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REVIEW

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Collaboration between biomedical research and community-based primary health care actors in chronic disease management: a scoping review

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Abstract

Background: Collaboration between biomedical research and community-based primary health care actors is essential to translate evidence into clinical practice. However, little is known about the characteristics and impacts of implementing collaborative models. Thus, we sought to identify and describe collaboration models that bridge biomedical research and community-based primary health care in chronic disease management.

Methods: We conducted a scoping review using Medline, Embase, Web of Science, and Cochrane Library from inception to November 2020, to identify studies describing or evaluating collaboration models. We also searched grey literature, screened reference lists, and contacted experts to retrieve further relevant references. The list of studies was then refined using more specific inclusion and exclusion criteria. Two reviewers independently selected studies and extracted relevant data (characteristics of studies, participants, collaborations, and outcomes). No bias assessment was performed. A panel of experts in the field was consulted to interpret the data. Results were presented with descriptive statistics and narrative synthesis.

Results: Thirteen studies presenting 20 unique collaboration models were included. These studies were conducted in North America ($n = 7$), Europe ($n = 5$) and Asia ($n = 1$). Collaborations were implemented between 1967 and 2014. They involved a variety of profiles including biomedical researchers ($n = 20$); community-based primary health care actors ($n = 20$); clinical researchers ($n = 15$); medical specialists ($n = 6$); and patients, citizens, or users ($n = 5$). The main clinical focus was cardiovascular disease ($n = 8$). Almost half of the collaborations operated at an international level ($n = 9$) and the majority adopted either a network ($n = 7$) or hierarchical structure ($n = 6$). We identified significant implementation barriers (lack of knowledge, financial support, and robust management structure) and collaboration facilitators (partnership, cooperation, multidisciplinary research teams). Out of the 20 included collaboration models, seven reported measurable impact.

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Conclusion: We identified a large variety of collaboration models representing several clinical and research profiles and fields of expertise. As they are all based in high-income countries, further research should aim to identify collaborations in low-income countries, to determine which models and/or characteristics, could better translate evidence into clinical practice in these contexts.

Keywords: Biomedical research, Chronic disease, Collaboration, Community health services, Patient engagement, Practice base research, Primary health care, Translational

Background

Until recently, the improvement of population health was the sole aim of medical research [1]. Lately, patient experience, clinical team wellbeing, and efficiency came to be on policymakers' radar [2, 3]. Scientific and technological progress resulting from biomedical research has provided patients and clinicians with new and promising avenues for treating and diagnosing many diseases. For example, chronic diseases such as diabetes, arteriosclerosis, cancer, chronic respiratory disease, and mental illness whose management continued to be a challenge in the world. Chronic diseases are responsible for almost 70% of all deaths worldwide [4].

Application of biomedical discoveries in community-based primary health care (CBPHC) to combating chronic diseases represents an important example of the research continuum from basic science to clinical practice, as primary care is the cornerstone of most health services systems and plays a critical role in chronic disease management [5, 6]. This has been well described in the literature [7]. Classically the translation of evidence into practice is a linear process that starts with a biomedical discovery (pillar 1), which then leads to clinical research (pillar 2), before having an impact on healthcare (pillar 3) [8]. The trajectory involves the challenge of closing the gaps between each of the pillars [9]. Failure to close these gaps generates a significant loss of knowledge for primary health care research. Many academic laboratories do not have the knowledge or infrastructure to translate their findings into clinical practice and even more so, in CBPHC where most the care occurs [10].

Translational research (also known as "translational medicine" or "translational science") focuses on building bridges between these three research pillars or by reducing the gaps between them [11]. As suggested in previous work [12], it is useful to distinguish different views of translational research on the basis of three dimensions: the scope of the collaboration (narrow or broad), the type of interaction between the people involved (linear or complex), and the presumed cause of the gap (internal or external to science) [12].

To improve the practical outcomes of biomedical research, insure the implementation of the knowledge it generates and finally improve population health, biomedical scientists (pillar 1) and health services stakeholders (pillar 3) should collaborate in a broad-scope, multidisciplinary translational research team through an elaborate complex model [12]. However, little is known about the characteristics and impacts of implementing collaborative models. Thus, we sought to identify and describe collaboration models that link biomedical research with CBPHC in chronic diseases management (see eligibility or inclusion criteria section for details).

Methods

Knowledge synthesis design

We carried out a scoping review following previous frameworks [13, 14]. A scoping review is defined as a type of knowledge synthesis that follows a systematic approach to map evidence on a topic and identify main concepts, theories, sources, and knowledge gaps [15]. This type of exploratory synthesis was preferentially chosen because it gave us an inventory of the evidence in a given field and a reproducible synthesis of it [12, 13]. In addition, it includes a consultation phase of different stakeholders (e.g., researchers, patient-partners, family physicians, manager and decision-makers) aimed at finding any missed published or unpublished literature and adding important contextual elements [12, 13]. We followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) in the reporting of this scoping review (Additional file 1) [15]. The protocol for this review was previously registered in the Open Science Framework [16].

Inclusion/exclusion criteria

The inclusion and exclusion criteria for our scoping review were defined according to the PICOS approach (P = Population in study, I = Intervention, C = Comparator, O = Outcome and S = Study design) [17] as follows:

Population

Any person with diabetes or its complications, obesity or its complications, cardiovascular diseases and their

complications or any other aging-associated chronic disease. Animal models were excluded

Intervention

Any model in which a collaboration between biomedical research (pillar 1) and CBPHC (pillar 3) actors was described. Clinical research (pillar 2) could be present or not. We used the Canadian Institutes of Health Research (CIHR) definition for pillar [18, 19]:

Biomedical research (pillar 1) is research with the goal of understanding normal and abnormal human functioning, at the molecular, cellular, organ system and whole-body levels, including development of tools and techniques to be applied for this purpose; developing new therapies or devices that improve health or the quality of life of individuals, up to the point where they are tested on human subjects. Biomedical research may also include studies on human participants that do not have a diagnostic or therapeutic orientation [18, 19]. Actors of pillar 1 are typically basic scientists (molecular or cellular biology, chemistry, etc..) [20].

Community-based primary health care (Part of pillar 3: Health services) covers the broad range of primary prevention (including public health) and primary care services within the community, including health promotion and disease prevention; the diagnosis, treatment, and management of chronic and episodic illness; rehabilitation support; and end of life care. CBPHC involves the coordination and provision of integrated care provided by a range of healthcare providers, including physicians, nurses, social workers, pharmacists, dietitians, public health practitioners, patients and others in a range of community settings including people's homes, healthcare clinics, physicians' offices, public health units, hospices, and workplaces [18, 19, 21]. It is important to note that Pillar 3 also includes secondary and tertiary healthcare (specialists). In our study, we focused on CBPHC, but we did not exclude other Pillar 3 actors.

Clinical research (pillar 2: transition between pillar 1 and 3) aims at improving the diagnosis and treatment of diseases. It then attempts to translate knowledge acquired through biomedical research (pillar 1) to improve the health and quality of life of individuals through healthcare advancements (pillar 3) [14]. Actors of the pillar 2 are typically clinical researchers that include clinicians (clinician-researchers) and other health practitioners engaged in clinical research [7]. In this pillar 2 group, clinician-researchers are considered to be an important figure in health research. They are physicians-researchers with active clinical practices as well as active basic science laboratories, who can understand a disease as both a scientific phenomenon and a medical problem afflicting patients [22]. As mentioned above, the research process makes the contribution of pillar 2 implicit in a collaboration between pillars 1 and 3.

Comparators

Any type of comparator was considered.

Outcomes

Any type of outcome measured that related directly or indirectly to the collaboration. We excluded all outcomes not related to collaboration.

Types of study

All study designs were considered except comments, editors' opinions and replies, and book chapters.

Information sources and search strategy

An information specialist (NR) created a comprehensive search strategy to identify studies that assessed a model of collaboration between biomedical researchers and CBPHC providers. We searched the following databases: Medline (Ovid), Embase, Web of Science, and the Cochrane Library from their inception to November 2020. The search strategy was refined by the information specialist (NR) and revised by a scientist (HTVZ) using the PRESS (Peer Review of Electronic Search Strategies) tool [23] (Additional file 2). Terms combined Medical Subject Headings (MeSH) or their equivalents (where available) with keywords, truncations, and Boolean operators. We did not apply any restrictions.

Additional search strategies

Besides formal literature searches, we retrieved additional relevant references using three methods. The first was an electronic search of the grey literature using the Google Search engine. The second was screening the reference lists of some of our included studies. The third was presenting the data to an expert panel. We selected them based on their profiles and experiences. They were biomedical researchers, clinician-researcher, specialists, CBPHC clinicians and patient partners ($n=25$) (Additional file 3). At a two-hour workshop, preliminary findings were presented to the panel and discussed. Results of this scoping review were presented in lay terms by the principal investigator (JSP). During the review process, team members were consulted regularly to identify articles and additional documents, for their advice on the data extraction and coding, and to guide orientation, analysis, and interpretation of data.

Data collection

Selection process

We selected the relevant articles and documents based on the inclusion criteria and our research questions stated thereafter. The selection process was validated by a conclusive pilot independently carried out by two reviewers (ED and GL) on a randomly selected sample of

10% of the articles. Subsequently, the two reviewers (ED and GL) independently evaluated all identified articles in a two-step screening process. The first step consisted of screening titles and abstracts, and the second of reading the full texts of articles that passed the screening. Any disagreements between reviewers were resolved by a third reviewer (JSP). Corresponding or first authors of studies were contacted by email to obtain missing information or clarification when needed.

Data extraction

We developed a data extraction form and extraction guide based on our research questions as follow:

1. What are the characteristics of collaborations between biomedical research and CBPHC actors in chronic disease management?
2. What are the elements that facilitate or hinder the implementation of these models?
3. What were the outcomes evaluated during the implementation of these models?
4. What was the impact of the implementation of these models?

We thus considered the following data:

1. Characteristics of the studies: first author, year of publication, country, and study design.
2. Characteristics of participants: people involved (e.g., biomedical researchers, clinical researchers, health care professionals, patients, citizens or users), their roles and fields of expertise.
3. Characteristics of the collaboration: its name, year(s) of implementation, level of the collaboration (e.g., international, local), clinical focus of the collaboration (e.g., obesity, diabetes), goal of the collaboration, its structure, activities initiated during the collaboration, its location, and the type of interaction between people involved.
4. Characteristics of the outcomes: outcomes measured, impact of the collaboration (reported or not), barriers and facilitators to implementation.

The data extraction process was independently performed by two reviewers (ED and GL). Before extracting data, we completed an extraction exercise on 10% of the articles included, randomly selected. Any disagreement was resolved by a third independent reviewer (JSP).

Bias assessment

No bias assessment was planned as this is a scoping review that aimed to analyse evidence available in the literature. This is consistent with our method frameworks [14, 24].

Data analysis and synthesis

Description and recoding of variables

The information extracted from the articles required cleaning and verification to create variables that were usable for the final analyses. Data extracted as text was recoded, while quantitative data was analyzed as is. All analyses were performed using Microsoft Excel (version 16; Microsoft corporation, Washington, USA).

Statistical, descriptive analyses

We described the characteristics of the studies, the participants, the collaboration models as well as the outcomes of the collaboration. For this description we used frequency measures such as numbers and their percentages for dichotomous and categorical variables, means and their standard deviations for continuous variables. Finally, we presented the results of our analyses in tabular and graphic form. To avoid misleading conclusions, we excluded variables with 50% or more of missing data from our analyses after contacting corresponding or first authors for further information.

Thematic analysis

We carried out a thematic analysis of the qualitative data based on methods in previous studies [25, 26]. The synthesis took the form of three stages which overlapped to some degree: the coding of primary analysis results, the organisation of these codes into related areas to construct descriptive themes; and the development of analytical themes [27].

Results

Search and selection

A total of 5139 studies were identified from bibliographic databases and 152 from additional searches. All duplicates were removed with Endnote (version X9.3.3); Clarivate Analytics, USA), and the remaining papers were screened using inclusion and exclusion criteria. We retained 13 studies reporting on 20 unique collaboration models [28–40] (Fig. 1).

Study characteristics

Collaborations were implemented between 1967 and 2014. Of the 13 included studies, seven were conducted in North America (four in Canada and three in USA) [28, 29, 31, 32, 34, 36, 39], five in Europe (Spain [30, 35], Denmark [33], Germany [38], and Netherlands [40] and one in Asia (China [37] (Fig. 2). Most of the included studies (62%) were empirical studies [28–33, 37, 39] and 38% were cross-sectional studies [34–36, 38, 40] (Fig. 3).

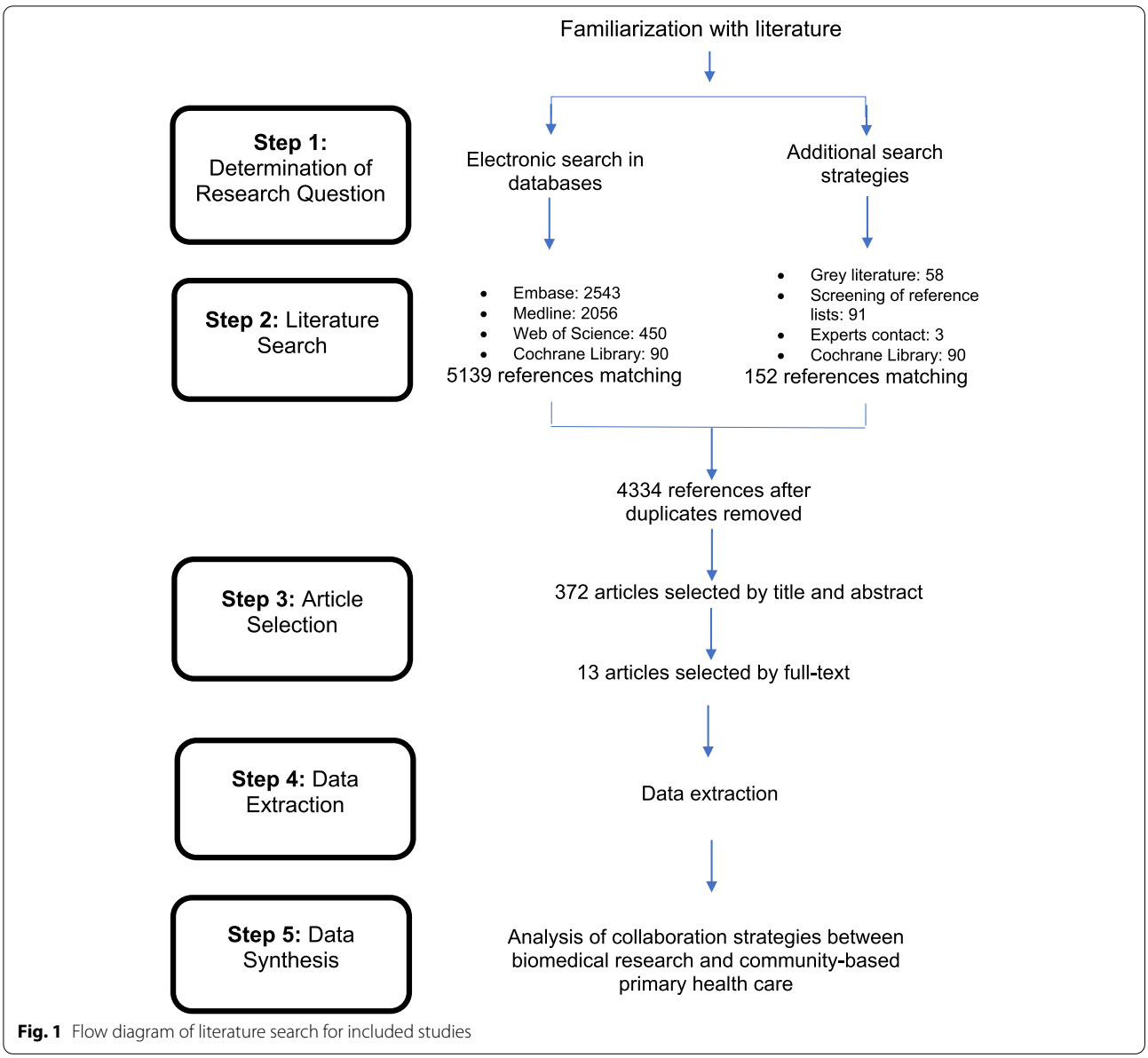

Fig. 1 Flow diagram of literature search for included studies

Characteristics of participants

All collaboration models ($n=20$) involved biomedical researchers and CBPHC actors. Four of the 20 collaboration models involved only these two groups [32, 34, 36, 39]. Eight collaboration models also included clinical researchers [37]. Three added both clinical researchers and specialists [28, 30, 38]. Three other collaboration models added clinical researchers, specialists and patients, citizens, or users (e.g., patient partners, policymakers, caregivers, or funding agencies) [29, 33, 35]. Two collaboration models added both clinical researchers and patients, citizens or users [31, 40]. Biomedical researchers in the 20 collaboration models worked in 26 different fields where the most frequent were biomedicine ($n=5$), neuroscience ($n=2$), biotechnology ($n=2$) and stem cell therapy ($n=2$). As for specialists, they worked in 18 different fields where the most frequent were cardiology (n = 3), epidemiology ($n=2$) and pharmacology ($n=2$). Physicians and nurses were the most frequent CBPHC actors involved in collaboration models (Table 1).

Characteristics of collaboration models

Among the 20 collaborations, the most prevalent level of operation was international ($n=9$) [31–35, 37, 38],

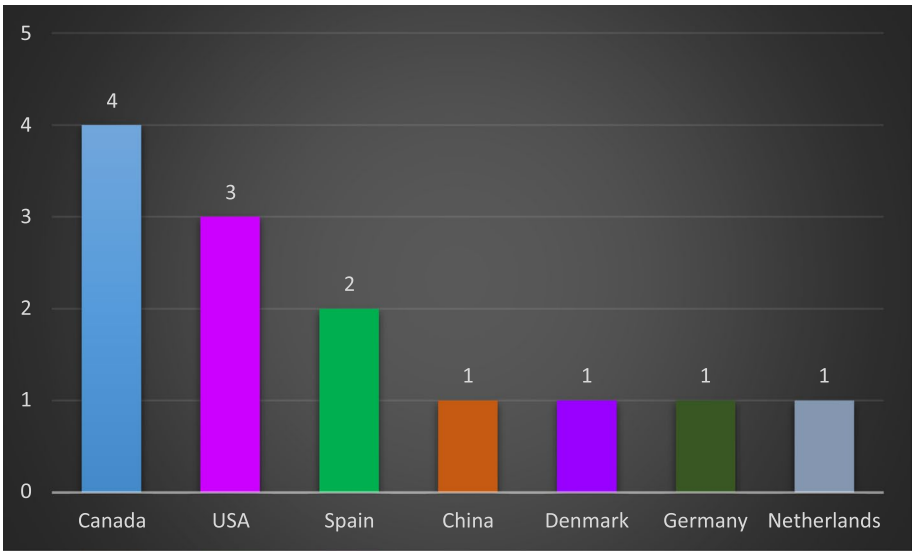

Fig. 2 Country of study

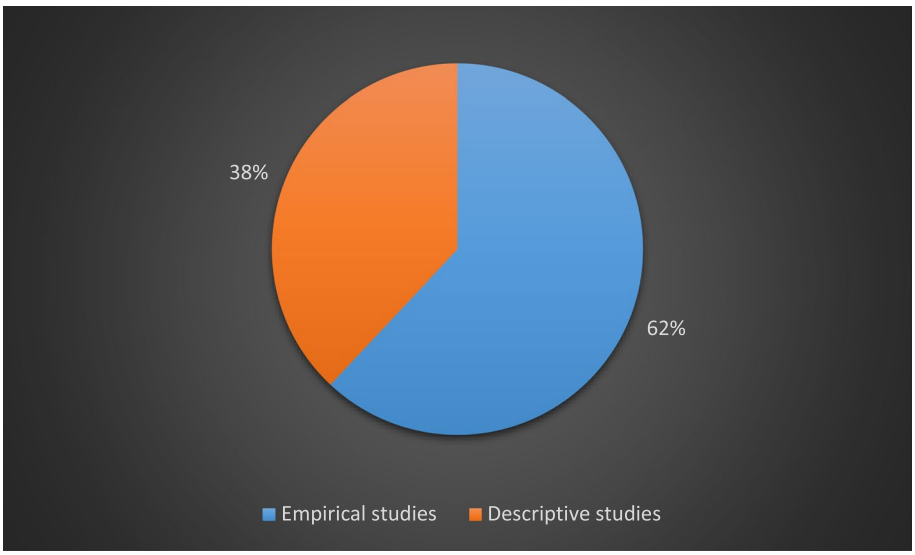

Fig. 3 Study design

followed by national ($n=4$) [29, 36, 37, 39], provincial ($n=4$) [37, 40] and local ($n=1$) [28]. The collaborations were implemented from 1967 to 2014 (Median = 2010) [28, 29, 32, 33, 35, 37–40]. About half of the collaboration models ($n=11$) had both public and private funding [29, 31, 34, 37, 40] and three had only public funding [35, 36, 39]. Nine collaboration models were centrally governed, i.e. by an authority that supervised the entire collaboration [29, 33, 34, 37, 40], two had multi-level governance, i.e. the authority was dispersed among all levels of the collaboration [37] and one had public governance i.e. were supervised by the government [35]. Six collaboration models had a hierarchical, i.e. pyramid structure where each level is in charge of the levels below and reports to the levels above [29, 33, 37]; and seven had network structures, i.e. collaboration was via informal networks rather than a formal organizational structure [28, 34–36, 38–40]. Half of the collaboration models ($n=10$) were located in both physical and virtual sites [29, 31, 35–37]. The clinical focus of the collaboration models ranged from cardiovascular disease ($n=8$), diabetes ($n=2$), gerontology ($n=2$), neurological ($n=1$) to brain

Table 1 Characteristics of participants

Variables	Number (n)	Percentage (%)
All profile groups involved in the collaboration (*n* = 20)		
Biomedical researchers and health care professionals	4	20
Biomedical researchers, health care professionals and clinical researchers	8	40
Biomedical researchers, health care professionals, clinical researchers and specialists	3	15
Biomedical researchers, health care professionals, specialists, clinical researchers and patients, citizens or users*	3	15
Biomedical researchers, health care professionals, clinical researchers and patients, citizens or users*	2	10
Field of study of biomedical researchers (*n* = 20)		
Biomedicine	2	10
Neurosciences	2	10
Cell biology	1	5
Lipidology	1	5
Molecular biology	1	5
Neurointerventional research	1	5
Mixed**	6	30
Biomedicine	*3*	*50*
Biotechnology	*2*	*33*
Stem cell therapy	*2*	*33*
Analytical chemistry	*1*	*17*
Bioinformatics	*1*	*17*
Biomaterials	*1*	*17*
Cellomics	*1*	*17*
Cell biology	*1*	*17*
Cell Technology	*1*	*17*
Chemistry	*1*	*17*
Developmental biology and birth defects	*1*	*17*
Energy	*1*	*17*
Environmental biological technology	*1*	*17*
Gene targeting	*1*	*17*
Genomics	*1*	*17*
Laparoscope technology	*1*	*17*
Materials science	*1*	*17*
Microscopy	*1*	*17*
Molecular biology	*1*	*17*
Pluripotent cell technology	*1*	*17*
Proteomics	*1*	*17*
Transgenesis	*1*	*17*
Viral vectors	*1*	*17*
Missing	6	30
Types of health care professional (except specialists, n=20)**		
Physicians	13	65
Nurses	4	20
Pharmacists	1	5
Dietitians	1	5
Laboratory technicians	1	5
Public health practitioners	1	5
Presence of clinical researchers (*n* = 20)		
Yes	15	75
No	4	20

Table 1 (continued)

Variables	Number (n)	Percentage (%)
Missing	1	5
Type of clinical researchers (*n* = 15)		
Clinician-researchers	3	20
Clinician and non-clinician-researchers	1	7
Missing	11	73
Presence of specialists (*n* = 20)		
Yes	7	35
No	3	15
Missing	10	50
Field of expertise of the specialists (*n* = 7)		
Mixed**	6	86
Cardiology	*3*	*50*
Epidemiology	*2*	*33*
Pharmacology	*2*	*33*
Atherothrombosis and Imaging	*1*	*17*
Genetic medicine	*1*	*17*
Internal medicine	*1*	*17*
Nephrology	*1*	*17*
Cardiovascular development and repair	*1*	*17*
Community health	*1*	*17*
Family and community medicine	*1*	*17*
General medicine	*1*	*17*
Geriatric	*1*	*17*
Methodology in clinical research	*1*	*17*
Neurology	*1*	*17*
Psychiatry	*1*	*17*
Public health	*1*	*17*
Vascular biology and inflammation	*1*	*17*
Vascular medicine	*1*	*17*
Missing	1	14
Presence of patients, citizens or users (*n* = 20)		
Yes	7	35
"Patients"	*2*	*29*
"Patients and citizens"	*2*	*29*
"Patients and users"	*1*	*13*
"Patients, citizens and users"	*2*	*29*
No	13	65
Roles of patients (*n* = 7)		
Patient participants****	4	70
Patient partners	3	30
Roles of citizens or users (*n* = 6)		
Caregivers	1	17
General public	1	17
Policy and decision-makers	1	17
Mixed**	3	49
Academia	*1*	*33*
Charities	*1*	*33*
Clients and/or their representatives	*1*	*33*
Caregivers	*1*	*33*

Table 1 (continued)

Variables	Number (n)	Percentage (%)
Funding agency	*1*	*33*
Health care directors	*1*	*33*
National Health System	*1*	*33*
Patient organizations	*1*	*33*
Pharmaceutical company representatives	*1*	*33*
Policy and decision-makers	*1*	*33*
Regulatory science experts	*1*	*33*
Scientific societies	*1*	*33*
Stakeholders	*1*	*33*
Teachers	*1*	*33*

* Only the partners of patients, citizens or users (included in the collaboration)

** For Non-mutually exclusive categories (each category was coded yes/no; the fraction was calculated as follows: the value of each category is divided by the total number of the mixed category)

*** Patient participants: Patients treated or included in research project but not included in the collaboration

disease ($n=1$) and four of them had more than one clinical focus (mixed) ($n=4$). The goals of the collaboration models included improving biomedical research ($n=17$), promoting collaborative practices ($n=15$), promoting knowledge translation ($n=14$), supporting patient treatment ($n=11$), improving clinical practice ($n=8$) and helping prevent disease ($n=6$). Characteristics of collaboration models are summarized in (Tables 2 and 3).

Characteristics of outcomes

Outcomes of interest measured in the 13 included studies were related to biomedical research ($n=1$) [30], to collaboration ($n=8$) [28, 29, 31, 35, 36, 38–40] and to both research and collaboration ($n=4$) [32–34, 37]. Among the studies, two used subjective measurement tools to measure outcomes [30, 32], one used objective measurement tools [39], another one used both objective and subjective measurement tools [37] and the nine other studies had missing measurement tools. In seven studies, we identified barriers to collaboration, such as lack of knowledge, information, financial support, leadership, or robust management structures [30, 32, 34, 36–39]. In 12 studies, we identified facilitators of collaboration, such as collaboration partnership, cooperation, multidisciplinary research teams, project management or leadership. Outcome characteristics are summarized in (Table 4).

Impacts of collaboration models

Only seven collaboration models reported a measurable impact (e.g. creation of a strong base of talented and expertly researchers, participation of patients in workshops, enrollment of medical professionals on training programs, etc.) [28, 31, 33, 35, 36, 38, 40].

In order to give a visual and comprehensive illustration of study findings, we created a summary figure presenting the characteristics of the collaborations described in the selected articles (Fig. 4).

Discussion

We identified and characterized the types of collaboration that connect biomedical researchers with CBPHC actors in chronic diseases research. We identified a total of 13 studies that described 20 unique collaboration models. All are from high income countries, and most were implemented between 2010 and 2014. Results revealed a wide array of collaboration models implicating a large spectrum of profiles and fields of expertise in biomedical research, health care and clinical research. Our results lead us to make the following observations.

First, studies identified in our scoping review were conducted solely in North America, Europe and Asia. No more information on low-income countries studies were found, results are limited to high-income countries. This observation is consistent with previous studies which concluded that high-income countries spend a substantial portion of their budgets on research [41, 42]. In contrast, research is less prioritized in low-income countries [41, 42]. In fact, most of the research conducted globally is initiated by North America and western Europe research (46.1%) followed by east Asia and the Pacific (40.6%). Only a small proportion of this research is conducted by central Asia (0.1%) and sub-Saharan Africa (0.8%) [42].

Second, in terms of scale, results show that a significant proportion of collaboration models operate at the international level (45%) while very few were at a local level

Table 2 Characteristics of collaborations

Variables	Number (n)	Percentage (%)
Level of the collaboration (*n* = 20)		
International	9	45
Federal	4	20
Provincial	4	20
Local	1	5
Missing	2	10
Year of implementation (*n* = 20)		
2010	4	20
2011	3	15
2014	2	10
2012	1	5
2009	1	5
2008	1	5
2002	1	5
1999	1	5
1998	1	5
1967	1	5
Missing	4	20
Funding sources (*n* = 20)		
Public and Private	11	55
Public	3	15
Missing	6	30
Structure** (*n* = 20)**		
Network structure	7	35
Hierarchical structure	6	30
Divisional structure	3	15
Team-based organizational Structure	3	15
Missing	1	5
Location (*n* = 20)		
Physical and Virtual sites	10	50
Physical site	3	15
Virtual site	2	10
Missing	5	25
Clinical focus (*n* = 20)		
Cardiovascular diseases	5	25
Mixed**	4	20
Cancer	*3*	*75*
Cardiovascular diseases	*3*	*75*
Brain glioma	*1*	*25*
Chronic metabolic diseases	*1*	*25*
Diabetes	*1*	*25*
Endocrine and metabolic diseases	*1*	*25*
Gerontology	*1*	*25*
Hemopoietic disease	*1*	*25*
HIV/AIDS	*1*	*25*
Inflammatory diseases	*1*	*25*
Kidney disease	*1*	*25*
Obesity	*1*	*25*
Neuropsychological disease	*1*	*25*

Table 2 (continued)

Variables	Number (n)	Percentage (%)
Psychosomatic diseases	*1*	*25*
Reproductive health	*1*	*25*
Trauma	*1*	*25*
Visual reconstruction	*1*	*25*
Cardiovascular disease complications	1	5
Diabetes	1	5
Diabetes complications	1	5
Gerontology	1	5
Neurological diseases	1	5
Brain diseases	1	5
Missing	5	25
Goal (*n* = 20)		
Mixed**	19	95
To improve biomedical research	*17*	*89*
To promote collaborative practices	*14*	*74*
To promote the translation between research and clinical practice	*14*	*74*
To support patient treatment	*11*	*58*
To improve clinical practices	*8*	*42*
To help prevent diseases	*6*	*32*
To ensure equitable benefit from scientific evidence	*1*	*5*
To promote collaborative practices	1	5
Type of interaction between the people involved (*n* = 20)		
Mixed**	18	90
Collaboration	*18*	*100*
Partnership	*18*	*100*
Information	*7*	*39*
Consultation	*4*	*22*
Collaboration	1	5
Missing	1	5
Governance (*n* = 20)***		
Central governance	9	45
Multi-level governance	2	10
Public governance	1	5
Missing	8	40

** Non-mutually exclusive categories (Each category was coded yes/no; The fraction was calculated as follows: the value of each category is divided by the total number of the mixed category)

**** **Hierarchical structure:** This structure looks like a pyramid: each level is in charge of the levels below and reports to the levels above (also referred to traditional structure).**:** In this structure, employees are grouped, with every employee having one clear supervisor. / **Network Structure:** Connected together by informal networks and the demands of the task, rather than a formal organizational structure. The network organization prioritizes its "soft structure" of relationships, networks, teams, groups and communities rather than reporting lines. / **Divisional Structure:** Organization is split up into semi-autonomous units called divisions. While the divisions have control over their day-to-day operations, they still are answerable to a central authority that provides the overall strategy for the organization and coordinates its implementation among the divisions. / **Team-based Organizational Structure:** Groups employees who perform specific duties into project teams that perform specific functions

***** **Multi-level governance:** There is a dispersion of authority between levels of collaboration / **Central governance:** An authority governs entire collaboration / **Public governance:** Refers to the evolving role of the State (government sector)

(5%). This indicates that few smaller-scales (local) translational collaborations are described in the literature. While it is possible that these collaborations are simply less likely to be published, it could also suggest that only larger research teams with an extensive international network possess the funding and resources to conduct translational research. Local teams, which have the expertise and proximity to foster discussions and collaborations between the community and researchers, are not well represented in the literature. Geographic proximity

Table 3 Characteristics of outcomes

Variables	Number (n)	Percentage (%)
Study outcomes (n=13)		
Collaboration outcomes	8	61
Collaboration and Research outcomes	4	31
Research outcomes	1	8
Outcome measurement tool (n=13)		
Subjective measure	2	15
Objective measure	1	8
Objective and Subjective measures	1	8
Missing	9	69
Barriers (n=20)		
Mixed**	11	55
Lack of financial support	*10*	*91*
Lack of knowledge/information	*10*	*91*
Lack of leadership	*8*	*73*
Lack of robust management structures	*8*	*73*
No integration in educational programs	*8*	*73*
Intellectual property rights	*1*	*9*
Arduous task	*1*	*9*
Ownership of data	*1*	*9*
Career disincentives	*1*	*9*
Difficulty of simultaneously performing health care and research activities in a hospital setting	*1*	*9*
Fragmented infrastructure	*1*	*9*
Incompatible databases	*1*	*9*
Lack of confidence	*1*	*9*
Practice limitations	*1*	*9*
Time-consuming	*1*	*9*
Lack of financial support	2	10
Lack of knowledge/information	1	5
Missing	6	30
Facilitators (n=20)		
Mixed**	18	90
Collaboration partnership	*12*	*67*
Cooperation	*8*	*44*
Multidisciplinary research teams	*8*	*44*
Project management	*8*	*44*
Researcher management	*8*	*44*
Collaboration internal organisation	*7*	*39*
Leadership	*6*	*33*
Collaboration infrastructure	*5*	*28*
Human resources	*4*	*22*
Material resources	*3*	*17*
Financial support	*3*	*17*
Flexibility	*1*	*6*
Interactions between Consortiums	*1*	*6*
Training course	*1*	*6*
Financial support	1	5
Missing	1	5
Impact (n=20)		
Not reported	13	65
Reported	7	35

** Non-mutually exclusive categories (Each category was coded yes/no; The fraction was calculated as follows: the value of each category is divided by the total number of the mixed category)

is recognized as facilitator to collaboration as it favors planned or spontaneous interactions between individuals. This increased interaction is said to be conducive to the exchange of ideas and transfer of knowledge [43, 44]. Therefore, supporting local collaborations can be an efficient way to promote translational research. In addition, local collaboration play a role into addressing health disparities with the creation of programs adapted for the sociocultural, geographic and economic determinants that characterize this area's minority community [45].

Third, our findings revealed that collaborations adopted two predominant organisational structures: network (35%) and hierarchical (30%). A hierarchical structure uses the traditional top-down line of authority for decision making. However, it tends to allow for less productive exchanges and communications and hinders teamwork which affects outcomes [46]. The network structure on the other end, consists of interactions between equal entities and tends to be more conducive to collaboration which leads to better outcomes [47, 48]. Accordingly, the literature indicates that the effectiveness of collaborations is strongly tied with the research team's power dynamics [49]. It is thought that, in complex models of translational research, the usability and relevance of medical knowledge and technologies are crucial for an effective translation process [12]. As a network structure creates an optimal environment for the communication of this knowledge and the sharing of these technologies, it would therefore be important to promote this collaborative organizational structure. Further research will be necessary to confirm the advantages of a network structure in translational research collaborations.

Fourth, previous studies suggested that a multidisciplinary, interdisciplinary, or transdisciplinary team is beneficial to a collaboration's success [50]. Patients, citizens or user's participation is now regarded as a central element in the promotion of sustainable health and health care [49, 51, 52]. In addition, specialists' integration in the planning, development and implementation of models for the management of chronic diseases has proven vital to its success [53]. Our findings reveal that only 25% of collaborations involve patients or citizens and only 30% involve specialists. Patients and specialists are facilitators who participate in knowledge transfer and help to improve understanding of the health care system. It is important to include them in research teams to improve translational research outcomes. In addition, effective communication foundations were identified in previous studies: (i) no one capable of making a relevant contribution has been excluded, (ii) participants have equal voice, (iii) they are internally free to speak their honest opinion without deception or self-deception, and (iv) there are no

Table 4 Description of collaboration models

Names of collaboration (n=20)	Country of study	Year of implementation	Objectives of the study	Article title
Centro Nacional de Investigaciones Cardiovasculares Carlos III (CNIC) [35]	Spain	1999	To improve cardiovascular health in the general population by generating scientific knowledge, efficiently translating that knowledge to the clinic, and providing new researchers with a comprehensive training	CNIC: Achieving Research Excellence Through Collaboration
Clinic of Nutrition, Metabolism and Atherosclerosis (CNMA) [28]	Canada	1967	To evaluate and care for dyslipoproteinemic patients with complex, rare and serious problems	A lipid clinic associated with a research laboratory working on dyslipoproteinemias and atherosclerosis
College of Translational Medical Research (CTMR) of the first hospital of Zhejiang province [37]	China	2010	To assist cooperation between basic and clinical research,provide support for translation and cooperation, and innovate management to realize cooperation of research groups	Challenges facing translational research organizations in China: a qualitative multiple case study
East Translational Medical Research Center (TMRC) of Tongji University [37]	China	2010	To integrate government, enterprise, education, research, and medicine; promote integration of basic and clinic care; prioritize the development of translational medical research as the primary task, adhering to the operation mode of "political, industry, education, research and medical field"; and fully integrate with advanced clinical and scientific research resources	Challenges facing translational research organizations in China: a qualitative multiple case study
European Brain Council (EBC) [33]	Denmark	2002	To promote a greater and more focused effort in thisarea, to improve public understanding of the brain sciencesand above all, to support brain research	Consensus document on European brain research
Heart failure specialists of Tomorrow (HoT) [38]	Germany	2014	To improve the care of heart failure patients	The heart failure specialists of tomorrow: a network for young cardiovascular scientists and clinicians
International Consortiumof Neuro Endovascular Centres (ICONE) [34]	Canada	Missing	To gather the scientific expertise, the know-how of clinical trial realization; To provide advisory or consulting services; To construct an international network of high-volume neurovascular centres, staffed with highly-skilled experts, communicating and coordinated in a central fashion; To report in a standardized way the outcome of their treatments, whether positive or negative	ICONE: An International Consortium of Neuro Endovascular Centres

Table 4 (continued)

Names of collaboration (n=20)	Country of study	Year of implementation	Objectives of the study	Article title
Living Lab in Ageing and Long-Term Care [40]	Netherlands	1998	To contribute through scientific research to improving quality of life for older people and their families; quality of care, and quality of work for those employed in long-term care	The Living Lab In Ageing and Long-Term Care: A Sustainable Model for Translational Research Improving Quality of Life, Quality of Care and Quality of Work
National Heart, Lung,and Blood Institute (NHLBI) [36]	USA	Missing	To pursuing excellent science both to advance scientific knowledge and to improve the public health	Translational Research for Cardiovascular Diseases at the NHLBI: Moving from Bench to Bedside and From Bedside to Community
Peking Union Medical College Hospital Translational Medical Center (PUMCH-TMC) [37]	China	2010	To provide a robust platform for translational medicine research programs (to provide consulting services and technical support to researchers, create more collaborations and partnerships) and provide post-graduate education. With consistent effort, the PUMCH-TMC aims to become a national and international translational medicine institute	Challenges facing translational research organizations in China: a qualitative multiple case study
Synergium (a forum for working synergistically together) [31]	Canada	Missing	To devise and prioritize new ways of accelerating progress in reducing the risks, effects, and consequences of stroke	Stroke: working toward a prioritized world agenda
The 13th Research Centers for Minority Institutions(RCMI) International Symposium on Health Disparities [32]	USA	2012	To explore: the role of translational research in clinical research and healthcare, determine if there is a need for a unified model for research workforce development, and ascertain if this intervention would increase the effectiveness of health interventions and reduce health disparities?	Incorporating translational research with clinical research to increase effectiveness in healthcare for better health
The Canadians Seeking Solutions and Innovations to Overcome Chronic Kidney Disease (Can-SOLVE CKD) Network [29]	Canada	2014	To accelerate the translation of knowledge about CKD into clinical research and practice	Canadians seeking solutions and innovations to overcome chronic kidney disease (Can-SOLVE CKD): Form and function
Translational Medical Research Center (TMRC) of Children's hospital of Fudan University [37]	China	2008	To be become the national or Asian center of child medicine and medical teaching and research and to facilitate the integration of basic and clinic research	Challenges facing translational research organizations in China: a qualitative multiple case study

Table 4 (continued)

Names of collaboration (n=20)	Country of study	Year of implementation	Objectives of the study	Article title
Translational Medical Research Center (TMRC) of North East of China [37]	China	2010	To integrate basic research, clinic medicine, and bio-industry; cultivate translational scientists; form a translational medical research network; integrate preclinical medicine, clinical medicine and drug development; establish open and cooperative networks in Northeast China; and develop medicine, disease diagnoses, and strategies for treatment	Challenges facing translational research organizations in China: a qualitative multiple case study
Translational Medical Research Center (TMRC) of West China Hospital [37]	China	2009	To promote cooperation between basic research and clinical care, support outcome translation, insist on research-education-industry cooperation, and encourage this center and industry to participate in translational research by a joint-stoke model	Challenges facing translational research organizations in China: a qualitative multiple case study
Translational Medical Research Center (TMRC) of Wuhan Union Hospital [37]	China	2011	To bridge basic, clinical, and bio-industry in order to promote new technology, products, and drugs; promote multidisciplinary cooperation; and cultivate translational scientists	Challenges facing translational research organizations in China: a qualitative multiple case study
Translational Research Center of Stem Cell Regenerative Medicine (TRCSR) in Shanghai Ninth hospital [37]	China	2011	To assist multidisciplinary cooperation, cultivate translational scientists, and provide a platform of domestic and international translational research in the field of regenerative medicine	Challenges facing translational research organizations in China: a qualitative multiple case study
Washington University Center for Diabetes Translation Research (WU-CDTR) [39]	USA	2011	To enhance scientific progress through support of rigorous translation research aimed at the prevention and treatment of diabetes and related conditions	Developing priorities to achieve health equity through diabetes translation research: a concept mapping study
Missing [30]	Spain	Missing	Missing	Interdisciplinarity of spanish cardivascular research teams

sources of coercion built into the process and procedures of discourse [54].

Fifth, in terms of collaboration between pillar 1 and pillar 3, pillar 2 actors (clinical researchers) play a major role in the translational research continuum as it bridges the gap between pillar 1 and pillar 3 [22]. Because of their knowledge of both basic research and clinical practice, they can inform basic researchers with clinical observations and generate new research questions and hypotheses based on the realities of a clinical setting. Also, clinical researchers often work with different organizations (government, academic, industrial) which further promotes the dissemination of knowledge and have access to grants that are not available to basic researchers. Thus, as we expected, pillar 2 are present in the collaborative models. Our results indicate that over 75% of studies include clinical researchers. However, even though many studies report clinical researchers, few studies specify the presence of clinician-researcher. Yet, clinician-researcher play

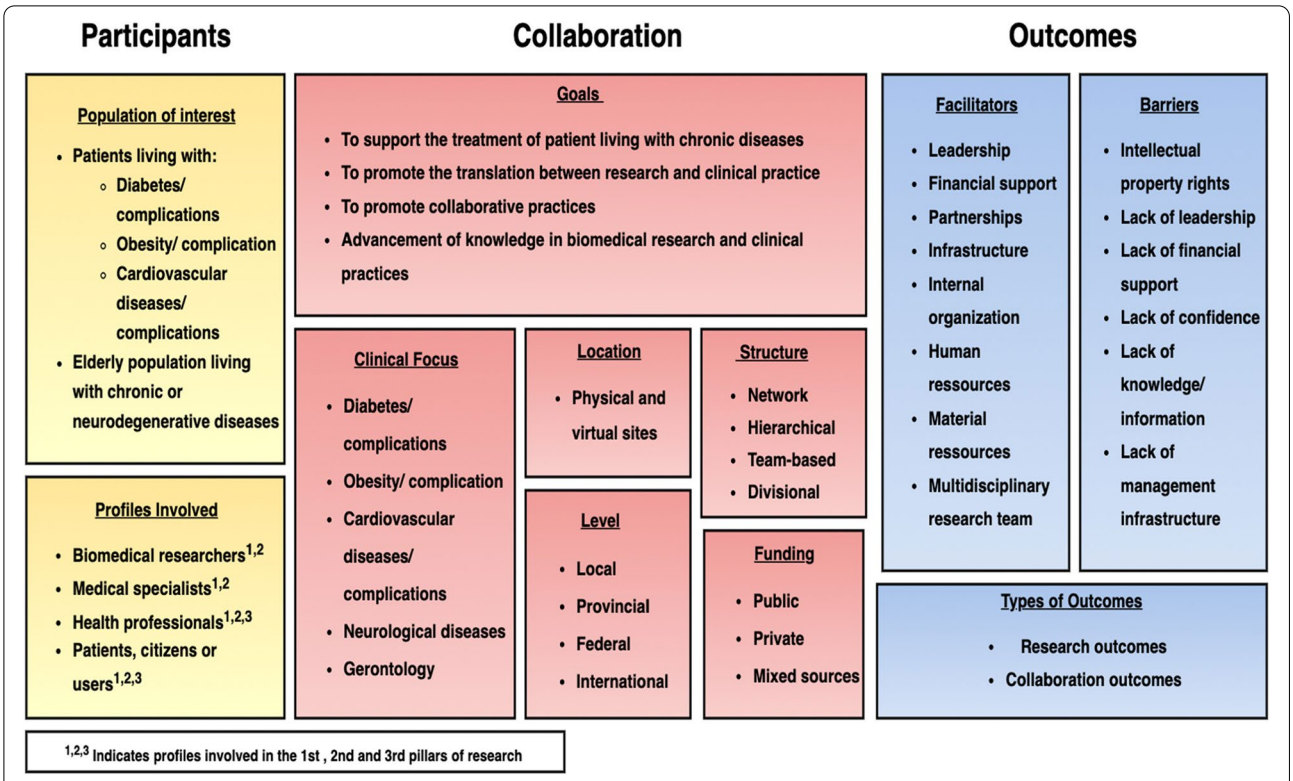

Fig. 4 Characteristics of collaboration models for translational research on chronic diseases. Note: This figure visually summarizes the findings of this scoping review with the characteristics of the collaborations described in the selected articles. Summarizes the characteristics of the participants (yellow), collaboration (red) and of the outcomes (blue) described in the selected articles

a very important role in bridging the gap and serving as effective bridge between pillar 1 and pillar 3 [55].

Sixth, whilst the importance and the benefits of translational research collaborations are known, we identified significant challenges reported by investigators. These barriers included significant lacks or insufficiencies in financial support, knowledge/information, leadership, management structures and integration in educational programs. These challenges were both external and internal to science, as previously described [12]. More than one translational gap may exist, and the cause for each gap may have multiple origins [12]. Other studies support the existence of the barriers revealed in this study. For example, in 2001, in highlighting the failures of collaborations to translate scientific discoveries into practice, authors attribute these failures to insufficient targeted resources, a shortage of qualified investigators, increasing regulatory burden, and a lack of mechanisms for addressing the problems that arise [56]. On the other hand, the facilitators reported by investigators related to their partnerships, multidisciplinary teams, management, infrastructures and resources. In a logical manner, these facilitators could all serve as solutions to the abovementioned challenges described by investigators.

Lastly, we identified 13 studies reporting on 20 collaboration models, only seven of which reported impact and the other 13 not reporting any impact at all, positive or negative. The amount of available evidence is also very limited in terms of describing collaborative teams, barriers, and facilitators between pillar 1 and 3. It seems that authors do not clearly describe their collaborative models and do not report the details of their team members, but rather their research project. All findings observed indicate the need for a comprehensive reporting guideline for collaboration models.

Limitations

Our review has some limitations. First, as in any literature review, we cannot be certain that we have identified all the relevant studies. It is possible that the rigorous selection criteria we used led us to reject some of them. However, if this is indeed the case, it would mean that these studies did not adequately describe the team composition, reinforcing the importance of having consistent guidelines for reporting on collaborative models in order to assess their effectiveness. Second, some variables were excluded from analyses due to missing information, which may have biased our results in favor of

a specific type of reporting process for collaborations. Third, no bias assessment was performed in our scoping review, therefore, bias in included studies is a potential limitation for our study. Fourth, studies described in the manuscript are focused on high-income countries which can have a major impact on the representativeness of the results.

Conclusions

Our scoping review provides a portrait of collaborative efforts between biomedical research and CBPHC actors for translational research in chronic disease. We identified a large variety of collaboration models mobilizing a large spectrum of profiles and fields of expertise in biomedical research, health care and clinical research. The small number of eligible studies indicate that there are little published reports of this type of collaboration or that the way by which collaborations report on their activities lacks the details necessary to properly identify them. The latter is also likely considering that the minority of the identified collaborations explicitly reported an impact. Moreover, studies being conducted in high-income countries limit the representativeness of the results. Further research should aim to identify collaborations in low-income countries, to determine which characteristics could better translate evidence into clinical practice and improve stakeholder outcomes in these contexts. With this data, we intend to develop a logic model that will assist managers and policymakers in planning future initiatives that will foster collaboration among all stakeholders in the research continuum.

Abbreviations

CBPHC: Community-based primary health care; OSF: Open Science Framework; PRISMA-ScR: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews; TR: Translational medicine or translational science.

Supplementary Information

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Additional file1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklists

Additional file2: Search strategy

Additional file3: List of experts participating in the 2-hour workshop

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Authors' contributions

JSP, HTVZ, ED, GL, NR and FL contributed to the conception and design of the scoping review. JSP, HTVZ, ED and GL participated to the selection of studies and the data extraction. JSP, HTVZ, ED and GL performed data analysis. JSP, HTVZ, ED, GL and FL drafted the first version of manuscript. All authors provided a critical review on the initial manuscript and its subsequent versions. All authors read and approved the final manuscript. Only the authors are responsible for the information provided or views expressed in this study.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All individuals named in the acknowledgements section below consented to being acknowledged in this publication. We did not include any other individual person's data in any form.

Competing interests

Authors have no potential conflicts of interest.

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