judges should be identified and approached in advance of the contest closing date to ensure a timely
evaluation process. Provide potential judges with an estimate of the time commitment that would be needed, the deadlines for providing evaluations to the contest organizers, and a summary of the judging criteria to enable them to assess their ability to commit to the judging process. Judges with a conflict of interest will recuse themselves from reviewing submissions during this stage. Estimate the number of judges needed to have a sufficiently large enough panel so that each contribution can be assessed by three independent reviewers.

**Judging process**

Once the panel of judges has been identified, the next step is to provide them with full instructions to evaluate contest contributions and the format for providing assessments/scores. These instructions should be developed and sent to judges before the judging process begins to expedite the evaluation process, and should include an overview of the goals of the contest, the evaluation rubric, and evaluation form. When using a point-based evaluation rubric (i.e., assigning each contribution a score on a numeric scale), it can be helpful to provide the judges with descriptions of what low, moderate, high, and exceptionally high scoring contributions would contain. Providing space on the evaluation form for judges to make optional notes or comments can also be useful if judges need to communicate additional information about the submission to the contest organizers and contributors.

The quality of crowdsourcing submissions can vary broadly, resulting in both low and high-quality contributions [9]. It is thus recommended to conduct an initial eligibility screening of all contributions in order to remove invalid, incomplete, or duplicate entries before forwarding to the judges, so that judges spend time assessing only those contributions that meet the contest criteria [1]. When there is a smaller number of contest contributions (typically fewer than 200),
Panel judging can then occur after this initial screening. Ensure that a master record is kept of which contributions have been sent to which judges in order to easily consolidate evaluations as they come in from panel members. If a contest receives a large number of crowdsourcing contributions (typically greater than 200), the judging process can be conducted using the following three phase process to limit the number of contributions considered for finalist selection [1].

1) Eligibility screening: two independent judges examine the contributions based on pre-specified criteria. Invalid, incomplete or duplicated entries are deleted and do not advance to the next judging round.

2) Crowd judging: a group of laypersons evaluates each eligible contribution using an evaluation rubric. Each contribution is reviewed by three independent judges; only those contributions that meet a pre-determined evaluation cut-off (e.g. the top 10-20% of submissions) will then proceed to the final round of panel judging.

3) Panel judging: a panel of experts and non-experts individually evaluates each contribution forwarded from the previous round of crowd judging, using an evaluation rubric.

Determining the finalists

Once the judges’ evaluations have been received, the contest steering committee reviews all evaluations to assess the scores and identify the contest finalists. Judges should be thanked for their assistance and notified when an announcement of the finalists will be made (see Stage 6 below on recognizing contributors). Typically, raw (unadjusted) scores are used to determine
which contributions are the top finalists, with mean score and standard deviation used to assess to assess overall contribution quality; while this information is not typically shared as a part of the dissemination strategy (see Stage 5 below), it can be a useful metric for reporting on the effectiveness of a contest to project funders or in research contexts.

Stage 5: Recognizing contributors
Recognizing contributors and organizers of crowdsourcing contests is critical to contest success and sustained stakeholder engagement. Considering that many contributors and organizers volunteer their time in order to make the contest possible, identifying an appropriate structure to recognize contributors and organizers is critical to organizing an effective crowdsourcing contest. Recognition in the context of a crowdsourcing contest can be difficult given that the organizers bring together experts, non-experts, and many other individuals who have different training backgrounds and expectations. Large variations in the time that people spend contributing to the contest further complicate matters. However, this is an important component of establishing and sustaining crowdsourcing contests. In this section, we describe how crowdsourcing contests recognize contributors, judges, and steering committee members.

Setting expectations
The first step in recognizing individuals is to establish clear expectations for all those who contribute. Among judges and steering committee members, this typically involves ensuring that potential participants are aware that their contributions would be voluntary. The amount of time required of judges and steering committee members varies, but is usually requires less than four hours in total. In explaining this commitment, we often compare it to the time required to
complete a single peer review for a research manuscript at a journal. Among contest contributors, the amount of time required to create a submission should be commensurate with the prize structure. In instances where there is uncertainty, asking individuals who make contributions to estimate the total time spent creating the submission may be helpful.

Determining appropriate recognition for those who contribute to contests is often dependent on the context and potential risks associated with publicly identifying contributors. For example, a contest in which people are asked to provide text-based suggestions regarding how to market HIV self-test kits to men who have sex with men from underserved communities may need to take into consideration local homophobia and the potential for inadvertent sexual orientation disclosure. The form of recognition is determined prior to the launch of the crowdsourcing contest and often in collaboration with key stakeholders, as well as the steering committee. Some individuals may want to participate and not be openly identified with their submissions.

**Examples of recognition strategies**

Table 6 provides examples of how various participants in a contest can be recognized for their contributions. Contributions to crowdsourcing contests include finalists (those whose contributions were deemed exceptional by judges), semi-finalists (those deemed good by judges), and others. Finalists may be recognized through public announcements using various platforms, including organizational websites, social media platforms, online public fora, and in-person events. There are several benefits to public announcements, including their ability to provide finalists with the opportunity to: 1) gain visibility and notoriety for their contributions towards solving a specific problem, and relatedly, improve their social status through recognition
from diverse audiences, including experts and their peers; and 2) market their skills or talents, furthering their careers. While more attention is given to contest finalists, it is important to acknowledge the efforts of all people who submitted contributions. There are a number of ways to do this, which include sending formal letters or emails notifying contributors of the contest outcome and thanking them for their efforts or listing their names on the study website or contest platform. Written feedback on submissions can also be shared with semi-finalists or finalists, depending on the nature of the contest. In any case, it is important for the steering committee to outline the approach to recognizing participants within the instructions for the contest to enable potential contest contributors to make informed decisions. Public announcements should be timely and occur shortly after the conclusion of a contest. Moreover, terms such as “winner” and “loser” are often avoided to acknowledge the hard work of all contest contributors and encourage future participation.

Table 6. Potential forms of recognizing individuals who contribute or organize a crowdsourcing contest.

<table>
<thead>
<tr>
<th></th>
<th>Prize</th>
<th>Public recognition</th>
<th>Feedback from professionals on submission</th>
<th>Included in publications*</th>
<th>Certificate of participation</th>
<th>Email of appreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finalists</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-finalists</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other contributors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Judges</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Steering Committee</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

*If individuals meet criteria for co-authorship, they could be recognized as co-authors.

Recognizing organizers
In addition, it is also important to acknowledge the efforts of the judges and steering committee members because their participation is critical to the success of the contest. For some judges and steering committee members, a formal commendation can help with promotion and career advancement. Figure 2 shows a sample certificate that was given to a steering committee member of a challenge contest. Including selected judges and steering committee members on peer-reviewed publications that result from crowdsourcing contests can also recognize their contributions. Recognizing those who contribute and organize crowdsourcing contests is essential to their success. However, the approaches and examples that we have suggested above should be appropriate for the local context.

Figure 2. Example certificate for judges

![Certificate Image]

Stage 6. Sharing and implementing ideas

One of the most important stages of community-engaged research projects is the process of sharing results, and there is need to emphasize the importance of dissemination beyond scientific
The main aim of the dissemination stage in crowdsourcing contests is to share with others the knowledge produced through crowdsourcing and/or to implement crowdsourced ideas [39]. Sharing in crowdsourcing is contest-specific, and the particular audience/setting to which the information/outcome is directed may determine the sharing method. However, there are some general guidelines and key stages to follow when considering how to report and spread contest results. One of the most important things to consider when sharing outputs is the purpose of the challenge. Crowdsourcing contests vary in their mission; for example, some challenges aim to deliver an actionable outcome to a specific community. In other cases, the contest is organized simply to raise awareness with regard to a particular issue. Some barriers to effective sharing include institutional priorities and organizational culture, practical difficulties, and other technical and infrastructural barriers [40].

**Rationale for sharing or not**

There are several strong reasons to widely share the outputs of a crowdsourcing contest. First, crowdsourcing involves soliciting outputs from a group of individuals and sharing allows the organizers to give back to the group who made the project possible. In addition, there is an ethical obligation to share widely. Often crowdsourcing projects are supported by public funds, enroll local participants, and are sanctioned by local public authorities. The ethos of crowdsourcing contests encourages wide sharing of selected contest outputs as a way to give back to those whose efforts and collaboration made the contest possible.

Despite the strong rationale for sharing, there are also many factors that may limit this process. Some submissions to contests include private information about those who submit or other individuals, which could have consequences for participants if sharing includes identifying the
individual(s) who made contributions to the contest. For example, a social media post that clearly identifies a contest participant as gay could have implications for that individual in the context of homophobic environments. Measures must be taken to ensure that appropriate consent is obtained before sharing, as well as clear communication with contest participants regarding what information will be publicly shared post-contest. In terms of research, scientists may be concerned with widely sharing materials that may interfere with trials.

**Types of sharing**

At the end of a crowdsourcing contest, finalists’ contributions can be shared with the public in different ways. The first stage is to specify an appropriate audience and select relevant ways of sharing. Sharing could include creating an open access website to display the contest results, presenting the contest results at a public meeting and inviting community stakeholders to attend, developing a white paper to inform policy, or implementing a program based on contest results. Below we describe in detail a variety of common formats for sharing contest results and the processes to consider during implementation.

**Online sharing**

Online sharing could encompass sharing via open access, social media platforms and/or other digital repositories. For example, a team could create a simple website reporting the contest and its results (see Table 4 for an example); exceptional entries can be archived and the link to the site shared widely with relevant networks. Oftentimes, infographics are created about key findings from the contest to be shared online using social media platforms (e.g. Facebook, Twitter and LinkedIn). There are also places to publish online without associated fees (e.g., Medium).
Table 4: The UJMT Fogarty Global Health Fellows Program Contest

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contest Purpose</strong></td>
<td>To increase interest in the UJMT programme by engaging UJMT partners (in-country collaborators, fellows, alumni, and others) to reflect on their experience and create messages to showcase the program. The results will be used in order to further promote the UJMT program</td>
</tr>
<tr>
<td><strong>Target Audience</strong></td>
<td>Potential applicants to the UJMT program</td>
</tr>
<tr>
<td><strong>Sharing Platform</strong></td>
<td>Facebook (<a href="https://www.facebook.com/FogartyGlobalHealthFellows">https://www.facebook.com/FogartyGlobalHealthFellows</a>)</td>
</tr>
<tr>
<td><strong>Contest Website</strong></td>
<td><a href="http://www.seshglobal.org/UJMT-Contest">http://www.seshglobal.org/UJMT-Contest</a></td>
</tr>
</tbody>
</table>

**Professional conferences and journal sharing**

Professional conferences and academic journals provide an avenue to share with other researchers. In this case, the contest process and outcomes would be written as a press release or research paper/communication brief in a relevant journal. Once published, the article may be shared on various social media platforms, or within relevant newsletters or email listservs. An abstract of the project can also be submitted for an oral or poster presentation at appropriate conferences or other relevant events. However, it is notable that professional society conferences and journals have limited ability to reach public audiences.

**Sharing with policy-makers**

Some contests are designed to directly inform health policies. For example, the hepatitis testing innovation contest identified descriptions of hepatitis approaches to support local programs and inform WHO guidelines on hepatitis B and C testing. The contest solicited descriptions and
exceptional contributions were then included as best practice cases in the 2017 World Health Organization Hepatitis Testing Guidelines [5].

Sharing through implementation

Another form of sharing the outcomes of a crowdsourcing contest is to implement the outcome of the contest or pilot programs in real settings (see Table 5 for an example). Here the key contest findings can be pitched as an idea to stakeholders in the relevant organizations.

Table 5: The diagnostics and AMR clinical case contest

<table>
<thead>
<tr>
<th>Purpose:</th>
<th>To create open access online learning resources on diagnostics and AMR using a challenge contest to crowdsource clinical cases on AMR/diagnostics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Audience:</td>
<td>Medical students, physicians, healthcare providers</td>
</tr>
<tr>
<td>Sharing Platform:</td>
<td>CME Module</td>
</tr>
<tr>
<td>Outcome:</td>
<td>Learning module was created</td>
</tr>
<tr>
<td>Contest Website</td>
<td><a href="http://www.seshglobal.org/DiagnosticsAMR2018">http://www.seshglobal.org/DiagnosticsAMR2018</a></td>
</tr>
<tr>
<td>Next steps:</td>
<td>Pilot finalized version of the module among physicians</td>
</tr>
</tbody>
</table>

Stage 7. Evaluating challenge contests

There are three primary ways in which crowdsourcing contests are evaluated: 1) qualitative/descriptive methods, 2) meta-synthesis, and 3) randomized controlled trials (RCTs). Qualitative or descriptive evaluations are typically used to assess the impact, effectiveness and/or reach of a crowdsourcing activity itself. Descriptive assessments may include of the number of
website followers, the amount of online traffic, the number of individual hits that the website receives regularly, or the number of social network connections among unique service users [5, 29, 41]. Qualitative evaluations can include thematic analysis of the content of all contest contributions, enabling the research team to examine the content of contributions to inform hypotheses or solve key problems. Qualitative evaluations tend to be more flexible, as they can be designed to be context-sensitive and specific. Meta-synthesis, which involves integrating the results of different qualitative studies on the same topic, has also been used to evaluate crowdsourcing. It is largely used to interpret the results of previous studies to provide direction for future research [42]. Lastly, RCTs are used to assess the effectiveness of crowdsourcing interventions when compared to more traditional methods. One study, for example, evaluated an online, peer support intervention designed to promote evidence-based techniques and use crowdsourcing to identify participants and solicit feedback from a wider group [43]. While considered to be the gold standard evaluation method, RCTs are often time and resource intensive. Moreover, conducting RCTs may have implications for study ethics approvals, as approved protocols may need to be amended after the selection of contest finalists and prior to trial implementation if the risks to participants were to change.

Discussion

The ultimate goal of crowdsourcing contests in health-related fields is to implement the crowd’s proposed solution to a problem to effect change. Increasingly, researchers and other stakeholders are applying principles of implementation science to promote the uptake of research findings. Implementation science describes the systematic study of methods aimed at improving the integration of evidence-based practices into real work settings thereby improving the
effectiveness and quality of healthcare services [44]. Implementation research often relies upon the expertise of transdisciplinary teams comprised of diverse stakeholders, including patients, researchers, practitioners, administrators, economists, or sociologists. Similar to the purpose of RCTs of crowdsourcing methods, the evaluation of implementation science studies often focuses on examining the implementation process and its effect on the targeted evidence-based practice. Moreover, similar to crowdsourcing methods, implementation science emphasizes the importance of stakeholder input and engagement throughout study design, evaluation, and dissemination and implementation [45].

There are several key benefits to integrating crowdsourcing and implementation research approaches. First, due to its ability to engage large groups of people, crowdsourcing methods can be leveraged to increase the reach and adoption of implementation science-based interventions. Moreover, the use of participatory methods to merge implementation science strategies and crowdsourcing methods could lead to more effective interventions due to a greater emphasis on engaging and empowering key stakeholders early in the research process [46]. Such an approach could improve community buy-in, which may increase the likelihood of sustained intervention engagement over time. Considering that crowdsourcing is atheoretical, these methods have the potential to be integrated with other theoretical approaches or frameworks, including participatory methods and implementation science frameworks.

Conclusion

Crowdsourcing can be an effective tool for informing the design and implementation of public health interventions and programming. With its broad applications, ability to incite creativity and
innovation, and emphasis on engaging the public to solve complex problems, crowdsourcing has the potential to advance public health research and influence policies that may lead to notable and sustainable behavioral changes.
References


Appendix A. **Sample crowdsourcing contest invitation letter**

Dear XXX,

We are going to hold a MSM-friendly doctor hackathon during 4-7 September in Guangzhou, China. The purpose of the hackathon is to bring together diverse individuals to develop a target prototype that links gay men and local MSM-friendly doctors (please see appendix for more details).

Given your expertise in public health (computer science, design, health communication), we would like to invite you to serve as a steering committee member. This would involve providing leadership and guidance for the contest, determining the purpose of the contest, and helping create a call for contributions. It would be a great honor to have you as one of the steering committee members. We look forward to your reply.

Best wishes,

XXX