

# Bibliometric Analysis of Immigrants' Health Education: Research Status, Evolution, and Trends with CiteSpace

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**Background:** Immigrants' health education (IHE) plays a critical role in improving the health status of immigrant populations, reducing public health risks, and promoting social integration. Over the past decade, IHE has emerged as a prominent research topic, with numerous studies exploring its specific characteristics; however, comprehensive overviews remain scarce. A detailed and systematic synthesis is needed to better understand the knowledge structure, thematic evolution, current research hotspots, and emerging trends in IHE.

**Methods:** A bibliometric approach was adopted to analyze the knowledge structure, collaborative relationships, research status, and developmental trends in IHE. CiteSpace was used as the tool; the study further constructed a comprehensive knowledge framework for IHE, identifying future research directions and enhancing understanding of the field.

**Results:** IHE research has developed rapidly, with 2984 publications over the past 20 years. Despite the complexity of regional and institutional collaborations, the United States has taken a leading role, accounting for 1196 regional collaborations with a centrality score of 0.2. Institutionally, the University of California System led with 196 collaborations. Journals with high co-citation frequencies generally showed higher impact factors; for instance, *Social Science & Medicine* was co-cited 1212 times with an impact factor (IF) of 5.2, and only two of the top ten journals had a 5-year IF below 3. IHE research includes medicine, education, and public health. The emergence of keywords such as "social determinants of health", "overweight", and "health equity" highlights the field's increasing specialization.

**Conclusion:** Over the past twenty years, IHE publications have increased significantly, spanning various journal categories and journals. While institutional and regional collaborations were relatively strong, the authors conducted research independently. The findings indicate that IHE remains rich in research opportunities. Moreover, the results of this study offer a theoretical foundation for policymakers and a guide for advancing interdisciplinary practices in IHE.

**Keywords:** immigrant, health education, public health, CiteSpace, bibliometrics

## Introduction

Health education refers to the planned, organized, and systematic social education activities that assist individuals in actively adopting behaviors and lifestyles beneficial to health. These activities aim to reduce or eliminate health risk factors, prevent diseases, promote health, and improve the quality of life while evaluating the effectiveness of such education.<sup>1,2</sup> The core of health education is to cultivate health awareness, encourage changes in unhealthy behaviors and lifestyles, and develop good health habits, thereby reducing health risks. Through health education, people can understand which behaviors may impact their health and consciously choose a healthy lifestyle. That contributes to improving individual health levels and lays the foundation for enhancing society's overall health status.<sup>3,4</sup>

Immigration typically refers to the movement of people from one region to another, where they settle. The reasons for migration may include seeking better medical care, living conditions, employment opportunities, educational resources,

or avoiding wars and natural disasters.<sup>5-7</sup> Immigrants' health education (IHE) is education provided to immigrant groups that includes information about health knowledge, disease prevention, and adapting to new environments.<sup>8,9</sup> Immigrants often face unique health challenges, such as difficulties in accessing local medical services and welfare information due to language or cultural differences, low health literacy, unequal health services, and psychological issues due to economic pressures; they pose challenges in controlling local infectious and chronic diseases, and maintaining social stability.<sup>10-12</sup> Through IHE, the health awareness of immigrants can be improved, public health risks can be reduced, and their integration into the local society can be promoted. Therefore, IHE is crucial for immigrants, the local community, and public health.

In IHE, governments, healthcare institutions, communities, employers, and educational institutions hold essential responsibilities. Governmental agencies have developed policy and legal frameworks aligned with international health organizations, provided financial support, and collaborated with local authorities, communities, and healthcare institutions to disseminate health information via various platforms.<sup>13</sup> Healthcare institutions and professionals enhance their medical competence and spread health knowledge through lectures and free medical consultations.<sup>14</sup> Immigrant communities conduct multilingual health education activities and act as bridges connecting immigrants with governmental and medical sectors to optimize health education programs.<sup>14</sup> Employers deliver occupational health education to immigrants and ensure equal access to medical and healthcare benefits.<sup>15</sup> Educational institutions incorporate basic health knowledge into curricula and collaborate with immigrant parents to hold health education seminars, thereby enhancing the overall health status of immigrant families.<sup>16</sup>

Existing research on IHE has explored various perspectives. Some studies have evaluated IHE outcomes, emphasizing the importance of IHE; findings indicate that after receiving health education, immigrants can improve their health by reducing disease incidence, changing health behaviors, and using public health services more effectively.<sup>17-19</sup> Some studies have focused on macro-level policies in IHE, analyzing how policies in different regions affect IHE implementation differently and how policy reforms optimize health education performances.<sup>20,21</sup> Some research has addressed specific practices in IHE, such as cultural adaptability, how immigrants from different cultural backgrounds understand health information, and how to adjust educational methods to meet diverse cultural needs.<sup>22-24</sup> Some studies have examined the use of language and communication practices in IHE, exploring how language barriers affect IHE performances and how multilingual materials and translation services can enhance educational effectiveness.<sup>25-27</sup> Additionally, some research has focused on the subjects of IHE - the immigrants themselves - exploring their psychological pressures in adapting to new environments and how health education can provide social support.<sup>28-30</sup> Finally, studies have examined the technologies and innovative tools used in IHE, discussing how digital applications and online platforms can deliver IHE, especially in areas with poor geographical access and limited educational resources.<sup>31,32</sup>

Although extensive research has deeply explored the specifics of the IHE field, comprehensive overviews remain scarce. Previous studies have summarized IHE from multiple perspectives, such as importance, policies, specific practices, target audiences, and technological methods. However, they often focus on detailed aspects, lack a comprehensive and integrated analysis, and do not utilize visualization tools to display research outcomes. This limitation hinders a panoramic presentation of the field and a clear description of its overall development trends, thereby restricting the potential for systematic integration by future scholars or practitioners. Specifically, existing research limitations and unresolved issues include:

- (1) Does IHE still hold potential research value and popularity?
- (2) What are the connections between stakeholders in the IHE research field?
- (3) What are the current research dynamics in IHE?
- (4) How are the research hotspots and future directions in IHE developing?

Therefore, there is an urgent need for more detailed and comprehensive research on IHE to summarize existing results and use visualization tools to analyze the development trends of IHE to understand better the overall landscape and development trajectory of the field. That includes examining the formation of its knowledge structure, the evolutionary path of key focuses, and current research hotspots and emerging trends. That helps discover new perspectives and

enhance the overall research efficiency in the IHE field, providing crucial theoretical support and practical reference for policymakers, educators, and health professionals, further advancing the development of the health education field. Specifically, this study systematically uses CiteSpace software to summarize research on IHE over the past two decades; it visually represents the distribution, development process, and evolution trends of authors, institutions, regions, journals, hotspots, and research themes within the research field. Additionally, this paper proposes a knowledge structure framework for IHE with high academic value and practical significance.

The paper provides an overview of the evolution and research hotspots in the IHE field, rather than comparing individual articles, aiming to provide a comprehensive reference for future research. Specifically:

- (1) The second part of the paper details the research methodology, including data sources, software selection, and key details of the research process.
- (2) The third part reviews the main characteristics of the literature (such as publication years, research subjects, and categories) and addresses the first question by reflecting on whether IHE still possesses research value and popularity; then, it analyzes the collaboration network (including institutions, regions, and authors' relationships), helps researchers find potential collaborators and reflects the basis of collaboration, addressing the second question; furthermore, it analyzes the co-citation network (journal co-citations, reference co-citations, author co-citations), presenting the authorities and dynamic topics in the IHE research field to address the third question; besides, it analyzes the co-occurrence network (category co-occurrence and keyword co-occurrence), outlining the evolution trends and hotspots, reflecting the current focus and future research dynamics of IHE, addressing the fourth question.
- (3) The fourth part constructs a knowledge structure framework, clarifies possible future research trends, and presents the practice recommendations for IHE.
- (4) The final part summarizes the research conclusions, highlights this study's innovativeness and limitations, and offers suggestions for future related research.

## Methods

### Data Collection

The first stage of the study design is to “determine the data source”.

The data was downloaded on October 1, 2024. We utilized the Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index from the Web of Science Core Collection (WoS) for the following reasons:

- (1) WoS is recognized for encompassing authoritative and widely disseminated peer-reviewed articles in the scientific domain, providing a credible and persuasive foundation for this study.
- (2) WoS provides detailed article information, including author details, affiliations, region or region, indexed journal information, and citations, facilitating in-depth data analysis and discussion.
- (3) WoS's global accessibility ensures that this study can collect research outcomes worldwide, providing the international nature of the data sources and broadening the study's impact and visibility.
- (4) The Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index cover various scientific fields and play a crucial role in assessing journal impact and tracking academic trends, offering multidimensional support for this research.

The second stage is to “determine the selection criteria”.

We employed specific search criteria to retrieve relevant articles during the data collection. Specifically, our search criteria included:

- (1) Search topics (Topic): Our topics encompass titles, abstracts, and keywords to identify relevant articles. The search terms were {[immigrant\*] or [migrant\*] or [resettlement] or [emigration] or [relocated]} and {[health\* education\*]}.

- (2) The time frame was from January 1, 2004, to October 1, 2024. Regarding the selected timeframe (2004–2024), our decision was based on the relevance and sample size adequacy. Earlier data, which was limited in number, might be less representative of highlighting prominent topics of IHE. Conversely, a shorter timeframe would result in insufficient sample sizes, limiting the capacity of CiteSpace to predict development trends accurately and identify current research hotspots. A smaller dataset would also negatively impact co-citation and collaborative analyses, hindering the identification of influential co-citations and researchers. Thus, selecting the 2004–2024 period was deemed optimal. The 20-year time frame is also widely used in other bibliometric analyses, such as urban tourism and social dilemmas.<sup>33,34</sup>
- (3) Restrictions on document type and language: We limited our search to articles and reviews in English.

The third stage is to “determine the exclusion criteria”.

Two researchers independently collected data, identifying 6713 articles meeting the search criteria. They subsequently screened titles and abstracts to exclude irrelevant articles. A third reviewer evaluated the results for discrepancies between the two researchers. The specific inclusion and exclusion outcomes were as follows: (1) completely irrelevant literature was removed, excluding 2302 articles and leaving 4411 articles; (2) studies solely focusing on health or other epidemiological aspects or exclusively on education, higher education, or medical education rather than health education, were excluded, totaling 742 articles and leaving 3669 articles; (3) studies focusing on demographic groups other than immigrants or resettled populations, such as specific genders, South American, or African populations, resulted in the exclusion of 671 articles, leaving 2998 articles; (4) withdrawn articles, anonymous authorship, or editorial forewords accounted for the exclusion of an additional 14 articles. Ultimately, 2984 articles were selected from the databases. The data sources were all from the database mentioned above and did not involve human or animal participants; therefore, no ethical considerations were necessary. Meanwhile, the data collection process of this study enhanced the credibility and reliability of the data through back-to-back collection and third-party approval. Finally, since bibliometric analysis was conducted using CiteSpace, there is no need to use sensitivity tests to verify the validity and reliability of the data.

## Data Processing

The first stage is to “determine the software”.

When selecting bibliometric and visualization analysis software, we compared tools such as RefViz, HistCite, SATI, and CiteSpace. RefViz is easy for grouping and keyword analysis but is limited in comprehensive analytical capabilities. HistCite is user-friendly and effective for analyzing keyword frequency, yet it cannot analyze co-citations or co-occurrences and does not describe the interrelationships among factors. SATI addresses these gaps but does not provide timeline visualizations, crucial for depicting research trends. Therefore, we chose CiteSpace as our bibliometric analysis and visualization tool as it addressed the above disadvantages.<sup>35</sup> However, we also admit that despite its powerful capabilities, CiteSpace has inherent limitations, including reliance on specific databases, insufficient semantic analysis capabilities, and reduced readability with complex clusters.<sup>36</sup> Nevertheless, compared to other visualization software, CiteSpace retains clear advantages, such as the capability for comprehensive analysis and visualized interpretations.

Data was processed using CiteSpace (V6.3.R1), a specialized software for bibliometric visualization that includes journal data, author information, region and region, co-occurrence, co-citation analysis, centrality, and burst analysis. CiteSpace can identify key nodes within the literature network, analyze research hotspots, and customize time slices and clustering parameters to optimize the structure of knowledge graphs. It highlights essential information to reveal the evolution of research themes and knowledge structures related to IHE.<sup>37,38</sup>

The second stage is “importing data into the software for analysis”.

After obtaining the target papers, (1) we imported the documents in “txt” format into CiteSpace. (2) In the time-slicing settings, we set parameters from January 2004 to October 2024, with each slice representing one year. (3) In the node type settings, parameters included authors, institutions, regions, references, cited authors, journals, and keywords. (4) In the “Selection Criteria”, we set the g-index at 20 and chose “Pathfinder”, “Pruning sliced networks”, and “Pruning the merged network” under “Pruning”. All other settings were kept at default values.

In addition, this study used artificial intelligence (AI) tools (Youdao Dict and Chat GPT) to translate from the original language to English and Grammarly to correct grammar. However, it did not use AI to generate any new content.

## Data Analysis

As shown in Figure 1, this study utilized CiteSpace to visualize target papers and conducted research based on the visualized data. Specifically, there are five stages:

- (1) Statistical data analysis: This section includes annual publication counts, leading journals, and categories within the IHE field. It aims to determine whether IHE remains a hot research topic and what trajectory it may have.
- (2) Collaboration network analysis: Understanding the collaborative relationships among regions, institutions, and authors will help assess the current state of research interactions in the IHE field and help researchers identify potential collaborators to address issues related to IHE. This section aims to evaluate the current foundation of IHE collaboration.
- (3) Co-citation network analysis: This section analyzes the co-citation of journals, references, and authors to understand the focus and progress of IHE research. It gives researchers a view of the field's knowledge accumulation and current dynamics and aims to determine the authority and topical status within the field.
- (4) Co-occurrence network analysis: This section aims to identify the hotspots in IHE research by analyzing categories, keywords, and bursts' co-occurrence. It helps researchers understand current and evolving research hotspots, predict future research focuses, and expand researchers' perspectives.
- (5) Finally, we present a comprehensive, streamlined knowledge structure to the readers, proposing future research characteristics to aid IHE-related policymakers, educators, and medical practitioners in enhancing policy formulation, research, and practice in IHE. This section aims to outline the key research and practice characteristics of IHE.

## Results

### Publication Statistical Analysis

Publication statistical analysis aims to uncover research trajectory, analyze the influence of publications and studies, and gauge interest levels in the IHE field. It also guides researchers in selecting suitable venues for disseminating their work. This section aims to answer the research question (1): does IHE still hold potential research value and popularity?

### Publications by Year

Figure 2 shows the trajectory of IHE publications. Over the past 20 years, 2984 papers related to IHE have been published. There are some findings.

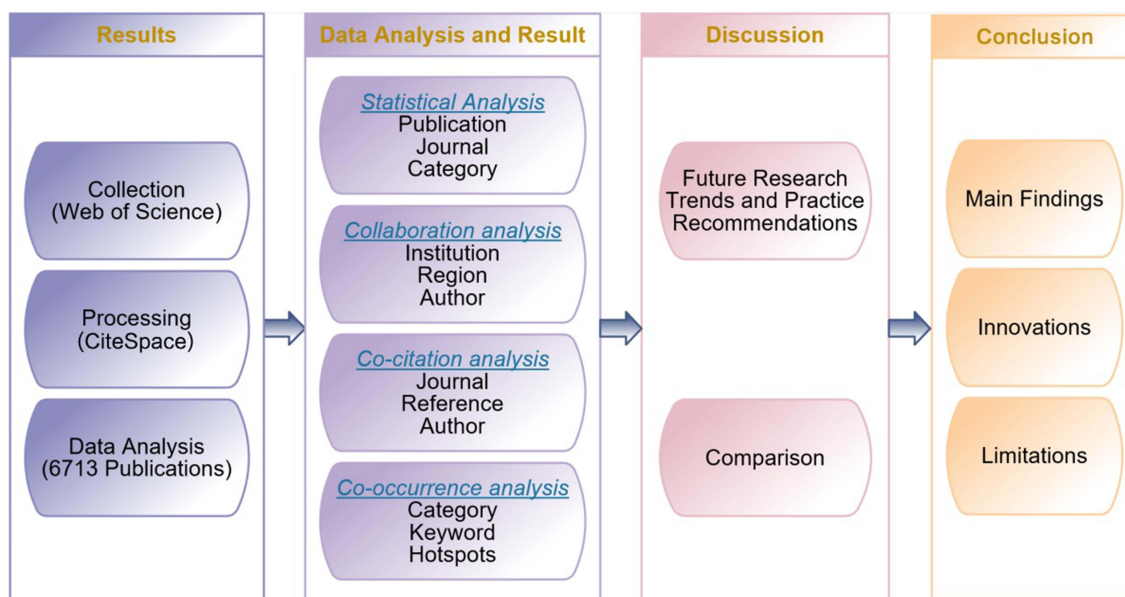
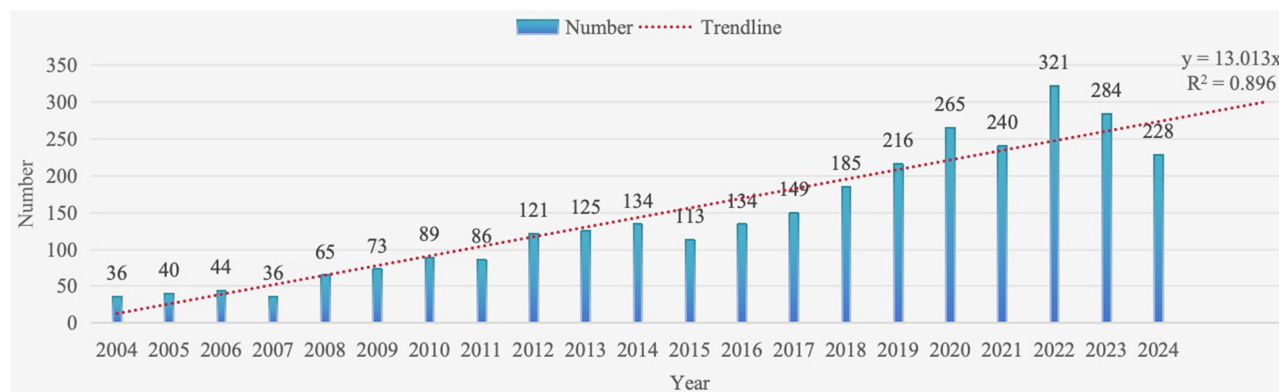


Figure 1 Research Process.



**Figure 2** Number of Publications by Years.

- (1) Although the growth rate of publications has slowed in recent years, the total number of publications continues to rise significantly. When conducting an inter-period comparison of publication growth rates over the past 20 years, we found that the average annual growth rate in the first decade (2004–2013) was approximately 17.594%, while in the second decade (2014–2023), this rate declined to around 9.770%, indicating a slowdown. Besides, by conducting an inter-period comparison between the most recent five years and the earliest five years, we found that in the initial five-year period (2004–2008), a total of 221 papers were published, accounting for approximately 7.406% of the total, whereas in the recent five-year period (2020–2024), 1338 papers were published, constituting around 44.84% of the total. This indicates a significant increase in publication volume over the past five years.
- (2) Some years witnessed publication fluctuations. During specific years (2007, 2011, 2015, 2021, and 2023), the number of publications experienced slight declines, with annual reductions of about 18.18%, 3.37%, 15.67%, 9.43%, and 11.53%, respectively. Besides, although the average annual growth rate decreased in the second decade, and the number of publications in 2024 was lower than in 2023, this reduction might result from incomplete data collection, as the statistics for 2024 only extend through October. In conclusion, despite fluctuations and a slowdown in the average growth rate, the overall trend in annual publications remains upward, reflecting increasing research attention towards IHE over the past five years.
- (3) The COVID-19 pandemic significantly impacted the publication trends in IHE research. There was a decline in 2021, marking the first drop in six years (2015–2021), likely due to the unique nature of migration during the pandemic when strict control measures were implemented globally, leading to a sharp decline in migration and consequently, a decrease in IHE research publications. However, as restrictions gradually eased in many regions and with COVID-19 still ongoing, there was an increase in studies examining the link between migration and COVID-19, leading to a surge in publications in 2022. There was a slight decline in 2023, consistent with other research results during the same period. For instance, bibliometric studies on college students' health education found that the number of related research papers suddenly increased in 2021 and 2022, but it dropped again in 2023.<sup>39</sup>

The red dashed line in [Figure 2](#), introduced through regression analysis, represents the trend line used to predict the future publication trajectory of IHE research. Despite the incomplete data for 2024, which was missing only three months, this does not significantly affect the overall trend prediction. The specific calculation formula is  $y = 21.764x + 15.4$ ;  $R^2 = 0.772$ , where  $y$  represents the number of publications each year,  $x$  represents the year, and  $R^2$  indicates the trend line's fit. A higher  $R^2$  suggests a more reliable trend line. The trend line confirms our prediction that the number of publications related to IHE will continue to increase annually, indicating a growing interest in IHE and the likelihood of more emerging research in this area.

### Publications by Journal Classification

Over the past 20 years, research on IHE topics has been published across 896 journals. [Table 1](#) lists the top ten journals by the number of IHE-related papers published. Notably:

**Table 1** Number of Publications by Journal

Ranking	Journal	5-years IF	Count	Percentage (%)
1	BMC Public Health	3.9	169	5.664%
2	Journal of Immigrant and Minority Health	2.2	151	5.060%
3	International Journal of Environmental Research and Public Health	4.799	144	4.826%
4	PLoS One	3.3	89	2.983%
5	Frontiers in Public Health	3.6	79	2.647%
6	BMJ Open	2.7	54	1.810%
7	Social Science & Medicine	5.2	51	1.709%
8	Journal of Community Health	3	47	1.575%
9	Ethnicity & Health	2.7	39	1.307%
10	International Journal for Equity in Health	4.7	35	1.173%

- (1) The field exhibits diversity in its publication outlets. The top ten journals have published 811 papers, accounting for approximately 28.754% of all published works. That is a relatively small proportion; in integrative and complementary medicine research, the publications published in the top ten journals account for more than 70% of all publications,<sup>40</sup> indicating that numerous other potential journals are available for researchers to submit the IHE research. The diversity also reflects a broad interest in IHE topics across many journals, suggesting that researchers should not limit themselves to the top ten journals but rather consider a variety of factors, such as the relevance of the journal to their research area, objectives, and content when selecting a publication outlet.
- (2) The publication of IHE-related papers shows that impact factors (IF) are not always positively correlated with publication volume. The impact factors among the top ten journals are generally low, mostly between 2 and 5. For instance, BMC Public Health, the journal with the most publications, has a 5-year IF of 3.9 and has published 169 papers. The journal with the highest IF among the top ten, Social Science & Medicine, has a 5-year IF of 5.2 and has only published 51 papers, ranking seventh in publication volume. Furthermore, the journal with the highest IF among all journals publishing IHE-related papers is Scientific Programming, with a 5-year IF of 9.6. However, it published only one paper in the examined time frame, cited only 11 times.

In summary, although the top ten journals have certain advantages and recognition, and journals with high IFs have academic influence, researchers should prioritize journal quality, specialty, and other factors when choosing where to publish IHE-related papers to enhance research visibility and attract scholarly attention. Therefore, when selecting a journal, one should be careful not to base it solely on rankings and IF.

### Number of Publications by Category

Table 2 presents the top ten categories for IHE-related publications. The distribution of publications is primarily in health and medicine, with significant representation in cross-disciplinary social sciences and environmental categories, highlighting the field's interdisciplinary nature. Specifically:

- (1) Health and medicine disciplines cover many categories. In the health field, IHE research covers Health Policy Services (162 papers) and Health Care Sciences Services (125 papers), totaling 287. In the medical field, IHE research is predominantly found in Nursing, Psychiatry, and General Internal Medicine. These three categories account for 209, 156, and 145 papers, accounting for 510.
- (2) IHE research is relatively multidisciplinary. For instance, it covers social sciences such as Interdisciplinary Social Sciences (88 papers), Social Work (85 papers), and Biomedical Social Sciences (83 papers), totaling 543 papers. Besides, the environmental category has the highest volume of publications within IHE research, reflecting its close connection with public ecological health. That category includes Public Environmental Occupational Health (1143 papers) and Environmental Sciences (127 papers). This indicates a strong link between IHE and public environmental occupational health.

**Table 2** Number of Publications by Category

Ranking	Category	Count	Percentage (%)
1	Public Environmental Occupational Health	1143	38.317%
2	Nursing	209	7.004%
3	Health Policy Services	162	5.429%
4	Psychiatry	156	5.228%
5	General Internal Medicine	145	4.859%
6	Environmental Sciences	127	4.256%
7	Health Care Sciences Services	125	4.189%
8	Interdisciplinary Social Sciences	88	2.949%
9	Social Work	85	2.849%
10	Biomedical Social Sciences	83	2.782%

We want to highlight that some categories, such as Biomedical Social Sciences and Public Environmental Occupational Health, are highly cross-disciplinary. Overall, the categorization of IHE-related papers primarily focuses on health and medicine, as well as cross-disciplinary social sciences and environmental sciences, demonstrating the comprehensive and interdisciplinary approach inherent in IHE research.

## Collaboration Analysis

Collaboration analysis aims to understand the connections between different institutions, regions, and authors in the IHE research field; analyzing these collaborative relationships helps scholars comprehend current research linkages and find partners to address complex scientific challenges. This section aims to answer the research question (2): what are the connections between stakeholders in the IHE research field?

### Institutional Collaboration Network

Table 3 displays the cooperation among global institutions. Among the top ten institutions, six are from the USA, with one each from Canada, Sweden, Netherlands, and the UK. Specifically:

- (1) US institutions dominate the collaboration network (6/10). The leading institution is the University of California System, which has engaged in 196 collaborations, being one of the earliest institutions to initiate cooperative research since 2004. A representative study from this institution examined the impact of public policies on immigrant health, including education, health insurance, medical benefits, and relief funds, suggesting that public policies can both exclude and facilitate immigrants' integration into American society, thereby providing insights for future policy development and implementation.<sup>41</sup> The latest research from this institution involves

**Table 3** Institution Collaboration Network

Ranking	Institutions	Region	Count	Centrality	Year
1	University of California System	USA	196	0.02	2004
2	University of Toronto	CAN	103	0.16	2004
3	University of California Los Angeles	USA	75	0.06	2006
4	Karolinska Institutet	SWE	75	0.09	2005
5	University of California San Francisco	USA	71	0.07	2004
6	University of London	UK	71	0.11	2010
7	University of Texas System	USA	66	0.08	2005
8	State University System of Florida	USA	55	0.06	2005
9	University of Amsterdam	NLD	55	0.1	2010
10	Harvard Medical School	USA	53	0.1	2004

- interventions on hepatitis B among Vietnamese immigrants, showing that tailoring health education materials to specific communities' cultural and social contexts can effectively improve hepatitis B awareness.<sup>42</sup>
- (2) Other early collaborators include the University of Toronto, the University of California San Francisco, and Harvard Medical School, all starting collaborations in 2004. The University of Toronto, with 104 collaborations, also has the highest centrality among institutions, with significant research evaluating the risk of diabetes among immigrants in Ontario, Canada, suggesting that health education strategies and other interventions should be tailored based on immigrants' education level, income, and age to reduce the prevalence of diabetes across all age groups.<sup>40</sup> The University of California San Francisco, with 71 collaborations, has recent studies focusing on the incidence of cervical cancer among immigrant women, finding that Vietnamese immigrant women have a slightly higher incidence than Caucasian women and recommending interventions like health education meetings, media utilization, and community outreach.<sup>41</sup> Harvard Medical School, with 53 collaborations, has recently researched the mental health issues of Latinos with mental illnesses, finding that higher education levels are associated with lower stigma perceptions, which can be improved through mental health education to enhance community and family support for patients.<sup>42</sup>
  - (3) The institutions that later collaborated include the University of London and the University of Amsterdam, which began their research collaborations in 2010. The University of London has conducted significant collaborative research into whether higher education institutions can meet the psychological needs of refugee students, showing that educators' involvement can improve refugees' well-being and welfare. The study suggests that higher education institutions should take measures to meet refugee students' psychological, health, and social needs due to existing limitations focused more on academic education and performance.<sup>43</sup> The University of Amsterdam's latest collaborative research aims to enhance immigrants' capabilities and health through education and to provide equitable and sustainable health services.<sup>44</sup>

Figure 3 displays an institutional collaboration cluster map, indicating different research themes by various cluster colors. The top three research themes of interest for collaborating institutions are cluster #0 (immigrant health), cluster #1 (health education), and cluster #2 (mental health).

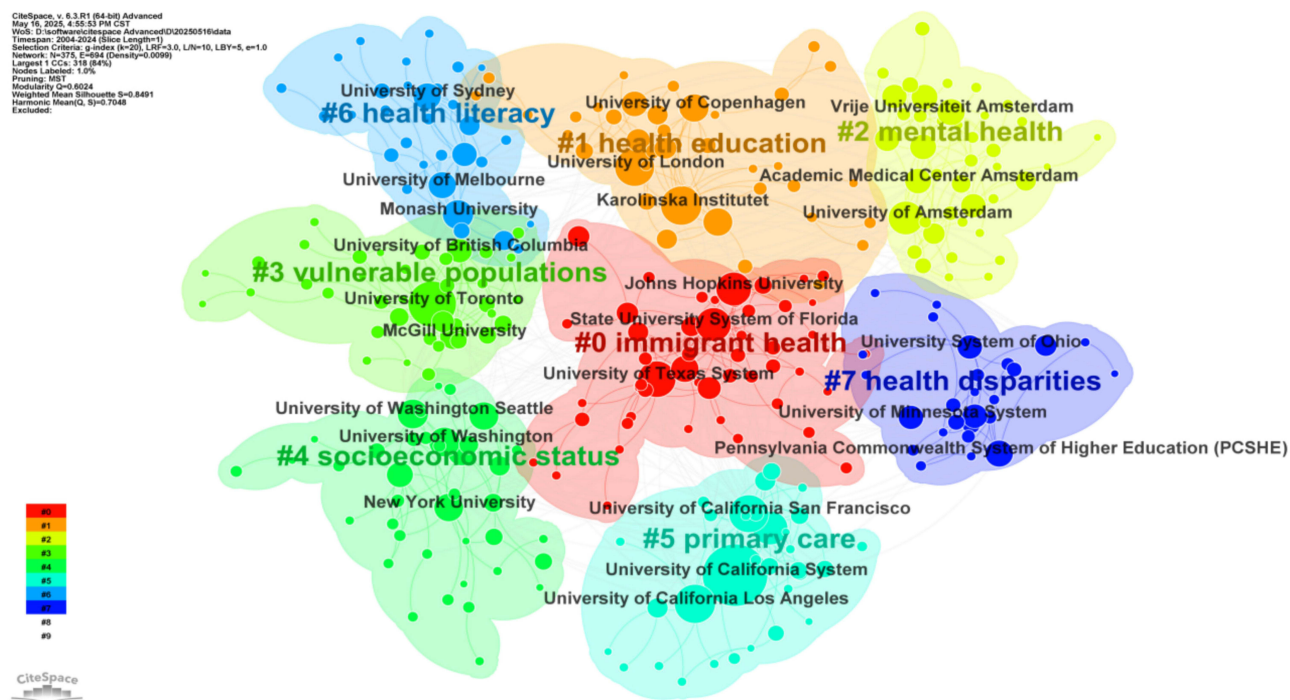


Figure 3 Visualization of institution collaboration network (N=377, E=689).

Specifically, cluster #0 (immigrant health) prominently features a collaboration between the University of California Los Angeles and the University of California System. The University of California Los Angeles has focused on assessing the mental health of Muslim refugees before resettlement, arguing for mental health assessments and categorizing resettlements alongside health education to enhance their awareness of mental health issues.<sup>45</sup> Building on this research, a 2024 study investigated interventions for the mental health of Muslim war refugees, suggesting that psychological education and interventions can effectively improve mental health issues caused by war and trauma.<sup>46</sup> The University of California System has conducted health education and assessments among women immigrants from East Africa, noting significant health challenges this group faces.<sup>47</sup> This research advocates for community assessments of their health status, appropriate placements, and mental health courses in prisons to meet the increased educational needs caused by chronic diseases, aiming to enhance the fairness of immigrant settlements and improve their conditions.<sup>48</sup>

Cluster #1 (health education) sees active collaboration between Johns Hopkins University and the University of North Carolina. Johns Hopkins University has researched how to promote health education among immigrant and refugee youth, identifying barriers such as language, trauma, and discrimination, and suggesting that educators use knowledge and funders provide resources to improve health education for these groups.<sup>49</sup> Recent research has acknowledged this study, which explored factors affecting immigrant youth's self-efficacy. It found that social support and community involvement can help enhance their self-efficacy and access to education and employment opportunities.<sup>50</sup> The University of North Carolina has conducted representative collaborative research on refugee resettlement in North Carolina,<sup>51</sup> addressing unmet needs such as health and living conditions, and highlighting the lack of health education materials and the need for improved living conditions and nutrition.<sup>52</sup>

Cluster #2 (mental health) includes notable institutions like Vrije University Amsterdam and the Academic Medical Center Amsterdam. Vrije University Amsterdam's latest collaborative research focuses on the mental health and welfare of underage and unaccompanied immigrants, discovering that mental health education can maintain their mental well-being and improve health welfare for refugee parents and minors.<sup>53</sup> The Academic Medical Center Amsterdam has studied post-traumatic stress disorder (PTSD) in unaccompanied minor immigrants, finding that the onset of PTSD is closely related to whether they receive psychological interventions or education, with early symptoms such as depression worsening over time.<sup>54</sup> A 2024 study found that PTSD symptoms in Syrian and Iraqi refugees worsen due to cumulative and victimization trauma and do not diminish over time, providing empirical guidance for interventions and resource allocation for refugees.<sup>55</sup> Within the same research themes, many institutions maintain close cooperative relationships with varying themes of interest across different institutions. These collaborative efforts deeply influence subsequent IHE research. As research in the IHE field progresses, institutions will engage in broader academic exchanges across various research areas, share findings, and further the development of IHE.

Other clusters, such as cluster #4 (socioeconomic status) and cluster #3 (vulnerable populations), explore topics from socioeconomic and demographic perspectives, while clusters like cluster #5 (primary care) and cluster #6 (health literacy) conduct research in healthcare knowledge. These clusters demonstrate a range of collaborative efforts across diverse topics. Researchers can find suitable collaboration partners based on their research interests.

## Regional Collaboration Network

Table 4 outlines the collaborative interactions across various regions, highlighting the ten areas with the most collaborations. Several key findings can be noted:

- (1) The United States is central to collaborative research on IHE. The United States plays a significant role in IHE collaborative research, with the highest number of collaborations, totaling 1196, initiating cooperation as early as 2004, and possessing the highest centrality score of 0.2. This underscores the United States' central role in this field, consistent with findings from the previous section that US institutions lead in collaborative research efforts. The centrality measure further emphasizes the United States' pivotal influence in IHE research.
- (2) Developed regions demonstrate predominant influence and early leadership in collaborative research on IHE. The regions with the highest centrality scores are predominantly developed regions, including the United States (0.2), Germany (0.08), Spain, the United Kingdom, the Netherlands (0.07 each), and Sweden (0.05). This indicates that

**Table 4** Region Collaboration Network

Ranking	Regions	Count	Centrality	Year
1	USA	1196	0.2	2004
2	P. R. China	338	0	2004
3	Canada	286	0	2004
4	Australia	242	0	2004
5	England, UK	201	0.07	2004
6	Sweden	177	0.05	2005
7	Netherlands	147	0.07	2004
8	Germany	142	0.08	2004
9	Spain	130	0.07	2004
10	Norway	93	0	2005

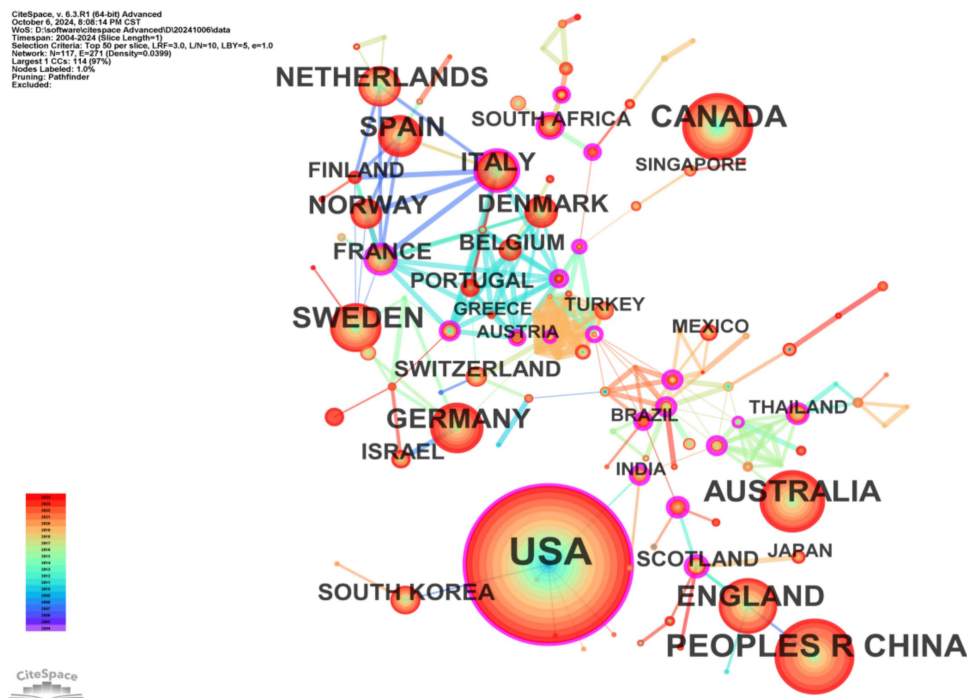
developed regions, led by the United States, engage in authoritative collaborative efforts and maintain close cooperation with other areas. Moreover, the earliest collaborations began primarily in these developed regions, with eight regions starting in 2004: the United States, China, Canada, Australia, England, the Netherlands, Germany, and Spain; seven were recognized as developed regions.

- (3) European regions exhibit extensive engagement and considerable influence in collaborative research on IHE. The top ten regions for collaboration feature seven European regions (Australia, England, Sweden, Netherlands, Germany, Spain, and Norway), highlighting Europe's significant participation and influence in the IHE field. Except for Australia and Norway, all these European regions show higher centrality, indicating that European nations engage extensively in IHE collaborations and exert considerable influence.
- (4) China is the leading representative of developing regions in collaborative research on IHE. Among the top ten regions, China is the only developing region, and the only Asian nation ranked prominently, with the second-highest number of collaborations (338). This suggests that while developing regions actively engage in IHE research, their global influence remains limited.

Overall, the IHE research field is predominantly led by European and North American regions, which also possess significant influence. Developing regions need to enhance their visibility and impact within IHE research, indicating potential for future collaborations and opportunities for growth. Researchers from all regions should actively seek partnerships to deepen cooperation and enhance the global impact of IHE research.

Figure 4 illustrates the visualization of the regional collaboration network, where the size of the nodes indicates each region's enthusiasm for collaboration. Notable nodes include the United States, China, England, Canada, and Australia. The detailed findings are as follows:

- (1) In the United States, recent collaborative research emphasizes the critical role of occupational health and community-based health education in addressing immigrants' mental and physical health challenges. Recent collaborative research in the US has focused on the mental health of immigrants, suggesting that unstable work environments can impact immigrants' psychological and mental health. It is recommended that employers and the government provide necessary health education support and professional medical services, along with preventive programs, to create a safe working environment. Additionally, it advises involving immigrants in essential occupational health and mental health education to better integrate them into society and improve their work conditions.<sup>56</sup> Another study highlights that the healthcare services and health education provided by the communities where immigrants live directly determine the mortality rates from chronic diseases among immigrants; giving health education can effectively reduce these mortality rates.<sup>57</sup>
- (2) Collaborative research in China highlights the significance of mental health education in promoting the urban integration and psychological well-being of immigrant families and children. China has also researched the mental health of immigrants, focusing on the integration of immigrant workers' families into urban settings. The study



**Figure 4** Visualization of region collaboration network (N=117, E=271).

found that multiple factors, including the mental health, income, and education level of immigrant workers, influence the level of urban integration of families. Providing mental health education and improving depression conditions can effectively enhance integration levels.<sup>58</sup> Another recent study compared the mental health of immigrant left-behind children with that of other left-behind children, showing differences in psychological issues. Immigrant left-behind children might react more emotionally to adverse events, while negative interpersonal experiences mainly influence depression in other left-behind children. The study suggests tailored mental health education focusing on emotional management and interpersonal relationships.<sup>59</sup>

- (3) In England, collaborative research underscores the need for sustained occupational health education to mitigate rising work-related injuries among immigrant workers. A representative collaborative study from England focused on the occupational health of immigrant construction workers. The study indicated that as the number of immigrant workers increases, so does the proportion of work-related injuries; thus, continuous occupational safety and health education are essential, along with improved safety measures to protect the health of immigrant workers.<sup>60</sup>
- (4) In Canada, collaborative research emphasizes the importance of culturally and family-oriented mental health education in supporting the psychological well-being of war refugees. Canadian collaborative research has primarily focused on war immigrants' resettlement and mental health education. The collaborative study notes that refugee parents are at high risk for poor mental health conditions. Hence, culturally and family-based mental health education and care are necessary to alleviate the psychological stresses faced by immigrants.<sup>61</sup>
- (5) Australian collaborative research underscores the essential contribution of social support and targeted health education in promoting immigrants' mental well-being. Australian representative collaborative research has examined the link between social support and immigrants' mental health. The study asserts that social support for immigrants, including health education, can improve their mental health. It also emphasizes the importance of expanding existing social support provisions and designing customized programs to strengthen humanitarian aid.<sup>62</sup>

Regions have primarily focused on immigrants' mental and occupational health. Despite differences in national conditions and cultural contexts affecting the target populations and research focuses, there is still close regional

collaboration. This cooperative effort underscores the global commitment to addressing immigrants' complex challenges, emphasizing a multifaceted approach to enhancing their well-being and integration into new societies and communities.

### Author Collaboration Network

Table 5 highlights the global collaboration network among authors within the field, indicating that out of 5214 authors, only 599 have collaborated more than once. The top four most collaborative authors are Stronks Karien, Kunst Anton E, Wieland Mark L, and Sundquist Jan, each with 12, 10, 10, and 10 collaborations, respectively. The following findings were identified in this study:

- (1) Stronks Karien stands out with the most collaborations, focusing on the impact of immigrant dietary habits on health. This author's collaborative research suggests that poor nutritional habits can lead to increased diabetes prevalence among immigrants, emphasizing the necessity of effective health education to alter these habits. However, changing dietary habits is challenging due to the diverse social classes, cultural backgrounds, educational levels, genders, and ages among immigrants.<sup>63–65</sup> The findings are widely recognized in the field, including in a study on diabetes disparities in Saudi Arabia, which found that higher-income, less-educated Saudi men have higher diabetes rates. This underscores the need for targeted diabetes prevention and control policies that consider socioeconomic inequalities and aim to enhance education and awareness about diabetes and nutritional interventions.<sup>66</sup>
- (2) Early collaborative research by Sundquist Jan, Kunst Anton E, and Gagnon Anita J has laid insights into the intersection of immigrant health and social factors, providing subsequent research and policy development. Sundquist Jan, Kunst Anton E, and Gagnon Anita J began collaborative research in 2007. Sundquist Jan's earliest collaborative study on the sleep health of immigrants in Sweden found that immigrants' sleep is affected by age, social status, and marital status, and that sleep health education did not significantly alleviate self-reported anxiety, sleep issues, or severe pain.<sup>67</sup> This finding has been referenced in recent studies on loneliness among college students post-COVID-19, suggesting that interventions to reduce loneliness should focus on psychosocial support and knowledge dissemination to alleviate stress and sleep disorders.<sup>68</sup> Kunst Anton E's first collaborative study explored the link between alcohol-related cancer mortality and socioeconomic factors among men in Europe, including immigrants, noting high correlations between economic status and health education levels in regions like France, Spain, and Switzerland.<sup>69</sup> Gagnon Anita J's initial research assessed risks for immigrant pregnant women in Canada, pointing out that delivery risks are influenced by economic, linguistic, maternal health, and birthplace factors, suggesting the need for more governmental support for mothers and newborns, including health education, to reduce delivery risks.<sup>70</sup> This research has influenced subsequent studies on the impact of immigration on reproductive health, providing reliable information for policy design aimed at protecting immigrants' reproductive health.<sup>71</sup>
- (3) Limited centrality among top individual collaborators highlights the potential to strengthen external research networks and expand influence within the IHE field. The centrality for the top ten collaborators is zero, indicating that these authors' external collaborations are not as prominent as institutional and regional collaborations. This

**Table 5** Author Collaboration Network

Ranking	Author	Count	Centrality	Year
1	Stronks Karien	12	0.00	2009
2	Kunst Anton E	10	0.00	2007
3	Wieland Mark L	10	0.00	2011
4	Sundquist Jan	10	0.00	2007
5	Sia Irene G	9	0.00	2011
6	Agyemang Charles	9	0.00	2016
7	Diaz Esperanza	9	0.00	2014
8	Lee Hee Yun	9	0.00	2010
9	Smeeth Liam	8	0.00	2016
10	Gagnon Anita J	8	0.00	2007

suggests that while individual researchers have distinct research areas and have significantly influenced subsequent studies, collaboration among collaborators could be improved. There is a potential opportunity for these leading researchers to increase their external collaborations to enhance their impact in the IHE field and explore new research directions.

Overall, these authors have made significant contributions to their respective areas, and their collaborative efforts have far-reaching effects on subsequent research. Enhancing connectivity and collaboration among top researchers could further advance the immigrant health and education field.

Figure 5 presents a clustered view of the collaboration network among authors in this research field, highlighting distinct collaborative groups focusing on similar research direction. Several notable clusters are worth noting:

- (1) Cluster #0 (immigrant children), focusing on immigrant children, includes Oxman-Martinez Jacqueline’s team, which concentrates on the psychological and emotional issues of immigrant children. They suggest that due to regional and cultural differences, immigrant children are prone to aggressive behavior, depression, and other negative emotions and unhealthy psychological states. They recommend that host regions address these issues by providing mental health education and corresponding healthcare benefits to help immigrant children overcome psychological problems.<sup>72,73</sup> Another researcher, Gagnon Anita J, focuses on maternal and child health within immigrant health. This research advocates for support for the health of immigrant children through online knowledge dissemination, mental health education, health security services, and revising relevant welfare policies to address the mental health issues of immigrants.<sup>74</sup>
- (2) Cluster #5 (health education), a prominent collaborator is Lin Li, who has researched how to reduce the incidence of cardiovascular diseases among Vietnamese American women through targeted health education, significantly reducing the risk of cardiovascular diseases among this group.<sup>75</sup> Another representative collaborative research by this author addresses the inadequate utilization of preventive healthcare for cancer among Chinese immigrants, suggesting that due to cultural and linguistic barriers, immigrants are unable to understand relevant welfare, leading to significant information gaps. This indicates that health education workers should consider various media channels when planning interventions for immigrants.<sup>76</sup>

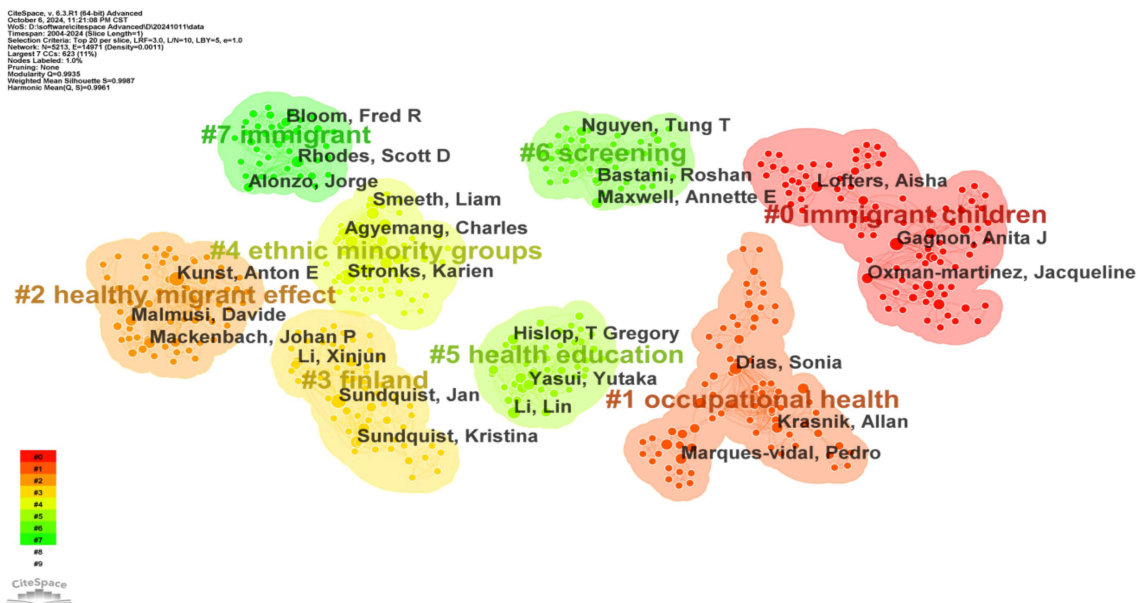


Figure 5 Visualization of author collaboration network (N=5213, E=14971).

- (3) Cluster #2 (healthy migrant effect) features notable collaborators such as Malmusi Davide and Mackenbach Johan P. Mackenbach Johan P's research compares the mental health and educational achievements of immigrant children with local children, suggesting that preventive mental health education can improve the academic performance of immigrant children.<sup>77</sup> Malmusi Davide explores how mental health affects educational performance, employment, and social status, arguing that good mental health is indispensable for effective health education, prevention, and intervention, and mentally healthy immigrants tend to achieve better academic, employment, and social outcomes than their unhealthy counterparts.<sup>78</sup>

In summary, outstanding collaborators exist in the subfields of IHE. Future researchers can establish research collaborations based on their areas of interest, find suitable partners, conduct in-depth studies, deepen cooperation across different fields, strengthen external collaborations, and explore emerging research areas.

## Co-Citation Analysis

Co-citation analysis helps researchers better understand the current state of research. It enables researchers to identify the renowned journals, publications, and researchers in the field, the current research focus, and their literature sources. This section aims to answer the research question (3): what are the current research dynamics in IHE?

### Journal Co-Citation Network

Table 6 illustrates the most frequently co-cited journals in IHE papers, revealing several new findings:

- (1) Journals with more co-citations tend to have higher IF. For example, "Lancet" and "JAMA-Journal of the American Medical Association" boast the highest five-year IF among the top ten journals, at 106.9 and 67, respectively. Only two journals in the top ten have a 5-year IF below 3.
- (2) Regarding co-citation counts, "Social Science & Medicine" and "American Journal of Public Health" lead with 1212 and 941 citations, respectively. These publications also have high five-year IFs of 5.2 and 10.1, respectively.
- (3) Regarding centrality, the journals with the highest five-year IFs exhibit the highest centrality. Specifically, "Lancet" has the highest IF and centrality (106.9 and 0.05), highlighting its pivotal role in the IHE field.
- (4) Journals with more co-citations also started being co-cited earlier. Among those with the most co-citations, the earliest began to be co-cited in 2004, the first-year data was collected, including "Social Science & Medicine", "American Journal of Public Health", and "JAMA- Journal of the American Medical Association". In contrast, the most recently co-cited journal is "International Journal of Environmental Research & Public Health", which started in 2017 and is the only top ten journal with a centrality of 0, having been co-cited 480 times.

Overall, in the IHE research field, journals with higher IFs are co-cited earlier and have higher centrality, indicating that they play a significant connecting role in the co-citation network and wield a greater, more substantial potential influence. These highly co-cited journals provide valuable references for future IHE research. Researchers aiming for broader citation and recognition of their work should consider submitting to these influential journals.

**Table 6** Journal Co-Citation Network

Ranking	Journals	5-year IF	Count	Centrality	Year
1	Social Science & Medicine	5.2	1212	0.04	2004
2	American Journal of Public Health	10.1	941	0.02	2004
3	BMC Public Health	3.9	889	0.03	2008
4	Journal of Immigrant and Minority Health	2.2	829	0.01	2010
5	Lancet	106.9	782	0.05	2005
6	PLoS One	3.3	681	0.02	2013
7	International Journal of Environmental Research and Public Health	4.799	480	0	2017
8	JAMA-Journal of the American Medical Association	67	472	0.04	2004

Figure 6 displays a visualization of the co-citation network of journals, showing a broad scope of engagement across various clusters, including health, medicine, sociology, and economics within the IHE-related fields. The specific findings are as follows:

- (1) Cluster #0 (mental health) focuses on mental health and predominantly addresses psychological and mental health issues with representative journals such as *Pediatrics* and *American Psychologist*. *Pediatrics* has specifically examined the impact of anti-immigrant sentiment on the psychological health of immigrant children, noting that exclusionary or prejudiced views can have adverse or chronic effects on their mental or physical health.<sup>79</sup> Another study assessed the developmental needs of immigrant children in the US, highlighting how factors like poverty, war, and malnutrition can lead to neglect of their physical and mental health, subsequently affecting their education and employment.<sup>80</sup> *American Psychologist* features key research on the experiences of discrimination based on race or ethnicity among adolescents, finding that discriminated youth are prone to depression, internalized distress, and other mental health issues, which can affect their self-esteem and academic performance.<sup>81</sup> These studies underscore the necessity of health education measures for immigrant children.
- (2) Cluster #1 (tuberculosis), the key journals include *BMC Public Health* and *Lancet*. *BMC Public Health* features highly co-cited articles on the health status and healthcare of immigrants and refugees in Europe, identifying ongoing inequities in healthcare access, with language and racial discrimination as significant barriers. The study calls for improved healthcare measures, especially for chronic (eg, hypertension) and infectious diseases (eg, tuberculosis). It highlights the need for better data on immigrant health status, needs, and healthcare access to better meet their needs.<sup>82</sup> *Lancet*'s most co-cited article in this cluster covers the declining tuberculosis rates in China from 1990 to 2010, attributed to a significant shift from hospital-based to public health center-based treatment using short-course direct observation strategies, which significantly improved tuberculosis treatment,<sup>83</sup> providing important insights for future IHE research.
- (3) Cluster #5 (socioeconomic status) features notable journals such as the *Journal of Health and Social Behavior* and the *American Journal of Public Health*. *Journal of Health and Social Behavior* focuses on how parental education levels influence the health of both parents and children, indicating that parental education, family economic status, and socioeconomic conditions impact health outcomes.<sup>84</sup> *American Journal of Public Health* addresses the health status of immigrant shrimpers, noting the impacts of insufficient health knowledge, unstable employment, and high stress levels on their health.<sup>85</sup> The study emphasizes the inadequate regulation of immigrant labor, high occupational risks, and physical demands, highlighting the necessity of considering the socioeconomic status of immigrants in health education efforts.

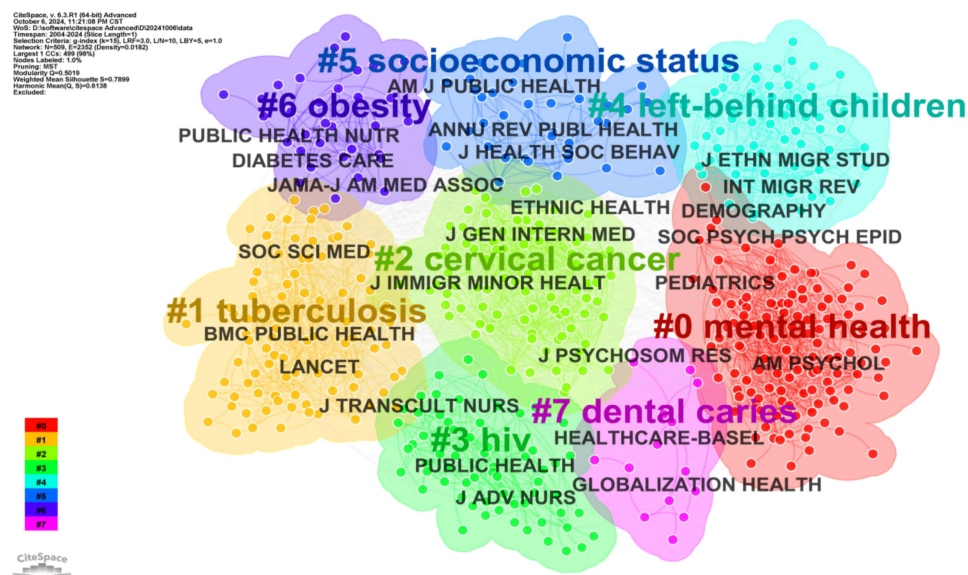


Figure 6 Visualization of journal co-citation network (N=509, E=2352).

These clusters highlight the topics that frequently receive attention from co-cited journals, providing researchers in the future with the inspiration of “which topics are given more emphasis”.

### Reference Co-Citation Network

Table 7 displays the top ten most co-cited references in IHE research. Specifically:

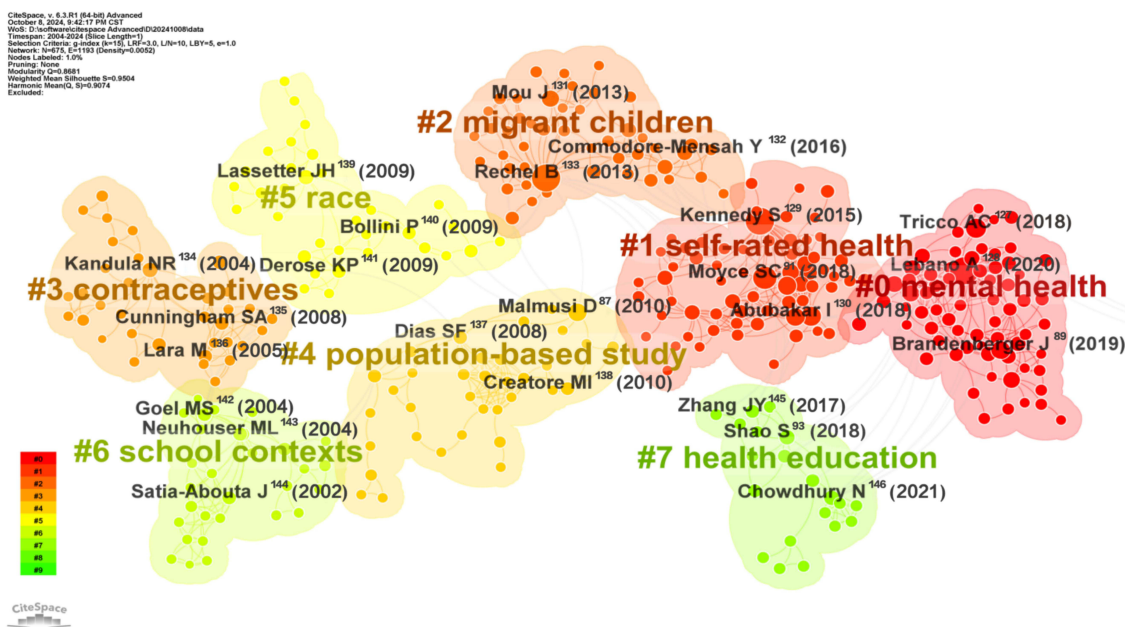
- (1) The most frequently co-cited article is by Rechel B, published in the *Lancet* (co-cited 10 times), which focuses on the health of immigrants in Europe. This 2013 publication discusses the scale of international migration, existing data on immigrant health, barriers to accessing medical services, methods to improve medical services for immigrants, and the health policies adopted across Europe. Despite challenges in improving immigrant health, the paper emphasizes the need for health education and continuous knowledge enhancement to achieve better health outcomes for immigrants.<sup>86</sup> This article is the earliest co-cited in 2013 and holds the third-highest centrality (0.21) among the top ten, indicating its broad recognition.
- (2) Regarding centrality, the articles by Malmusi D and Kennedy S have the highest values, at 0.28 and 0.25, respectively. Malmusi D’s work, published in *Social Science & Medicine*, reviews theories and research outcomes related to immigration and health, analyzes factors associated with health inequalities among immigrants, and finds significant disparities related to social class and gender in health and socio-economic conditions.<sup>93</sup> Kennedy S’s article in the *Journal of International Migration and Integration* confirms the effect of healthy immigrants in the USA, Canada, the UK, and Australia, where the average health status of immigrants is better than that of native-born individuals.<sup>87</sup>
- (3) Regarding the first co-citation date, Rechel B’s work is the earliest, first co-cited in 2013. The latest is by Lebano A, whose article was first mentioned in 2020 in *BMC Public Health*. This review aims to identify known information about the access to and use of healthcare by immigrants and refugees in EU member states. The study argues for improving existing data on immigrant health status, needs, and healthcare access to tailor care based on immigrant needs.<sup>82</sup>

These findings provide valuable insights, highlighting that highly co-cited papers in this field revolve around immigrant health, access to healthcare, and health inequalities. They play a significant role in future research, as these influential papers profoundly impact ongoing studies in the domain.

Figure 7 presents a clustered view of co-cited references, showing the main topical categories among co-cited publications, with the top eight categories identified as mental health, self-rated health, migrant children, contraceptives, population-based study, race, school contexts, and health education. These clusters encompass subfields within medicine, education, and demography. Key findings include:

**Table 7** Reference Co-Citation Network

Ranking	Journals	Count	Centrality	Year
1	<i>Lancet</i> , Rechel B <sup>86</sup>	27	0.21	2013
2	<i>Journal of International Migration and Integration</i> , Kennedy S <sup>87</sup>	26	0.25	2015
3	<i>BMC Public Health</i> , Lebano A <sup>82</sup>	25	0.1	2020
4	<i>Annual Review of Public Health</i> , Moyce SC <sup>88</sup>	17	0.02	2018
5	<i>Lancet</i> , Abubakar I <sup>89</sup>	13	0.1	2018
6	<i>Annals of Internal Medicine</i> , Tricco AC <sup>90</sup>	12	0.01	2018
7	<i>Ethnicity &amp; Health</i> , Vang ZM <sup>91</sup>	10	0.11	2017
8	<i>American Sociological Review</i> , Feliciano C <sup>92</sup>	10	0.01	2017
9	<i>Social Science &amp; Medicine</i> , Malmusi D <sup>93</sup>	10	0.28	2010
10	<i>BMC Public Health</i> , Brandenberger J <sup>94</sup>	10	0	2019



**Figure 7** Visualization of reference co-citation network (N=675, E=1193).

- (1) Cluster #0 (mental health): Represented by Brandenberger J, the co-cited research focuses on the significant health needs of immigrants and refugees and addresses the challenges of regaining confidence and equal opportunities for health under conditions of health inequality. The study comprehensively summarizes the main challenges faced in healthcare services for refugees and immigrants, considering communication, continuity of care, and trust. This has important implications for supporting clinicians' daily practices and guiding stakeholders in developing health policies and educational programs for immigrants and refugees.<sup>94</sup> Recent studies influenced by this research have investigated the mental health dilemmas of Asian Americans, highlighting issues such as loss of confidence and trust in therapists and a lack of cultural understanding by therapists, which hinder their willingness to seek psychological treatment.<sup>113</sup>
- (2) Cluster #1 (self-rated health): represented by Moyce SC, the co-cited research focuses on the occupational health self-assessment of immigrant workers, noting that they often work in more hazardous environments for longer hours and lower pay. It calls for effective self-assessment of health and work conditions by immigrant workers, businesses, and governments to pay attention to their occupational health, provide health education programs, and actively improve their working conditions and health.<sup>88</sup> Building on this research, studies have explored the mental health of new immigrants in unstable work environments, suggesting a multidimensional approach to improve workplace conditions to promote their mental well-being.<sup>56</sup>
- (3) Cluster #4 (population-based study): represented by Malmusi D, the co-cited research, from a demographic perspective, investigates factors causing health inequalities among immigrants, identifying determinants such as gender, social status, and place of birth. The co-cited study notes that class and gender inequalities are evident in health and socioeconomic conditions and that immigrants from poorer birthplaces tend to have worse economic conditions after migration.<sup>93</sup> Based on this, research has been conducted on the mental health of rural women in China, finding that the built environment has a significant impact on mental health, with the social environment acting as a mediator between the built environment and mental health.<sup>114</sup>
- (4) Cluster #7 (health education): represented by Shao S, the co-cited research discusses health education for the mobile population and assisting them in accessing medical services. It notes that the mobile population often faces exclusion from urban social welfare and security systems and frequently encounters high health risks. The existing health service system is not conducive to seeking appropriate health services. The study advocates for policies and measures such as health education to improve the health literacy of the mobile population, increase medical

insurance coverage, and provide affordable health services to change their health service utilization behavior.<sup>95</sup> Recent studies have explored factors affecting oral health among female university students, highlighting barriers such as lack of knowledge, fear of dental treatment, and unaffordable costs, emphasizing the importance of targeted health education.<sup>115</sup>

These co-cited references serve as foundational contributions in the IHE field, with each representative reference within the clusters serving as a crucial source of knowledge. Overall, valuable references continually foster the development of this research field; scholars can refer to these core references to advance their research endeavors.

### Author Co-Citation Network

Table 8 highlights the top ten most frequently co-cited authors in the field of IHE, with notable findings:

- (1) The World Health Organization (WHO) leads with 383 co-citations, followed by the Centers for Disease Control and Prevention (CDC) with 75 co-citations. Both organizations were first co-cited in 2004, making them the earliest co-cited authors and indicating their early involvement in IHE research. Their centrality scores of 0.18 and 0.1 signify their authoritative and influential contributions to the field.
- (2) The author with the highest centrality, Williams DR (0.2), was first co-cited in 2005 and has been co-cited 74 times. His most co-cited work deals with racism and health, outlining how structural and cultural racism and personal discrimination are linked to both psychological and physical health outcomes, significantly contributing to health inequalities.<sup>116</sup> His latest research explores the relationship between discrimination against older women and their sleep quality, suggesting that discrimination can adversely affect women's sleep health. The study indicates that discrimination is associated with insomnia and insufficient sleep, which are severe indicators of poor cardiovascular health. This is particularly evident among individuals with less than a bachelor's degree.<sup>117</sup>
- (3) The earliest co-cited individual authors, Williams DR and Singh GK, were first mentioned in 2005. With 71 co-citations and a centrality of 0.16, Singh GK has recently discussed the increasing disparities in COVID-19 mortality and life expectancy among different racial groups. His research highlights the persistent and widening health inequalities related to race or ethnicity and socioeconomic status, exacerbated by the COVID-19 pandemic, which further amplifies these health disparities in terms of mortality rates and reductions in life expectancy during the pandemic.<sup>118</sup>

Understanding these highly co-cited authors and organizations not only enhances the efficiency of future research but also provides valuable learning opportunities for other researchers in the field. These influential individuals and entities have shaped and continue to impact the trajectory of IHE research, offering foundational insights and directions for future studies.

The visualization of the author co-citation network timeline in Figure 8 reveals the formation and duration of clusters on different topics, showing the varying popularity and relevance of these topics over time. Here are the specific conclusions:

**Table 8** Author Co-Citation Network

Ranking	Authors	Count	Centrality	Year
1	World Health Organization	383	0.18	2004
2	Berry JW	126	0.14	2006
3	Braun V	97	0.06	2016
4	Centers for Disease Control and Prevention	75	0.1	2004
5	Williams DR	74	0.2	2005
6	Singh GK	71	0.16	2005
7	Abraído-Lanza AF	70	0.12	2007
8	Marmot M	64	0.11	2013
9	Rechel B	63	0.07	2014
10	Lu Y	63	0.09	2016

- (1) Variations in the start and duration of research clusters reflect shifting research priorities and relevance within the IHE field. Different clusters' varying start times and durations illustrate the fluctuating popularity of topics. For instance, cluster #2 (health education) has been active from 2004 to 2023, indicating its long-term dominance in the IHE field. Some clusters began early, such as cluster #0 (socioeconomic status), cluster #1 (mental health), and cluster #6 (cultural competence), all starting in 2005 but ending in 2022 or 2023, suggesting a decrease in their current popularity. Meanwhile, cluster #3 (health literacy), cluster #4 (Syrian refugees), cluster #5 (reproductive health), and cluster #7 (school adaptation) remain highly relevant today, suggesting areas that researchers should mainly focus on.
- (2) Cluster #2 demonstrates sustained scholarly attention to IHE, offering critical insights into disease prevention and behavioral intervention strategies. Cluster #2 (health education) has the longest continuity, focusing on developing health education for immigrants. Notable contributors include institutions like the Centers for Disease Control and Prevention, which has conducted significant research on tuberculosis prevention among immigrants. Their studies suggest that diverse health education approaches, such as online campaigns, outpatient education, and advertising, can effectively increase health information dissemination and improve tuberculosis control rates.<sup>119</sup> Another key researcher, Loue S, has focused on the high-risk behaviors for HIV among male immigrant laborers and the factors affecting these rates. This author's research indicates that interventions like sexual health education and preventative health measures can reduce disease rates among male laborers.<sup>120</sup> These diverse focal points provide valuable insights for policymakers and educators to effectively address different groups' psychological and health issues.
- (3) Cluster #7, despite its brief duration, underscores the vital connection between educational environments and students' mental health outcomes. Cluster #7 (school adaptation) focuses on the impact of education on students, with significant contributions from researchers like Wong DFK and Heckman JJ. Wong DFK's studies highlight the challenges of large class sizes in effectively preventing depression among teenagers and profoundly engaging with students' emotions and thoughts.<sup>121</sup> Heckman JJ argues for increased investment in children's education, suggesting that higher-quality education can prevent diseases and promote health.<sup>122</sup>

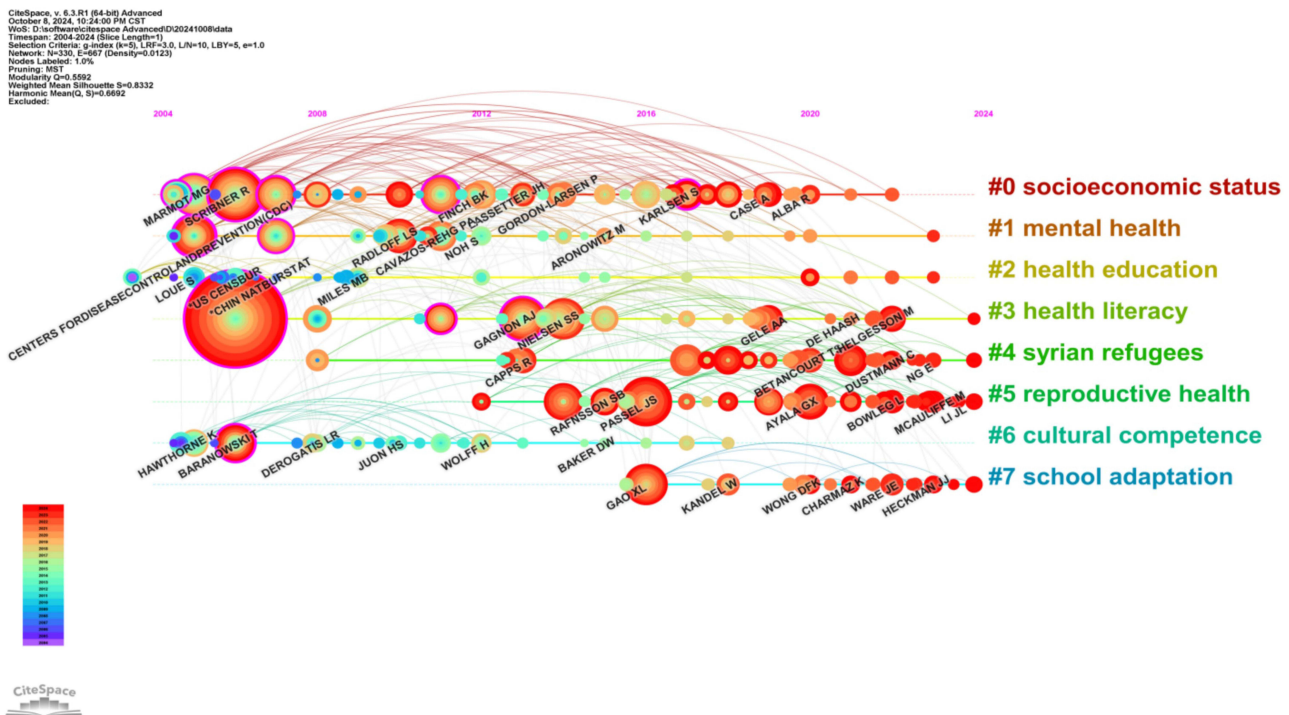


Figure 8 Cluster visualization of author co-citation network (N=330, E=667).

Overall, the author co-citation timeline illustrates the cumulative frequency of author co-citations over time, reflecting their influence and the persistence of their research impact. This timeline is crucial for assessing contributions within the research field and guiding future researchers in their learning and research direction determination. It offers a dynamic view of how different research topics have evolved and persisted, indicating shifts in research focus and highlighting enduring areas of interest.

## Co-Occurrence Analysis

The co-occurrence analysis within the field of IHE demonstrates current research hotspots and potential directions, offering valuable guidance for future studies. This section aims to answer the research question (4): how are the research hotspots and future directions in IHE developing?

### Category Co-Occurrence

Table 9 presents the top 10 most frequently co-occurring categories in IHE research, mainly related to medical, sociological, and environmental sciences. Here are details of the findings:

- (1) The Public, Environmental & Occupational Health category promotes theoretical and practical developments in the IHE field. With a centrality of 0.41, this category demonstrates significant influence, representing various factors that impact health, such as public health, environmental health, and workplace conditions. It is the most frequently co-occurring category (1251 times) and one of the earliest to appear in the data from 2004. This indicates that Public, Environmental, and Occupational Health is critical in shaping the scientific theory and practice of IHE, highlighting its foundational impact in the field.
- (2) The prominence of medical-related categories highlights the importance of IHE research within immigration and epidemiology. Six of the top 10 categories are related to medicine (Public Environmental & Occupational Health, Nursing, Health Policy & Services, Psychiatry, General & Internal Medicine, Health Care Sciences & Services, with co-occurring appearances of 1251, 207, 161, 154, 146, 124, respectively). This shows an intense concentration of IHE research within the medical field.
- (3) Integrating sociological and environmental categories reflects the multidisciplinary nature of IHE research and the various approaches for IHE. Three categories related to social sciences (Interdisciplinary Social Sciences with 99 co-occurrences, Social Work with 89, and Biomedical Social Sciences with 88) and one related to Environmental Sciences (143 co-occurrences) highlight the multidisciplinary integration within IHE research. These findings indicate that sociological and environmental aspects are also considered frontiers in IHE research alongside medical studies, underlining the comprehensive approach to addressing health education issues among immigrant populations.

Overall, the co-occurrence of these categories within IHE research underscores the field's multidisciplinary nature. There is an emphasis on combining medical, sociological, and environmental insights to enhance understanding and

**Table 9** Category Co-Occurrence

Ranking	Category	Count	Centrality	Year
1	Public, Environmental Occupational Health	1251	0.41	2004
2	Nursing	207	0.18	2004
3	Health Policy Services	161	0.12	2004
4	Psychiatry	154	0.07	2004
5	Medicine General Internal	146	0.03	2004
6	Environmental Sciences	143	0.08	2005
7	Health Care Sciences Services	124	0.07	2004
8	Social Sciences Interdisciplinary	99	0.17	2004
9	Social Work	89	0.02	2008
10	Social Sciences Biomedical	88	0.12	2004



represents research on the development of boarding students, many of whom are left-behind children in rural areas. Their physical and psychological health significantly influences their academic development, highlighting the need for schools and teachers to provide health education and psychological counseling to support the students' future development.<sup>129</sup>

- (3) Cluster #0 highlights the fundamental impact of malnutrition and adverse working conditions on immigrant health, reinforcing the importance of public health education interventions. Cluster #0 (public health) explores how malnutrition and poor working conditions affect the health of immigrant groups. Understanding these health determinants is crucial for aid workers to better assist immigrants, address their health issues, and promote public health initiatives.<sup>51</sup>

The clustering of these co-occurring categories in IHE research provides a comprehensive view of how diverse topics are interlinked. It emphasizes the multidisciplinary approach necessary to address the complex health needs of immigrants effectively. Each cluster represents a crucial area of focus that contributes to the overall understanding and improvement of IHE, influencing policy and practice in public health.

### Keyword Co-Occurrence

The analysis of keyword co-occurrence in Table 10 provides a clear view of the core content and emerging hotspots in this study area. The high frequency of specific co-occurring keywords highlights this research domain's focused and evolving interests.

- (1) Keyword co-occurrence analysis reveals that immigrant health, education, and cultural adaptation are central themes in IHE research, reflecting foundational priorities and emerging gender- and context-specific concerns. The most frequently co-occurrence keywords include "immigrants" (888 co-occurring times), "health" (583 times), and "education" (261 times), which are central to the IHE field. These terms reflect the primary concerns of researchers related to the health and educational needs of immigrant populations. Other widespread keywords such as "risk", "mental health", "care", "the United States", "prevalence", "acculturation", and "women" indicate specific areas that have drawn considerable attention in recent years. "Acculturation" is particularly significant, reflecting the complex interaction between cultural adaptation, psychological health, and education.<sup>130,131</sup> Cultural adaptation involves adjusting to the host region's dietary, linguistic, and religious customs, which can significantly affect immigrants' psychological well-being and, consequently, their integration, employment, and overall life circumstances.<sup>128,132</sup> Research on "women" emphasizes gender-specific studies within the immigrant population, noting that targeted sexual health education can effectively improve outcomes, especially for women, potentially reducing their disease rates.<sup>133</sup>
- (2) The impact and centrality of keywords such as "acculturation" and "women" highlight the critical role of cultural and gender-specific factors in IHE research. The keyword "acculturation" shows the highest centrality (0.04) with 201 co-occurrences, underscoring its perceived importance in IHE research. This indicates that many studies

**Table 10** Keyword Co-Occurrence

Ranking	Keyword	Count	Centrality	Year
1	Immigrants	888	0	2004
2	Health	583	0.02	2004
3	Risk	368	0.02	2004
4	Mental health	354	0.02	2004
5	Care	306	0.01	2004
6	United States	281	0.01	2004
7	Education	261	0.02	2004
8	Prevalence	241	0.01	2004
9	Acculturation	201	0.04	2004
10	Women	196	0	2004

consider cultural adaptation a highly influential research direction and have engaged in in-depth and interdisciplinary studies on this topic. The focus on “women” also aligns with specific life stages and challenges faced by female immigrants, such as childbirth and marriage. Studies examining the impacts of cultural adaptation and mental health on the marital satisfaction of immigrant women suggest that enhancing social support and health education could improve their marital satisfaction.

These findings demonstrate the sustained interest and priority that researchers in the IHE field place on understanding and addressing the complex issues facing immigrants. This keyword analysis is a valuable tool for researchers to identify and engage with the primary themes and challenges within the scope of immigrant health education.

Figure 10 shows a timeline of keyword co-occurrence within IHE research and provides valuable insights into the development of key topics within the field. This visualization is crucial for understanding the strong internal relationships among keywords that form clusters, and their evolution over time reveals both the shifting research priorities and the core ideas that have shaped the field. The analysis of the duration, onset, and focus areas of these clusters reveals the following:

- (1) The long-term existence and evolution of the clusters emphasize the significance of health literacy, mental health and sexual health in shaping the research trends of IHE. The clusters with the most extended duration, such as cluster #1 (health literacy), cluster #2 (mental health), cluster #3 (sexual health), and cluster #7 (health education), spanning from 2004 to 2024, indicate areas of persistent focus in IHE research. These topics, having evolved over two decades, show the continuous and growing interest in integrating health education, psychological, and sexual health considerations into the broader understanding of IHE. The earliest appearing cluster, cluster #1 (health literacy), starting in 2004 and continuing into 2023, underscores the foundational role of health literacy in IHE research. Over time, this cluster has likely informed and intersected with other research areas like mental and sexual health, reflecting a maturation of research focus from specialized topics to multiple themes.
- (2) Cluster #6 reflects a progression in IHE research from demographic analysis to practical health education interventions. The latest cluster #6 (immigrant health) emerged in 2005 and illustrates the field’s expansion from demographic and social determinants to direct health implications and interventions. This cluster initially

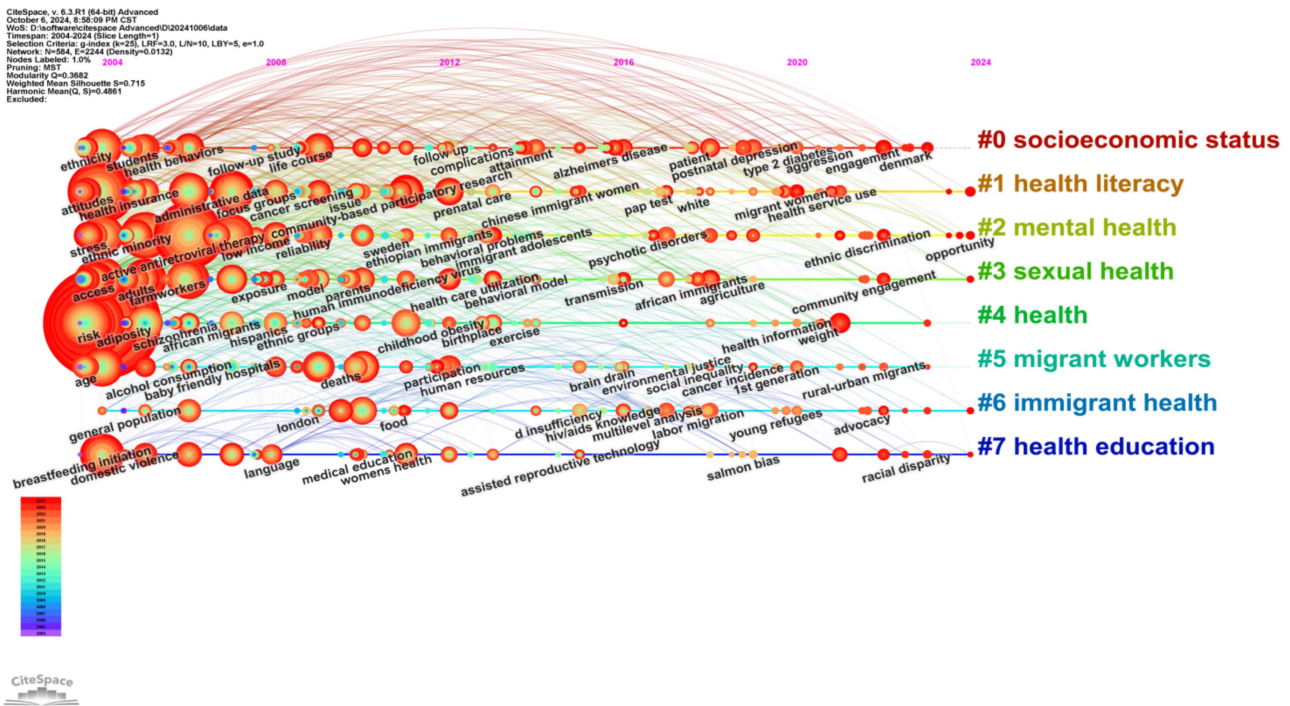


Figure 10 Cluster visualization of keyword co-occurrence (N=584, E=2244).

focused on demographic impacts on IHE and has evolved to encompass the effects of diet and health advocacy, broadening the scope to include practical health education interventions.

- (3) The interlaced development of clusters indicates the transformation of research from broad basic topics to more specialized and specific problem studies within IHE. These clusters' non-uniform start and end times indicate a logical progression in research focus, where older, broader themes give way to more specialized subdivisions, such as mental and sexual health education. This transition demonstrates how researchers in IHE have responded to emerging health issues among immigrants and refined their research approaches to address these issues more comprehensively. The refinement and specialization in research topics are evident in the sustained attention to areas like mental health and sexual health, where specific concerns are explored in depth. Integrating health and cultural education within these clusters indicates a holistic approach to addressing the complex needs of immigrant populations.

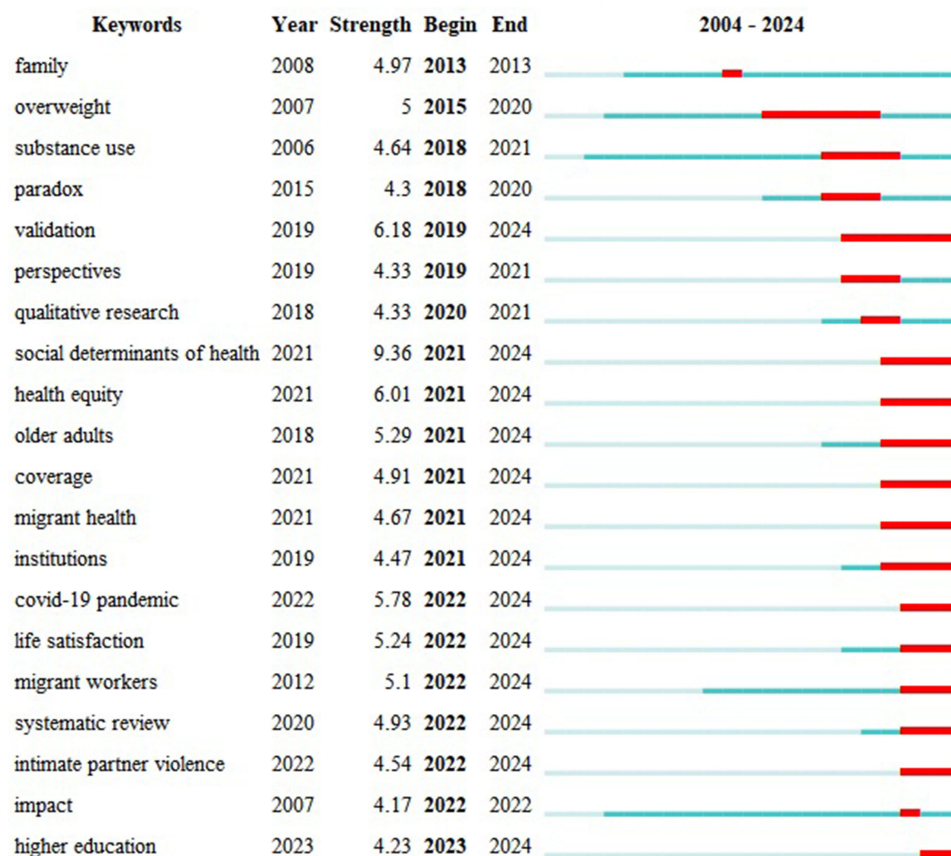
In summary, the enduring clusters in IHE research have evolved into refined domains, examining various aspects from mental to sexual health and incorporating educational strategies. This enduring focus reflects the field's responsiveness to the changing dynamics of immigrant populations and the evolving understanding of their diverse health education needs. Such insights can guide future research directions, ensuring that studies continue to address the most pressing and relevant issues within the field.

### Keywords Bursts

The burst analysis of keywords from 2004 to 2024, as depicted in [Figure 11](#), highlights the dynamically emerging trends and focal points within the field of IHE. Overall, keywords that bursted earlier tended to focus on individual or family health education issues, such as “family” (bursts in 2008) and “overweight” (bursts in 2007) and were relatively short durations. In contrast, keywords that emerged later were not only greater in number but also more diverse and extensive, highlighting social determinants, health equity, immigration issues, and pandemic impacts. Examples include “social determinants of health” and “health equity”, both burst in 2021 and exhibited sustained durations. Specifically speaking:

- (1) Keywords with intense bursts reveal emerging priorities in IHE research, particularly social determinants, health equity, and pandemic-related challenges. “Social determinants of health” (burst strength 9.36) emerges as the keyword with the most vigorous citation burst, emphasizing the impact of social factors like income, work environment, education levels, gender, and race on IHE. Research under this keyword suggests that improving psychological health and well-being among immigrants requires addressing issues such as employment limitations, restricted health services, and inequalities in health and education.<sup>134</sup> Other keywords with significant bursts include “validation”, “health equity”, “COVID-19 pandemic”, and “older adults”. These keywords represent areas of research that have rapidly gained attention in IHE research, such as methodologies in IHE studies, equitable health education access for immigrants, the impact of the pandemic on this population, and health education concerns specific to older immigrants.<sup>134</sup>
- (2) The differences in the duration of keyword bursts highlight the varying degrees of sustained academic attention, with a long-term focus on issues such as immigrant obesity and a short-term focus on broader family dynamics. “Overweight” has the most extended burst activity duration (6 years), indicating sustained interest in the impact of obesity on IHE. Studies have focused on the obesity risks in children of immigrant families and how health education can alter dietary habits to mitigate these risks.<sup>135</sup> The keyword “family” had the shortest burst duration (1 year), suggesting a shift from general family studies to more specific demographic groups within families, such as men, women, and children.
- (3) The latest burst of keywords marks the exploration of new IHE patterns and the focus on the mental health changes of immigrant students during the educational process. “Higher education” began its burst in 2023, highlighting new concerns about its impact on immigrants. Research in this area examines the psychological costs of immigrants pursuing higher education; it suggests integrating health education with higher education to aid immigrant students in assimilating into local cultures and managing psychological stress.<sup>136</sup> Such integration can better meet the psychological health needs of immigrant students.<sup>43</sup>

## Top 20 Keywords with the Strongest Citation Bursts



**Figure 11** Keywords with Strong Citation Bursts.

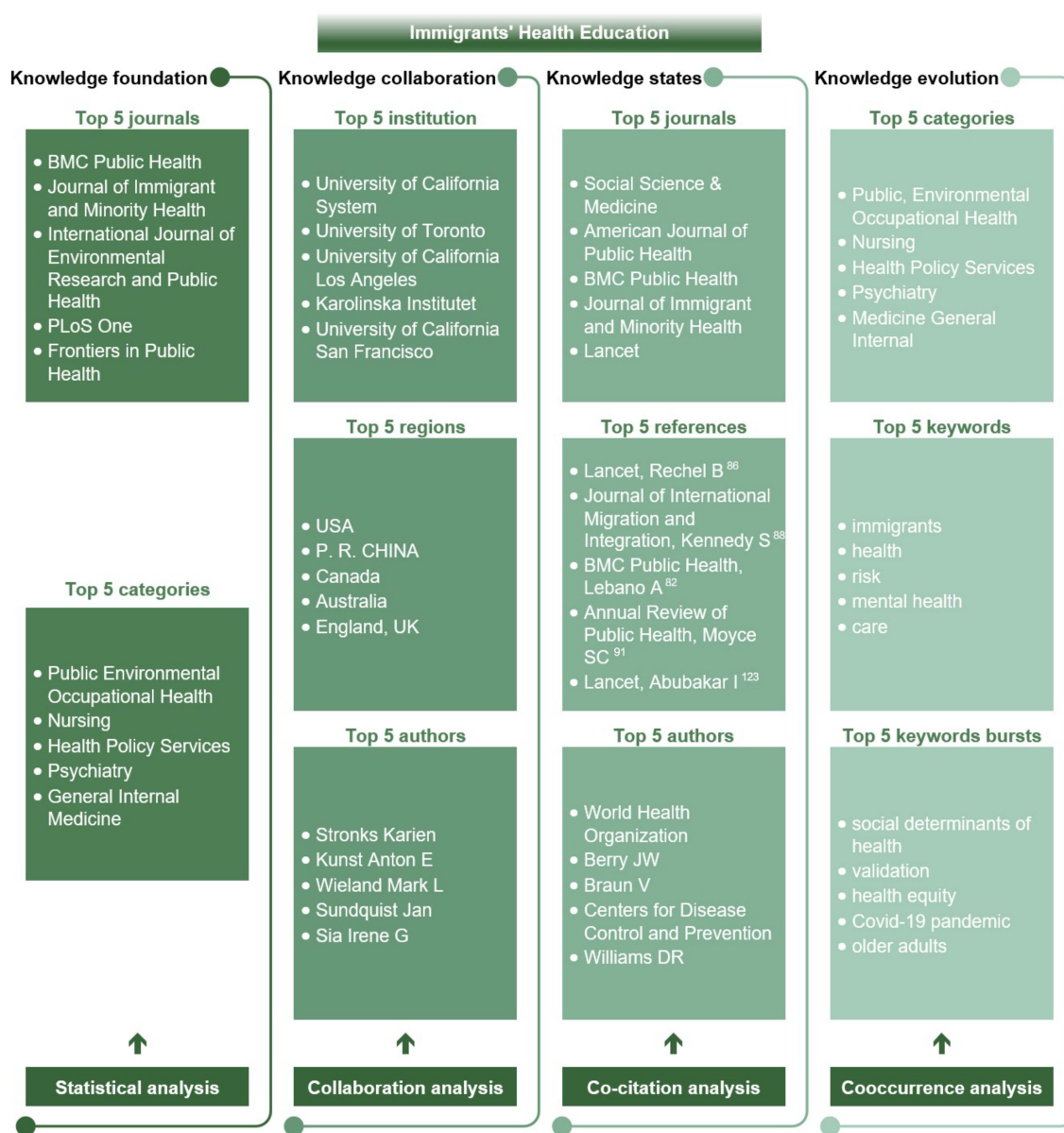
Overall, the analysis of bursting keywords reveals that researchers in the IHE field are continuously refining their focus areas and delving deeper into current research domains. This ongoing specialization contributes to the academic richness of the field and helps address various aspects of immigrant health and education. As IHE research progresses, these keywords guide the educational community in understanding immigrant populations' evolving challenges and needs, shaping future research directions and interventions.

## Theoretical Summary

### Knowledge Framework

As shown in [Figure 12](#), the exploration of the knowledge framework within the field of IHE emphasizes the comprehensive, dynamic, and complex nature of research in this area. This framework serves multiple purposes:

- (1) Establishing a structured knowledge foundation facilitates the identification of popularity in IHE research, offering a support for future scholarly exploration. It is essential to build mechanisms that display the focus areas within IHE, allowing scholars to easily grasp the core topics in the field; this aids in simplifying the understanding of a complex domain and provides valuable references for future exploration. The statistical foundations highlight the field's popularity and significance; it points out preferred journals and research categories, a motivational guide for scholars aiming to deepen their research or publish their findings.
- (2) The collaborative network among scholars, institutions, and regions reveals the structural connections of academics in IHE research and supports the future search for global partnerships. It displays the interconnections between scholars, institutions, and regions, illustrating the collaborative dynamics within the academic



**Figure 12** Knowledge Framework.

community. This insight is particularly valuable for identifying potential collaborators and fostering international and inter-institutional cooperation, which is critical in a globally related field like IHE.

- (3) Co-citation analysis offers an overview of influential sources, revealing research authorities, thematic linkages, and the temporal evolution of the IHE field. The framework outlines the current state of research by analyzing co-cited journals, references, and authors; it identifies high-impact topics and the associated keywords and categories. This helps pinpoint ongoing research hotspots and timelines, enhancing the understanding of how the field is authoritative and evolving.
- (4) Co-occurrence analysis maps the developmental trajectory of IHE research by clustering categories and keyword bursts, offering guidance for future scholarly exploration. This analysis sketches the developmental trends within the field, clustering research categories and bursts of keywords. This strategic insight directs scholars on what aspects to focus on in their forthcoming studies.

Deep dive into the framework: (1) the framework reveals an increasing popularity of IHE, as evidenced by the favored journals like “BMC Public Health”, “Journal of Immigrant & Minority Health”, and “International Journal of Environmental Research & Public Health”. These journals primarily focus on categories like Public Environmental Occupational Health, Nursing, Health Policy Services, and Psychiatry, highlighting the field’s interdisciplinary nature; (2) collaborative statuses often involve prominent institutions and regions active in research, such as the University of California System, the University of Toronto, and the Karolinska Institute, with significant activity in the US, China, and Canada. This reflects the global and diverse involvement to tackling IHE issues; (3) research dynamics varies covering public health, medical, and social sciences, focusing on psychological health, health education, and the health of left-behind children, underscoring the field’s broad scope; (4) future trends in IHE will likely emphasize psychological health education, public and occupational health education, and sociological or demographic-based health education, predicting these areas to become increasingly popular topics.

Overall, this knowledge framework informs current researchers about the state and direction of IHE and serves as a guide for navigating and contributing to the field effectively. By understanding the evolution of knowledge within IHE, researchers can anticipate and align with future trends, thus making impactful contributions to the field.

## Future Research Trends and Practice Recommendations

### Research Trends

The recent upsurge in research within IHE reflects a growing recognition of its complexity and the urgent need for broader and more detailed approaches. The multifaceted exploration can be categorized into specific directions for future research:

- (1) The interdisciplinary nature of IHE research underscores the necessity of collaborative approaches that integrate expertise across health, education, and social sciences to address IHE challenges comprehensively. The need for multidisciplinary efforts is evident, as research in IHE overlaps with fields like psychology, demography, cultural studies, and infectious disease management. This suggests a push toward projects integrating expertise from educational fields, medicine, nursing, and auxiliary disciplines like statistics, sociology, and demography. Future collaborative research could involve management studies to innovate health education delivery and resettlement processes for immigrants, merging statistical methods to use health education outcomes as benchmarks for immigrant resettlement evaluation, and combining sociology and demography to assess health outcomes across different races, cultures, and genders after targeted health education interventions.
- (2) Co-citation analysis reveals the expanding topic complexity of IHE research, highlighting its interdisciplinary scope and the need to address health within broader social and occupational health. Co-citation analysis has uncovered a variety of themes, such as dietary health education, environmental health, health welfare and policy, and health literacy enhancement, indicating the interdisciplinary nature of IHE research. The scope of the study is moving beyond just the physical health issues of immigrants to encompass more diverse topics, including workplace conditions, social status, income levels, educational background, and psychological factors. Researchers are encouraged to engage with medical professionals, immigration officers, and business administrators to broaden the scope of their studies and include more diverse case studies. They are also advised to consider the impacts of complex backgrounds, such as war and conflict, on IHE and explore specific mechanisms and manifestations under such conditions.
- (3) Adopting theories and methodologies from other disciplines reflects a growing trend in IHE research toward analytical innovation and cross-field integration. The occurrence of terms like “multilevel analysis” in co-occurrence analysis highlights the significant cross-disciplinary data analysis in IHE, suggesting a trend towards adopting advanced techniques and innovative methodologies from other fields to optimize IHE outcomes. Potential theories for future research include coupling coordination theory to study the complex dynamics between immigrant health and physical and social environments (like air quality, housing conditions, and community resources) and employing global mobility theory to study globalization trends and health education methods for immigrants from an international perspective. Structured interviews, structural equation modeling, data mining, and machine learning could be used more effectively to analyze complex relationships within IHE.

By embracing these changes, IHE research can continue to evolve and respond to the global challenges immigrant populations face, providing comprehensive insights and practical solutions to improve their health and integration outcomes.

### Recommendations for Practice

Interdisciplinary and intersectoral collaboration is crucial for IHE, necessitating diverse demands on governments, medical practitioners, and educators. We recommend the following actions:

- (1) Governments and policymakers should tailor IHE to the diverse cultural backgrounds, immigration reasons, and religious beliefs of immigrant groups. This could include offering multilingual health promotion materials, videos, and online courses, and implementing planned health education. Additionally, cross-sector collaboration is vital, leveraging immigrant communities, schools with immigrant children, and hospitals to expand health education channels, such as offering free medical consultations, incorporating health courses in school curricula, and organizing educational talks. Regular assessments on immigrants' health status and needs are essential to develop targeted health policies, adjust educational content, and improve teaching methods. Through these measures, the government can help immigrants tackle health challenges, improve their overall health levels, foster social inclusiveness, and lay the foundation for a more harmonious and healthier societal environment.
- (2) Medical practitioners should possess adequate foreign language skills and proficiently use translation tools to ensure smooth communication with immigrant patients. They should provide easy-to-understand health education tailored to different populations, cultural backgrounds, health literacy levels, and economic statuses. Furthermore, practitioners should have expertise in both physical health issues and common mental health concerns among immigrants, such as anxiety, depression, and post-traumatic stress disorder, to offer preliminary educational interventions and timely referral services. This ensures higher quality health education services, enhances immigrants' trust in the medical system, and aids their integration into society.
- (3) Educators play a significant role in health education for immigrants and should enhance their teaching methods, cultural adaptability, and expertise. They should employ diverse teaching techniques to cater to individual needs, reduce language and cultural barriers, and ensure that immigrant students understand and accept the health education provided. Educators need to be culturally sensitive, respect immigrant students' cultural backgrounds and beliefs to avoid cultural conflicts, and be good at using digital teaching tools to enhance educational outcomes. Additionally, educators should strengthen collaboration with medical institutions, communities, and governments to provide comprehensive support to immigrant students. This support helps immigrant students adapt to new environments, improve their health literacy and quality of life, and lay the groundwork for societal integration.

### Comparison

Although there are existing review studies on related topics, this study is the only comprehensive review of IHE. By comparing these studies, we can highlight the uniqueness of our research, demonstrating the novelty of our results. Some studies target the immigrant population, showing that immigrants' psychological well-being affects regional stability and influences their integration into local communities. For example, one study revealed that psychological interventions received by immigrants at their destination could alleviate emotional distress, enhance quality of life, boost self-efficacy, and improve adaptability.<sup>137</sup> This emphasizes the importance of psychological guidance and intervention for immigrants, which aligns with our findings. Moreover, our study covers issues such as mental health education among immigrants of different religious beliefs, the significance of boosting self-efficacy among immigrant youths, and psychological educational interventions for specific groups like post-war immigrants, making our analysis more comprehensive.

Reviews on "health education" focus on the benefits to maternal well-being and fetal health after pregnant women change their dietary habits following health education. This is consistent with our findings that health education can modify immigrants' nutritional habits, enhancing their life quality and health status. However, our discussion goes further by emphasizing the importance of health education and its impact on future generations and addressing psychological

and physical health education. Therefore, it is necessary to develop comprehensive health education plans to prevent and tailor diseases to different diseases and populations.<sup>138</sup>

The population focus of existing reviews differs. There are retrospective studies on “health education” for “adolescents” that identify academic and employment pressures as key factors affecting adolescents’ mental health. At the same time, drugs, alcohol, and sexual behaviors are the main factors impacting their physical health. These findings share similarities with our IHE. However, for the immigrant population, employment pressure, economic income, social status, and cultural and dietary differences are the main factors affecting their mental health.<sup>139</sup> At the same time, working conditions and unequal medical conditions are significant factors impacting their health.

Finally, inter-period comparisons were conducted to analyze data across different timeframes, allowing for observing shifts and developmental patterns, thereby strengthening the study’s findings. We divided the timescale from 2004 to 2024 into two decades: the first stage (2004–2013) and the second stage (2014–2024). Research in the first period primarily focused on mental health education for specific immigrant groups such as war refugees, second-generation immigrants, and children.<sup>140,141</sup> In contrast, the second period saw a shift toward addressing the physical and mental health education needs of immigrants affected by poverty and climate change. Additionally, the latter period emphasized post-diagnosis health education for immigrants with specific diseases. There was also increased attention to health issues arising from differences in language, cultural practices, dietary habits, and lifestyles, leading to the development of tailored IHE programs based on these variances.<sup>142,143</sup>

In summary: (1) review studies on IHE are insufficient, and our review has directly advanced this field; (2) limited studies on related topics have not utilized visualization software to depict the evolution of research, whereas our study used CiteSpace to make the literature analysis more precise, persuasive, and intuitive; (3) unlike limited research on related topics, our study spans a sufficient length of time to gather more comprehensive literature and further develops the knowledge framework of IHE; (4) through the inter-period comparisons, we can find that the number of publications shows an increasing trajectory, and the research hotspots have gradually shifted from being individual-centered to being social and global public issue-centered, presenting a broader, deeper and more sustainable research trend. This helps scholars better understand the development and structure of IHE knowledge from a new perspective, providing theoretical support for practitioners.

## Conclusions

This study utilized CiteSpace to analyze the bibliometric evolution of the IHE field’s literature, providing a fresh perspective on assessing research development in this area. Our main findings include:

- (1) The steady growth in IHE-related publications highlights the field’s rising academic significance and expansion across diverse research domains. Over the past two decades, the number of publications related to IHE has increased significantly, underscoring its prominence as a rapidly developing field of research. 2984 related articles were published during this period, with an average annual growth rate of 9.67%. These studies appeared across 896 journals, including public health-focused journals such as BMC Public Health, specialized journals like the Journal of Immigrant and Minority Health, which concentrates on immigrant health, and broad-disciplinary journals such as PLoS One. Moreover, IHE-related research spans 169 disciplinary categories, including sociology, medicine, public and environmental occupational health, biology, and environmental science. This highlights the integrative and interdisciplinary nature of the field. These findings reflect the growing importance of IHE research and offer guidance for future scholars: emphasize interdisciplinary integration, strategically select journal platforms, and be optimistic to explore new frontiers in this field.
- (2) The analysis of the cooperative network indicates that the cooperative relationships among authors, institutions, and regions, especially those among developed countries, are of great significance for promoting IHE research. Regarding author collaboration, 599 authors have collaborated more than once; however, all authors exhibit a centrality score 0. This suggests that many researchers work independently, indicating a need to strengthen external collaboration. Some organizations have established complex collaborative networks in terms of institutional collaboration. The U.S.-based institutions demonstrate the highest number of collaborations (196 times) and

the earliest initiation of cooperation (in 2004). Canadian institutions, meanwhile, exhibit the most prominent external collaborations, with the highest centrality score (0.16) and a relatively high collaboration frequency (103 times). Regarding regional collaboration, developed regions in Europe and North America exhibit strong cross-regional partnerships. The United States remains dominant in these collaborations, with the highest frequency (1196 times) and the highest centrality score (0.2). Among developing regions, China shows a relatively high number of collaborations (338 times) and an early start (2004); however, its external collaboration influence remains limited, with a centrality score of 0. These findings offer valuable insights for future researchers, helping them identify potential collaborators and encouraging more active participation in international partnerships. Such efforts can enhance the impact of research outputs in IHE and drive the field's continued development.

- (3) This study systematically analyzed co-citation patterns in the field of IHE, revealing that high-impact journals, authors, and publications play central roles in shaping the field. Journals with higher five-year impact factors, such as “Lancet” (IF=106.9) and “JAMA-Journal of the American Medical Association” (IF = 67), are not only co-cited more frequently but also show higher centrality, reflecting their significant influence. Among the top 10 co-citation journals, only two have IFs below 3, and most were co-cited as early as 2004. The most co-cited article was Rechel B's, which was co-cited 10 times, had a centrality of 0.21, and was also the first co-cited article. This 2013 publication discusses the scale of international immigrants, available data on immigrants' health, barriers and ways to improve immigrants' health care, and corresponding health policies adopted across Europe. In terms of centrality, Malmusi D had the highest centrality (0.28). A systematic review of theories and research findings related to immigrants and health analyzed factors associated with health inequalities between immigrants and found significant differences in health and socioeconomic conditions related to social class and gender. Co-cited articles clustered of topics such as mental health, tuberculosis, and socioeconomic status reflect the interdisciplinary nature of the IHE. Representative studies address the mental health of immigrant children, barriers to health care for immigrants, and the impact of socioeconomic conditions on health outcomes. The clusters highlighted the main challenges faced by migrant populations in terms of health equity and education. “Health education” remains a long-standing core theme, active from 2004 to 2023, while newer clusters such as “health literacy” and “school adaptation” are gaining attention. The WHO was co-cited 383 times, the most frequently among the co-cited authors, with a centrality of 0.18. The author with the highest centrality, Williams DR (0.2), was first co-cited in 2005, and his research focused on racism and health issues, showing that discrimination can adversely affect women's sleep health. These findings can help researchers identify high-impact journals, literature, and authors, help researchers select references, and improve the academic quality and influence. At the same time, the hot topics revealed can provide direction for topic selection and improve the pertinence and influence of research.
- (4) Co-occurrence analysis reflects the current knowledge structure of IHE research, reveals key topic concentrations, and indicates future directions for interdisciplinary research. The top 10 co-occurrence categories in IHE studies were mainly related to medicine, sociology, and the environment. Public Environmental & Occupational Health had a significant influence, with a centrality of 0.41. This category encompasses a range of factors that impact health, with a focus on the effects of public health, environmental health, workplace factors, and other related factors on the health of immigrants. It is also the most frequently and the earliest co-occurring category (1251 times and the year 2004), indicating that Public, Environmental & Occupational Health has a significant influence on the theory and practice of IHE in this field. Keyword co-occurrence analysis revealed that the most co-occurring keywords were “risk” and “mental health”, which appeared 368 and 354 times, respectively, alongside “immigration”, “health”, and “education”. This suggests that the current research focus is on mental health and health risk factors in immigrant populations. Future research could build on this to explore differences in mental health, sources of stress, and coping mechanisms among different immigrant groups. Additionally, the keyword burst analysis revealed that education, environment, medicine, nursing, sociology, and other related topics were current research hotspots. This suggests that IHE research is shifting towards interdisciplinary integration and multidimensional frameworks. Finally, the timing and intensity of keyword bursts showed strong momentum for terms such as “social determinants of health” (burst strength 9.36), “validation” (burst strength 6.18), “health equity” (burst strength 6.01) and “COVID-19 pandemic” (burst strength 5.78). The latest keyword to emerge is “higher education”, which has begun to surge since 2023. These trends suggest that social determinants of health, health equity, and the role of the education system, especially higher

education, in shaping migrant health will be key areas of growth in the future. These findings highlight the core issues of current IHE research, providing future researchers with clear directions for topic selection, theoretical grounding, and methodological tools. Researchers should anchor their work in existing high-frequency themes while closely monitoring the evolution of emerging keywords.

- (5) This study identifies key future research trends and practical recommendations within the field of IHE, highlighting its interdisciplinary nature and expanding complexity. Future research is expected to adopt more collaborative, cross-disciplinary approaches, integrating knowledge from health, education, and social sciences. Co-citation and co-occurrence analyses reveal the increasing breadth of IHE topics, urging researchers to consider a wider array of factors such as occupational health, psychological well-being, and socio-demographic diversity. Methodologically, IHE research is moving toward analytical innovation by incorporating advanced theories and tools from other fields, which can help uncover deeper mechanisms and optimize outcomes for immigrant populations. In practice, promoting IHE requires coordinated efforts from governments, medical professionals, and educators. Policymakers should develop culturally sensitive, multilingual, and needs-based health education programs while strengthening intersectoral cooperation. Medical practitioners need strong communication and cultural competencies to deliver tailored education and early interventions. Educators are advised to enhance cultural adaptability, diversify teaching strategies, and collaborate closely with communities and institutions to support immigrant students. These strategies aim to improve immigrants' health literacy, facilitate social integration, and contribute to a more inclusive and healthier society.

This study is innovative in several ways:

- (1) By combining health education with immigration issues, this study systematically analyzes the research development trajectory in the IHE field, addressing the lack of a comprehensive and integrated analysis in previous research.
- (2) Building and precisely describing this field's knowledge framework provides readers and scholars with a comprehensive and straightforward tool to understand the structure and evolution of knowledge in the field.
- (3) This study proposes crucial future research directions for the field, further enriching the knowledge system and providing valuable guidance for scholars to explore research related to immigrant health education more efficiently.
- (4) This study offers practical suggestions for practitioners in the IHE field and reliable support for policymakers, filling research gaps and laying the foundation for deepening the field's development.

However, this study also has some limitations. (1) It only selected publications in English, neglecting research in other languages; (2) it overlooked the latest literature written during the study period, despite the rapid update rate of literature in the field; (3) it did not conduct a detailed classification study of immigrant groups, such as post-disaster immigrants, war immigrants, African immigrants, South American immigrants, Asian immigrants, Muslim immigrants, and Jewish immigrants. Future research could select publications in other languages and compare the differences in results; additionally, it could choose the latest publications and further discuss their evolutionary trends. Further bibliometric studies on the health education of the subgroups could deepen our understanding of IHE.

## Data Sharing Statement

The data will be available from the corresponding author.

## Ethics Statement

This research did not involve human or animal participants.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors declare no conflicts of interest in this work.

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