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RESEARCH FRONTIERS AND TRENDS IN YOUTH EMPOWERMENT: A BIBLIOMETRIC ANALYSIS FROM YEAR 2015-2025

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Abstract:

Youth empowerment is widely discussed across health, education, community development, and policy research. However, rapid growth and varied terminology make it difficult to obtain an integrated picture of how the field has progressed and where contemporary research efforts are focused. This bibliometric analysis maps publication trends, influential articles, leading countries, major keywords, and international collaboration patterns in the Scopus-indexed literature on empowerment among youth. Using Scopus's advanced search, 1,041 records were retrieved. Data was cleaned and harmonized in OpenRefine to improve consistency of metadata (e.g., author keywords and country names). Scopus Analyzer was used to generate descriptive statistics and trend graphs, while VOSviewer was applied to visualize keyword co-occurrence as well as country co-authorship networks. The results demonstrate a substantial rise in annual publication output, rising from 29 publications in 2015 to 109 publications in 2025, with more rapid expansion after 2020. The top 10 most cited articles (published between 2015 and 2020) received between 71 and 95 citations, suggesting that a small set of applied and methodologically robust studies attracts substantial attention. The United States is on top with 274 publications, followed by the United Kingdom with 75 and Australia with 47, with some Asian and African countries also making significant contributions. The output of the country is concentrated in a few research centers. A total of 1,356 distinct keywords were generated through the process of keyword mapping. A threshold of five instances was used for 102 retained terms, with the centrally placed terms "empowerment," "adolescent," and "youth" associated with topics or challenges such as economic empowerment, mental health, and participatory modalities. At the same time, the co-authorship research revealed 103 countries, and 43 of them fulfilled the minimum-document

condition, and the United States was a significant center of cooperation (Total Link Strength = 132). Overall, the findings contribute to more efficient agenda-setting.

Introduction

Youth empowerment is a major topic of discussion that fills the rift between personal empowerment and the potential for community and meaningful social change. The different theories conceptualize youth empowerment as a process and an outcome with a focus on skills such as assertiveness, advocacy, and critical thinking. Empowerment, based on empowerment theory and the ideas of critical social theory, is associated with personal development and with active participation in the community and civic life. In this, empowerment is also a complex notion that is adaptable and can accommodate the conditions experienced by youths in various social and economic setups (Cargo et al., 2003; Holden et al., 2004; Kohfeldt et al., 2011; Messman et al., 2022).

Recent works on youth empowerment focus on the importance of dialogue between psychological, social, and contextual factors. According to the research, safe places, good relationships between youth and adults, and opportunities for participation may help young people to obtain self-confidence, interact with their communities, and become more socially aware. Programs that help an individual develop and encourage broader change can be developed through a focus on technical skills and strategies that encourage independence. Altogether, the literature provides evidence that empowerment depends on local communities, cultures, and bigger social systems, the help of which can be used to design more effective programs among youths (Jennings et al., 2006, 2012; Kranke, 2019; Maschietto, 2016).

Literature Review

The youth empowerment literature demonstrates that numerous definitions, theories, and frameworks exist for this problematic issue. Initial studies, informed by empowerment theory, view empowerment as both a process and an outcome. More prosocial behavior, increased self-esteem, and involvement in the community have been linked to psychological empowerment.

Two perspectives have been addressed by researchers: one is centered on skills such as assertiveness and advocacy, and the other is centered on power-sharing, as well as critical awareness. This continuous debate reflects how context and culture could influence the empowerment outcomes of youth (Christens et al., 2016; Joseph, 2020; Maschietto, 2016; Messman et al., 2022).

Research has provided a better insight into the working mechanism of youth empowerment and its outcomes. Research indicates that family support, peer support, school support, and the community at large are all important when it comes to influencing the process of empowerment among youth in society. Aspects such as a sense of control, a sense of community, and psychological empowerment are associated with a decreasing number of risky behaviors and an increase in civic participation. Positive development has been achieved through programs that promote the involvement of young people in decisions and collaboration with adults as well, which indicates that participatory strategies can empower people (Christens & Andrew Peterson, 2012; Christens & Lin, 2014; Messman et al., 2022; L. A. Zimmerman et al., 2024).

New approaches, such as Youth Participatory Action Research (YPAR), have lately proved to be effective in engaging youth in the process of research and change as co-researchers and leaders. YPAR motivates young people to research, and this has broadened our knowledge of empowerment, as well as showing the challenges of maintaining a balance of power. Besides all these participatory techniques, other novel tools like multidimensional indices and scales have also assisted in standardizing the measures of empowerment. These tools offer objective ways to determine how much people and communities feel empowered and introduce a more effective way of comparing interventions across different cultures and social contexts (Planas-Lladó & Úcar, 2024; Szoko et al., 2025).

Despite these new developments, there are still some gaps. To demonstrate, further research is lacking on the specific role of adults in empowerment programs, and no studies have been conducted on marginalized groups like youth in foster care or girls in their teens. Researchers should integrate practical evidence and more stringent theories to overcome these problems. This will assist in making the empowerment programs more viable and developing more inclusive strategies for youth development. New research also points to the value of trauma-informed and intersectional approaches, as well as the need for flexible frameworks that work across different cultures (Austin et al., 2025; Bulanda & Byro Johnson, 2016; Goedhuys et al., 2024; Hilfinger Messias et al., 2005; Iacobini et al., 2025; Jennings et al., 2012; Kaplan et al., 2009; Pande et al., 2025; Planas-Lladó & Úcar, 2024; Soler-Masó et al., 2025; Wagaman, 2015; Williams, 2024; L. A. Zimmerman et al., 2024).

Research Questions

1. What are the research trends in youth empowerment according to the year of publication?
2. Which paper gets the most citations?
3. Which countries have published in the field, and how many publications have been published?
4. What is the author's keywords co-occurrence analysis?
5. What is collaborative co-authorship by countries?

Methodology

Bibliometrics involves systematically gathering, structuring, and examining bibliographic data derived from scholarly publications (Alves et al., 2021; Assyakur & Rosa, 2022; Verbeek et al., 2002). In addition to basic descriptive measures, such as determining core journals, publication timelines, and highly productive authors (Wu & Wu, 2017), this approach also incorporates advanced methods, including document co-citation analysis. The review is conducted in a series of steps, including the subsequent improvement of keywords, a literature search, and an in-depth study of the results, to create a comprehensive pool of sources and draw credible conclusions (Fahimnia et al., 2015). In this direction, the review will narrow down to high-impact journals in order to emphasize the key theories that inform the field. Scopus was the primary source to ensure the accuracy of the data (Al-Khoury et al., 2022; di Stefano et al., 2010; Khiste & Paithankar, 2017). Peer-reviewed journal articles only were considered to enhance the quality, whereas books and lecture notes were not (Gu et al., 2019). The reviews of publications published from 2015 onwards, up to December 2025, were gathered using the Scopus database provided by Elsevier, which is known to have a wide scope.

Data Search Strategy

The literature search strategy employed in this study was a systematic literature search strategy to improve both the methodological rigor and the relevance of the theme in searching scholarly articles on the topic of empowerment among youth. Scopus database has been selected because it provides full coverage of quality, peer-reviewed journals. A sophisticated title-based search was conducted, using terms in the field of empowerment and filtering it with terms describing youth, as provided in Table 1. The search was restricted to article titles, which enhanced conceptual refinement by making sure empowerment was the main theme of the studies retrieved and thus limited the inclusion of peripheral literature. To reflect the latest changes in the field and the development of the topic in a more general way, only articles published since 2015 were used, which is why they show the recent focus of scholarly and policy attention on youth empowerment and socially motivated entrepreneurial activities. Additional filters were applied to narrow down the results to documents published in the English language and those in their final stages. This methodical process allowed a set of 1,041 publications to be obtained, which can be employed as a strong starting point for trend analysis and bibliometric mapping.

The inclusion and exclusion criteria were then narrowed down, as presented in Table 2, in order to improve the validity, consistency, and transparency of the datasets. Papers in English that were published between 2015 and 2025 (but indexed as final documents) only were included, and non-English studies, articles published before 2015, and in-press records were excluded. Confidence in the credibility of the data, stability of citation, and comparability across publications are achieved by these standards. Even though these restrictions might not represent the emergent or non-English scholarship, the combination of Tables 1 and 2 allowed the creation of a final corpus that represents mature and high-quality research applicable to youth empowerment in the context of entrepreneurial and social innovation. This obtained dataset provides a solid empirical foundation for the analysis of the progression of the subject, its primary driving forces, the intellectual organization, and publication patterns of the literature in terms of a bibliometric approach.

Table 1: The Search String Example

Scopus	TITLE (("empower" OR "empowerment") AND ("youth" OR "young adult" OR "adolescent*" OR "adolescence" OR "young" OR "teen")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2025)))

Source: Scopus

Table 2: The Selection Criterion Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2015-2025	<2015
Publication Stage	Final	In Press

Source: Scopus

Data Analysis

One of the most popular and easy-to-use bibliometric analysis and visualization tools is VOSviewer, developed by Nees Jan van Eck and Ludo Waltman at Leiden University (van Eck & Waltman, 2010a, 2017). It is built specifically to visualize scientific literature, such that it can be possible to construct density maps, group related objects, and visualize networks. The tools support the different types of bibliometric relationships, such as co-authorship, co-citation, and co-occurring keywords, and help users explore the depths of research landscapes. VOSviewer is a good alternative in terms of analysis by researchers because of its interactive nature, periodic updates, the standard indicators can be calculated, flexible visualization, and it can be used with different sources of information.

The greatest advantage of VOSviewer is that it transforms complicated bibliometric information into maps that are easily understandable. The software has a strong capability in network-based analysis, such as clustering, patterns observed in the co-occurrence of keywords, and the generation of density views. The trends are easily determined because they are designed in a manner that is easy to analyze by a new analyst as well as an experienced analyst. Periodic updates have made VOSviewer a bibliometric visualization leader, and its versatile capabilities are effective in both authorship and citation networks.

The records obtained in this study consisted of publication year, article titles, authors' names, source journals, citation frequencies, and keywords in Plain Text format, obtained from Scopus, and included works published between 2015 and December 2025. The analyses were performed using VOSviewer version 1.6.19. Through VOS mapping and clustering procedures, bibliometric networks were constructed and examined. As an alternative to Multidimensional Scaling (MDS), VOSviewer positions items within a low-dimensional space such that the distances between items represent their level of relatedness (van Eck & Waltman, 2010b).

Although conceptually akin to MDS (Appio et al., 2014), the VOS approach employs normalization techniques tailored to co-occurrence data, notably the Association Strength (AS_{ij}), calculated as follows (Van Eck & Waltman, 2007):

$$AS_{ij} = \frac{C_{ij}}{w_i w_j},$$

which is "proportional to the ratio between the actual number of co-occurrences of i and j and the anticipated number of co-occurrences of i and j under the assumption that co-occurrences of i and j are statistically independent" (Van Eck & Waltman, 2007).

Result And Discussion

RQ1: What Are The Research Trends In Youth Empowerment According To The Year Of Publication?

The yearly distribution of publications on youth empowerment from 2015 to 2025 (N = 727) is illustrated in Figure 1. These findings indicate a gradual positive trend, which has been in line with the growing academic interest in youth empowerment as a multidimensional concept in social, educational, and community-based studies. In 2015, 29 articles were published, and in 2018, 57 articles were published, which indicates that the publication output is still in an early conceptualization and empirical exploration stage. The figure dropped by a slight margin to 52 in 2019. However, the downward trend was still favorable, implying that the scholar was still engaged in academic activity and not stagnating.

Since 2020, there has been a strong increase in publications, with 69.1% of the total output being publications from 2020 to 2025. The highest annual growth was in 2021, when publications increased by 61.4% with 92 articles published compared to 57 in 2020. Following a more modest decrease of 19.6% and 74 publications in 2022, the research activity has rebounded in 2023 and 2024 (85 publications each) and an over-the-top increase in 2025 (109 publications). The recent focus on output is indicative of the fact that youth empowerment has become a mature and highly pertinent area of research, emerging as a point of intersection between social development, health, education, and policy-oriented scholarship.
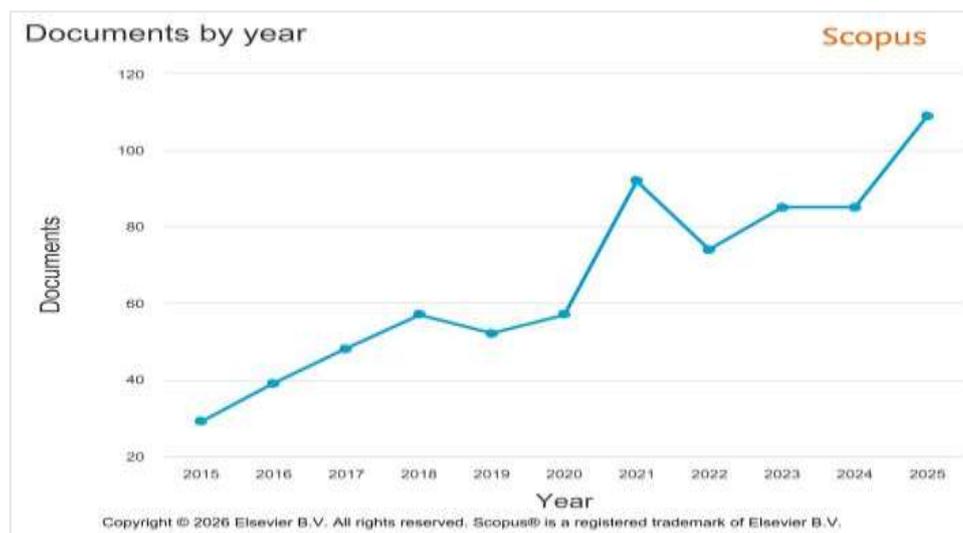
Figure 1: Trend Of Research In Young Empowerment By Years
Source: Scopus Analyzer

RQ2: Which Papers Get The Most Citations?

Table 3 summarizes the top 10 most referenced articles on youth empowerment published during the period between 2015 and 2020, with the number of citations ranging from 71 to 95. The most impactful publication is Olney et al. (2016) in the Journal of Nutrition, which has 95 citations and focused on the outcomes of empowerment in an integrated agriculture and nutrition intervention with a cluster-randomized controlled trial. Other extensively cited works include (Cicognani et al., 2015) in Voluntas with 92 citations and (M. A. Zimmerman et al., 2018) in Health Education and Behavior with 88 citations. Both authors focus on the themes of psychological empowerment, civic participation, and engagement of the community. The popularity of this work shows that empirically rigorous research and theoretically oriented research placed in the context of health, community development, and social well-being are more likely to draw the attention of the scholarly community.

All these reference publications have a high degree of multidisciplinary interest, and the concept of empowerment is discussed within the framework of the challenges in public health, education, social development, and the environment. There are multiple population-specific studies involved in low-income settings, such as among adolescent girls (Austrian et al., 2020; Clonan-Roy et al., 2016) or youths with chronic health conditions (Browne et al., 2015; Sequeira et al., 2015), which emphasize the practical applicability of empowerment models. In conceptual terms, the studies come to the point of considering empowerment as a multidimensional and context-specific process that involves agency, participation, learning, and structural change. Overall, citation patterns suggest that youth empowerment research exerts the greatest impact when it integrates robust methodological designs, clear conceptual foundations, and practical implications for policy and intervention.

Table 3: Top 10 Most Cited Articles

Authors	Title	Year	Source title	Cited by
(Olney et al., 2016)	A 2-year integrated agriculture and nutrition program targeted to mothers of young children in Burkina Faso reduces underweight among mothers and increases their empowerment: A cluster-randomized controlled trial	2016	Journal of Nutrition	95
(Cicognani et al., 2015)	Sense of Community and Empowerment Among Young People: Understanding Pathways from Civic Participation to Social Well-Being	2015	Voluntas	92
(M. A. Zimmerman et al., 2018)	Youth Empowerment Solutions: Evaluation of an After-School Program to Engage Middle School Students in Community Change	2018	Health Education and Behavior	88

(Sequeira et al., 2015)	Let's empower and prepare (LEAP): Evaluation of a structured transition program for young adults with type 1 diabetes	2015	Diabetes Care	87
(Browne et al., 2015)	Depression, anxiety and self-care behaviours of young adults with Type 2 diabetes: Results from the International Diabetes Management and Impact for Long-term Empowerment and Success (MILES) Study	2015	Diabetic Medicine	79
(Austrian et al., 2020)	The impact of the Adolescent Girls Empowerment Program (AGEP) on short and long-term social, economic, education and fertility outcomes: A cluster randomized controlled trial in Zambia	2020	BMC Public Health	78
(Bucholtz et al., 2016)	Beyond empowerment: Accompaniment and sociolinguistic justice in a youth research program	2016		78
(Clonan-Roy et al., 2016)	Towards a Model of Positive Youth Development Specific to Girls of Color: Perspectives on Development, Resilience, and Empowerment	2016	Gender Issues	77
(Úcar Martínez et al., 2017)	Exploring the conceptualization and research of empowerment in the field of youth	2017	International Journal of Adolescence and Youth	72
(Bentz & O'Brien, 2019)	ART for CHANGE: Transformative learning and youth empowerment in a changing climate	2019	Elementa	71

Source: Scopus

RQ3: Which Countries Have Published In The Field, And How Many Publications Have Been Published?

Based on the publication output illustrated in the map (Table 4 and Figure 2), the United States leads as a contributor to research on youth empowerment, with 274 publications, far more than any other country. This is followed by the United Kingdom with 75 publications, and Australia with 47 publications, showing a strong concentration of scholarly output in Anglophone countries. Canada, with 43 publications, and South Africa, with 35 publications, also contribute significantly to research activity, highlighting ongoing academic interest in youth empowerment in both the Global North and parts of the Global South contexts.

Beyond these leading contributors, several emerging and middle-income countries are actively participating in the field. Indonesia and Spain each contributed 31 publications, while Kenya (27 publications), India (26 publications), and Nigeria (26 publications) complete the top ten countries. The map demonstrates that, although most research productivity is dominated by a small number of high-income countries, youth empowerment studies are increasingly global, with growing contributions from Africa and Asia. This tendency indicates an increased diversification of the literature and indicates an increase in the ability to conduct cross-regional collaboration and comparison studies in future research.

Table 4: Top 10 Countries Distribution of Publications on Young Empowerment

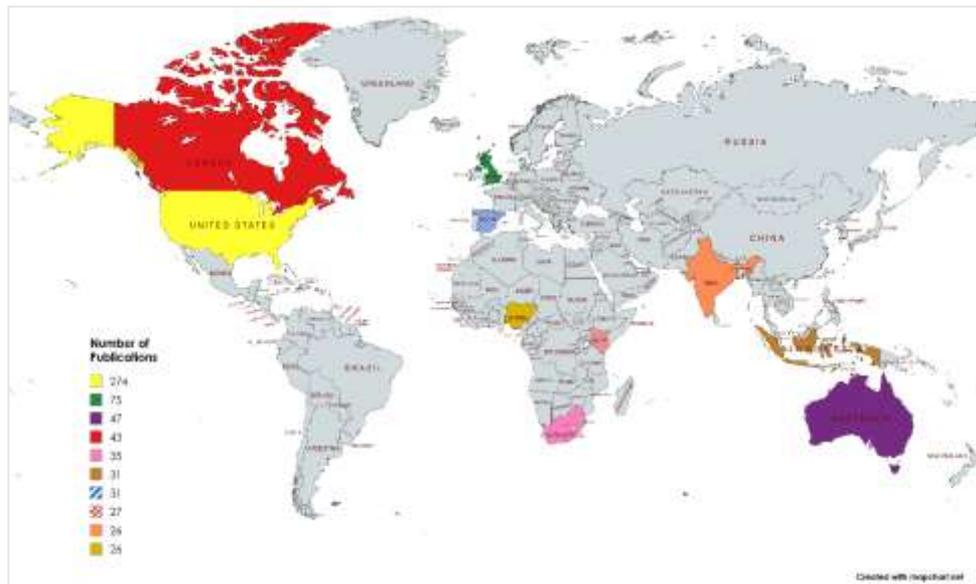| COUNTRY/TERRITORY	Number of publications
United States	274
United Kingdom	75
Australia	47
Canada	43
South Africa	35
Indonesia	31
Spain	31
Kenya	27
India	26
Nigeria	26

Source: Scopus

Figure 2 Global Distribution Of Publications On Empowerment Among Young People By Country

Source: mapchart.net

RQ 4: What Is The Author Keywords Co-Occurrence Analysis?

The concept and thematic relationships of a research field are seen through the frequency of grouping of some keywords in the same publications, and this is called the keyword co-occurrence analysis. The keywords are represented as nodes, and the relationship between the nodes as co-occurrence relationships using VOSviewer. The strength of these links indicates the degree to which the concepts are related throughout the literature, and sets of keywords depict the prevailing research topics or sub-areas. Note that the keyword co-occurrence analysis is relevant to the research on youth empowerment, as it can be used to define the main concepts, open issues, and interdisciplinary connections that influence the intellectual field of youth empowerment.

The keyword network was produced on the basis of the full counting method, wherein every time a keyword appeared in a publication, it was counted the same, irrespective of the number of keywords attributed to that document. The threshold of five instances was used to make the analysis robust and to determine terms of substantive interest. Out of a list of 1,356 keywords, 102 keywords were found to satisfy the threshold and were incorporated into the visualization. Total Link Strength (TLS) is introduced into the analysis to show the overall strength of all the links that a keyword has with others. The keywords with a higher frequency of occurrence and a larger TLS value take more central spots in the network, indicating their conceptual significance in the literature on youth empowerment.

Based on the results (Figure 3), it is evident that research on youth empowerment is organized into several clear themes. The most frequent and strongest occurrences of key words like *empowerment, adolescent, youth,* and *youth empowerment* prove the presence of empowerment as the key organizing concept of the field. Close associations with other concepts like *participatory action research, mental health, economic empowerment, psychological empowerment,* and *positive youth development* indicate the multidimensional quality of empowerment, which involves psychological, social, economic, and participatory approaches. The interdisciplinary nature of youth empowerment scholarship can be proved by the fact that health-related keywords (e.g., *HIV, sexual and reproductive health, mental health, type 1 diabetes*) are present, and so are development-oriented ones (e.g., *education, employment, entrepreneurship, capacity building*). Altogether, these tendencies have contributed to the body of knowledge by charting the operationalization of the concept of empowerment in a variety of settings and pointing to the change in emphasis toward integrative, context-sensitive, and intervention-focused research in the field.
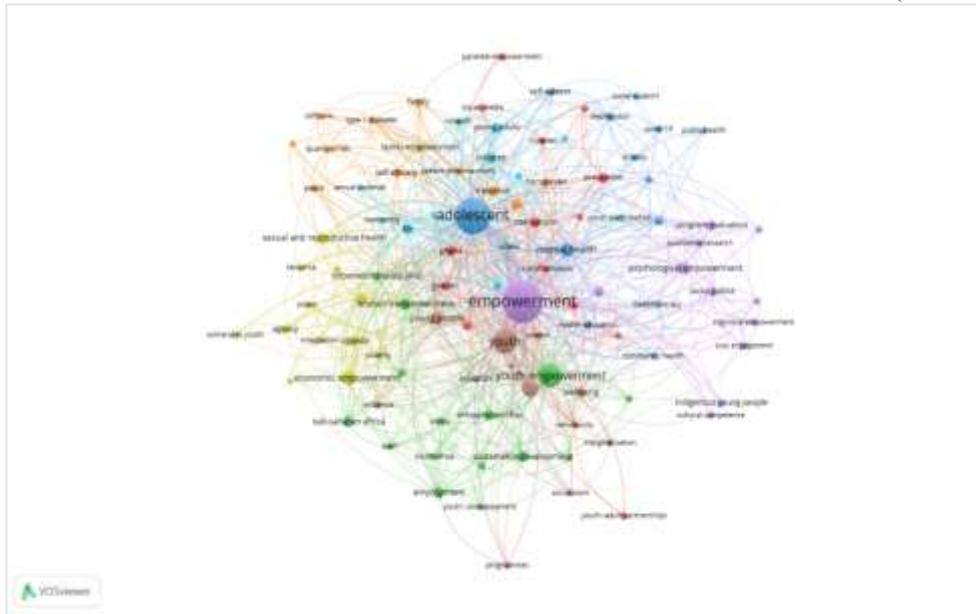
Figure 3 Network Visualization Map Of Keywords' Co-Occurrence

Source: VOSviewer

RQ 5: What Is The Collaborative Co-Authorship By Countries?

The collaboration of countries in research is a term used to denote co-authorship and is credited to the progression of international research collaboration, where scholars based in various countries contribute scholarly articles together. Through bibliometric analysis using VOSviewer, this cooperation takes the form of a network, with each node corresponding to a country and the network edge showing co-authored publications between countries. The intensity of collaboration is linked to the strength of these links, and the volume of publications is identified with the size of each node. The given approach will enable the researcher to determine the major countries, networks of collaborations, and the general organization of international knowledge transfer in a specific area of research, which is youth empowerment, in this case.

The creation of the network of co-authors was done by the full counting method, which implies that every country in a co-authored publication was awarded full marks on that document, regardless of how many countries were involved. Five documents were selected as the minimum threshold in every country to achieve analytical strength and to eliminate the insignificant ones. This threshold was reached in 43 countries out of 103 countries in the dataset. Therefore, they were incorporated into the final visualization. The analysis also included the number of citations and TLS, with TLS being the total strength of the collaborative relationships of a country with other countries. The greater the TS values, the greater and more comprehensive the international collaboration networks are.

The results (Figure 4) indicate that studies on youth empowerment are supported by a cluster of countries that are internationally connected. The US has been confirmed as the core of the youth empowerment research, having the highest level of collaboration (TLS = 132). Strong collaborative linkages can also be observed in other countries, including the United Kingdom, South Africa, Australia, Spain, and Kenya, which shows that active knowledge production in this field is getting more and more dependent on cross-national cooperation. Notably, the

existence of multiple Global South nations with moderate and high TLS scores also indicates the increased diversification of academic collaboration outside of the conventional research hubs. The tendency is significant to the body of knowledge because it shows that the research in the field of youth empowerment is growing in size and becoming more international, hence diversifying the contextual angles of the field and enhancing the international applicability of its empirical and theoretical evidence.
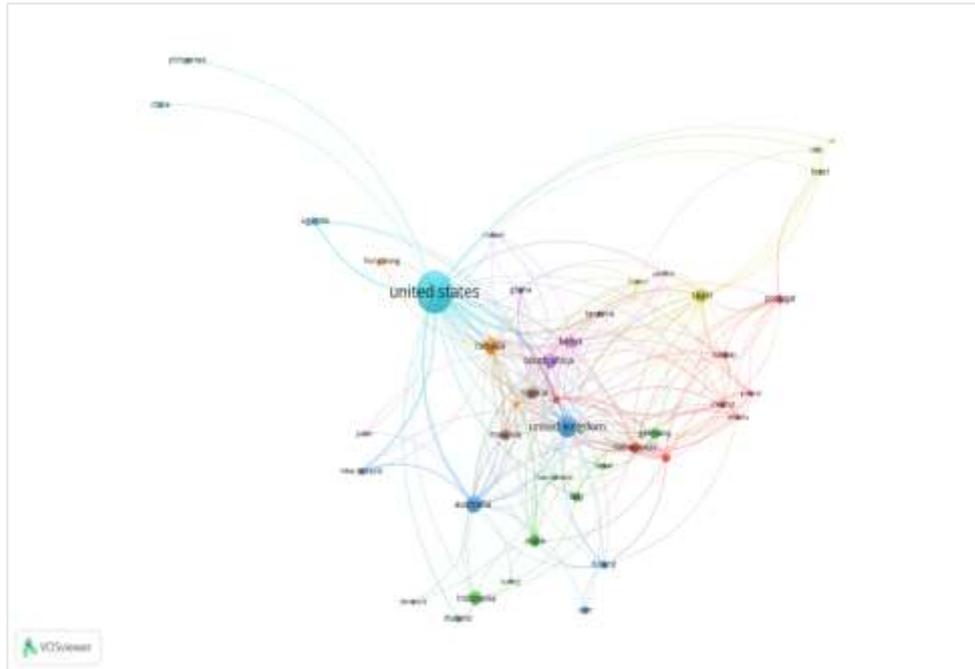

Figure 4 Network Visualization Map Of Countries' Co-Authorship
Source: VOSviewer

Conclusion

The aim of this bibliometric analysis was to map and characterize the knowledge structure of youth empowerment research, using Scopus-indexed articles published between 2015 and 2025. The study covered five crucial topics, namely: (i) trends in publications; (ii) most cited publications; (iii) dominant contributing countries; (iv) the most popular keywords; and (v) international collaboration trends in country co-authorship.

In general, the results demonstrate that publications have been increasing significantly over the period, with notable growth in the latest years, which demonstrates that youth empowerment has become a more recognizable and actively discussed field of research. The most frequently cited articles are largely focused on the applied fields of health, community engagement, and development interventions, which leads to the presumption that research with a good design, clarity of outcomes, and practical use may be given more scholarly consideration. Geographically, publication output is concentrated in a few countries, with the United States being the top and a few other countries being the second tier. Simultaneously, contributions from certain African and Asian regions suggest an increase in international interaction and a gradual expansion of the contexts of investigation. The findings of keyword co-occurrence additionally testify to the fact that the field is structured around the central terms (e.g., empowerment, adolescent, youth, youth empowerment) and related to various thematic

threads, such as mental health, participatory approaches, economic empowerment, and positive youth development, which testifies to the multidimensional and interdisciplinary research environment. Co-authorship mapping also indicates that the literature is supported by an internationally connected group of countries, with certain countries acting as collaboration hubs and showing stronger network linkages than others.

These outcomes contribute by providing a compact "map" of how the field has developed, where the strongest influence is located, and which themes repeatedly appear across the literature. The results can support practice and policy in a practical way by helping to identify: (a) dominant intervention areas (health, education, community change), (b) under-represented settings and populations that may need more attention, and (c) topics that frequently connect across clusters, which can be used to design more integrated youth empowerment programs. For research planning, the findings can guide the selection of core concepts and keywords, target journals and themes with higher visibility, and encourage cross-country research partnerships that bring more contextual diversity into the evidence base.

Other than that, several limitations should be considered. The dataset is restricted to one database and selected filters, which may exclude relevant studies indexed elsewhere, non-English publications, and newer items affected by citation time-lag. Network results are also sensitive to parameter choices (e.g., minimum thresholds and counting method). Therefore, the maps reflect patterns within the selected settings rather than an absolute representation of the full global literature. Future studies could expand the scope of coverage by integrating multiple databases and incorporating non-English sources, trying different search fields such as title, abstract, or keywords, and applying longitudinal thematic analysis to track changes in topics and shifts in collaboration patterns over time. In conclusion, bibliometric analysis is a valuable way to map evidence in youth empowerment studies. It helps highlight areas of growth, influential works, and collaboration patterns, while also pointing to priorities for more inclusive and comparative research.

Ethics Statement:	This study did not involve any human participants, animals, or sensitive personal data requiring ethical approval. The authors confirm that the research was conducted using publicly available bibliographic records and in accordance with accepted academic integrity and ethical publishing standards.
Author Contribution Statement:	All authors contributed significantly to the development of this manuscript. Jurainah Ali led the conceptualization, designed the methodology, conducted data collection and data cleaning, performed the bibliometric analysis and visualization, and drafted the original manuscript. Ainul Azreen Adam provided overall supervision, contributed to the refinement of the study design and analytical approach, reviewed and edited the manuscript critically for important intellectual content, and guided revisions. All authors read and approved the final version of the manuscript prior to submission.

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