Review

Evolution of Therapeutic Patient Education: A Systematic Scoping Review and Scientometric Analysis

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Abstract: Therapeutic patient education (TPE) aims to empower the patients and their caregivers to effectively care for and manage their conditions. Such educational programs have been shown to improve health behaviors, disease outcomes and quality of life among different patient populations. The field of TPE has evolved extensively over decades, owing to interdisciplinary research. No study so far has been done to map this field, to identify the stakeholders and gaps requiring future research. By leveraging the theory of co-citation, Citespace was used to visualize the bibliographic data pertaining to TPE research. A total of 54,533 articles published in English language were analyzed to identify influential funders, regions and institutes contributing to this field. Besides these, important theoretical and empirical work that has shaped this field has also been mapped. Our analysis revealed several important insights. Most of the important theories which helped shape TPE were inspired from the social sciences. Five important themes of research were identified including disorders, study designs utilized in TPE research, scope of the TPE literature, and outcomes, and populations. The research focused on improving perceptions, behaviors, and attitudes for health promotion, reducing stigma as well as self-management and medication adherence. Most of the research was developed in the context of high income countries. The future research should more involve patients and use digital technology. Meta-analytical studies need to be done to identify the specificities of TPE interventions across different disorders. More research should involve low and middle income countries (LMIC) to ensure knowledge and technology transfer.

Keywords: Patient education; health literacy; scientometric analysis

1. Introduction

Therapeutic patient education (TPE) helps patients and their caregivers understand and effectively manage their chronic disorders [1,2]. These programmes have been shown to positively alter health behaviours and thus improve biological, psychological, and quality of life outcomes, for many chronic disorders [3–6]. Recognizing the potential of TPE interventions, several stakeholders and international medical organizations have recommended their use in routine patient care [4,5,7].

The field of patient education and health literacy is interdisciplinary, underpinned by frameworks derived from disciplines such as psychology and education [8,9]. And it is essential to identify major theories and empirical works on TPE, to understand how this field has evolved over the years. [10]. This has become possible in recent years due to

developments in the field of scientometrics (analysing scholarly literature) and the availability of bibliographic databases [11]. By utilizing statistical and machine learning approaches, analyses of bibliographic databases can yield insights pertaining to the field-specific impact of scientists, collaborative networks, and institutes, and major scholarly works [12,13]. Such exercises not only help map the scholarly contributions in a discipline but also identify gaps or areas which require more effort [15]. Thus, using these techniques all stakeholders in the research and development process including researchers, policy-makers, and funding agencies can determine areas where more infrastructure and human resource personnel and funding is required [13].

As previously noted, the discipline of TPE is a broad one, owing its evolution to interdisciplinary collaborative work. Therefore, it is important to identify those influential theoretical and empirical works, which form the basis of this discipline. It is also important to identify the areas where research in this field is most concentrated in and the gaps where more resources are required. To our knowledge, there is a paucity of such literature in the field of patient education. This investigation addresses this paucity, and aims to i) quantize the research output, ii) identify major stakeholders and iii) map the influential works which have contributed to this field.

2. Methods

We searched the Web of Science (WoS) core database, for literature pertaining to health literacy and TPE, using a pretested search strategy, through inception to May 2021 (Table 1). WoS yielded 54,533 articles published in English language. Bibliographic characteristics of these articles along with their citing references were downloaded. This database was chosen for this investigation [11] because of its multidisciplinary coverage spanning over 20,000 journals and over 79 million references records. It also allows detailed advanced scientometric analyses due to the availability of cited references for each article [16].

Table 1. Search strategy to identify studies pertaining to patient education research.

Scope	Details
Terms	("Health education*" OR "patient education*" OR psychoeducation* OR "therapeutic education*" OR "consumer health information*" OR "health knowledge" OR "health literacy")
Scope of search	TS: Topic, Title, Abstract, Author Keywords and Keywords Plus®
Period	Through May 17, 2021
Filters	Articles published in English language
Total search results	54,533

For scientometric analyses, we utilized the CiteSpace software (v 5.7.R5W), which is a Java based platform for visualization of bibliographic data [17]. An excellent feature of this software is the ability to conduct co-citation analyses to reveal the collaborative networks in bibliographic data. It is based on the Theory of co-citation which posits that two studies are related when one or more studies them together [10,18].

We analyzed the whole dataset (without restriction to year of publication) to quantify the trends in the research output and major players in the field of TPE. However, co-citation analyses were only conducted for bibliographic records from 1990 to 2021. These records were divided into 1-year periods, using time slicing methods, with each time slice represented by top 100 articles published in that period. This analytical strategy was employed for identifying top keywords, and elucidate networks of countries, institutions, research categories and funding organizations.

Furthermore, we sought to identify influential studies in TPE research. By doing this, we envisioned constructing the roadmap presenting the evolution of the field of TPE over time. For this purpose, we divided the bibliographic records into six time periods from 1922 to 2021: Pre-1985; 1985 to 1996; 1997 to 2006; 2007 to 2011; 2012 to 2016; 2017 to 2021. Within each time-period, we chose top 50 cited articles per 1 year slice. Separate network graphs were created for each time-period, which visualized different studies as nodes and

co-citations links between them as lines or edges [15]. These influential studies yielded high centrality values (≥ 0.1) and were visualized as either a purple ring, a red ring or a citation tree [16]. Purple rings reflected a study with between-ness centrality representing a new theory or concept while red rings represented citation bursts i.e., hot topics of research. The citation tree presented the volume of citations accrued by each study, with each concentric ring corresponding to a year. The influential studies identified during each period may also include studies from previous periods which may have influenced their collaborative networks.

These network analyses were run using link reduction method with pathfinder network scaling method. The strengths between links were estimated within slices using Cosine index. Cluster analyses were then utilized to identify clusters of research in each time period, where each cluster was named by processing titles of articles by employing two algorithms: log-likelihood ratio (LLR) and latent semantic indexing (LSI) [16].

3. Results & Discussion

3.1. Publication trends and stakeholders on TPE

Overall, publication trends in TPE research revealed an increasing linear trend (Figure 1). So far, 54,533 research articles have been indexed in WoS. The earliest research study on TPE was indexed in the WoS in 1922, with trend of publications increasing after the year 1990. The research output increased from 112 in 1990 to 6004 in 2020.
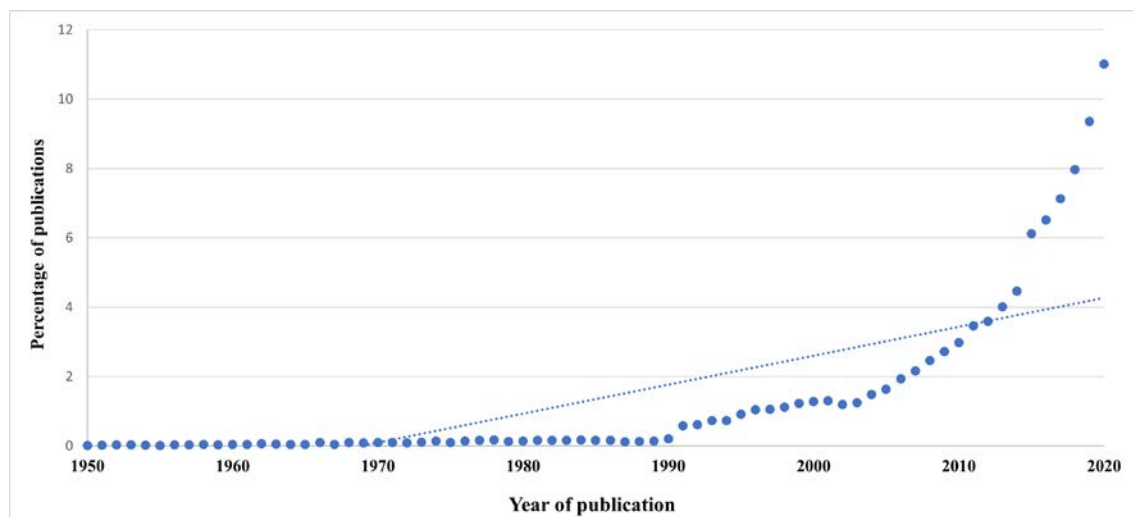

Figure 1. Trends of Publications in patient education research.

A variety of disciplines published TPE research with public, environmental, and occupational health yielding both the highest number of citations (n=12671) and centrality (0.22). In terms of citations, it was followed by health services research, general and internal medicine, nursing, psychology, psychiatry, education and health policy and oncology. In terms of innovation however, research published in disciplines of pharmacology and pharmacy, (bio)engineering and economics yielded the highest centrality values (>0.10) (Supplementary Figure 1).

There were 159 nodes and 1217 edges in the network graph of countries. Authors from high income countries contributed to 97.82% of research studies published on TPE, followed by upper income countries (15.44%), LMIC (8.41%) and low income countries (2.31%) (Figure 2). In terms of research output, USA was the single largest contributor to TPE research, accounting for 44.05% of all published research studies. It was followed by England (8.01%), Australia (7.75%), Canada (5.85%) and the People's Republic of China (4.65%) (Table 2). Brazil and India despite being Upper and lower middle income countries, were top ten contributors of research in this domain. Four of the countries not only

contributed to innovations in TPE research but were highly collaborative, as visualized by purple rings in Supplementary Figure 2 and 3 and high centrality values (≥0.10).

The top 25 funding agencies (Supplementary table 2) were in high income countries, except for National Natural Science Foundation (NSF) of China. National Institutes of Health accounted for the highest proportion of funding at 23.75% of funded research projects. Only two countries from Asia contributed to funding of TPE research including NSF China (0.68%), Ministry of Education Culture Sports Science and Technology Japan MEXT (0.53%) and the Japan Society for Promotion of Science (0.45%). European Commission ranked fourth overall (2.12%).
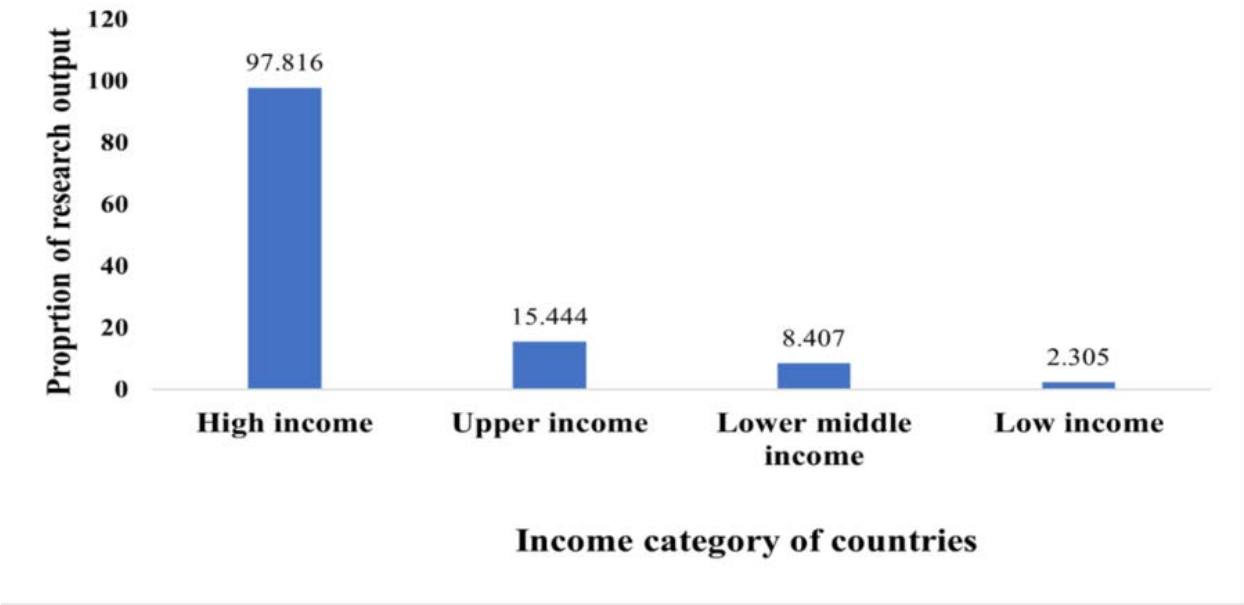
Figure 2. Regional contributors of patient education research.

Table 2. Top 5 stakeholders in patient education research.

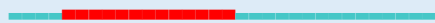| Institutes	Countries	Journals
University of California System (n = 2215)	USA (n = 24, 021)	Patient Education and Counseling (n = 1,109)
Harvard University (n = 1363)	England (n = 4367)	BMC Public Health (n = 666)
University of London (n = 1256)	Australia (n = 4226)	PloS One (n = 619)
University of North Carolina (n = 1086)	Canada (n= 3188)	Journal of School Health (n = 586)
University of Texas System (n = 1084)	Peoples Republic of China (n = 2537)	International Journal of Environmental Research & Public Health (n = 525)

3.2. Keywords

Top keywords were analyzed to yield two important insights; a) central and most cited keywords to identify important themes of research and b) burst words to identify hotspots of research in different time periods. A critical appraisal of central and keywords accruing >300 citations, was conducted to analyze themes of research that have most frequently been researched in TPE. There were 413 nodes and 2455 edges in this network graph. It revealed five important themes of research including disorders, study designs, scope, outcomes, and populations (Supplementary figure 4). Table 3 cites important disorders identified around these themes, which presented as citation bursts exhibiting substantial research activity during specific time periods.

The scope of research clinically was focused on improving perceptions, behaviors, and attitudes for health promotion, self-management and medication adherence as well as for reducing stigma. In addition, to knowledge and awareness related outcomes quality

of life, and decision making for patients were frequently cited outcomes as well. From 2020 to 2021 specifically, keywords showed social media, health communication and coronavirus as the top cited keywords, indicating a shift of research on these important topics (Supplementary table 3).The strongest keyword showing burst of research activity was controlled trial (1991 to 2009), while the top five disorders exhibiting the strongest research activity were asthma (year 1991 to 2013), diabetes mellitus (1991 to 2004), hypertension (1991to 2008), rheumatoid arthritis (1992 to 2003) and smoking cessation (1991 to 2006).

Table 3. Keyword bursts for disorders explored in patient education research.

Keywords	Strength	Begin	End	1990 - 2021
Alcohol	34.6	1991	2006	
Arthritis	30.51	1991	2002	
Asthma	103.39	1991	2013	
Blood pressure	53.05	1991	2008	
Cardiovascular disease	20.76	2005	2008	
Childhood asthma	5.82	1992	1998	
Cholesterol	18.22	1991	1997	
Cigarette smoking	23.95	1992	1998	
Coronary heart disease	20.72	2005	2007	
Dental caries	8.37	1990	2002	
Diabetes	31.4	2015	2017	
Diabetes mellitus	28.53	1995	2007	
Diarrhea	6.59	1991	1996	
Heart disease	9.17	1992	1997	
HIV infection	20.02	1992	2000	
Hospitalization	4.76	1991	1993	
Human immunodeficiency virus	12.01	1991	1995	
Hypertension	12.17	2011	2013	
Immunization	4.65	1992	1996	
Infection	7.86	2010	2011	
Low birth weight	4.07	1992	1994	
Malignant melanoma	7.16	1995	1999	
Mammography	12.54	1991	2004	
Mental health	44.63	2019	2021	
Mortality	4.72	1994	1995	
Myocardial infarction	12.93	1992	1998	
Oral health	39.24	2014	2018	
Pain	18.58	2013	2014	
Relapse	66.57	1991	2006	
Rheumatoid arthritis	48.38	1992	2003	
Schizophrenia	4.21	1996	1998	
Schizophrenic patient	16.54	1992	1999	
Sexual behavior	4.55	1991	1997	

Sexually transmitted disease	**8.53**	1991	2001	
Smoking	**15.08**	2009	2010	
Smoking cessation	**45.33**	1994	2006	
Stress	**62.87**	2019	2021	

3.3. Clusters and Influential Publications in TPE Research

To examine clusters of research in TPE, the research literature was divided into two timeframes: Pre-1985 and Post-1985. Due to the extent of literature, the bibliographic dataset pertaining to literature published after 1986, was divided into seven 5 yearly time slices. This strategy allowed us to get a *dynamic* snapshot changing research themes over time. This also allowed us to identify important pieces of work published during each time slice, thus, marking the evolution and complexity of TPE research overtime (Table 4 and Supplementary table 4).

Table 4. Theories in patient education research yielding the highest centrality values (≥0.1).

Author, year	Theory	Comment
Lazarus & Folkman (1984)	*Stress, Appraisal and Coping*	A detailed theory of psychological stress, building on the concepts of cognitive appraisal and coping
Bandura A (1986)	*Social Foundations of Thought and Action: A Social Cognitive Theory*	An influential piece of work in psychology which presented a comprehensive theory of human motivation and action. It explores the role of cognition, self-regulation, and self-reflective processes in improving psychosocial functioning
Ajzen (1991)	*Ajzen's theory of planned behavior*	Behavioral intentions and actions result due to interplay of three components: attitudes, subjective norms, and perceived behavioral control
Marlatt GA (1985)	*CB model of the relapse process*	It challenged the then notions of viewing relapse as "treatment failure"
Woodcock (1990) & McGrew (1991)	*Measures of Cognitive Ability*	Laid down the theoretical foundations of -R Measures of Cognitive Ability
David Baker's (2006)	*Meaning and the measure of health literacy*	Defining health literacy.

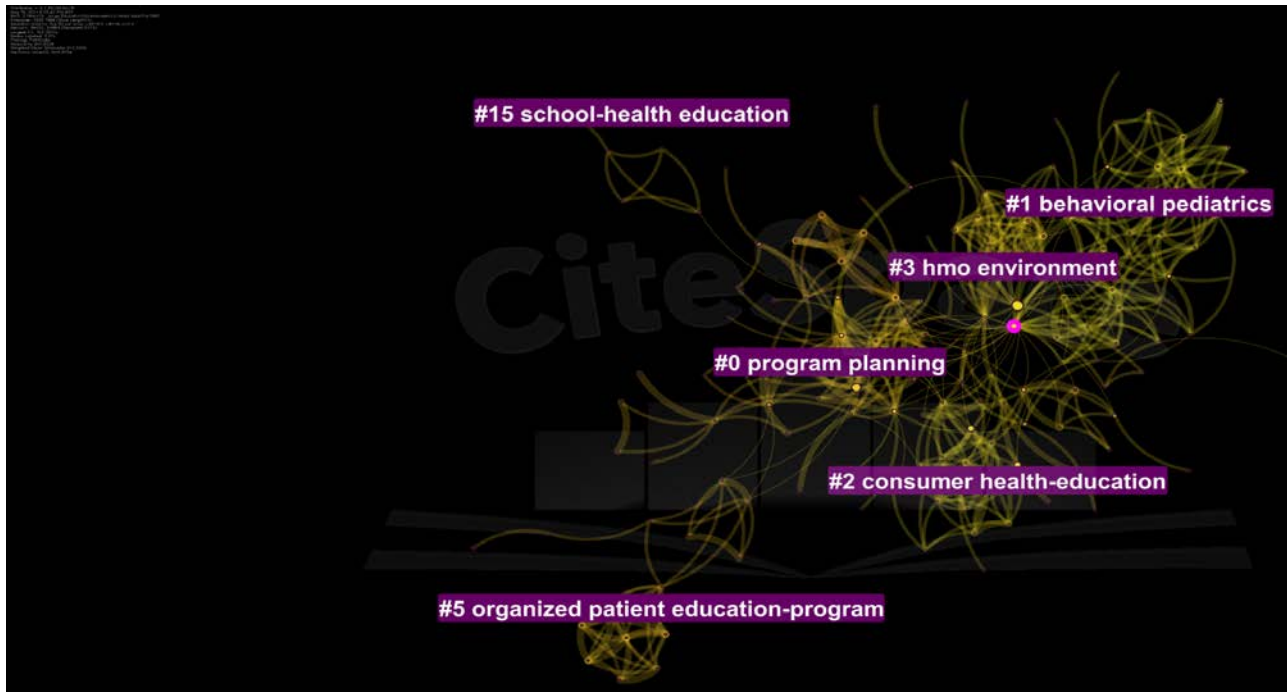### 3.3.1. Analysis of literature published before 1985

Before the year 1985, 1942 research studies accounting for 3.57% of the total research output in TPE was published. The earliest study indexed in WoS, was published in 1922. In the resulting network, there were 320 nodes and 881 edges, with a density of 0.0173.

Five clusters of research with a silhouette value > 0.9 were identified (Figure 3). The largest cluster of research comprised of 47 studies focused on *program planning* (ID # 0, LLR), and included studies on programme planning, cost-benefit and impact evaluation of health education programs. The first cluster comprised of 38 studies termed *behavioral pediatrics*, which included research on school health education programmes. The second cluster termed *consumer health education*, and included studies focused on TPE in chronic diseases, hypertension in the elderly and aging. Cluster # 3 termed *HMO environment* predominantly comprised of health education and promotion among individuals living in houses with multiple occupancies. The last cluster ID # 5 comprised of 15 studies, termed *organized patient education programme*.

Only one study during this period yielded a high centrality score of 0.21. In this study, Farquhar et al., tested the effectiveness of a novel and untested community education intervention to improve cardiovascular health [24]. This novel intervention was a combination of extensive mass-media campaign plus face to face instruction comprised of information as well as behavioral skills to affect attitude and motivation[25]. It also attracted significant research burst for 4.28 years. During this period, the works of Green

LW although did not gain high centrality scores, attracted significant research activity [26]. Notable works focused on frameworks for studying impact and cost-effectiveness evaluations of TPE programs.

Figure 3. Top clusters of research in patient education research before 1985.

3.3.2. Analysis of literature published from 1985 to 1996

From 1985 to 1996, a total of 3026 studies were published. There were 608 nodes and 1,362 edges in the network, yielding an adequate modularity (0.87) and mean silhouette value (0.96). Several innovative and central works were published during this period, indicating a rapid scholarly progress in TPE research (Supplementary Figure 5). These influential research studies were diverse in their scope and employed rigorous study designs. All the influential works were published from high income Western nations.

There were sixteen parsimonious clusters of research (Figure 4), represented by at least 10 studies published, during this era. The zeroeth cluster (#0) comprised of 69 studies with a mean silhouette value of 0.99. It was termed as *social skills training* (LLR) and schizophrenia (LSI). It was followed by clusters entitled as *development, reliability, and prospective pricing* (#1); relevant theories (cluster #2), national asthma education (#3), therapeutic potential and rheumatoid arthritis (#4); diabetes, brief office based intervention and dietary management (#5); asthma and school setting (#6); polio vaccine information & mammography usage (#7); AIDS prevention program (#8), health belief model (#9); and 5 city project and Stanford (#10). The next two clusters were entitled as adolescents (#11) and learning disabilities (#12).

Several important works in the field of psychology built the philosophical and conceptual foundations of TPE were published during this period. Lazarus & Folkman (1984) presented an integrative theoretical analysis *Stress, Appraisal and Coping* as a detailed theory of psychological stress, building on the concepts of cognitive appraisal and coping which have become major themes of theory and investigation [27]. Another book by Bandura A (1986) published their seminal work *Social Foundations of Thought and Action: A Social Cognitive Theory*, an influential piece of work in psychology which presented a comprehensive theory of human motivation and action [28]. It analyzed the role of cognition, self-regulation, and self-reflective processes in improving psychosocial functioning. An-

other important insight during this period was the concept of self-efficacy and its application in bringing about a sustained behavior change. This was elaborated by Strecher et al (1986) who examined its utility in several domains including cigarette smoking, obesity, contraception, alcohol use and physical activity. Extending upon the cognitive behavioral model [29], Marlatt GA (1985) presented their breakthrough *CB model of the relapse process*. This work was seminal because it challenged the then notions of viewing relapse as "treatment failure" [30]. The field of TPE was also developed further based on Ajzen's theory of planned behavior, which emphasized that behavioral intentions and actions result due to interplay of three components: attitudes, subjective norms and perceived behavioral control [8]. Using path analysis techniques, Rippetoe & Rogers (1987) described the utility of protection-motivation theory on adaptive and maladaptive coping skills to manage health threats [31].

An important body of work focused on developing psychological constructs and testing measures for utilization in TPE research. The Diagnostic and Statistical Manual (3rd edition) proved to be a central work in guiding psychoeducation programs for people with chronic mental illnesses [32]. Woodcock (1990) & McGrew (1991) laid down the theoretical foundations of -R Measures of Cognitive Ability and Anastasi A (1986) published a book of published an easy to understand book on psychological testing [33–35].

A body of work focused on understanding processes to improve patient participation in their clinical care. Most of these research studies however, focused on either cardiovascular diseases or post-surgical recovery. For instance, Davis et al (1990) emphasized the importance of designing patient reading material with better readability and Greenfield et al (1988) tested utility of algorithmic prompts to encourage patients to negotiate medical decisions [36]. Morisky et al., (1983) yielded the highest centrality (0.28) during this period, demonstrating the high effectiveness of TPE programme in improving pressure control and mortality among hypertensive patients belonging to poor urban households [37]. Devine et al., (1986) presented a meta-analysis of 102 studies to demonstrate the clinical effectiveness and cost-saving benefits of psychoeducational interventions among surgical patients, to improve recovery, pain, satisfaction and psychological well-being [38]. In 1983, Devine and Cook also used meta-analytical methods to demonstrate lower post-surgical hospital stays among surgical patients [39] . Mullen et al., (1985) presented another meta-analysis comparing the effectiveness of educational programs for people with long-term health problems, with a particular focus on moderators of treatment [40]. Faraquhar (1990) led the *Stanford five city project* and demonstrated the effectiveness of low-cost community wide TPE programs in improving stroke and coronary heart disease [25].

Only one study on a psychiatric disease was considered landmark during this period. In 1986, Hogarty et al., published a landmark study combining a patient-centered behavioral treatment and a psychoeducational family to reduce relapse rates in patients with schizophrenia [41].
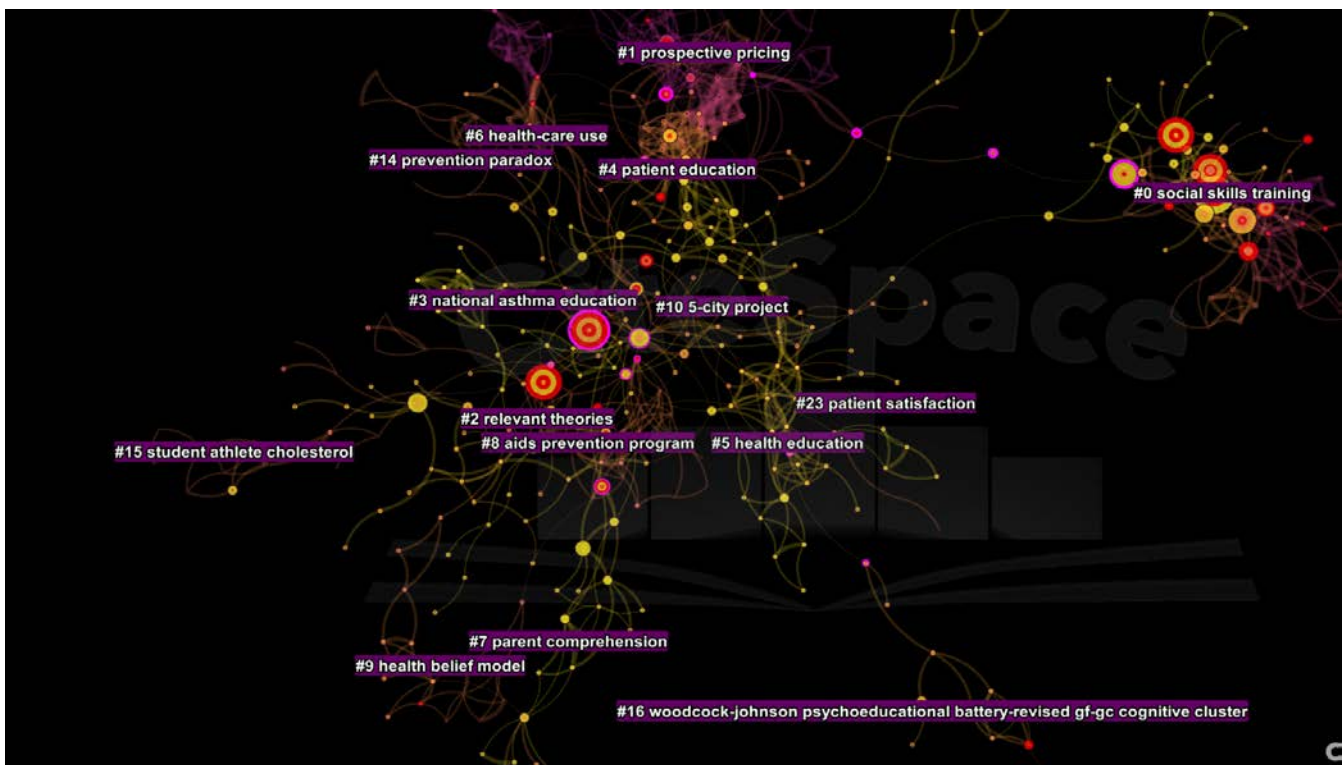
Figure 4. Top clusters of research in patient education from 1985 to 1996.

3.3.3. Analysis of literature published from 1997 to 2006

From 1997 to 2006, a total of 7370 records were analyzed. The resulting network graph comprised of 435 nodes and 713 edges: with a modularity of 0.79 and silhouette value of 0.94 (Supplementary Figure 6). Eleven research clusters comprising of at least 10 studies and adequate silhouette values were identified. The largest health cluster (#0) focused on functional health literacy, comprising of 63 studies. Cluster # 1 comprising of 50 studies focused on digital interventions. Rest of the clusters were entitled major depression (#2), health education & health promotion (#3), rheumatoid arthritis and educational-behavioural joint protection programme (#4), bipolar disorder (#5), diabetes TPE research (#6 and #9), health education material and physical activity (#7), family intervention and schizophrenic patient (#8), and the American Heart Association Disease Management (#10) (Figure 5).

Most of the influential articles in TPE reported findings from controlled trials and impact assessments of TPE interventions in the Western countries. Albeit, Campbell & colleagues (2000), building on a larger report of the Medical Research Council, published a debate to attract the researcher community to go beyond RCT and focus on design, evaluation, and implementation of complex TPE interventions [42]. Three works of note focused on measuring patient's literacy skills with a particular focus on health communication for patients with low literacy levels [43–46].

Two important pieces of legislations and policy documents provided an impetus to TPE research during this period and beyond. The guide to clinical and preventive services published by the US preventive services taskforce (1996), which endorsed counselling interventions for prevention and clinical services including counselling for substance abuse, diet and exercise, injury prevention, sexual behavior and dental health [47]. While in the UK, an expenditure and funding report published by the Health and Personal Social Services Programmes, placed much emphasis on TPE and counselling services [48].

Most of research evidence on interventions assessed evidence for a variety of chronic disorders. In mental health, the most influential work comprised of two reviews of re-

search evidence pertaining to social skills training, family interventions, cognitive reha-
bilitation, and coping with residual positive symptoms, among patients with schizophre-
nia [49,50]. Four studies explored Multidisciplinary Intervention to Prevent the Readmis-
sion of Elderly Patients with Congestive Heart Failure [51]; quality of life in asthma and
Chronic Obstructive Pulmonary Disease [52]; and type 2 Diabetes Mellitus [53]. This pe-
riod also saw the two central work utilizing a digital platform, aimed at reducing hospital
admission through computer supported education for asthma patients and improving di-
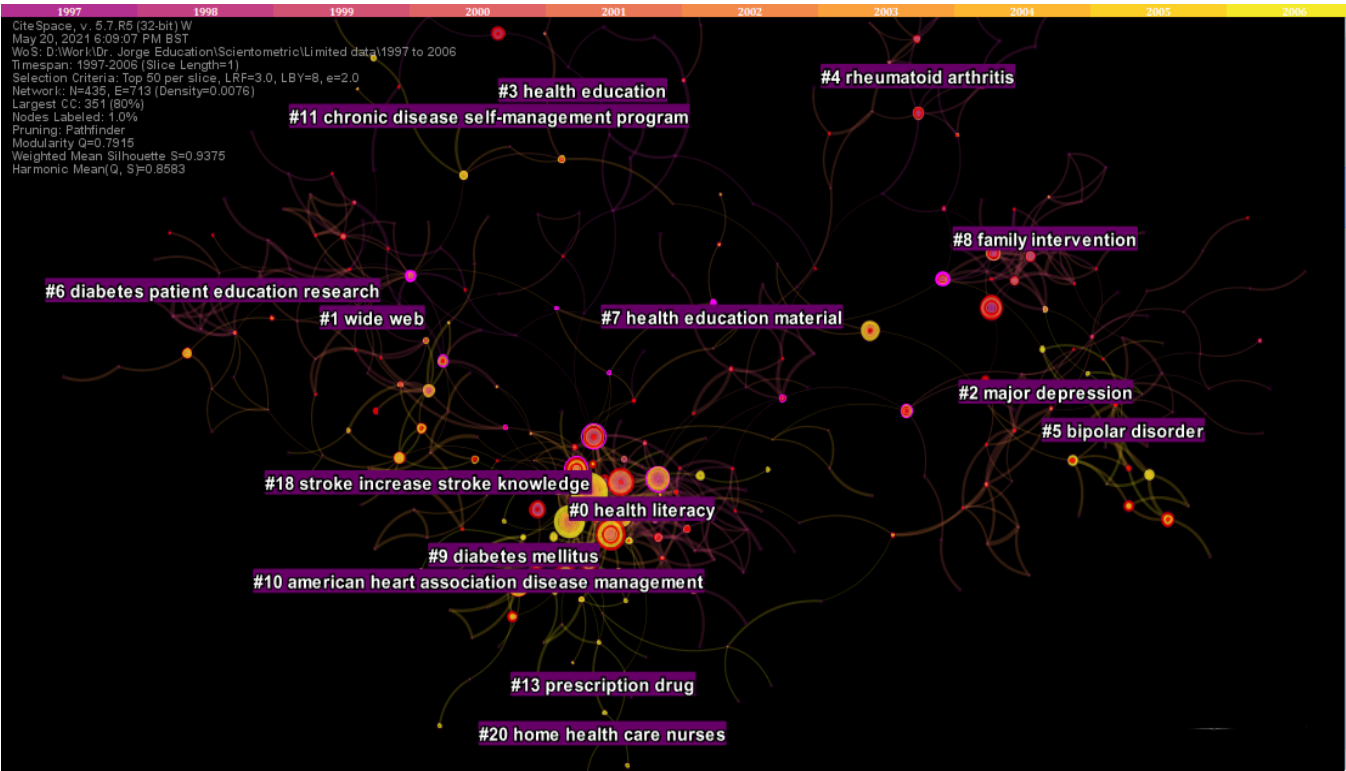etary behavior in primary care [54][55].

Figure 5. Top clusters of research from 1997 to 2006.

3.3.4. Analysis of literature published from 2007 to 2011

From 2007 to 2011, total of 7517 records were published during this period. There
were 152 nodes and 226 edges in the network graph: with a mean modularity of 0.61 and
silhouette value of 0.81 (Supplementary Figure 7).

Two studies focused on theoretical developments in the field of TPE. The narrative
during this period shifted to *health literacy*, emphasizing the need to understand this com-
plex construct. In this context, David Baker's (2006) perspective on *the meaning and the
measure of health literacy* yielded a lot of significance in this field [56]. An influential review
during this period by DeWalt & colleagues (2004) showed that the patients with low liter-
acy scored poorer on several psychosocial and biological health outcomes [57].

These theoretical works aided in several of empirical investigations. Davis et al.,
(2006) demonstrated a poorer understanding of dosage labels among contributing to non-
adherence [58]. While lower use of preventive services was also evident in people with
low literacy levels [59]. Further hazards of low literacy levels were also demonstrated in
people with diabetes (Schillinger et al., 2003) and cancer patients [60], where poorer un-
derstanding of cancer screening and of symptoms of cancer, adversely affects the stage of
cancer at diagnosis. Most central intervention focused reviews and trials focused studies
during this period targeted bipolar disorder [61], type 2 diabetes [62] and chronic condi-
tions [63].

Computer assisted interventions and health informatics began to emerge as a central field of study during this period. Three main studies were published during this period. Berland et al., (2001) demonstrated that most of the information provided on internet may be accurate but lacks good coverage and require high readability [64]. Deborah et al., (2003) reported computer delivered TPE to be effective [65]. There was barriers in its access but generally no socioeconomic disparities in its usage were evident. Ziebland et al., (2004) conducted a qualitative study among patients with cancer and explored their internet usage in context of their illnesses [66].

There were five clusters with ≥ 10 studies and adequate silhouette values. Cluster #0 comprised of 22 studies and was labelled as clinical association & health literacy. Cluster #1 was labelled as screening question and health literacy; cluster #2 risk factor, self-management and controlled trial. Cluster #3 qualitative evaluation and controlled trial; cluster #4 computer literacy and #5 bipolar disorder and psychosocial treatment (Figure 6).
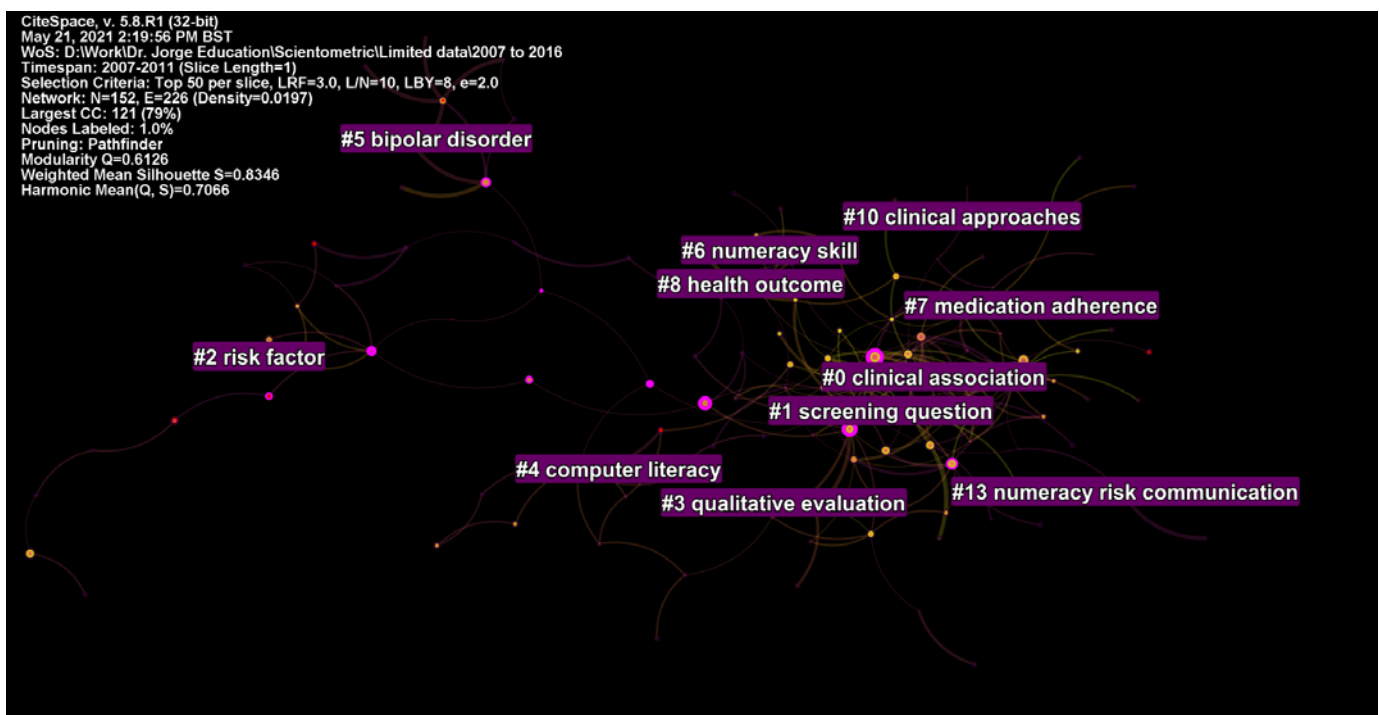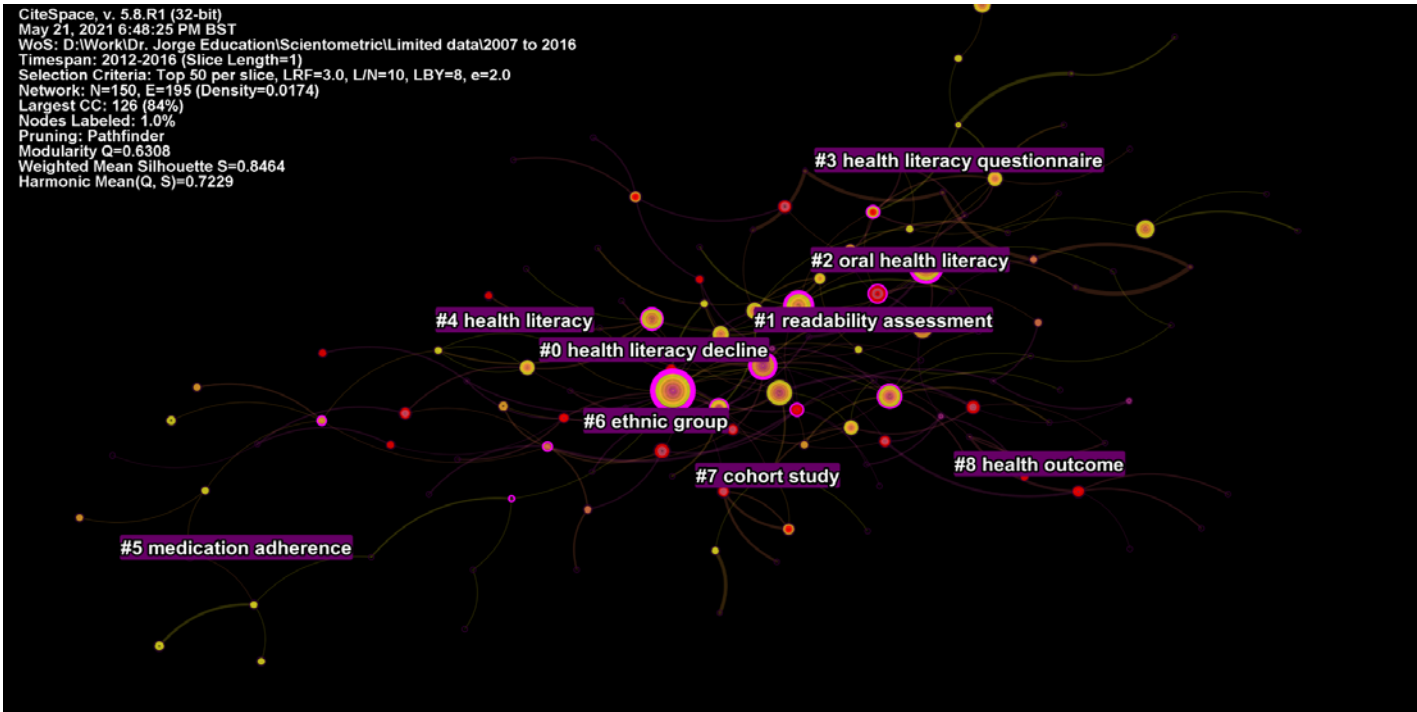

Figure 6. Top clusters of research from 2007 to 2011.

3.3.5. Analysis of literature published from 2012 to 2016

From 2012 to 2016, a total of 13,746 studies were published. There were 150 nodes and 195 edges in the network graph, yielding a modularity of 0.63 and silhouette value of 0.85 (Supplementary figure 8). Research during this period diversified in terms of populations (Figure 7). In contrast to previous Speriods, a lot of emphasis on racial disparities, non-Caucasians and ethnic minorities was evident. The largest cluster (#0) comprising of 20 studies pertained to health literacy decline and health disparities. The second cluster (#1) focused on readability assessment of internet based education material. The third cluster (#2) was oral health and mental health literacy; health literacy questionnaire (#3); health literacy (#4), medication adherence (#5); ethnic group (#6); cohort study (#7) and health outcome (#8) (Figure 7).

By examining the most central works on TPE during this period, three major themes of research studies emerged. The first body of central works focused on the evolving concept of health literacy, their definitions and measurement methods. Don Nutbeam (2008) emphasized the evolving concept of health literacy by dividing it into two disciplines as

a measure of clinical risk emphasized in public health and an asset which arose of education research into adult learning and health promotion [67]. The *Newest Vital Sign* emerged as a widely used short tool for measurement of health literacy [68,69]. Further conceptual work on health literacy was conducted by Sørensen et al (2012), who put forward an influential integrative model for health literacy, to aid in development of health promotion interventions [70]. Jordan et al's (2010) summarized the evidence for health literacy scales, and reported inconsistencies in concepts and measurements underpinning these scales [71].

This period also recognized patient activation as a measure for health related outcomes, citing their need to be included as an effective component of TPE intervention [9]. TPE intervention for diverse populations gained momentum including for child related outcomes [72]; and geriatric populations [73,74]. The seminal work by Osborn et al., (2011) emphasized that the racial disparities in health outcomes were explainable in part by health literacy [75].

Figure 7. Top clusters of research published from 2012 to 2016.

3.3.7. Analysis of literature published from 2017 to 2021

From 2017 to 2021, a total of 21,185 were published. The resulting network had 194 nodes and 288 edges. Modularity of the network was o.66 and silhouette value of 0.89 (Supplementary Figure 9). Nine parsimonious clusters with > 10 studies and adequate silhouette values were identified during this period. The zeroeth cluster (#0) was entitled pragmatic randomized controlled trial; followed by e-health literacy scale (#1); Covid-19 pandemic (#2); health literacy questionnaire (#3); study design and latent trait (#4); mixed methods study (#5); health literacy & decision aid (#6); mental health literacy (#7); diabetes mellitus (#8) (Figure 8).

A total of 19 studies yielded a centrality value > 0.10 during this period. Three policy documents in this period attracted research on TPE. The diabetes atlas (IDF, 2017) published by the International Diabetes Federation and the WHO's report Global Report on Diabetes (2016) yielded a lot of significance among TPE researchers, which introduced several initiatives and calls for TPE programmes targeting people with diabetes mellitus [76,77]. Among the research community, a focus was observed on measuring health literacy in different regions by conducting large surveys. Sorensen et al. (2015) published the

European Health Literacy Survey to report literacy levels in eight European countries [78]. They reported a social gradient in health literacy levels with poorer literacy observed among people with financial deprivation, low social status, low education and old age. These findings were also corroborated by Rikard et al., (2016), who reported health literacy disparities in the US [79] and Levin-Zamir et al., (2016) in Israel [80] and Duong et al., in Taiwan [81]. During this period, Duong et al., (2015) also validated European health literacy questionnaire (HLS-EU-Q47) in six Asian countries [82].

This period also saw publication of several influential articles pertaining to health literacy assessment tools. An influential review by Altin et al., who reported that there was clear consensus on health literacy measurement [83]. In a similar context, a review of 51 instruments for measuring health literacy [84] highlighted that these tools represent only a narrow set of conceptual dimensions, limited modes of administration and lack information on their reliability and validity. Meta-analytical studies published during this period investigated the negative association between health literacy and ability to evaluate online health information (Divani et al., 2015); self-management skills in chronic disease management [85]; medication adherence [86,87] and the role of decision aids for taking choosing health treatments or making screening decisions [88].

Although only one study on mental health gained adequate centrality during this period, but in contrast to previous interventions, it was focused on mental health first aid to empower public to approach, support and refer individuals in distress [89].

The year 2020 to 2021 was unique in terms of publications in TPE, because the focus during this period shifted to the COVID-19 pandemic. A mushroom growth in publications during this period was revealed. After the WHO's declaration of COVID-19 as a pandemic, a lot of researchers strived to work for solutions. Three articles of interest were published during this period. Nguyen et al., (2020) who reported that people with suspected COVID-19 symptoms reported higher likelihood for depression and quality of life, however, this effect was moderated by health literacy levels [90]. Wang et al., (2020) reported the psychological impact of COVID-19 in 194 cities in China, with a high proportion of Chinese people reported psychological impact as moderate to severe and one-third reporting moderate to severe anxiety [91]. Brooks et al., (2020) published a rapid review on the psychological impact of quarantine and recommended that officials should quarantine individuals for no longer than required, provide clear rationale for quarantine and information about protocols, and ensure sufficient supplies are provided [92].
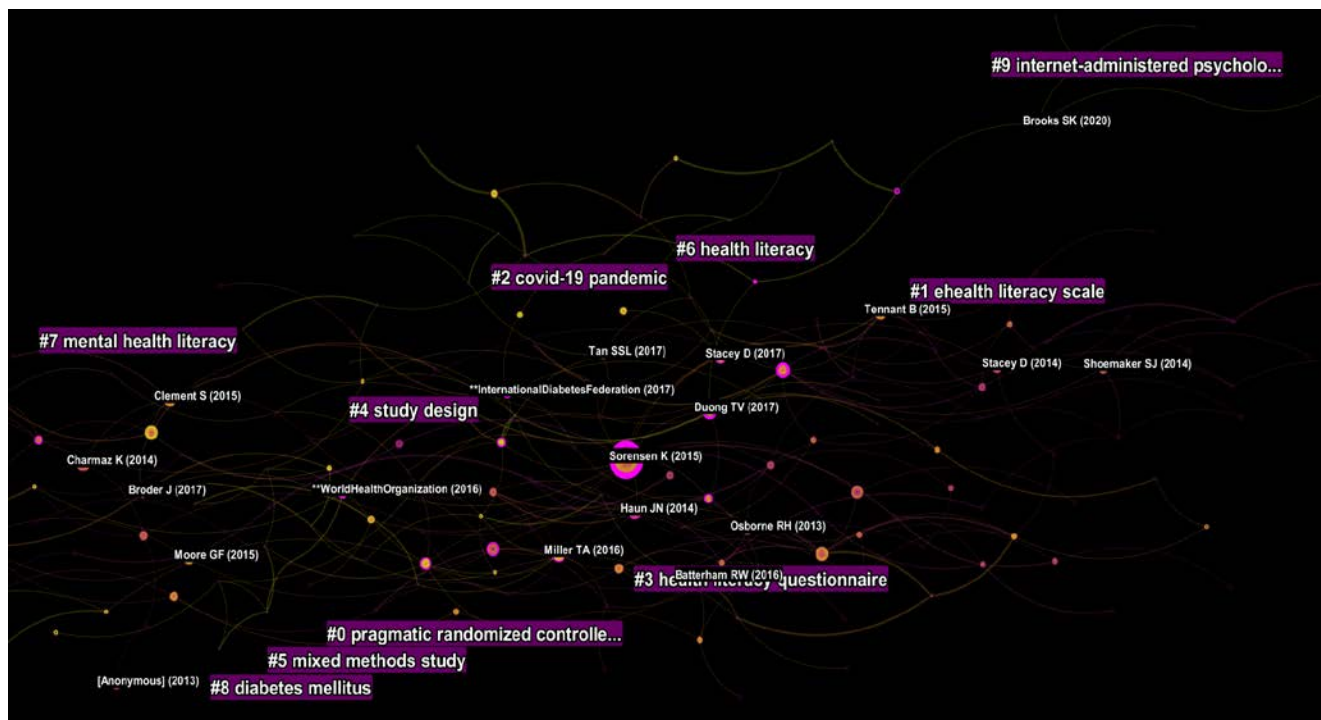
Figure 8. Top clusters published from 2017 to 2021.

4. Discussion

The present scientometric analyses is part of a larger project the research team is leading to evaluate the state of research in patient education and its effectiveness in the management of chronic diseases. We found that most of the interventions found to be central in TPE research as well as the outcomes tested, lacked involvement of patients. Patient and lay public involvement in health research is a huge field at present. Just as they are important stakeholders in clinical decision making, their involvement in design of TPE interventions should be ensured. This can lead to interventions being more feasible, acceptable and sustainable and transparent [93].

More recently, a lot of focus has been put on use of digital technology in provision of healthcare [94]. Adoption of digital technology is a huge breakthrough in population health, because it can ensure equitable health access to specialized resources [95,96]. Although digital health has been tested in several facets of healthcare including access to specialized clinical help [94], more research is needed on it in provision of TPE. Currently, a lot of research is going on in provision of TPE on web platform, which need to be streamlined by government stakeholders to prevent content which may cause harm. The recent COVID-19 infodemic of hoaxes and conspiracy theories regarding it is an excellent example in this context [97].

Although the publication trends in TPE seem satisfactory, a huge research deficit was seen in low to middle income countries (LMIC). This may be partly explained by a deficit of clinical resources including a lack of healthcare personnel (HCP) and medications [19,20]. Shortage of HCP is far below the recommended numbers by the WHO, leading to short consultation times, and therefore, patients with chronic disorders usually get poorer (if any) TPE [21,22]. The world therefore, is far from achieving equitable health access as declared in the Alma Ata declaration four decades ago [23]. To counter this inequity in resources, multidisciplinary research is required in these countries to develop culture sensitive theories and intervention programs as well as innovations for equitable delivery. Researchers based in high income countries should collaborate with those in LMICs to ensure knowledge and technology transfer. The knowledge transfer activities could range

from training and education of scholars, assistance in development of interventions and cross-cultural adaptations of important theories for conceptual advances.

The advances in research in TPE should be centralized on a single platform gathering researchers and stakeholders from around the globe. Priority setting should be done to the gaps identified to yield maximum benefits. This centralized platform could be housed as a collaboration between different international societies on TPE. An important example to emulate could the James Lind Alliance for priority setting in clinical trials which involves patients and physicians to set priorities for research in different disorders. By using Delphi study methods, stakeholder consensus could be achieved in TPE research. Another important task for this consensus committee should be the standardization of definition and terminologies across the TPE field. This would allow harmonization of literature and concepts across different fields and researchers.

Meta-analytical studies need to be done, not only to identify effectiveness of TPE interventions across different disorders but also to define their moderators. For instance, it is important to identify in which conditions; what modalities of delivery and for whom these TPE interventions work the best. And this is indeed possible by using meta-analytical methods. Research is required on large scale implementation aspects of TPE interventions. A lot of clinical trials and meta-analyses have been conducted to prove the effectiveness of these interventions across a variety of biopsychosocial outcomes. However, the real life implementation of any intervention, and its feasibility and uptake are determined by various forces, which could be identified with implementation driven studies.

5. Conclusion

The present scientometric analyses reveal several important insights in TPE research. Research in TPE is very diverse, with research topics ranging from development of theories and interventions, development, and testing of tools to measure outcomes and tailoring and testing of interventions. TPE is a highly interdisciplinary area, with various interventions underpinned by theories from field on intelligence research, education, and psychology. Restricted research interests on specific chronic disorders were evident in this scientometric analyses. A satisfactory trend in research activity was observed over years, however, most of this activity was focused on high income countries. Low to middle income countries only account for a small proportion of this research activity.

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