RESEARCH ARTICLE

Rare Disease Research Partnership (RAinDRoP): a collaborative approach to identify the top 15 research priorities for rare diseases [version 1; peer review: 2 approved with reservations]

Suja Somanadhan\textsuperscript{1}, Emma Nicholson\textsuperscript{1}, Emma Dorris\textsuperscript{2}, Aoife Brinkley\textsuperscript{3}, Avril Kennan\textsuperscript{4}, Eileen Treacy\textsuperscript{2,5,6}, Awan Atif\textsuperscript{7}, Sean Ennis\textsuperscript{2}, Vicky McGrath\textsuperscript{8}, Derick Mitchell\textsuperscript{9}, Grace O'Sullivan\textsuperscript{5}, Julie Power\textsuperscript{10}, Anne Lawlor\textsuperscript{11}, Paul Harkin\textsuperscript{2}, Sally Ann Lynch\textsuperscript{2,12}, Philip Watt\textsuperscript{13}, Avril Daly\textsuperscript{14}, Susie Donnelly\textsuperscript{1}, Thilo Kroll\textsuperscript{1}

\textsuperscript{1}UCD School of Nursing, Midwifery and Health Systems, University College Dublin, Belfield, County Dublin, D04 V1W8, Ireland
\textsuperscript{2}UCD School of Medicine, University College Dublin, Belfield, County Dublin, D04 V1W8, Ireland
\textsuperscript{3}Children’s Health Ireland (CHI) Ireland, Children's Health Ireland (CHI) at Connolly, Blanchardstown, Dublin, D01 YC67, Ireland
\textsuperscript{4}Health Research Charities Ireland / HRCI, 12 Camden Row, Dublin, D08 R9CN, Ireland
\textsuperscript{5}National Clinical Programme for Rare Diseases, Royal College of Physicians of Ireland, Dublin-2, Ireland
\textsuperscript{6}National Rare Diseases Office, The Mater Misericordiae University Hospital, Dublin-7, D07 R2WY, Ireland
\textsuperscript{7}Children’s Health Ireland (CHI) at Temple Street, Temple Street, Dublin, D01 YC67, Ireland
\textsuperscript{8}Rare Diseases Ireland, Dublin, Ireland
\textsuperscript{9}IPPOSI - The Irish Platform for Patient Organisations, Science and Industry, Dublin 2, Dublin, D02 XE80, Ireland
\textsuperscript{10}NIRDP- Northern Ireland Rare Disease Partnership, 2 William Street, Northern Ireland, BT23 4AH, UK
\textsuperscript{11}22Q11 Ireland, North Brunswick Street, Dublin, Ireland
\textsuperscript{12}Children's Health Ireland (CHI) at Crumlin, Crumlin, Dublin, D1N5122, Ireland
\textsuperscript{13}Rare Disease Task force, CF House, 24 Lower Rathmines Road, Dublin 6, Ireland
\textsuperscript{14}European Organisation for Rare Diseases (EURODIS), Paris, 75014, France

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Abstract

\textbf{Background:} The Rare Disease Research Partnership (RAinDRoP) was established in 2018 to bring together a wide variety of diverse voices in the rare disease community in Ireland and form a research partnership. This approach enabled clinicians, patients, carers and researchers to work together to identify top research priorities for rare diseases, which focused on a life-course perspective rather than a disease-specific need.

\textbf{Methods:} A participatory multiple phase approach was used to identify research priorities for rare diseases. The research process involved three main phases: Phase I, Public Consultation Survey on Research in Rare Diseases in Ireland (PCSRRDI); Phase II, Research
Prioritisation Workshop (RPW); Phase III, Follow-up Public Consultation and Prioritisation Survey (FWPCPS).

**Results:** In total, 240 individuals completed the phase I PCSRRDI, which comprised of a cross-section of health care professionals, researchers and people living with rare diseases. One thousand and fifteen statements were collected, reflecting issues and shared challenges in rare diseases. A shortlisting step by step was used to identify any statements that had received a total score of above 50% into 10-12 researchable questions or statements per the theme for the phase II workshop. Phase II was focused on three main themes: (1) Route to Diagnosis, (2) Living with Rare Disease, (3) Integrated and Palliative Care. In total, 62 individuals attended the overall workshop; 42 participated in the prioritisation sessions. A cross-section of health care professionals, researchers and people living with rare diseases were engaged at each workshop. Seventy-five individuals completed the final phase III public ranking by priority responses, and they ranked the top 15 research priorities defined by the multi-stakeholders at the phase II consensus meeting.

**Conclusions:** This study identified priorities for rare diseases research aimed at improving the health and wellbeing of people living with rare diseases.

**Keywords**
Rare Disease, life-course, participatory, research prioritisation, PPI

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Corresponding author: Suja Somanadhan (suja.somanadhan@ucd.ie)

**Author roles:**
Somanadhan S: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; Nicholson E: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Writing – Review & Editing; Dorris E: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Writing – Review & Editing; Brinkley A: Data Curation, Funding Acquisition, Investigation, Methodology, Writing – Review & Editing; Kennan A: Conceptualization, Formal Analysis, Funding Acquisition, Investigation, Methodology, Writing – Review & Editing; Treacy E: Conceptualization, Investigation, Supervision, Writing – Review & Editing; Atif A: Funding Acquisition, Investigation, Resources, Writing – Review & Editing; Ennis S: Conceptualization, Funding Acquisition, Resources; McGrath V: Conceptualization, Formal Analysis, Funding Acquisition, Writing – Review & Editing; Mitchell D: Conceptualization, Funding Acquisition, Writing – Review & Editing; O’Sullivan G: Conceptualization, Formal Analysis, Investigation, Writing – Review & Editing; Power J: Conceptualization, Formal Analysis, Investigation, Methodology, Resources, Writing – Review & Editing; Lawlor A: Conceptualization, Formal Analysis, Investigation, Resources; Harkin P: Conceptualization, Funding Acquisition, Writing – Review & Editing; Lynch SA: Conceptualization, Funding Acquisition; Daly A: Conceptualization, Funding Acquisition, Methodology, Resources; Donnelly S: Data Curation, Formal Analysis, Writing – Review & Editing; Kroll T: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Supervision, Writing – Review & Editing

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Abbreviations
Rare Disease Research Partnership (RAinD RoP); Health Research Charities In Ireland (HRCI); Health Research Board Ireland (HRB); Patient and Public Involvement (PPI); University College Dublin (UCD); European Reference Networks (ERNs); European Joint Programme (EJP); International Rare Diseases Research Consortium (IRDiRC); General Data Protection Regulation (GDPR)

Introduction
Rare diseases are individually unique, but collectively they share substantial unmet health and social care needs. These pose a significant public health challenge. To date, there are at least 7,000 characterised rare conditions, and many of these conditions have genetic causes. Definitions vary, with some definitions depending solely on the number of people living with certain diseases. In Europe, they are defined as conditions that affect fewer than five people in 10,000. Individually, these numbers might appear small. However, collectively, these conditions affect an estimated 30 million Europeans and 20 million Americans and create significant challenges for affected individuals and their families, health and social care systems and society as a whole. To date, approximately 7,000 rare diseases have been identified, with estimates of around 300 million people affected worldwide. An estimated 95% of rare diseases have no approved treatment. Since 2001, only 140 orphan medicines have been used in the European Union for treatment. Of these 60% were designated for use in paediatric populations. Rare diseases are challenging for clinicians in terms of reaching a conclusive diagnosis and determining an appropriate course of treatment due to their low prevalence, heterogeneity and complex nature. Considering these challenges, the European Commission (2017) has established the first European Reference Networks (ERNs) across Europe, which share knowledge and resources concerning diagnosis, treatment and support. The European Commission also supports research, development and innovation in this area through projects funds and joint actions. Currently, 24 ERNs are working on a range of thematic issues involving highly specialized complex care, aiming to facilitate access to diagnosis, treatment and provision of affordable, high-quality and cost-effective healthcare.

Research on rare diseases is a top priority by the European Commission, and according to estimates, more than 1.4 billion euro has been invested in 200 or more research and innovation projects. However, at the national level in Europe, rare diseases are currently under-researched and under-resourced, and no uniform standards are governing the collection, management or use of rare disease data registries. As specialist expertise is scarce, patients and their families may find it challenging to gain access to diagnostic testing and treatments. Psycho-social support is also limited, leaving families feeling isolated and vulnerable. The research into rare diseases and holistic care for people living with rare diseases are now an EU Commission priority. In Ireland, the National Rare Disease Plan contains the recommendation to develop a rare disease research network in line with its strategic priorities. It emphasizes that “the needs and experiences of people with a rare disease are recognized, understood and addressed within all aspects of the Irish health system, including policy, services and research/information system.” In 2011, the European Commission jointly with the US National Institutes of Health (NIH) launched the International Rare Diseases Research Consortium (IRDiRC). The Consortium strives to strengthen international collaboration in the area of rare disease research. Specifically, the IRDiRC’s vision for the period 2017–2027 is to ensure that all people with rare diseases receive a timely diagnosis, as well as appropriate care and treatment within the first year of diagnosis.

The Health Research Charities In Ireland (HRCI), formerly known as Medical Research Charities Group (MCRG), brings many charities together and supports collaborative health research. The HRCI and the Health Research Board Ireland (HRB) have been operating a joint funding scheme since 2006, and as of 2018, they have funded 125 projects. Cody (2018) highlighted in a recent workshop on clinical research in rare diseases by HSE clinical strategy and programmes division that nearly two-thirds of HRB-funded rare disease research projects are focused on applied biomedical research or clinical research projects in rare diseases. Given the low prevalence and considerable heterogeneity of rare diseases, it can be challenging to focus research on specific conditions and thus, identifying shared research priorities across rare diseases can increase the impact of research in this area. It is, therefore, imperative to identify top research priorities for rare diseases which could gain consensus about areas focused on a life-course perspective rather than a disease-specific need.

There has been a lack of discussion on the research topics that should be prioritised and gaining consensus about research priority areas is timely and important. Health research prioritisation is a critical element of health system strengthening efforts to maximize impactful research and ultimately, better care quality and health outcomes. In alignment with the National Rare Disease Plan, a Rare Disease Research Partnership (RAinD RoP) was formally established in 2018. RAinD RoP is a collaborative research partnership of the rare disease community in Ireland, and it comprises of academic researchers, health professionals, rare disease advocates and families living with rare diseases. The research partnership places the lived experience of people with rare diseases at the centre as opposed to a biomedical or condition-specific orientation. As the recognition for the patient and public involvement (PPI) in Irish health and social care research grows, we want to make sure that the patient voice is central rather than merely the professional or academic view and expertise. The identification of shared research priorities will strengthen the health system overall as this approach will likely translate into better immediate benefits for patients. Biomedical research is critical for rare diseases, but the impact can take many years to reach patients and so this type of work can help families in the interim. This article reports on a rare disease research prioritization exercise. The initiative was led by the University College Dublin (UCD) in Ireland and supported by HRB Ireland, the National Clinical Programme for Rare...
Aim and objectives
The aim of the RAinDRoP initiative was two-fold. First, RAinDRoP was established as a collaborative research partnership and evolving network in response to the National Rare Disease Plan for Ireland to ensure relevantly, focused and coherent research informed by the needs and experiences of people living with rare diseases. Second, a multi-phase, systematic research priority setting exercise was conducted, structured around three thematic areas: (1) Route to Diagnosis, (2) Living with Rare Diseases, (3) Integrated Care and Palliative care.

Objectives
• To launch RAinDRoP as an Irish Network for rare disease research.
• To identify rare disease research priorities for Ireland from multiple stakeholder perspectives.
• To support the integration of rare disease research within relevant forthcoming Government research policy and legislation as per the National Plan for Rare Diseases, Ireland, 2014–2018.

Methods
A participatory multiple phase approach was agreed to identify national research priorities for rare diseases. Three phases of the RAinDRoP priority setting phases are listed in Table 1. The patient and family voice have been integral to this work from the start and adopted the priority setting partnership process to conduct multiple rounds of stakeholder recruitment, engagement and research prioritization. An expert group was formed to oversee the RAinDRoP Prioritisation exercise at the meeting in June 2018. This group comprised of members of the rare disease taskforce, patient organisation representatives (n=3); patients and families living with rare diseases (n=3); members of the National Rare Disease Office in Ireland (n=2); and rare disease research interest groups (established via UCD rare disease symposium 2018) (n=3) and RCPI clinical research workshop in rare diseases 2018 (n=2).

Ethical considerations
This study received an exemption from full ethical review by the Office of Research Ethics at UCD. The Ethics Exemption Reference Number (REERN): LS-E-19-32-Somanadhan.

Phase I: Public consultation survey on Research in Rare Diseases in Ireland (PCSRRDI)
The expert group collaboratively designed the survey. The focus was on “What questions would you like to see answered by Rare Disease research?”. The expert group identified a long list of priority areas for the survey through a review of existing literature and policies relevant to rare disease. Six key topics were chosen, and these are listed in Table 2.

The survey was officially launched on the National Rare Diseases Day on the 28th of February 2019. A paper-based and online version using SurveyMonkey® was made available for four weeks (February to March 2019). Social media (Twitter, LinkedIn, Facebook) was utilised to share participant information leaflets (Extended data: File 1) and the online survey (Extended Table 2. Survey thematic priority areas and related questions

<table>
<thead>
<tr>
<th>Priority areas</th>
<th>Question(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diagnosis</td>
<td>What question(s) about dealing with the diagnosis of Rare Disease would you like to see answered by research?</td>
</tr>
<tr>
<td>2. Day-to-day life</td>
<td>What question(s) about managing day-to-day life with Rare Disease would you like to see answered by research?</td>
</tr>
<tr>
<td>3. Treatment</td>
<td>What question(s) about the treatment of Rare Diseases would you like to see answered by research?</td>
</tr>
<tr>
<td>4. Self-management / overall management</td>
<td>What question(s) about the self-management/overall management of Rare Disease would you like to see answered by research?</td>
</tr>
<tr>
<td>5. Integrated / holistic care</td>
<td>What question(s) about the integrated care/holistic care of Rare Disease would you like to see answered by research?</td>
</tr>
<tr>
<td>6. Palliative care</td>
<td>What question(s) about the palliative care service for advanced Rare Disease would you like to see answered by research?</td>
</tr>
</tbody>
</table>

Phase II: Research Prioritisation Workshop (RPW)
A research priority setting interdisciplinary workshop with patients, carers, public and clinician groups together on an equal footing.

Phase III. Follow-up Public Consultation and Prioritisation Survey (FWPCPS)
FWPCPS was developed and launched to validate the top 15 priorities with a broader audience.
The survey asked respondents to think of questions they would like to see answered by rare disease research in relation to the six topics identified by the expert group. There was also an open field to capture any other questions respondents felt were important. The expert group met to examine the research issues and statements identified through the survey. Each expert group individually scored statements specific to each theme (Diagnosis, Day to Day Life, Treatment, Self-Management, Integrated and Palliative care, and other). More than 50% of the expert group thought a question/statement was important to consider as part of the priority setting workshop was included, and any scoring below 50% was excluded. This was to reduce the number of questions/statements to a manageable level. From this ranking, 29 themes or statements identified from the surveys were brought forward for discussion at the phase II workshop.

As the data was collected anonymously, the UCD Human Research Ethics Committee approved an ethics exemption for the conduct of the phased priority setting exercise. Participants did not receive any incentives for completing the survey. Participants indicated written consent to participate at the beginning of the survey.

Phase II: Research Prioritisation Workshop (RPW)

The phase II RPW took place at UCD. Prior to the event, a short animation\textsuperscript{27} was produced to promote the event and shared on social media to raise awareness. Targeted invitations to attend the workshop were circulated by the Rare Disease Taskforce, Rare Disease Ireland, National Clinical Programme for Rare Diseases, and IPPOSI. There was a focus on creating a cross-section of individuals from service providers, service users, and the public perspective. Participants included those living with rare diseases, family, carers, clinicians, genetics/scientist, policymakers, research funding bodies, interdisciplinary healthcare and social care professionals, and researchers with a particular interest in rare diseases. Eligibility criteria were as follows: English speaking; 18 years and older; and able to provide informed consent to participate. There was a clear focus in this workshop to achieve gender balance, leading to a 50:50 split of men and women. It was also ensured that minority ethnic groups were included during the invitation.

The workshop sessions were chosen with a life course perspective in mind. The focus of these sessions predominantly centred around three themes distilled by the expert group from phase I (see below). On the morning of the workshop, each theme was introduced by expert speakers, so that participants had an opportunity to learn more about the three themes, ask questions and share knowledge and experiences (Extended data: File 3 contains the RPW agenda\textsuperscript{27}). The three thematic sessions based on the results of phase I are as follows:

Theme 1: Route to Diagnosis: This session focused on research questions about obtaining a timely diagnosis, methods of diagnosis, as a basis for bespoke treatment options. Aside from basic genetic research challenges, the session also focused on how to communicate diagnosis and treatment options to patients and their families.

Theme 2: Living with and Caring for Rare Diseases (Experience/Quality of Life/Psycho-social needs): This session examined the patient experience of living with a rare disease journey rather than a disease-specific experience.

Theme 3: Integrated and Palliative Care: Providing integrated care pathways. The session aimed to identify integrated care challenges about rare diseases and areas for research.

The afternoon of the workshop focused on creative conversations in smaller interdisciplinary and heterogeneous groups. In-depth discussions following the prioritisation exercise were referred to as ‘RAinDRoP cafés’. Two ‘café hosts’ per session guided the groups through the process. Each group had approximately 40 minutes to discuss a theme (either Route to Diagnosis; Living with Rare Disease; or Integrated and Palliative Care). Café agenda was as follows:

- Café hosts introduced the session theme and gave participants a pack that consisted of handouts of each theme and examples, sticker sets (blue/low importance, yellow/medium importance, red/high importance; 10 of each sticker colour per person) and play money (one set per person consisting of: 1 x €50 2 x €20, 1 x €10, 1 x €5).
- Aspects that contribute to feasibility and whether they would impact the prioritization of the theme were discussed, e.g. cost, availability of resources, capacity to build resources, electronic health records, samples sizes, expertise, local knowledge.

A group discussion was then performed concerning what attributes they attribute importance to for research in the given theme.

- Finally, participants were explicitly asked to rate questions/statements (10–12 per theme) identified through the PCSRRDI in phase I in terms of their importance and feasibility. Participants were also asked how much they would invest in these questions. The colour-coded stickers were used to indicate the degree of importance and feasibility and the money was used to ‘cash invest’ into questions/statements displayed on large poster boards (see Figure 1).

Three prioritisation poster boards per session were available to determine similarities and differences of ratings between the three groups:

Board 1: People living with rare disease (including family members, carers, patient advocates, advocacy groups).

Board 2: Health Care Practitioners, including all clinical policymakers.
The workshop created an opportunity for information-sharing and an open dialogue around the challenges faced by a rare disease, as well as its future direction. Relationships built between researchers and those with lived experience have the potential to extend to future collaborations. Only 29 themes or statements identified from the surveys were brought forward for discussion at the phase II workshop to identify top 15 list of priorities that can inform the direction of rare disease research over the next seven years.

Phase III: Follow-up Public Consultation and Prioritisation Survey (FWPCPS)
The top 15 research priorities defined during phase II were opened to the broader public for ranking by priority. There was no formal target sample size set for this survey. The ranking survey was also constructed with SurveyMonkey® (Extended data: File 4). The FWPCPS link was distributed by email and the survey was also available in paper format if participants preferred. The RAinDRoP expert group members and partners were asked to promote the survey to stakeholders via email, relevant meetings, social media, web sites, and any other opportunities that arose. A social media promotion plan was developed, similar to phase I, and there were no incentives offered for return of the survey. Respondents were asked to rank the top 15 research priority areas in order of importance. All respondents’ votes were considered equally valuable, and no weighting system was applied. Based on respondent rankings, we identified which of the top 15 rare disease research priorities were the most important. The survey was live for four weeks between May 2019 to June 2019.

Results
Each phase generated findings that informed the subsequent phase. Project timelines are contained in Extended data: File 5.

Phase I: PCSRRDI
In total, there were 240 respondents to the survey. However, a total of 144 survey participants skipped their answers to describe their category. In total, 96 survey participants provided information on their background: 32% (n=31) self-identified as a person living with a rare disease(s); 32% (n=31) self-identified as health and social care professionals (e.g. doctors, nurses, consultants, researchers, managers); 19% (n=18) self-identified as a friend or family member of a person living with a rare disease; 11% (n=10) self-identified as carers of a person living with a rare disease; and 6% (n=5) indicated ‘other’ (including academic researchers). A total of 1015 statements were submitted through the survey, which reflected issues and shared challenges in rare diseases (Underlying data: File 1; Figure 2). Most research questions proposed by participants were related to ‘diagnosis’, e.g. ‘What is the best way to tell someone about the diagnosis?’; followed by ‘day-to-day life’ with rare disease, e.g. ‘How do rare diseases affect family life?’, and ‘treatment’, e.g. ‘How often do GPs or consultants put patients with a rare disease forward for clinical trials?’.

Figure 1. Example of a prioritisation board used in phase II.
Phase II: RPW

Sixty-two (n=62) people participated in the event. These included living with rare diseases (n=15), family (n=10), carers (n=10), clinicians (n=10), genetics/scientist (n=5), policymakers (n=5), research funding bodies (n=2), interdisciplinary healthcare and social care professionals (n=15), and researchers with a special interest in rare diseases (n=10). Of the 62 participants, 42 took part in the RAinDRoP café portion of the day. We assigned them to three cafés (see Table 3). Each group contained a cross-section of health care professionals (HCPs), people living with a rare disease (PwRD), including family members, carers, patient advocates and advocacy groups, and others, including academics, researchers, academic policymakers and research managers.

Each participant was given sticker sets and play money (as described in the Methods). Participants were then asked to assign a level of importance and feasibility to each subtheme using the colour coded stickers. To further clarify their decision-making, each participant was asked to invest the play money as they saw fit – to put their money where their mouth is! Data was sorted by % of high priorities, and then % of euro investment. Applied heat mapping to show which themes are more dominant within the high priority group are available as Underlying data: File 32.

The RPW identified the top 3 subthemes from each café within each main theme by importance. The top priority refers to the number (count) of “high priority” stickers. Each Café distributed stickers in a variety of three colours (red, yellow and blue). In Cafés 2 & 3 red stickers were used to denote “high” priority and in Café 1 blue stickers were used to denote “high priority”- the colours are nominal, we refer to them as high, medium or low priority stickers.

Café 3 (Integrated and Palliative Care) had two subthemes that were equally ranked in 1st, 2nd and 7th, 8th position. ‘Data sharing and integration’ and ‘co-designing services’ ranked evenly as high importance (24 high importance stickers each) but euro investment was €945 for data sharing and €365 for co-designing services (Table 4).

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The RPW also revealed differences in prioritisation between HCPs, PwRDs and others. The two priorities equally identified by these three groups were ‘co-designing services’ and ‘data sharing and integration’. PwRDs scored high importance score (9), and HCPs scored (7) for the theme ‘support at the time of diagnosis’ compared to others, and they scored (3). PwRDs identified the ‘best way to deliver diagnosis’ as their top research priority. They scored it 10 while respondents of the ‘others’ category assigned a score of 0 and HCPs gave a rating of 3. ‘Patient voice’ as part of research was highly prioritised by the PwRD (9), and it is worth noticing that this was HCPs least prioritised theme with a score = 1. The different views expressed in the scoring illustrate the importance to including all stakeholders in the research prioritisation process. Table 5 highlighted overall scoring from the RPW and Underlying data: File 42 highlights
Table 3. Composition of the three cafés in phase II.

<table>
<thead>
<tr>
<th>Café 1. Route to Diagnosis</th>
<th>Café 2. Living with Rare Diseases</th>
<th>Café 3. Integrated and Palliative Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare practitioners (n=4)</td>
<td>Healthcare practitioners (n=5). People living with a rare disease (n=5) Others (n=5)</td>
<td>Healthcare practitioners (n=5). People living with a rare disease (n=4) Others (n=4)</td>
</tr>
<tr>
<td>People living with a rare disease (n=5)</td>
<td>Others (n=5)</td>
<td></td>
</tr>
<tr>
<td>Others (n=5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Research Prioritisation Workshop café top 10 priorities.

<table>
<thead>
<tr>
<th>Café: Top Priorities (i.e. based on top three subthemes within each café)</th>
<th>Importance assigned to each theme</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
</tbody>
</table>
| Data sharing and integration (Integrated and Palliative Care)            | 24 | 21  | 945 | 44 
| Co-designing services (Integrated and Palliative Care)                   | 24 | 21  | 365 | 17 
| Psychosocial impact (Living with Rare Disease)                           | 19 | 18  | 590 | 22 
| Support at the time of diagnosis (Route to Diagnosis)                    | 19 | 16  | 170 | 6  
| Transition services (Living with Rare Disease)                           | 16 | 15  | 425 | 16 
| Economic impact (Living with Rare Disease)                               | 16 | 15  | 245 | 9  
| Community-based services, treatment, multi-morbidity (Integrated and Palliative Care) | 15 | 13  | 230 | 11 
| Evidence-based models of integrated care                                  | 15 | 13  | 180 | 8  
| Role of infrastructure in diagnosis (Route to Diagnosis)                 | 15 | 13  | 525 | 18 
| Psychosocial impact of a diagnosis (Route to Diagnosis)                  | 14 | 12  | 570 | 20 

Table 5. Research Prioritisation Workshop overall scoring from all café’s for all 15 subthemes.

<table>
<thead>
<tr>
<th>Stickers (n)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data sharing and integration</td>
<td>24</td>
</tr>
<tr>
<td>Co-designing services</td>
<td>24</td>
</tr>
<tr>
<td>Support at the time of diagnosis</td>
<td>19</td>
</tr>
<tr>
<td>Psychosocial impact</td>
<td>19</td>
</tr>
<tr>
<td>Transition services</td>
<td>16</td>
</tr>
<tr>
<td>Economic impact</td>
<td>16</td>
</tr>
<tr>
<td>Role of infrastructure in diagnosis</td>
<td>15</td>
</tr>
<tr>
<td>Community-based services, treatment, multi-morbidity</td>
<td>15</td>
</tr>
<tr>
<td>Evidence-based models of integrated care</td>
<td>15</td>
</tr>
<tr>
<td>Psychosocial impact of a diagnosis</td>
<td>14</td>
</tr>
<tr>
<td>Best way to deliver a diagnosis</td>
<td>13</td>
</tr>
<tr>
<td>Family experience</td>
<td>13</td>
</tr>
<tr>
<td>Palliative care at home</td>
<td>13</td>
</tr>
<tr>
<td>Diagnostic tests</td>
<td>12</td>
</tr>
<tr>
<td>Patient voice</td>
<td>12</td>
</tr>
</tbody>
</table>

Priority ratings in terms of importance by all café groups in phase II.

Phase III: FWPCPS

There were 75 total responses to the FWPCPS. However, 27 survey participants did not complete the demographic section. A total of 48 survey participants described their categories: 67% were from the Leinster province; 30% (n=14) self-reported as a friend or family member of someone with a rare disease, whereas 19% (n=9) self-reported as a PwRDs. Underlying data: File 5 provides priorities ranked in the first position by respondents during the FWPCPS. Of the 15 topics for ranking, ‘support at the time of diagnosis’ ranked the highest with 23% (n=10) of respondents identifying this as a top priority area. ‘Diagnostic testing for rare disease’ and ‘education and training’ also ranked highly at 14% (n=6) each. Research into ‘how best to deliver a rare disease diagnosis’ was not identified as a priority by any of the survey respondents. It may be the case that respondents felt this was already captured by the theme ‘support at the time of diagnosis’. Table 6 contains the top 15 areas in full.

Discussion

This study identified research priorities for rare diseases through PPI aimed at improving the health and wellbeing of people living with rare diseases. This was a co-designed approach at every stage of the process from the concept design, survey design,
Support at the time of a rare disease diagnosis was a top priority in the public ranking survey. At the workshop, participants discussed the importance of communication at the time of diagnosis and issues, such as ‘who is the most appropriate person to deliver a rare disease diagnosis?’ and ‘how should it be delivered?’. Participants also considered that not having a diagnosis created a blockage to care and felt that more research was needed to explore the impact of this.

Diagnostic testing was ranked as the second most important research area by survey respondents. The category encompasses the development of diagnostic genetic procedures for stratified medicine, targeted molecular therapies and gene therapies. EURORDISCARE 2 (2007)\(^5\) showed that 25% of patients with one of eight rare diseases had to wait between 5 and 30 years for a confirmed diagnosis. During that time, 40% received an incorrect diagnosis. Accurate and timely diagnosis is essential.

Understanding and improving the education and training of people and institutions who interact with the rare disease community is a priority. Included were health and social care professionals who treat and manage people with rare diseases and the relevant institutions (i.e. schools and workplaces) that also need to understand their illness. Further, this priority also included the education needs of people living with a rare disease in this category.

Data sharing integration was a top priority for rare disease research. In the workshop, it received the highest importance ratings and attracted the most substantial cash investment. During the café discussions, participants talked about a lack of infrastructure to share data, and the implications of General Data Protection Regulation (GDPR) on data sharing across disciplines and sites and in terms of learning and linking in with other partners, in other countries to create high-quality research.

Participants would like to see more research into the economic impact of living with a rare disease. Indirect cost measures should be part of this effort (e.g. excess family expenditure for transportation, home adaptations, etc.).

The psycho-social impact of living with a rare disease was another top research priority. This encompasses the effects on education and employment opportunities, stigmatisation, friendships etc.

Community-based services, treatment, multi-morbidity was discussed in terms of delivering care closer to home in an integrated way.

Evidence-based models of integrated care were discussed in the workshop as part of integrated and palliative care. Participants suggested that the rare disease research partnership should explore what evidence for pathway and integrated care models for rare diseases and other conditions may have been developed in other countries and learn from these experiences.

The impact of rare diseases on family members other than the patient is currently under-researched. A Europe-wide survey on juggling care and daily life with a rare disease, conducted by EURORDIS-Rare Diseases Europe via its Rare Barometer Voices platform (May 2017)\(^6\), identified that seven in ten patients and carers reduced or stopped professional activity due to their or their family member’s rare disease, and this group are three times more likely to report to be unhappy or depressed than the general population.

The transition of services was discussed not only in terms of transition of care but also the shift of responsibility from the parent to the child, or young adult. Potential areas of research included the cost of poorly managed transition and the transfer of information from paediatric to adult services and associated challenges presented by GDPR.

<table>
<thead>
<tr>
<th>Table 6. Top 15 rare disease research priorities identified in phase III in order of priority.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Support at the time of a rare disease diagnosis</td>
</tr>
<tr>
<td>2. Diagnostic tests for rare diseases (e.g. use of genetics, stratified medicine/molecularly targeted therapies, gene therapy etc.)</td>
</tr>
<tr>
<td>3. Education and training (e.g. health and social care professionals, school, GP and patient information and understanding of their illness and management)</td>
</tr>
<tr>
<td>4. Patient voice (e.g. how to include the child's voice about their care)</td>
</tr>
<tr>
<td>5. Data sharing and integration of services for rare diseases</td>
</tr>
<tr>
<td>6. The economic impact of living with rare diseases (e.g. healthcare costs, transportation costs, education costs, loss of earnings, etc.)</td>
</tr>
<tr>
<td>7. Psycho-social impact of living with rare diseases (e.g. physical functioning, psychological, social and mental health and quality of life etc.)</td>
</tr>
<tr>
<td>8. Community-based services and treatment for rare diseases</td>
</tr>
<tr>
<td>9. Evidence-based models of integrated care for rare diseases</td>
</tr>
<tr>
<td>10. Family experience of living with rare diseases (e.g. parents, mother, father, siblings and grandparents experience of living and caring and life-course transitions)</td>
</tr>
<tr>
<td>11. Transition services for rare diseases (e.g. barriers and enablers for transitioning from paediatric to adults’ services)</td>
</tr>
</tbody>
</table>
Co-design of research, services, information, dissemination for rare diseases
Participants regarded research into and involving collaborative service design as a priority. This approach enables academics, health and social care professionals and patients and carers to co-design services and care pathways.

Psycho-social impact of a rare disease diagnosis
Research into the psycho-social impact of a rare disease. The diagnosis was a high priority for participants, especially for those living with a rare disease. Participants expressed that this is a vulnerable point in the lives of people living with a rare disease and that better understanding of what is required to support them through this period would be valuable.

Role of infrastructure in diagnosing a rare disease (e.g. Registry/European Reference Networks Centres of Excellence)
Role of infrastructure in diagnosis was a high priority. This referred to the role of European Reference Networks (virtual networks involving healthcare providers across Europe), and patient registries. Health care practitioners were particularly concerned about the feasibility of developing infrastructure around diagnosis.

Best way to deliver a rare disease diagnosis (e.g. mail, phone, in person (Consultant, GP, Nurse, other))
The best way to deliver the diagnosis was an issue that was consistently highlighted throughout this process. Notably, the need to improve communication skills among health care professionals was one of the top education and research priorities.

European-wide priorities for rare diseases have been identified by E-rare and EJP. EJP identified the need for better epidemiological data and information on the natural history of rare diseases. Most of the survey participants were basic researchers and clinical scientists (85%) in contrast to survey participants in our prioritisation exercise. The RAinDRoP research prioritisation offered an ongoing process of participation, involvement and engagement across various members including clinicians, patients, families, academics, researchers and NGOs. These process of participation, involvement and engagement are accurately managed and applied correctly at the RAinDRoP research activity using the participatory approaches, by asking the question, ‘Who should be involved, why and how?’ for each phase of this process an appropriate and context-specific participatory approach was developed.

The RAinDRoP research prioritisation activity enhanced relationships between researchers, public and health care professionals, thereby increased public knowledge and awareness, understanding and support of rare disease research. This prioritisation process stimulated the development of a rare diseases research consensus group, which included national and international experts from the clinical, academic, professional disciplines and patients and caregivers. The utilisation of modified priority setting partnership methodology raises the benchmark for quality and good practice for research priority setting partnership. The PPI ultimately increased accountability and transparency of research design, collaboration and knowledge translation through participation, involvement and engagement.

Limitations
The research priority setting exercise itself has cleared several key limitations. Participants across all three phases are not necessarily representative for all stakeholder groups nor for the entire rare disease community in Ireland. Many individuals and families living with rare diseases may not have been able to participate in this exercise. Similarly, from the health and social care field, advocates or academic experts may have been missed. Despite various endeavours to make the workshop itself as accessible and inclusive as possible, it may still have excluded individuals who could not attend on the day.

In the prioritisation exercise, the focus on research may have been lost for some participants. This became evident in some of the survey responses or café discussions where distinctions were blurred between advocacy, health and social care support and research. Finally, while we made efforts to reflect the differences in perspective from various stakeholders in the final top 15, we cannot rule out a bias towards one or other respondent group as we did not proportionally weigh responses.

Despite these caveats, the research prioritisation exercise was the first multi-stakeholder participatory approach focused on a broadened scope of rare diseases research in Ireland. There is a need for an ongoing engagement with the RAinDRoP steering group to establish plans for translation of the research priorities into actual research via policies and funding. Also, to create more patient and public awareness about European wide rare diseases research potential where patients and their families could be part of the research process, for example,
ERN, EJP etc. Findings from the prioritisation exercise will inform future collaborative research programmes, networking opportunities, joint grants and research engagement events.

Implications for policy
Public support of research lends authenticity to research advocacy that it would otherwise be impossible to achieve. The combined public/academic/clinician approach to strategy is more relevant and compelling. Collaborative tools and partnership allowed ethical data sharing for and with patients, and along with co-designing interventions, this will aim at improving patient-reported outcomes. This activity did not focus on a specific disease but the shared challenges of rare disease. Through the inclusion of interdisciplinary researchers, clinicians and stakeholders, this workshop facilitated and fostered knowledge exchange between those working towards an improved quality of life for people living with a rare disease. Finally, this enabled setting up research priorities based on patients living with rare diseases (rather than their diagnosis specific), which can eventually feed into the emerging policy framework relating to the research session in the Irish Rare Disease National Plan, and rare disease plans and strategies in European member states and the World Health Organization.

Implications for practice
The RAINDRoP research prioritisation activity ensures transforming Irish health and educational systems to increase rare diseases awareness. This type of engagement utilising the PPI approach builds trust between research institutions and society. Involving patients and public in the RAINDRoP project has been demonstrated that their involvement in the research process helped us to identity paucity of evidence currently available to address the experience of living with a rare disease. This form of funding supports engagement to strengthen partnership with HRB and other key stakeholders within the rare disease community, academia, patient, clinicians and public, and also increases responsiveness to societal needs through patient and public engagement.

Conclusion
The results of the RAINDRoP research prioritisation may reflect the key points from the initial 2012 consultation process on rare disease research as part of the national plan for rare diseases in 2014. The National Plan on Rare Diseases for Ireland identified several research challenges, such as the lack of dedicated national funding for rare disease research in Ireland. If this situation does not change, it will be a significant challenge for the rare disease community to translate research priorities into funded research projects. Conversely, the strengths of the RAINDRoP prioritisation include transparency and the high level of participation, engagement, involvement and agreement from a collective focus to inform future research to improve the experience and outcomes of people living with rare diseases in Ireland.

Ethics approval and consent to participate
All participants received a comprehensive information sheet that outlined the nature and purpose of each survey, along with issues related to consent, confidentiality, voluntary participation and the rights of withdrawal from the survey.

We obtained an exemption from the full ethics review by the University College Dublin Research Ethics Committee (LS-E-19-32-Somanadhan).

Data availability
Underlying data

This project contains the following underlying data (available in one PDF document):
- File 1: Statements received from the phase I surveys
- File 2: Initial grouping of statements (n=1015) into questions from the phase I surveys
- File 3: All café priority-based data on high importance and investment
- File 4: Priority ratings in terms of ‘importance’ by café group in phase II
- File 5: Priorities ranked in the first position by respondents in FWPCPS

Extended data

This project contains the following extended data (available in one PDF document):
- File 1: PCSRRDI Participant Information Sheet
- File 2: Phase I survey
- File 3: RPW Workshop agenda
- File 4: Follow-up Public Consultation and Prioritisation Survey (FWPCPS)
- File 5: RAINDRoP Project Timelines

Data available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgements
The authors are incredibly thankful to the individuals and their families who so generously shared their experiences and insights with unmet needs of rare diseases. Without their input, this project would not have been possible. We would also like to thank all the speakers and participants at the RAINDRoP Workshop.
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Open Peer Review

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Reviewer Report 17 August 2020

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Helen McAneney
Northern Ireland Rare Disease Partnership, Newtownards, UK

Julie McMullan
Queen's University Belfast, Belfast, UK

Overall Comments
This study is timely and very much needed. It has been conducted to a high level and with much thought given to the various voices, as evident from the level of PPI throughout. The authors have endeavored to obtain the views and opinions of all stakeholders, and to reduce bias through the multi-phase approach. However, the manuscript does not convey the study as clearly as it might. The methods and results section require clearer articulation, particularly as there are elements of methods in the result section and vice versa. A flow diagram through the various phases and how one informed the next would be beneficial. Lastly, do make more of the findings, rather than the process, as the 15 priorities are the central aspect of the study's aims and objectives.

Title
I would suggest adding 'Ireland' to the title if the priorities are specifically for this country and have been identified for this region only.

Abstract
The abstract requires more of a focus on the current study. The information given is confusing as the RAinDRoP project is overlapping and getting mixed in with the current study. Confusing for the reader to determine which information is relevant.

It is not clear in the abstract what the main conclusions are from this study, these should be stated clearly to enable the reader to gain an understanding of what the study has found and what implications the findings might have in a wider context.

Also suggest putting the keywords into alphabetical order.

Specific comments/queries
1. Please include within the methods the timeframe of the entire study, or the phases.

2. Within the methods section the sentence “a shortlisting step by step …” sentence is confusing. Please clarify this and explain what a ‘total score of above 50%’ means, as the ‘total score’ has not been explained here. You also mention 10-12 RQ per theme, but in the abstract themes are not explained – i.e. in the main text you have that there were 6 themes in phase I, yet in the abstract you only mention the 3 themes of phase II.

3. The steps of phase II are not clear, how does phase I results become those in phase III?

4. Conclusions – you mention that priorities were identified, but no where in the abstract are these given or summarised.

**Introduction**
Within the first paragraph there is repetition of some facts, such as the individual rare yet collectively common, as well as the mentioning of 7,000 rare conditions/7,000 rare diseases.

In the second paragraph, you mention the 1.4 billion Euros invested, but what is the time frame of this, is it recent, or over a period of time?

It may be useful to mention that in rare disease research, that the patients are often the experts, due to the nature of the conditions, and so the greater importance of including the patient and carer’s voice in the priority setting exercise, rather than just academics and HCPs.

**Aims and objectives**
The aims and objectives of the study need a clearer focus on the current study. Again, confusion between this study and RAinDRoP make it difficult for the reader to determine the relevance for the current project. Would suggest moving the overall RAinDRoP aims and objectives into the background section and only give the aims and objectives of the prioritization exercise in the aims and objectives section.

**Methods**
In the methods section a rationale should be provided for the methodology chosen. Was consideration given to other methods? What were the benefits or potential pitfalls of the method chosen? For instance, why were three phases conducted and not just two?

Although Table 1 is useful, it would be preferred that this is developed into a flow diagram that then leads the reader through the three phases, what is obtained in each and how progress to the next phase occurs. This would summarize the process and progress through the methods section and map the text to the figure.

Phase I, you mention expert groups carried out the scoring of the statements – previously you mentioned just one expert group, so please explain who are ‘each expert group’.

Phase II developed the top 15 research priorities, and then phase III took these and ranked them again – what does this ranking add in phase III, over and above the results of Phase II, as they are the same? What was the methodological thinking being the third phase?

How were the 3 themes chosen for the Phase 3 workshop?
How did the 29 themes identified in Phase 1 become 3 themes for discussion in Phase 2? More detail is needed as to how this process happened.

The abbreviations for the three phases are difficult to read, and not helpful. Please think of rephrasing them.

PPI has been central to this work from the beginning which is very encouraging to read.

Some information included in the ‘Methods’ section that should be moved to the ‘Discussion’ e.g. *The workshop created an opportunity for information-sharing and an open dialogue around the challenges faced by a rare disease, as well as its future direction. Relationships built between researchers and those with lived experience have the potential to extend to future collaborations.*

Also some information in the ‘methods’ is actually ‘results’ e.g., “From this ranking 29 themes or statements identified from the surveys were brought forward for discussion at the phase II workshop”.

**Results**

Similarly, the results section includes, ‘Each participant was given sticker sets and play money (as described in the Methods). Participants were then asked to assign a level of importance and feasibility to each subtheme using the colour coded stickers. To further clarify their decision-making, each participant was asked to invest the play money as they saw fit - to put their money where their mouth is! Data was sorted by % of high priorities, and then % of euro investment. Applied heat mapping to show which themes are more dominant within the high priority group are available as Underlying data: File3.’ This should be in the ‘Methods’ section. I suggest rereading the ‘Methods’ and ‘Results’ to ensure the information is included in the correct sections.

There are abbreviations in this section, not given in full or listed under abbreviations, e.g. PwRDs, HCPs.

Figure 2, there is a typo as the number of responses were 1,015, and not 10015.

**Table 5 and Table 6**

- Table 5 are the 15 priorities identified in Phase 2. Table 6 and the same 15 priorities but re-ranked. If so, then where does the ‘Palliative care at home’ in Table 5 go as it is not in Table 6, and likewise in Table 6 we have ‘Education and Training’ which is not in Table 5.

- Table 5, it would be worth a foot note to say that the percentages add up to approx. 72% as these are the statements with the highest %.

- Table 5, you have a ‘psychosocial impact’ and a ‘psychosocial impact of a diagnosis’ listed, please clarify how these are different.

- Table 6, this is the re-ranking of the 15 priorities, but it would be useful to show the change in positioning, e.g. 2nd in Table 5 is now in 12th place in Table 6. Is the ranking important and if so, does the change in position matter, was it expected, why the change etc. These points should be discussed in the discussion.

**Discussion**
This is the section that should take the findings and summarise and expand on them. Are the listed 15 priorities what you expected to find? Are they the same as in other countries, or are some specific to Ireland? What did the re-ranking do/add to the study? Please reflect on your findings and discuss.

**Conclusion**
This section needs to be linked to the results more closely. Currently this section does not clearly display the main conclusions from the study. These should be made explicit in this section for the reader.

**Is the work clearly and accurately presented and does it cite the current literature?**
Partly

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**
Not applicable

**Are all the source data underlying the results available to ensure full reproducibility?**
Yes

**Are the conclusions drawn adequately supported by the results?**
Partly

*Competing Interests:* No competing interests were disclosed.

*Reviewer Expertise:* Rare diseases, methodology, qualitative studies.

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Author Response 21 Oct 2020

**Suja Somanadhan,** University College Dublin, Belfield, Ireland

Many thanks for your comments. We considered each in turn and, have amended the manuscript in light of these considerations. Other comments and questions we answer here.

**Overall Comments**
This study is timely and very much needed. It has been conducted to a high level and with much thought given to the various voices, as evident from the level of PPI throughout. The
authors have endeavoured to obtain the views and opinions of all stakeholders and to reduce bias through the multi-phase approach. However, the manuscript does not convey the study as clearly as it might. The methods and results section require clearer articulation, particularly as there are elements of methods in the result section and vice versa. A flow diagram through the various phases and how one informed the next would be beneficial. Lastly, do make more of the findings, rather than the process, as the 15 priorities are the central aspect of the study's aims and objectives.

The manuscript has been amended to address these recommendations.

Title
I would suggest adding 'Ireland' to the title if the priorities are specifically for this country and have been identified for this region only.

Tile has been amended as follows: Rare Disease Research Partnership (RAinDROp): a collaborative approach to identify research priorities for rare diseases in Ireland

Abstract
The abstract requires more of a focus on the current study. The information given is confusing as the RAinDROp project is overlapping and getting mixed in with the current study. Confusing for the reader to determine which information is relevant.

It is not clear in the abstract what the main conclusions are from this study, these should be stated clearly to enable the reader to gain an understanding of what the study has found and what implications the findings might have in a wider context.

Specific comments/queries
1. Please include within the methods the timeframe of the entire study, or the phases. Amended

2. Within the methods section the sentence “a shortlisting step by step ...” sentence is confusing. Please clarify this and explain what a ‘total score of above 50%’ means, as the ‘total score’ has not been explained here. You also mention 10-12 RQ per theme, but in the abstract themes are not explained – i.e. in the main text you have that there were 6 themes in phase I, yet in the abstract you only mention the 3 themes of phase II. Amended

3. The steps of phase II are not clear, how does phase I results become those in phase III? Amended

4. Conclusions – you mention that priorities were identified, but no where in the abstract are these given or summarised. Amended

Response: Abstract restructured within the 300-word limit in light of three reviewer's recommendations:
Background:
Rare diseases are individually rare, but collectively these conditions are common.
Research on rare diseases are currently focused on disease-specific needs rather than
a life-course perspective. The Rare Disease Research Partnership (RAinDRoP) was established in 2018 to bring together a wide variety of diverse voices in the rare disease community in Ireland and form a research partnership.

Methods: A participatory multiple phase approach was used to identify research priorities for rare diseases. The research process involved three main phases: Phase I, Public Consultation Survey (PCS); Phase II, Research Prioritisation Workshop (RPW); Phase III, Public Prioritisation Ranking Survey (PRS). The time frame for the entire study was from November 2018 to June 2019.

Results: In total, 240 individuals completed the phase I, of which only 96 survey participants provided information on their background, 32% (n=31) self-identified as a person living with a rare disease(s). One thousand and fifteen statements were collected, which reflected issues and shared challenges in rare diseases. MSExcel was used to gain frequencies and percentages.

Phase II was focused on three main themes (1) Route to Diagnosis (2) Living with Rare Disease (3) Integrated and Palliative Care. 42 participants engaged at each workshop. Seventy-five individuals completed the phase III prioritisation ranking survey and ranked the top 15 research priorities. The top five priorities were (1) Support at the time of diagnosis, (2) Diagnostic test for rare diseases (3) Education and training (4) Patient voice (5) Data sharing and integration of services for rare diseases.

Conclusions: The research priorities identified here for rare diseases were developed jointly in collaboration with patients, families, healthcare professionals and policymakers. So, we encourage researchers, funding bodies and other stakeholders to use this priority list as a guiding document for future research work to improve the health and lives of people living with rare diseases.

Also suggest putting the keywords into alphabetical order. **Amended**

Introduction

Within the first paragraph there is repetition of some facts, such as the individual rare yet collectively common, as well as the mentioning of 7,000 rare conditions/7,000 rare diseases. **The manuscript has been amended in light of this consideration**

In the second paragraph, you mention the 1.4 billion Euros invested, but what is the time frame of this, is it recent, or over a period of time? **The manuscript has been amended in light of this consideration**

It may be useful to mention that in rare disease research, that the patients are often the experts, due to the nature of the conditions, and so the greater importance of including the patient and carer’s voice in the priority setting exercise, rather than just academics and HCPs. **The manuscript has been amended in light of this consideration**

Aims and objectives

The aims and objectives of the study need a clearer focus on the current study. Again, confusion between this study and RAinDRoP make it difficult for the reader to determine the relevance for the current project. Would suggest moving the overall RAinDRoP aims and objectives into the background section and only give the aims and objectives of the
Agreed and amended

Methods
In the methods section a rationale should be provided for the methodology chosen. Was consideration given to other methods? What were the benefits or potential pitfalls of the method chosen? For instance, why were three phases conducted and not just two?
Amended

Having considered the various methodologies and schools of thoughts, participatory multiple method was chosen as a suitable methodological approach for this project. We felt this approach would be the most appropriate to reflect and promote participation from the patients and public involvement (PPI) perspective to focus and identify research priorities that address uncertainties of living with rare diseases. Participation in this study means that individuals are involved in Rare Disease research Partnership (RAinDRoP) was engaged in a meaningful way from the beginning of the process with a focus to improve the quality of the patient-focused rare diseases research and its impact. An expert group was formed to oversee this research prioritisation exercise and this group composed of members of the rare disease taskforce, patient organisation representatives (n=3); patients and families living with rare diseases (n=3); members of the National Rare Disease Office in Ireland (n=2), academics (n=2), researchers (n=2), healthcare professionals (n=2).

Although Table 1 is useful, it would be preferred that this is developed into a flow diagram that then leads the reader through the three phases, what is obtained in each and how progress to the next phase occurs. This would summarize the process and progress through the methods section and map the text to the figure.
Amended: Table is restructured into Figure 1 flow diagram that then leads the reader through the three phases.

Phase I, you mention expert groups carried out the scoring of the statements – previously you mentioned just one expert group, so please explain who are ‘each expert group’.

Phase II developed the top 15 research priorities, and then phase III took these and ranked them again – what does this ranking add in phase III, over and above the results of Phase II, as they are the same? What was the methodological thinking being the third phase?

In the prioritisation process, the focus on research may have been lost for some participants. This became evident in some of the survey responses and at the workshop discussions where distinctions were blurred between advocacy, health and social care support and research. Finally, we made efforts to reflect the differences in
perspective from various stakeholders in the final phase as a public ranking to offer the opportunity to respond to this consultation process.

How were the 3 themes chosen for the Phase 3 workshop?
Research Prioritisation Workshop was Phase II

How did the 29 themes identified in Phase 1 become 3 themes for discussion in Phase 2? More detail is needed as to how this process happened.

The three emerging themes identified via online survey phase I became the focus of the Research Prioritisation Workshop (RPW) Phase II.

The abbreviations for the three phases are difficult to read, and not helpful. Please think of rephrasing them.

The manuscript has been amended in light of these recommendations.
Phase I, Public Consultation Survey (PCS); Phase II, Research Prioritisation Workshop (RPW); Phase III, Public Prioritisation Ranking Survey (PRS).

Some information included in the ‘Methods’ section that should be moved to the ‘Discussion’ e.g. The workshop created an opportunity for information-sharing and an open dialogue around the challenges faced by a rare disease, as well as its future direction. Relationships built between researchers and those with lived experience have the potential to extend to future collaborations.

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The manuscript has been amended in light of these recommendations.

There are abbreviations in this section, not given in full or listed under abbreviations, e.g. PwRDs, HCPs.

The manuscript has been amended in light of these recommendations, see below
People living with a rare disease (PwRDs) Health Care Practitioners (HCPs)

Figure 2, there is a typo as the number of responses were 1,015, and not 10015. Corrected
Table 5 and Table 6

- Table 5 are the 15 priorities identified in Phase 2. Table 6 and the same 15 priorities but re-ranked. If so, then where does the ‘Palliative care at home’ in Table 5 go as it is not in Table 6, and likewise in Table 6 we have ‘Education and Training’ which is not in Table 5.

All topics from the research prioritisation workshop (RPW) Phase II were included, and respondents were asked to rank these areas in order of importance. From this, a final set of research priorities were identified to inform the phase III Public Prioritisation Ranking Survey (PRS).

Community-based services, treatment, multi-morbidity was discussed in terms of delivering care closer to home in an integrated way. This category included palliative care needs for individuals living with rare progressive and complex illness. Education and training were also one of the priority identified form RPW. See above answer and the manuscript has been amended in light of these recommendations

- Table 5, it would be worth a foot note to say that the percentages add up to approx. 72% as these are the statements with the highest %.

Amended

- Table 5, you have a ‘psychosocial impact’ and a ‘psychosocial impact of a diagnosis’ listed, please clarify how these are different.

Psychosocial impact of living with rare diseases, this encompasses the effects on education and employment opportunities, stigmatisation, friendships etc. and the second priority was focused on the psychosocial impact of rare disease diagnosis.

- Table 6, this is the re-ranking of the 15 priorities, but it would be useful to show the change in positioning, e.g. 2nd in Table 5 is now in 12th place in Table 6. Is the ranking important and if so, does the change in position matter, was it expected, why the change etc. These points should be discussed in the discussion.

This priority exercise was a co-designed at every stage of the process from the concept design, survey design, thematic analysis, workshop and the final ranking. The exercise aimed to maximise the impact of the rare disease community in Ireland. Therefore, the public ranking survey was important to offer an equal opportunity to respond to this consultation process. Hence the change in position of priority list doesn’t affect the overall process.

Discussion
This is the section that should take the findings and summarise and expand on them. Are the listed 15 priorities what you expected to find? Are they the same as in other countries, or are some specific to Ireland? What did the re-ranking do/add to the study? Please reflect on your findings and discuss.

The manuscript has been amended in light of these recommendations

Conclusion
This section needs to be linked to the results more closely. Currently this section does not clearly display the main conclusions from the study. These should be made explicit in this section for the reader.
Overall comments

1. The project seems well justified and conducted, with plenty of consumer/patient input. I got a little lost at some points in the methods and results. In some cases there needs to be more detail, or in others I would like to see a little more justification of some of the methods decisions made. Then in the discussion, there could be more consideration of how these decisions might've affected the results.

2. The authors might also consider re-structuring the methods and results. It seems a little muddled in places as to what goes in the methods and what goes in the results. Suggest results should stick to participant numbers and demographics and research priorities generated/prioritised.

3. The flow of priorities through the project (particularly the numbers) were unclear to me. Would appreciate a flow diagram.

4. It's hard to get a sense of your main results as these are not summarised in the abstract, nor the discussion or conclusion. Instead, you focus on the process you used to generate the results. The reader is left to pick apart quite a number of different tables and results presented in the results section. A concise summary would help.

5. Consider using the REPRIZE reporting checklist for research priority setting exercises (Tong et al. (2019)\(^1\)) to ensure completeness of reporting.

Abstract

In the results section:

1. Suggest adding how many of the 240 participants were patients and carers.

2. This part seems a little muddled and some of what you have here seems more appropriate for the methods (i.e. how the process worked).
3. It also seems important to describe what the final 15 research priorities actually were (or some kind of summary) in the results, so I suggest that should be your focus here.

4. It seems like there is a line missing between the second and third sentences. You go from mentioning 1000-odd suggestions to those that scored more than 50%. It would be helpful to have the process explained here (but perhaps in the methods).

5. The words, “A shortlisting step by step” don't make sense. Is there a word missing?

6. How did you go from 10-12 statements at the workshop to 15 in the final survey?

Aims and objectives
1. These seem a little muddled between the aims of RAINDROP and the aims of the priority setting exercise. Given you state in the background, “This article reports on a rare disease research prioritization exercise” consider tightening the focus onto the aims of the prioritisation exercise (i.e. to identify rare disease research priorities for Ireland from multiple stakeholder perspectives). The aims and objectives of RAINDROP could go in the background.

Methods
1. Please add a line stating what type of research you were wanting to prioritise (i.e. interventions, psychosocial etc).

2. Please provide more detail about the process you used (literature and policy document review then I assume some form of thematic analysis) to generate the six key topics about which respondents were asked.

3. It would be helpful if you could justify why you framed the questions around the six key topics, instead of leaving the survey open-ended (i.e. just asking what questions people wanted answered in research) and then grouping the responses into inductive themes. Your a priori grouping of the questions would've shaped the final priorities generated. Perhaps this could also be discussed in the discussion.

4. I notice you advertised the exercise (in the flyer in your supplementary material) as being about finding top 10 priorities, but you ended up with 15. It would be good to be explicit about this in the methods and why you increased it to 15.

5. It would be helpful if you could create a flow diagram to show to number of priorities/themes generated at each stage of the project. It's currently a little confusing.

6. Can you explain why you asked people to rank importance, feasibility and assign euros when it seems that you only considered their score for importance when generating the top priorities?

7. Can you explain why, when you generated a prioritised list of 15 research topics, you then went back out to public consultation to seek further input into this prioritisation? I’m not sure of the value when the 15 priorities remained the same, but their order might’ve changed a little.

Results
1. In the section, ‘Phase II: RPW’ you have a lot of information that is more appropriate in the methods section (some of it is repeated there). Suggest you stick to describing the participants and the results of the prioritisation here.

2. I'm a bit confused about the flow of priorities in the workshop. So you had 29 sub-themes to start with, and then you took the top 3 from each of the three overall themes to get to a top 10 (with one theme having two equal highest scoring themes), but how did you get to a top 15? And why do you report a top 10 and a top 15?

3. In the section, Phase III: FWPCPS, suggest you describe at least the top five priorities in the text.

4. Based on your supplementary material it looks like you took research priorities framed as questions into the workshop (grouped under different areas) but you came away with priorities framed as thematic areas. It's not clear why this happened. Presumably, the priorities framed as questions would be very helpful to researchers. The statements you have accompanying the top 15 priorities are helpful but could still be framed as a myriad of different research questions. I wonder if you lost something valuable in this transition?

Discussion
1. Suggest you provide a summary of the main findings at the start of the discussion. It may be helpful to ‘unpack’ some of your secondary findings in terms of differences between stakeholder groups, shifting of relative priorities between workshop and final survey and how results compared between importance/feasibility and funding rankings.

2. As mentioned earlier, a deeper reflection on how some of your methods decisions may have affected the results would be helpful.

Minor points
1. The acronyms used for each of the three phases are not helpful. Consider using the terms in full or shortening to ‘Initial survey’, ‘workshop’ and ‘final survey’ or similar.

References
Yes

Are the conclusions drawn adequately supported by the results?
No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Research priority setting, consumer involvement in research.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 21 Oct 2020

**Suja Somanadhan**, University College Dublin, Belfield, Ireland

Many thanks for your comments. We considered each in turn and, have amended the manuscript in light of these considerations. Other comments and questions we answer here

- The project seems well justified and conducted, with plenty of consumer/patient input. I got a little lost at some points in the methods and results. In some cases, there needs to be more detail, or in others I would like to see a little more justification of some of the methods decisions made. Then in the discussion, there could be more consideration of how these decisions might’ve affected the results.

**The methods and discussion sessions have been amended to address these recommendations.**

- The authors might also consider re-structuring the methods and results. It seems a little muddled in places as to what goes in the methods and what goes in the results. Suggest results should stick to participant numbers and demographics and research priorities generated/prioritised.

**The method and results sessions have been amended to address these recommendations.**

- The flow of priorities through the project (particularly the numbers) were unclear to me. Would appreciate a flow diagram.

**Figure I has been amended to illustrate the project phases (see Figure 1)**

- It’s hard to get a sense of your main results as these are not summarised in the abstract, nor the discussion or conclusion. Instead, you focus on the process you used to generate the results. The reader is left to pick apart quite a number of different tables and results presented in the results section. A concise summary would help.

The abstract has been restructured within the 300-word limit in light of three reviewer’s recommendations to provide a concise summary.

**Background:**

Rare diseases are individually rare, but collectively these conditions are common. Research on rare diseases are currently focused on disease-specific needs rather than a life-course perspective. The Rare Disease Research Partnership (RAiNDroP) was
established in 2018 to bring together a wide variety of diverse voices in the rare
disease community in Ireland and form a research partnership.

**Methods:** Participatory multiple phases approach were used to identify research
priorities for rare diseases. The research process involved three main phases: Phase I,
Public Consultation Survey (PCS); Phase II, Research Prioritisation Workshop (RPW);
Phase III, Public Prioritisation Ranking Survey (PRS). The time frame for the entire
study was from November 2018 to June 2019.

**Results:** In total, 240 individuals completed the phase I, of which only 96 survey
participants provided information on their background, 32% (n=31) self-identified as a
person living with a rare disease(s). One thousand and fifteen statements were
collected, which reflected issues and shared challenges in rare diseases. MSExcel was
used to gain frequencies and percentages.

Phase II was focused on three main themes (1) Route to Diagnosis (2) Living with Rare
Disease (3) Integrated and Palliative Care. Forty-two participants engaged at each
workshop. Seventy-five individuals completed the phase III prioritisation ranking
survey and ranked the top 15 research priorities. The top five priorities were
(1) Support at the time of diagnosis, (2) Diagnostic test for rare diseases (3) Education
and training (4) Patient voice (5) Data sharing and integration of services for rare
diseases.

**Conclusions:** The research priorities identified here for rare diseases were developed
jointly in collaboration with patients, families, healthcare professionals and
policymakers. So, we encourage researchers, funding bodies and other stakeholders
to use this priority list as a guiding document for future research work to improve the
health and lives of people living with rare diseases.

Consider using the REPRISE reporting checklist for research priority setting exercises (Tong
et al. (2019)) to ensure completeness of reporting.

**Thank you for sharing this checklist. We amended reporting followed by REPRISE
checklist and guidelines**

**Abstract**

In the results section:
- Suggest adding how many of the 240 participants were patients and carers.

**Amended**
- This part seems a little muddled and some of what you have here seems more
appropriate for the methods (i.e. how the process worked).

**Amended**
- It also seems important to describe what the final 15 research priorities actually were
(or some kind of summary) in the results, so I suggest that should be your focus here.

**Amended**
- It seems like there is a line missing between the second and third sentences. You go
from mentioning 1000-odd suggestions to those that scored more than 50%. It would
be helpful to have the process explained here (but perhaps in the methods).
The words, “A shortlisting step by step” don't make sense. Is there a word missing?

**Amended**

- How did you go from 10-12 statements at the workshop to 15 in the final survey?

**Amended**

Abstract restructured within the 300-word limit in light of three reviewer's recommendations (see above)

**Aims and objectives**

- These seem a little muddled between the aims of RAINDROP and the aims of the priority setting exercise. Given you state in the background, “This article reports on a rare disease research prioritization exercise” consider tightening the focus onto the aims of the prioritisation exercise (i.e. to identify rare disease research priorities for Ireland from multiple stakeholder perspectives). The aims and objectives of RAINDROP could go in the background.

**Amended**

**Methods**

- Please add a line stating what type of research you were wanting to prioritise (i.e. interventions, psychosocial etc).

**Amended**

- Please provide more detail about the process you used (literature and policy document review then I assume some form of thematic analysis) to generate the six key topics about which respondents were asked.

**The manuscript has been amended in light of these considerations**

- It would be helpful if you could justify why you framed the questions around the six key topics, instead of leaving the survey open-ended (i.e. just asking what questions people wanted answered in research) and then grouping the responses into inductive themes. Your a priori grouping of the questions would've shaped the final priorities generated. Perhaps this could also be discussed in the discussion.

**The process of research priority setting for rare diseases can be complex due to heterogeneity, and each rare disease impacts a small population. However, collectively many individuals are affected by these conditions. Therefore, identifying research prioritisation on each rare illness can be challenging in a single priority setting to identify, address and integrate the different perspectives from estimated 7000 rare diseases. Hence, the expert group collaboratively designed the initial framework of the survey from a life-course perspective rather than a disease-specific focus.**

- I notice you advertised the exercise (in the flyer in your supplementary material) as being about finding top 10 priorities, but you ended up with 15. It would be good to be explicit about this in the methods and why you increased it to 15.

**The manuscript has been amended in light of these considerations**

- It would be helpful if you could create a flow diagram to show to number of priorities/themes generated at each stage of the project. It's currently a little confusing.
Amended

○ Can you explain why you asked people to rank importance, feasibility and assign euros when it seems that you only considered their score for importance when generating the top priorities?

Participants were then given colour-coded stickers to assign a level of importance, and feasibility to each subtheme. To further clarify their decision-making and encourage active participation, each participant was given play money and asked to invest it as they saw fit – to put their money where their mouth is! However, we only considered their score for importance when generating the top priorities due to indifference approach to feasibility across three workshops.

○ Can you explain why, when you generated a prioritised list of 15 research topics, you then went back out to public consultation to seek further input into this prioritisation? I'm not sure of the value when the 15 priorities remained the same, but their order might've changed a little.

In the prioritisation process, the focus on research may have been lost for some participants. This became evident in some of the survey responses or café discussions where distinctions were blurred between advocacy, health and social care support and research. Finally, we made efforts to reflect the differences in perspective from various stakeholders in the final phase as a public ranking to offer the opportunity to respond to this consultation process.

Results

○ In the section, ‘PhaseII: RPW’ you have a lot of information that is more appropriate in the methods section (some of it is repeated there). Suggest you stick to describing the participants and the results of the prioritisation here.

Amended

○ I’m a bit confused about the flow of priorities in the workshop. So you had 29 sub-themes to start with, and then you took the top 3 from each of the three overall themes to get to a top 10 (with one theme having two equal highest scoring themes), but how did you get to a top 15? And why do you report a top 10 and a top 15?

Amended

○ In the section, Phase III: FWPCPS, suggest you describe at least the top five priorities in the text.

In light of all reviewer’s recommendations, it has been included as part of the results.

○ Based on your supplementary material it looks like you took research priorities framed as questions into the workshop (grouped under different areas) but you came away with priorities framed as thematic areas. It's not clear why this happened. Assumedly, the priorities framed as questions would be very helpful to researchers. The statements you have accompanying the top 15 priorities are helpful but could still be framed as a myriad of different research questions. I wonder if you lost something valuable in this transition?

The rare disease research-related topic areas were developed from input solicited through a multiphase process such as public survey, research prioritisation workshop and prioritisation ranking survey. The 15 rare disease research priorities were ranged very broadly from diagnosis, support at the time of diagnosis, to challenges of day to day life living with rare diseases, and integrated and palliative care. We felt these
research priorities represent key strategic areas that are executional in nature. We agreed to keep priorities are categorized within broader themes to represent the view of the patient, family and healthcare professionals across life-span, rather than narrow it down to a research question specific priority with a focus on particular rare disease.

Discussion
○ Suggest you provide a summary of the main findings at the start of the discussion. It may be helpful to ‘unpack’ some of your secondary findings in terms of differences between stakeholder groups, shifting of relative priorities between the workshop and final survey and how results compared between importance/feasibility and funding rankings.

The manuscript has been amended in light of these recommendations.
○ As mentioned earlier, a deeper reflection on how some of your methods decisions may have affected the results would be helpful.

The manuscript has been amended in light of these recommendations

Competing Interests: No Competing Interests