DIGITAL HEALTH

Development of an innovative strategy to determine functioning attributed to health conditions in low-resource settings

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Abstract

Objectives: Rehabilitation is a health strategy that aims to reduce functioning problems. There is a lack of country-level data on the burden and type of functioning problems to inform service planning and management of patients' rehabilitation needs, particularly at primary care level in low-resource settings. Health researchers need an application that automates synthesis of data extracted from several peer-reviewed publications to determine the most prevalent functioning problems compared across several health states. This article describes the journey leading to the conceptualization and development of the *Rehab4all* application and compares the application's performance to a standard desktop program.

Methods: A descriptive case study approach was used to report on the following steps involved in the development of the web-based *Rehab4all* application: (i) preliminary literature review to assess the evidence gap of country-level data on functioning problems comparable across several health states; (ii) an initial attempt to perform data extraction and synthesis in Excel; (iii) design and development of *Rehab4all*; (iv) piloting of the *Rehab4all* application; and (v) implementation of application with input data from South Africa and Zimbabwe.

Results: The *Rehab4all* application offers a feasible solution for synthesizing data from several peer-reviewed publications to provide information on context-specific, priority functioning problems at country level through the integrated global International Classification of Functioning, Disability and Health Framework (ICF).

Conclusion: This bespoke innovation provides impetus for further development, profile comparison and shared information between countries to co-develop strategies which can strengthen rehabilitation service delivery.

Keywords

Application, functioning, ICF, primary care, rehabilitation, web based

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Introduction

The goal of rehabilitative care for patients with any health condition goes beyond eradicating disease, to maximize function in everyday life.[1] Disability attributed to common health conditions is expected to rise in the following years; particularly with expanding and ageing populations in low- to middle-income countries (LMICs).[2] Additionally, the growing burden of multimorbidity creates complexities in the nexus of functioning problems

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arising from the co-existing and potentially interacting chronic health conditions and side-effects of multiple medical treatments.[3] An integrated, holistic approach to the provision of rehabilitation has reportedly been marred by poor integration of care.[4]

The situation is worse at primary care level in low-resource settings where rehabilitation professionals are inadequate.[5,6] The few available primary care workforce is largely unsupported, inexperienced and unskilled in their capacity to cope with the increased need for basic and advanced rehabilitation.[7] Thus, patients commonly receive care that is not interprofessional and centred on the individual's holistic presentation. Such care is unacceptable, especially in poor, vulnerable populations which often have to overcome multiple challenges to access rehabilitation.[8] Further research initiatives and collaborations are evidently required to address the gap created by growing, increasingly complex functioning problems and potentially suboptimal rehabilitation care.[9]

An interprofessional approach to rehabilitation is ideal in settings with limited available rehabilitation professional disciplines.[10] To facilitate person-centred care for multimorbidity and chronic disease-related disability, it is pivotal to move away from a disease-driven approach.[11] Diseases often have far-reaching consequences that extend beyond impairments to negatively influence individuals' life roles.[12] Therefore, engagement across health professions and other sectors such as transport, labour or education is often needed.[13] Understanding individuals' context-specific functioning problems can assist in educating relevant stakeholders to strengthen rehabilitation as a health strategy.[14]

Local contextually relevant information should inform health service planners and policymakers in the tailoring and operationalizing of innovative strategies that will be effective in the strengthening the healthcare system.[15] For example, in remote rural settings of many LMICs, inpatient rehabilitation facilities are often not available and patients are discharged into the care of relatives despite significant, remaining functioning problems.[13] These patients are often unable to attend regular clinic- or hospital-based outpatient rehabilitation sessions because of their disabilities, limited financial resources or the long travelling distances involved.[16] Supported self-management and task shifting at primary care is paramount; however, it is not well incorporated in many low-resourced healthcare systems.[17] Thus, more evidence is needed to inform the development and implementation of contextualized and patient-centred interventions and clinical practice guidelines (CPGs) that target the unique functioning problems of these marginalized populations.[13] As such information is currently unavailable, there is an urgent knowledge gap to fill, given the rising needs for access to quality rehabilitation services.

Clinical data on functioning in LMICs is available but is siloed into the different health conditions. There is need for a composite and comprehensive mapping of functioning problems compared across health conditions at country level as one of the first steps towards improving rehabilitation service delivery in poorly resourced settings.[15] We aim to describe the journey leading up to the development of an innovative technological application that involves artificial intelligence for synthesizing the evidence from large volumes of peer-reviewed publications on functioning problems. We also compare the application's performance to a standard desktop program. Systematic information-gathering of comparable data on priority functioning problems of patients will provide a solid base for context-specific planning and resourcing for rehabilitation to be better integrated in healthcare systems.

Methodology

This case study describes the process involved in conceptualizing and designing a web-based software program, named *Rehab4all*, which was developed as part of the planning of a scoping review on functioning problems associated with 10 health conditions that contribute most to the burden of disability in two LMICs (South Africa and Zimbabwe). Another objective of our scoping review was to classify the identified functioning problems according to the International Classification of Functioning, Disability and Health Framework (ICF) to provide a consistent aetiologically neutral language for objectively comparing data across the condition-specific studies and settings.[18] The case study approach is useful in exploring phenomena, including health interventions, in their real-life context.[19] To report our study, we adapted the CONSORT_AI guideline used for reporting randomized trials of artificial intelligence interventions,[20] and guidelines by Runeson et al.[21] for conducting and reporting case study research in software engineering.

The research was approved by Stellenbosch University's Health Research Ethics Committee (S21/01/002 (PhD)). The development team consisted of two rehabilitation researchers, three postgraduate rehabilitation students and one software programmer/engineer.

Process

Five main steps led up to the development of the *Rehab4all* application (Figure 1). These included (i) a preliminary literature review to assess the evidence gap of country-level data on functioning problems comparable across several health states; (ii) an initial attempt to perform data extraction and synthesis in Excel as part of a mini-scoping review; (iii) design and development of *Rehab4all*; (iv) piloting of the *Rehab4all* application; and (v) implementation of the application with input data of two countries (South Africa and Zimbabwe).
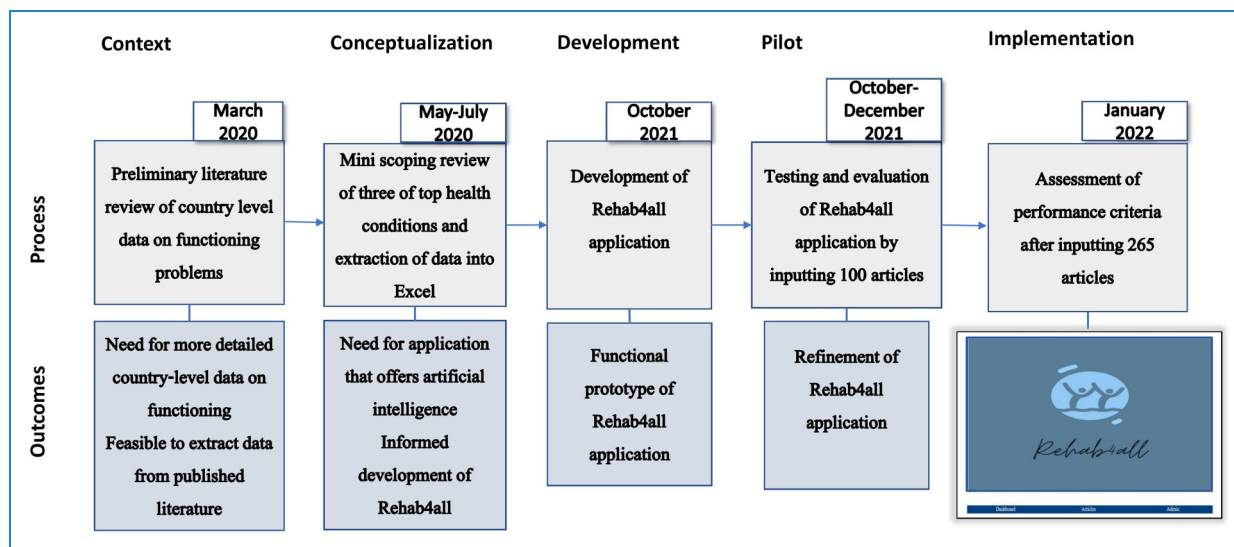
Figure 1. The process leading up to the development of the Rehab4all application.

Study preliminaries to assess the evidence gap of country-level data on functioning problems comparable across several health states: A non-systematic review of literature[22] regarding functioning problems (impairments, activity limitations and participation restrictions) associated with the top 10 health conditions contributing to disability in South Africa and Zimbabwe was conducted in March 2020. The aim was to assess the availability and appropriateness of information on the burden and type of functioning problems in patient populations which is required to effectively plan for rehabilitation services, training and upskilling of healthcare professionals at country level.

Country-level planning is often based on the Global Burden of Disease (GBD) studies, which provide global estimates of health states that cause substantial disability.[23] The burden of disability is commonly depicted by Years Lived with Disability (YLD),[23] which is a weighted measurement of years lived in suboptimal health before disease either resolves or results in fatality.[24] While this metric gives an estimate of disability at country and global levels, our assessment indicated that a gap exists in detailed descriptions of the functioning problems.

Data provided through population censuses and national disability surveys were found to be mostly insufficient as most census or survey data collection tools are modelled to be brief. For example, the Washington Group's Short Set incorporated in South African[25] and Zimbabwean[26,27] population censuses and surveys uses six questions on difficulties with functioning to capture disability data. However, in rehabilitation service planning, training or supporting healthcare professionals to effectively address patients' functioning problems, a broader understanding of the underlying problems is required. For example, in exploring the difficulty with walking, assessing specific problems such as poor balance, pain or endurance when walking is helpful for planning targeted rehabilitation strategies.

We concluded that it would be possible to extract data on functioning problems associated with specific health conditions from already-published peer-reviewed literature. However, research studies often investigated functioning problems within one health condition such as HIV,[28,29] but not compared across several conditions; thus not addressing issues of complex multimorbidity mostly seen in adults seen by clinicians.[30] Multiple systematic scoping reviews per condition would need to be done to provide greater depth of information on functioning problems compared across different health states to better inform rehabilitation service planners and policymakers about the priority functioning problems. Conducting a scoping review would be relatively manageable and more cost-effective than carrying out national surveys in the two selected LMICs.

Challenges of an initial attempt to perform data extraction and synthesis in Excel: A mini-scoping review and synthesis of peer-reviewed literature on three (HIV, tuberculosis and stroke) of the top 10 health conditions that were associated with greatest disability in South Africa[2] was done between May and July 2020. The rationale for selecting the specific three conditions for preliminary scoping was that they retrieved higher numbers of records from the searches (e.g. 300 potentially eligible HIV full texts compared to 5 potentially eligible burns studies). It was anticipated that data extracted from studies on these conditions would be sufficient to provide a good overview of the demands and requirements of the review process and refine our requisite outcomes.

Data on the three health conditions was initially extracted into a Microsoft Excel spreadsheet adapted from

the Joanna Briggs Institute (JBI) data extraction form for prevalence studies.[31] The process revealed the following challenges: (1) cumbersome manual processes (clicking across several columns in Excel and having to copy and paste every data entry); (2) time-consuming (on average each entry in Excel took 15–30 minutes); (3) multiple opportunities for human errors and omissions affecting data credibility; and (4) multi-layer filtering in Excel was impractical. These problems led us to the idea that something more innovative was needed.

Conceptualization of the Rehab4all application: We required an application that would provide an overview of functioning problems based on a synthesis of secondary data extracted from many articles. This had proved impossible using a traditional desktop application such as Microsoft Excel. The application would be solely used by researchers or academics. However, the outputs would be useful to rehabilitation service planners, policymakers, rehabilitation curricula designers and clinicians and ultimately benefit patients with functioning problems (Box 1).

Box 1:   Overview of the Rehab4all application

Description of the Rehab4all application: A bespoke, purpose-built, web-based application which automates visualization of functioning problems compared within and across conditions at country level.

Function and outputs: To allow electronic entry of information extracted from eligible peer-reviewed publications (secondary data) on functioning problems. The application's capacity allows for large amounts of country-level data to be stored. The application has automated data synthesis functions. First, it provides real-time outputs on the most common functioning problems compared within and across health conditions. This allows regular updating as more peer-reviewed studies become available. Second, it automates the mapping of functioning problems to the ICF which provides consistent terminology for describing function.

Users of the application: Researchers and academics.

Visualization of outputs: The types and prevalence of presenting functioning problems can be visualized in graph or table format by (1) country, (2) health care setting (e.g. primary health care facility, hospital and rehabilitation centre), (3) geolocation (e.g. rural, urban or peri-urban) and (4) ICF classifications. The most prevalent functioning problems for a given setting can thus be determined.

Usage of the outputs: The outputs are useful to inform clinicians, rehabilitation service planners, policymakers, researchers and rehabilitation curriculum developers to plan, develop or implement targeted rehabilitation interventions, resources, guidelines and training. Identification of key functioning problems will help to prioritize rehabilitation services and resources which are limited in low-resource settings.

We envisaged an application that offers intelligence to overcome problems experienced in Excel by providing (1) an audit log for tracking data management; (2) automated filtering and export functions for seamless data downloads and customized according to our objectives; (3) shared, password protected access for authorized users; (4) enhanced capacity for large data sets; and (5) system that allows customized queries for data manipulation. Moreover, existing data extraction tools[31] would have been useful for data extraction but not for classifying it according to the comprehensive ICF. The task was to custom-build a system that would integrate the ICF in dichotomizing the identified functioning problems.

Development of the prototype web-based application: The research team prepared a specification document that comprised a detailed itemization of all questions and logic. A software engineer developed the prototype web-based application. A MySQL database was used as the backend. The front end was developed in web development software called WebDev version 22. The first step in the process was to design an Entity Relationship Diagram (ERD) according to the specification outlined in the specification document. The graphical user interface provides for easy navigation with user login. It is hosted on a secured Linux Ubuntu self-managed server from a leading South African hosting service provider. Regular feedback meetings were held to discuss and test the prototype throughout the development stages.

The application that was developed consisted of several data entry windows that enable management of the layers of information resulting from our scoping review of functioning problems associated with the different health conditions (Figure 2). The first data entry window captures the study details (including the author, year of publication and study design) and description of the participants (mean age, sample size, gender, level of care, setting, country and the health condition(s)). The second data entry window captures the functioning problems as they were reported in the article. This would be the equivalent of the patients' complaints when presenting to a primary care health professional. The functioning problems were thus labelled using simple terms with limited medical jargon. The English language was used as this is the preferred language among health professionals in the countries where the application will be piloted. This data entry window also captures the outcome measures used to assess the functioning problem, as well as the percentage of participants reported as having the functioning problem. The percentages will be used to calculate a non-weighted prevalence of the functioning problem. It is possible to enter and classify data for articles that did not report the prevalence of the functioning problem, perhaps reporting the problem narratively and supported by standard means. These articles are still useful in identifying

Figure 2. The data entry windows that are in the Rehab4all application.

associated functioning problems even though they will not be used in determining the prevalence. The same data entry window can be used to capture several functioning problems since it could be possible for one study to report on more than one functioning problem associated with the health condition. The final data entry window serves the purpose of classifying the problem according to the ICF component, domain/category and qualifier. The data entry window uses a drop-down function to select the ICF component under which the functioning problem can be classified; body function impairment (b), body structure impairment (s), activity limitation and/or participation restriction (d). A search menu can be used to assign the ICF codes at the domain and category levels, and – if the article provides sufficient detail – to further code at the qualifier level.

Piloting of the functional prototype of the Rehab4all application: A functional prototype was ready in October 2021. Initially, data from 100 articles on functioning problems associated with 10 health conditions that contribute most to the burden of disability in South Africa and Zimbabwe were entered to test the functionality. Human-artificial intelligence interaction was involved as a user was required to read through the eligible full-text articles and extract data into the application. The user needed to be a rehabilitation researcher or academic with a good understanding of the ICF.

Refinements were made to the *Rehab4all* application by creating drop-down lists from health conditions listed in the GBD study data visualization tool, GBD Compare,[32] as well as the WHO's eleventh version of the International Classification of Diseases (ICD-11)[33] to provide a standardized list of health conditions.

Implementation of application with input data of two countries: The revised version of the *Rehab4all* application was implemented. Data from the remaining articles that were identified for inclusion into the review were entered to test how robust the system was with higher data loads. Currently the database contains 265 articles.

Data analysis/synthesis

A description of the novel functions/outputs and our experience of using the *Rehab4all* application are compared to our initial experience of using the traditional method of Excel. Both qualitative and quantitative data analysis methods were used. Quantitative methods were used to assess the time efficiency by calculating the average time spend per single article. Qualitative reflective analysis was used to integrate and document issues of interest observed from our personal experiences in the use of the application. The analysis required several cycles of interpretation of both major and unexpected themes pertaining to the performance of the application.[34]

The expected performance criteria for the application are shown in Table 1.

Performance outcomes of the application

This section describes the performance outcomes of the *Rehab4all* application after entering data from 265 articles on functioning problems associated with 10 health conditions that contribute most to the burden of disability in South Africa and Zimbabwe.

Design fit for purpose. The *Rehab4all* application appeared to be efficient in achieving our ambitious goal of obtaining automatic output on the functioning problems that can be classified according to the ICF and compared across multiple health conditions at country level. The *Rehab4all* application enabled the user to foremost identify the most prevalent functioning problems regardless of the associated health conditions. Figure 3 demonstrates the process followed. Data (including prevalence) on functioning problems from the 265 articles related to the top 10 health conditions contributing to greatest disability were entered into the application. These functioning problems, currently totalling 98, were mapped to the ICF. According to the ICF coding system, functioning and disability is divided into

Table 1. Performance criteria for Rehab4all application.

Performance criterion	Description of criterion	Method of assessing performance
Fit for purpose	Application can synthesize large data sets on functioning problems that are comparable across health conditions	Qualitative
Data quality and output credibility	Reduced human error and standardization of data fields in the terminology used for presenting functioning problems	Qualitative
Time efficiency	Speed of data extraction and ease of updating new data	Quantitative
Real-time data and output sharing for authorised users	Up-to-date data on functioning problems available to researchers who have the application's password and link	Qualitative
Ease of use	The application has a user-friendly interface with seamless and logical flow on and between windows	Qualitative
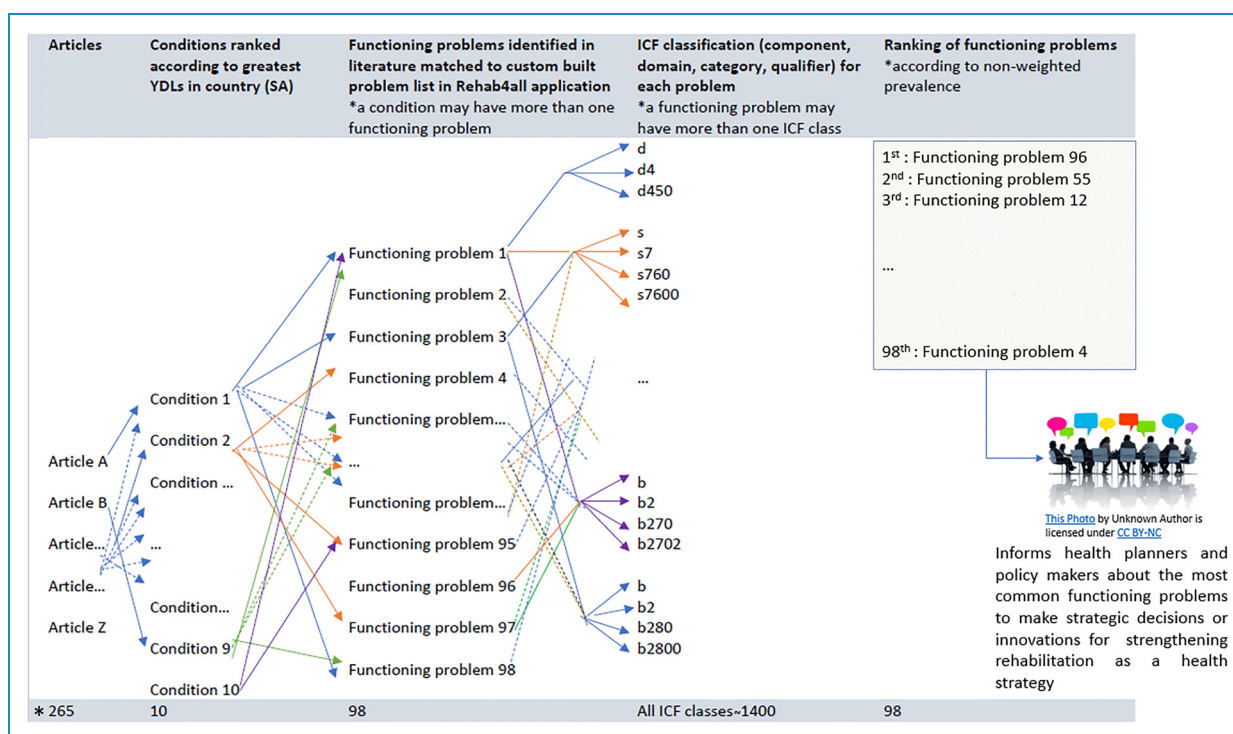
Figure 3. Process of identifying functioning problems from published literature at country level using Rehab4all application. Priority functioning problems, for example, based on prevalence, can inform rehabilitation service planning and policymaking.
*The last row indicates the current values in the database.

four components: body function (coded 'b'), anatomical structures (coded 's'), activities and participation (coded 'd').[35] The numbers indicate the domains, categories and qualifiers to the fourth level. The data inputted was synthesized to provide information regarding which of the listed 98 functioning problems were most prevalent and/or commonly reported. Thus, the *Rehab4all* application proved its ability to promote person-centred care through a model driven by functioning and not disease.

Improved data quality and output credibility. The automated functions allowed for standardization of terms, transparent data filtering and management and provided output reports that were easily customized for our project with

greater apparent reliability and validity than Microsoft Excel.

Standardization of terms. The terms used to describe functioning problems were standardized. The articles reported the functioning problems using different terminology. For example, the terms 'lethargy', 'tiredness', 'fatigue', 'drowsiness' and 'low energy' described the same construct. A standard problem list (currently 98 items) was generated during the conception of the *Rehab4all* application using data from the included studies and applying limited medical jargon and simple terms that were most proximate to how patients would report problems when presenting to clinicians. The system only allowed authorized team members to add to the list of terms, which further helped to ensure that the selected problem closely reflected the functioning problems reported in the studies. In Microsoft Excel, variations in spelling or terminology of the same problems created uncertainties and consequently reduced confidence in the outputs. The application provided internal consistency and thus facilitated comparability of similar constructs between research articles.

Automated data filtering and management reduced human error. The several layers of data (Figure 3) could be better managed. The first layer in this pilot project existed from exploring several health conditions. The next layer came from most health conditions linked to several functioning problems. Additionally, each functioning problem had to be classified according to the ICF, which contains four layers from the component, domain, categories and qualifiers. These layers were difficult to manually manage in Excel but the automated filtering in the *Rehab4all* application enabled real-time output with one click.

Classifying the functioning problems according to the ICF was streamlined. While working in Excel, it was arduous to constantly refer to the ICF online browser for the codes and then copy and paste them into Excel. Although drop-down functions can be created in Microsoft Excel, the added autofill function fluent branching logic applied within the application enhanced efficiency, and arguably reduced omissions and errors, which were easy to track in the application. The system did not allow entry of ICF codes that are not existent, and the user had to review and confirm the selected codes before saving. Also, all the prompts per article had to be filled to completion for the entries to be saved, which prevented incomplete data entries. However, we acknowledge that the user must be familiar with the ICF when classifying the functioning problems. As with Excel, a second reviewer could be used to check randomly selected articles to ensure that the correct data were entered.

Evidence-based outputs. The application provided outputs based on data from peer-reviewed studies which included cross-sectional and cohort study designs. This increased the credibility of the outputs. The source reference of each data line could be easily viewed/tracked. Figure 4 shows how by selecting a single functioning problem, the left column filters data on the total number of people experiencing the functioning problem, the total sample size, prevalence and number of articles reporting. The right column provides titles of each article per functioning problem, with the additional filtering to show data extracted from the individual article. Therefore, each output could be linked back to the underpinning evidence source.

Improved speed of data extraction and easy to update new data
Improved speed of data extraction. The time to enter one research article was significantly reduced when using the *Rehab4all* application. A comparison was made of the average time it took to enter five articles in the *Rehab4all* application to entering the same articles in Microsoft Excel. The average time (5 minutes) taken to enter all data fields for one article in the *Rehab4all* application was significantly decreased to a third of the time that was initially taken when Excel was used (15–30 minutes).

Easy to update new data. The ease of keeping abreast of new evidence is notable because new publications can be entered as they become available, and the output reports are immediately updated.

Real-time data and output sharing for authorized users. The *Rehab4all* application synthesized the inputted data to create outputs for the purpose of understanding functioning problems experienced by patient populations. An overview of total included articles was given, with the option to view the data by country, health condition (Figure 5 shows, e.g. that 47% (n = 126) of the 265 inputted articles for all countries were articles on patient populations with HIV without any associated co-morbidity), healthcare setting and demographic setting. The percentages of patients who had functioning problems were used to re-calculate a non-weighted prevalence of the functioning problem. The functions allowed for seamless data downloads in a format that could be easily analysed in Microsoft Excel, whereas this synthesis was found to be difficult to perform manually in Excel in a reliable manner.

Ease of use. The *Rehab4all* application provided a good user experience due to its user-friendly interface and system stability.

Software usability. The interface was user-friendly. The flow of the prompts for the information was intuitive and presented in a logical sequence on and between windows. It was easy to operate after a single 30-minute training
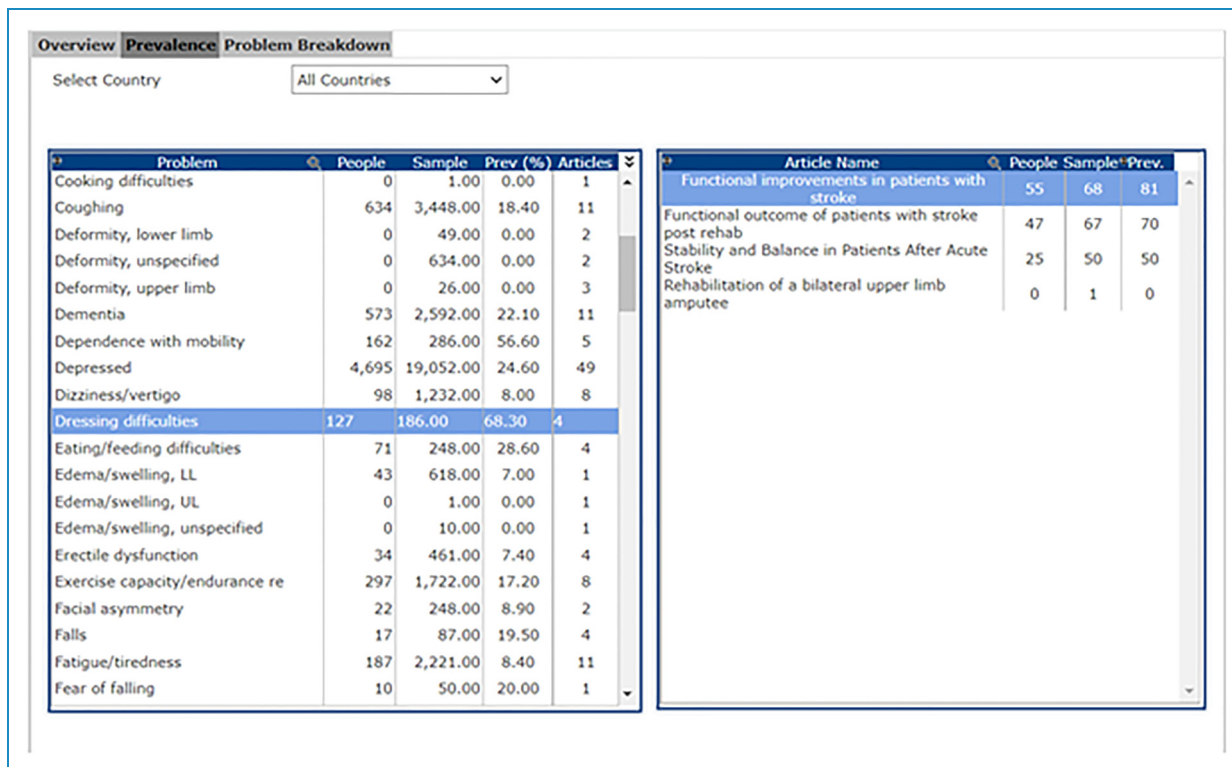
Figure 4. Dashboard of prevalence of each identified functioning problem and database of referenced articles.
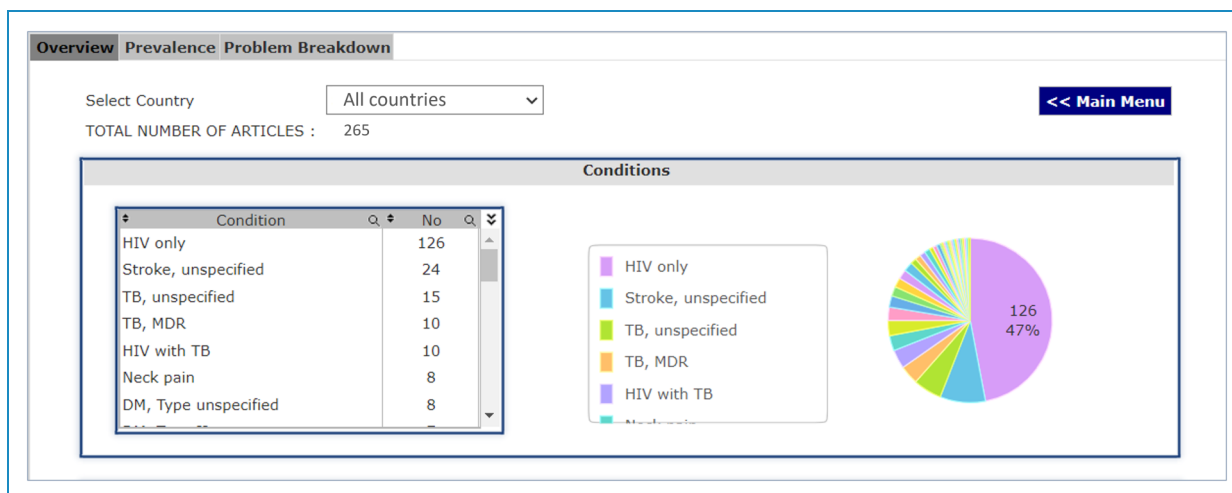

Figure 5. Dashboard providing visualization of proportion of articles providing data per health condition. Similar tabs provide data per type of healthcare facility and demographic setting.

session. Additionally, the application's performance remained consistent throughout the entire process regardless of the number of studies entered. All data could be entered without experiencing any glitches.

System stability. No system crashes were experienced due to the robust design of the system and its ability to accommodate large data sets. The system is highly responsive to user interactions contributing to its stability.

Discussion

This article described development of an innovative technology and method to determine the burden and type of
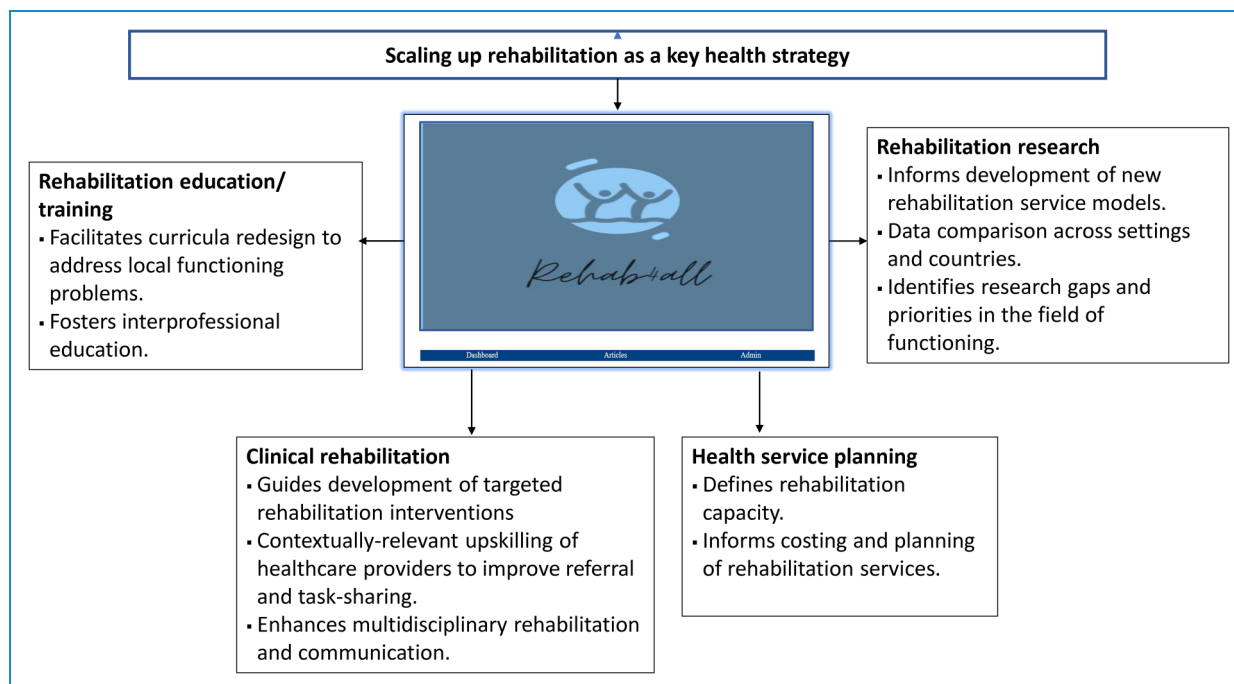
Figure 6. Proposed application of the Rehab4all application to better integrate rehabilitation into healthcare systems.

functioning problems (across a single or multiple conditions) experienced by patient populations at country level. The *Rehab4all* application enhanced both the speed and accuracy of our data extraction process, facilitated data synthesis and automated visualization of findings for our key objective, namely, to determine the functioning problems compared across health conditions in patient populations.

The *Rehab4all* application proved efficient and effective in gathering and synthesizing context-specific data on functioning compared across health conditions (Figure 3). Because the *Rehab4all* application promotes the functioning-first (rather than disease-first) approach as the underlying determinant of rehabilitation interventions, it enables all rehabilitation disciplines to use a patient-centred approach that targets the rehabilitation needs of the potential rehabilitation beneficiaries.[36] Similar-purposed studies aimed at providing data on functioning have been carried out; however, these provided data on functioning associated with one health condition.[28,37] Our study shows that it is feasible to describe functioning compared across several disease states, which is particularly useful in addressing the complex functional sequalae of multimorbidity.

Data outputs from the *Rehab4all* application may have several applications useful for rehabilitation practice, research and training. Figure 6 summarizes proposed uses of the *Rehab4all* outputs in scaling up rehabilitation as a key health strategy, resulting in improved outcomes.

With regards to clinical practice, the mapped functioning problems can guide the development of targeted rehabilitation interventions relevant to each setting. A comprehensive overview of the functioning problems related to each health condition using the ICF will facilitate collaboration of all rehabilitation disciplines, including speech–language and hearing therapy, occupational therapy and physiotherapy, towards a holistic, patient-centred approach,[11] thus moving away from a siloed approach to rehabilitation. In a study conducted at an Israeli rehabilitation centre, rehabilitation specialists who had implemented the ICF in clinical practice expressed how the biopsychosocial model reinforced a holistic approach by providing an overview of the patient that incorporates multiple aspects of functioning.[38] This is particularly useful in poorly resourced primary care settings where some rehabilitation disciplines are not available.[5,6] The comprehensive framework provides a consistent language for the multidisciplinary team to present and discuss patient profiles during team meetings[38] or in documenting patient notes. Because functioning, rather than a health condition, is used as the underlying determinant of rehabilitation interventions, all rehabilitation disciplines can work towards meeting the rehabilitation needs of the potential rehabilitation beneficiaries.[36]

The *Rehab4all* application will present functioning problems that can be related to specified health conditions. This will increase the awareness of rehabilitation specialists regarding what potential functioning problems to assess as a priority when a patient presents with a diagnosed health condition. The use of the ICF in this regard has been reported to contribute to organized thought and practice.[38] This conceptual advantage supports the development

of relevant treatment goals and systematic selection of targeted rehabilitation interventions to address the identified functioning problems.[39] Because the ICF recognizes that the patients are an integral part of their environment, rehabilitation specialists will go so far as to re-integrate the individuals into their communities rather than solely address the body function and structural impairments.[40]

The outputs can further be used to inform restructuring of the rehabilitation curriculum and training methods (e.g. at undergraduate level) to address the key functioning problems that have been identified, especially as new contextually relevant evidence arises. The gap between the competencies that newly graduated therapists have acquired over their period of training, and the reality of service needs is quite evident especially at primary care.[4] Community service therapists, who are often the sole rehabilitation providers at primary care, have to work largely unsupported and are generally inexperienced in their capacity to serve people in need of complex and advanced rehabilitation.[7] Therefore, designing the rehabilitation curricula to equip the rehabilitation students with a skill set that will meet the contextual rehabilitation needs of the people particularly at primary care in low-resourced settings is crucial. Moreover, using the ICF approach will foster interprofessional learning because of the consistent evidence base aimed at addressing the identified functioning problems.[41] This will ensure that the available workforce has the bare minimum knowledge and competencies to identify, refer or manage at least the priority functioning problems.

The data visualization of the number of studies per health condition will make it easier for researchers to quickly identify which health conditions require more evidence regarding associated functioning problems. A lack of contextually relevant primary care CPG for rehabilitation interventions has been reported.[42] Quality CPG drive the implementation of evidence in healthcare decision-making to ensure optimum rehabilitation service delivery and improving patient health outcomes.[43] Outputs from the *Rehab4all* application can inform rehabilitation researchers on where to direct their research efforts to address the evidence gaps regarding effective rehabilitation interventions for the most prevalent functioning problems.

An expansion on the outputs from the *Rehab4all* application by obtaining more high-level evidence on prevalence of functioning problems can be used to inform rehabilitation health services planning. Establishing the prevalence of activity limitations and related impairments associated with conditions contributing greater burden of disease may be a useful indicator of rehabilitation need.[2] It is anticipated that determining rehabilitation need will be the first step in determining the rehabilitation capacity of the public healthcare system in the selected regions. Mapping the scope of rehabilitation need will also prove valuable in building a rehabilitation investment case for funders, healthcare managers and policymakers to make informed decisions with regards to providing adequate finance and human resources in support of the rehabilitation vision. This will improve transparency in the rehabilitation policy and service planning process to improve health services delivery and access to rehabilitation services especially at primary care.

Limitations and future work

The case study results should be interpreted with caution considering the subjectivity resulting from reporting only the design team's personal experiences of the *Rehab4all* application. This is still a pilot development and more extensive feedback on the performance outcomes will be sought in the future. However, the flexibility of the case study approach was useful in advancing the development and implementation of the *Rehab4all* application because new information that was unforeseen in our original research plan could be discovered and explored.[34]

Currently, the piloted data related to two LMICs and may be generalizable to similar low-resource settings. Recommendations for future iterations to improve the functionality of the application include translation into several main languages to improve accessibility in non-English language settings to accommodate more countries and reduce language bias of data. We plan to engage a statistician and data scientist to add more advanced techniques to understand the burden of each type of functioning problem and control for confounding factors such as publication bias.

Further limitations result from using prevalence of the identified functioning problems as a main indicator of the impact, yet the most prevalent functioning problems may not have the most impact on individuals' life roles. We plan to explore new methods for understanding the impact of functioning problems that extends beyond prevalence.

Additionally, the application may be enhanced to keep track of collaboration, should more than one reviewer work on it.

Conclusion

Rehab4all is an innovative solution to strengthen rehabilitation, especially at primary care level, by unlocking information on context-specific, priority functioning problems at country level, which can be used for service planning, training, rehabilitation service delivery and research to advance integration of rehabilitation into healthcare systems. This innovation provides impetus for comparison or shared information between countries to co-develop strategies that can strengthen rehabilitation. Further development is needed, and next steps should incorporate evidence-based care packages for priority functioning problems, which can be delivered by general or rehabilitation professionals.

Currently, access to Rehab4all application is limited to rehabilitation researchers at Stellenbosch University.

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