Supplementary material 1: Interview topic guide

Barriers and enablers to pulmonary rehabilitation in low- and middle-income countries: a qualitative study of healthcare professionals

Topic guide for semi-structured in-depth interviews

This guide may be adapted during the interview in response to emerging issues.

Overall structure of the interview

i. Participant welcomed and thanked
ii. Recorder started
iii. Verbal verification of participant's written informed consent received via email
iv. Self-introductions by the researcher and participant
i. Brief discussion of study and participant's questions answered
i. Discussion about participant's PR experience in LMIC
ii. Structured discussion around barriers and enablers to PR in LMIC based on participant's experience
    a. Use open questions
    b. Where necessary, prob to explore further
iii. Recorder stopped

Introduction (read out verbatim and slowly)

> *"Pulmonary rehabilitation (or simply PR) is a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behaviour change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviours.*
>
> *PR is recommended in international guidelines for the management of patients with chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD).*
>
> *In this discussion, I would like to know your thoughts, based on your experience, on the barriers and enablers or facilitators to the implementation or delivery of PR in a low- and/or middle-income country (or simply LMIC)."*

Participant's knowledge, skills, and experience of PR

- What do you know of PR?
- What PR skills do you have?
- Describe the LMIC setting of the PR service you have been involved in.
- In what capacity/role have you been involved? Were you involved in setting up the programme? Are you involved in running the programme?
- How long have you been involved in this way?
- Have you worked in any other PR setting during your career?
- Did you receive any PR training (either formal or informal) prior to implementing/running your PR service?

Further discussion [open questions to participant]

1. I want to start by thinking about the positive experiences you found when setting up or running a PR service in an LMIC *(open questions, which can be further probed).*
   a. General
      - Based on your experience, what factors helped you set up or run a successful PR service in an LMIC setting?

   b. Specific
      - *Environmental enablers/facilitators*
        - Thinking about the LMIC environment in which you implemented or run your PR, what would you consider to be the most important or helpful factors? When I use the term 'environment' I mean things like the geographical location of your PR service, weather, interaction with your colleagues, or anything of that sort.

      - *Structural/organisational/institutional/systemic enablers/facilitators*
        - When setting up or running the PR service in an LMIC setting, what would you consider to be the most useful or helpful structural or organisational factors? When I use the term 'structural' I mean thinking about the organisational context in which your PR is placed.

      - *Resource enablers/facilitators*

        - Thinking about the resources available to you when setting up or running the service in an LMIC setting, what were the most important? I use the term ‘resources’ to mean things like staff members, venue, equipment, or anything else of that sort.

    - *PR-intrinsic/inherent enablers/facilitators*
        - Thinking about the PR intervention itself, what inherent features or elements of it would you consider enabling to set it up or run it in an LMIC setting? When I say “features” or “elements”, I mean things like its content, staff, or anything else of that sort.

    - *Personal enablers/facilitators*
        - Now, thinking of yourself as a PR practitioner in an LMIC setting, what would say are your personal attributes that make it easy for you to set up or run a PR service? When I say, “personal attributes”, I mean things like personal confidence, motivation, skills, or anything else of that sort.

    - *Patient enablers/facilitators*
        - From your perspective, what would you say are the factors that facilitate patient uptake of PR in LMIC? When I say, “patient uptake”, I mean things like patient access to the PR service, or patient acceptance, attendance, and adherence to the PR service.

    - *Other*
        - Thank you. We have finished this part of enablers or facilitators to PR in an LMIC. Before we proceed to the “barriers” part, feel free to explain any other enablers or facilitators to PR in an LMIC that we have not discussed.

2. Barriers to PR in LMIC *(open questions, which can be further probed)*
    a. General

- I would like you to start by considering any challenges that you faced or face when implementing or running your PR programme. Based on your experience, what would you consider to be the greatest challenge (or barrier) to PR in LMIC?

b. Specific

- *Personal barriers (skills, time, confidence, motivation, etc)*
  - Thinking about your own priorities, and how you approach the implementation or running of PR, do you think you experienced any personal barriers to PR in LMIC?
- *Patient barriers (transport, motivation, etc)*
  - Thinking about the patients in the LMIC setting who would benefit from the PR service, what do you see, or think are their barriers to PR?
- *Structural/organisational/institutional/systemic barriers*
  - When setting up or running the PR service in an LMIC setting, what would you consider to be structural or organisational barriers? When I use the term 'structural', I mean thinking about the organisational context in which your PR is placed.
- *Resource barriers*
  - In our discussion of enablers or facilitators, you mentioned the important resources that need to be available when setting up or running a PR service in an LMIC setting. What resource barriers did you (do you) experience?
- *Environmental barriers*
  - Thinking about the LMIC environment in which you implemented or run your PR, what would you consider to be challenging? When I use the term 'environment' I mean things

like the geographical location of your PR service, weather, interaction with your colleagues, or anything of that sort.

- *PR-intrinsic/inherent barriers*

  Thinking about the PR intervention itself, what inherent features or elements of it would you consider challenging or discouraging to set it up or run it in an LMIC setting? When I say “features” or “elements”, I mean things like its content, duration, or anything else of that sort.

- *Other*
  - Thank you. We have now come to the end of our discussion. Is there anything else you would like to say or that you forgot to mention?

Supplementary material 2: Additional participants' quotes for barrier themes

Limited resources	
Staff	*"Zimbabwe has less than uhm… I think I checked with them in March. And in March their final year class right now has 25 physiotherapists who will finish this year. Australia is looking at graduating 2500 physiotherapists this year. Australia has a population of 25 million. Zimbabwe has a population of 18 million. So, for a 7 million difference, they have like 2475 more physiotherapists than us, you know what I mean? So, when you look at the differences in personnel and then the demands of pulmonary rehab, it becomes very difficult to try and do every little thing that is on the checklist of pulmonary rehab in an environment where you're graduating 25 people."* (Participant ID 2, Zimbabwe).
Expertise	*"Uhm, I think from your definition, actually, I think what I'm now seeing is what we did mostly was cardiorespiratory physiotherapy as opposed to the definition of pulmonary rehab."* (Participant ID 2, Zimbabwe).
Curriculum	*"I mean, maybe now they are, but they weren't particularly taught pulmonary rehab. In that it's just not something that happens…. So, they weren't a bad physio. They were really good physio. It's just that they've been exposed ninety nine percent to musculoskeletal physio."* (Participant ID 5, Kenya).
Equipment	*"… our room is already equipped. It's OK… but in the other hospitals, we still have poor equipment, very old, from Soviet Union sometimes. You know Fanuel, we have two systems in same time of our medicine service. So, it's government medical system and primary or in private. In private health care facilities, there is all good because there is really good-looking rooms, a lot of equipment, very expensive equipment for echocardiography, etc. Spirometry. A lot. Because it's private. So, it's a business, you know. Yeah. So, they have the owner who does really good business. But in same times, we have a government medicine. So, there's not too good condition and very poor equipment…"* (Participant ID 1, Kyrgyzstan)
	"The other thing is there were no diagnostics, so we don't have spirometry. So, diagnostics are basically based on a history and ruling out TB…. So, they don't have the inhalers… And so, the whole package kind of isn't there." (Participant ID 5, Kenya)
	"Because in Primary Health services they don't even uh, you know there aren't, uh, enough resources to even diagnose a patient for COPD. They don't have spirometry… the diagnosis itself is so difficult to be made that rehab equipment is I mean, it's a remote possibility of having anything of that sort." (Participant ID 7, India)
General lack of awareness or recognition	
Patient level	*"And I think there was a lack of understanding of how doing rehab can help versus having an injection. So, they much preferred the idea of we get really sick and have an injection to cure us than we do pulmonary rehab, which is a new entity."* (Participant ID 5, Kenya)

	"So, you and I understand the role of physiotherapy in health care. You want to understand why it is important to have strong physiotherapy services, but the people whom you expected to serve don't know what we do. And as a result, they don't understand why we're important. So, at the grassroots, if you right now went… just did a survey of (hospital name) just randomly went outside the gate and asked him what a physiotherapist does. The answers will be very very disappointing because no one knows who we are… there's just a broad lack of knowledge about what physiotherapy is to the community that we are serving and to other health professionals we. Uhm, we are called various names, we're called the exercise people, we're called uhm the breathing people. We are called the people who beat up on your chest, depending on what environment we're in, you know what I mean? Uhm, we are called the people who are helping you stretch, you know. But again, this just points to a generalised lack of knowledge of what physiotherapy is and what role physiotherapy plays in, uhm, in a holistic setting." (Participant ID 2, Zimbabwe).
Healthcare professional level	*"We are like (sigh)…. what can I say? You are like the tomato sauce of a meal. I can still have my nsima with my fish and you know, everything is sorted, you know, with or without tomato sauce, yeah, but you know… do you know what I mean? Uhm, so, that's it that we are we are then considered a discretionary service. And because we are considered a discretionary service, the doctors themselves then also don't know what we are all about. So, then they don't really refer patients."* (Participant ID 2, Zimbabwe).
Government level	*"… over the past decade, there's been a tremendous increase in the training of health care professionals. And specifically medical doctors. And the intake has increased, classes have doubled… And now a lot of resources are devoted to them. So, if you qualify as, uh, occupational therapist or a physiotherapist, it is almost impossible to get a person in the public sector. There aren't posts available. You can go private, but not in the public sector. They are such limited posts. So, the consequence is that for a community like the one I'm living in, four hundred and sixty thousand people, there are two or three physiotherapists in the hospital and there's one or two physiotherapists for the community…, and pulmonary rehabilitation falls behind in terms of a priority. Yeah, so those would be barriers."* (Participant ID 4, South Africa)
COVID-19	
Face-to-face PR	*"… but the number of patients that we have now is very less than previous to covid… Uhm, we can now attend two patients per physiotherapist; before the covid, we attended about fifteen."* (Participant ID 3, Argentina)
	"…. hospitals are overrun. Um, and that was before covid. There's limited beds, limited space, limited offices, um, limited outpatient departments. It's overrun and now covid happens and it's even more so. So, doing it [PR] in health care facilities doesn't make sense to me." (Participant ID 4, South Africa)
Tele-PR	*"… one of the barriers that we have is the skills of the patients to use technology. It's the most barrier because if they don't have the skill… or maybe they have the technology, but it's more important to have the skills to use it. It's really big barrier."* (Participant ID 3, Argentina)
Patient direct and indirect costs	

Direct costs – transport	*"They so they weren't ready to come twice a week for so many weeks…. I think it's very demanding for the patients to come all the way to the centre, because may or may not be very close."* (Participant ID 7, India)
	"… some of patients cannot participate due to financial reasons, due to transport. And some of patients ask us to help them with transport, because some of them come here from really far away." (Participant ID 1, Kyrgyzstan)
	"But it was it was quite a challenge and basically people were not interested in coming because the choice was between transport or food and because they weren't acutely sick, they picked the food…." (Participant ID 5, Kenya)
Indirect costs – work time loss	*"… in our cohort, Group A, who participate in rehab… so uhm it's interesting, but the majority of the patients are female. Because male patients, they have to work. And it's more like time problem, you know? So, problems/challenges with timing. So… they would like to participate, but actually cannot because they work in daytime. Some of them work in full time/full day, … in rural Kyrgyzstan, you know, it's more farmers, who work with the cows, sheep, you know. And then third, patients, it's more related to young female patients who have children at home and some of them should be with them and cannot participate."* (Participant ID 1, Kyrgyzstan)

Supplementary material 3: Additional participants' quotes for enabler themes

Local adaptation	
Community-based PR	*"And also looking at us using the community-based approach… you look at the distance, you look at the transportation costs, and then you ask these patients… to be going in this case to DD Hospital which is very far. Actually, that wasn't going to be realistic at all and I think it makes sense to have these patients just living or making the existing impairments within themselves a normal thing. So, uhm I looked at the approach as well, going to the patients as compared to patients coming for the intervention as a facilitator for the establishment of this intervention and for sustainability, actually, of this intervention…"* (Participant ID 6, Malawi)
Local staff	*"The other thing as well I think as a facilitator looking at knowledge – acquisition of knowledge and support system, using the locally available resources with regards to knowledge and, yes, the expertise. So, because in this case we are looking at the HSAs [Health Surveillance Assistants]. HSAs live with these people in these communities, and they are actually the ones who may tell us more about the challenges that these people face on day-to-day basis because they are living together with them in their rural areas. So, engaging the HSAs was actually enlightening…. by the end of the day, I realised that actually it was a good idea to use the HAS as compared to the nurse. Because of their busy schedules, the nurse wouldn't be there full time to assist as well as the medical assistant. While the HSAs… there are several HSAs at each healthcare facility because I think they outnumber nurses and medical assistants as well. So, it was more a sustainable way… realistic and feasible way of ensuring that the intervention is sustained even after the intervention as well."* (Participant ID 6, Malawi)
	"I think the other major enabler that would make cardiopulmonary rehab much easier to implement in Zimbabwe is, and I suppose in sub-Saharan Africa in general, is our socio-cultural context that you hardly ever live alone. It is hardly ever just you living on your own; you live with your mom, you live with your aunt, you live with a cousin, there is someone, you know, so those people can be seconded to be your physiotherapist in the house. Do you know what I mean? So even in instances where the physiotherapist is in hospital and the patients are at home, you know that there will be someone who can assist for the most part, who can assist the patient if/when they need help. You know what I mean? So, I think that sociocultural context works to our advantage because then, you know that there'll always be someone to render assistance." (Participant ID 2, Zimbabwe).
Local equipment	*"But you wouldn't get the machine, so you'd have to use local equipment. But I think that might be better."* (Participant ID 5, Kenya)
	"You might have the treadmill, but there might be no electricity. So that means you need to use something that doesn't depend on electricity, something that can be used on or under any circumstances. So instead of a treadmill, then we use a

	hospital corridor. We just walk from the one end to the other, approximates the distance, check the time. And then that will do. Uhm, if we need to change the surface and make it more challenging, instead of just walking on the hospital corridor, we're going to walk outside. So now it's outside the terrain is a bit difficult. So, you know, it would be it would present a challenge of sorts. If it was resistance work, then we may not have dumbbells. So that means just knowing that a packet of sugar is 2kgs and then lifting 2kgs or knowing going to get some sand outside and put it in a plastic bag and in a sock and, you know, and that's it. So, it is not going to be I'm going to use dumbbells and you will be thinking in that respect. Or you then use body weight, you know, you have the edge of the bed. So, we're going to use triceps dips, for example, and then use your body weight or we are going to be doing just squats, body weight, you know. So, most of the interventions that I remember designing or prescribing would be low cost." (Participant ID 2, Zimbabwe).
COVID-19	
Tele-PR	*"Then a facilitator for the patients is that they don't have to move from their homes. They can do in different times of the day if we offer, of course…. We are using the 60-second sit to stand test for exercise tolerance. Uhm, we are using the COPD assessment test for quality of life. We are doing MRC dyspnoea scale. They are ways we can do in a tele-rehab session, right?... So, I think that the covid is a facilitator for pulmonary rehab now, because there will be a lot of patients that need pulmonary rehab programs. More much patients that can centres receive. So, in a way, it's a facilitator for pulmonary rehab to grow."* (Participant ID 3, Argentina)
	"So, I suppose perhaps the same could be said about cardiopulmonary rehab that while I wanted to last for six weeks in the clean corridors of a hospital with nice pink dumbbells and (sparky?) looking treadmill, I don't have that, and my conditions are: a person who is unable to come to my hospital twice a week and then the third time. So how else can I reach them? And I think COVID has shown that that, you know, telehealth can work. Amongst other options, telehealth can work." (Participant ID 2, Zimbabwe).
Better awareness or recognition	
Government awareness	*"So, I think at government level there needs to be better recognition of chronic lung disease. Full stop... And I think the three big things that could help are a national level understanding of where pulmonary rehab fits into the whole chronic lung disease picture and better funding of chronic lung disease as a whole with pulmonary rehab being part of that." (Participant ID 5, Kenya)*
Patient and referrer awareness	*"I believe the patient awareness has to increase. I mean, apart from the awareness or education of the referrers or the doctors, the patients also have to be made aware that there is a rehab service, and this really helps you get better…. I think it's important for the patients to believe in rehab. And it's important that rehab is covered in the education system of the REFERERS, which is not done as extensively as it should be done. I would like to highlight that this is a change that is required in the health policies…. it's time to give, you know, importance to*

	chronic respiratory diseases and its management including rehab. Because prevalence is not less. The awareness is very less." (Participant ID 7, India)
Facilitates referral	*"So, our referrers in our small hospitals, TB hospitals, they refer immediately because they know that our institution really have big authority."* (Participant ID 1, Kyrgyzstan)
Multiple stakeholder engagement	
	"So, we tried education to address it, but I think what would have been better, looking back on it, is to try and engage other stakeholders with education to address the problem, because they didn't want to pay the transport to come to the hospital, to get the education, do you see what I mean? (Participant ID 5, Kenya)
	"… engagement of different stakeholders just to make sure that … there was a strong support to the intervention… They had already considered engaging multiple stakeholders to make sure that the project of the intervention is successful. So, issues of nutritionists, social workers and so on and so forth was considered. But one stakeholder which I forgot was the ministry of health and the local governance." (Participant ID 6, Malawi)
Available resources support	
Equipment	*"It's enough. Now we have five treadmills, six cycle ergometers. We have three min gyms. We have kettle bells. We have elastic bands, balls… we have all the equipment that we need, and the oxygen is the central oxygen… that, yes, the hospital provides us – the oxygen. Yea it's a central hospital, the tubes out of the hospital…"* (Participant ID 3, Argentina)
	"But we were OK for rehabilitation equipment because we had a gym. So, we had like one running machine, one bike, the stairs and stepper. We've got some weights; we've got some Thera bands. So, there was enough stuff and things you could use locally to actually do the rehab quite well. So, there was nothing equipment wise for the rehab that was a problem…" (Participant ID 5, Kenya)
Financial	*"I do pulmonary rehab in two different centres. One is a public health centre. It's a hospital, a public hospital. The patients do pulmonary rehab for free… I think that one facilitator is that is it's for free."* (Participant ID 3, Argentina)
	"And I think the way to probably implement it is to implement it as a package and get that covered by the government insurance scheme." (Participant ID 5, Kenya)
	"And the project is supposed to run for five years, I think. So, that will continue to be the habit for until five years, because the funding of this program will finish or will end or reach the endpoint after five years." (Participant ID 6, Malawi)