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Research Article

Sedentary Behaviours Among Children: A Four Decade Bibliometric Analysis of Global Outlook

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Abstract: The present study investigated the global overview of sedentary behaviour among children from 1982 - 2023 using a bibliometric evaluation approach from Scopus data set. The results retrieved from the investigation include author key words and keyword plus, key authors in the field, most relevant nations in terms of citation numbers and publications, leading institutions in the field, relevant journal source, and trending topics in the research niche among others. A sum of 2187 articles were retrieved from Scopus data set with an average citations per doc and co-authors per document ratio of 52.23 and 6.82, accordingly. Research on sedentary behaviour among children was correlated in line with the years span ($R2 = 0.7604$; $y = 4.9319x - 9824.1$), which indicates increase in article numbers with increase in years. Australia was the leading nation with regards to article (n = 381) and citations (n = 22624) numbers. While UK and Canada were second and third (n = 324; n = 226) in publication and citation (n = 22502; n = 17151) numbers, respectively. In addition, nations including Australia (n = 165), UK (n = 123), Canada (n = 69), Spain (n = 40), Netherlands (n = 30) and USA (n = 29) had the highest number of multiply country publications (MCP) with other nations, respectively. The most trending topics of author keywords in the field include; Physical activity, Sedentary behaviour, Children, Obesity, Screen time and Overweight among others. Scientifically advance and financially stable countries were observed to have higher research publications as compared to developing countries. The trending topics observed from this study suggests the direction of future research for policy makers, government parastatals, institutions and other stakeholders in addressing the issue of sedentary behaviours among children as a concern for public health.

Keywords: Physical Inactivity, Scientometric, Healthy Behaviour, Obesity, Trending Topics

Introduction

Unhealthy behaviours such as physical inactivity and sedentary lifestyles at a young age may increase the risk of early exposure to non-communicable diseases, overweight/obesity, diminishing health and quality of life (Bull *et al.*, 2020). The health status of children in the future is therefore hinged on the type of healthy behaviours that has early origins (Katzmarzyk *et al.*, 2015). Promoting a healthy lifestyle at a younger age, such as regular exercise and increased development of movement skills in children could improve lifelong participation in physical activities (PA) and possibly prevent overweight and obesity in them (Sgrò *et al.*, 2013; Crumbley *et al.*, 2020). The consistent engaging of children on these healthy lifestyle activities may serve as a strong foundation for more advanced movement skills, long-term participation in sports, and exercise later in life (Lloyd *et al.*, 2015; Westerbeek and Eime, 2021).

Critical investigation on Sedentary Behaviour (SB) and PA revealed that both behaviours can contribute to the health status of children and adolescents (Katzmarzyk *et al.*, 2019). Sedentary behaviour is described as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents while in a sitting, reclining or lying posture (Tremblay *et al.*, 2017). Common sedentary behaviours include the use of smartphone or tablet, viewing of television, playing of video games, and use of computers or laptops among

children and adolescents around the world (LeBlanc *et al.*, 2017), and there are emerging evidences on the negative health implications and the potential public health burden associated with high levels of sedentary behaviours (Gibbs *et al.*, 2015). The World Health Organization (WHO) global action plan on physical activity for the year 2018 to 2030 was launched in 2018 with all 194 WHO member states agreeing to the new target of a 15% relative reduction in physical inactivity of children globally by 2030 (Bull *et al.*, 2020).

Following the release of the report cards by WHO, there was a decrease in PA levels and a high sedentary behaviours recorded amongst children and adolescents globally (Lee *et al.*, 2022). The average grade for PA in 2022 globally was a D score, with only 27 to 33% of children reaching the recommended 1 h of regular Moderate-to-Vigorous-Physical Activity (MVPA). Similar to the global matrix of 3.0 in 2018, 77% of countries in the world measured very low grades for overall PA of children (Abdeta *et al.*, 2018). On the other hand, the level of sedentary behaviours were high with majority of the children globally engaging in different kinds of sedentary activities (Lee *et al.*, 2022).

Sedentary behaviour is currently seen as an emerging highly prevalent disease in the 21st century as a result of the severe risk to public health (Arocha Rodulfo, 2019). The estimation by the WHO showed that extreme sedentary behaviour is accountable for nearly 3.2 million deaths annually (Park *et al.*, 2020). Substantial evidence proved that high rates of SB increase leads to Cardiovascular Disease (CVD) and mortality in humans (Lavie *et al.*, 2019). In addition, SB is seen as a risk factor independent of PA, and they are associated to prolonged high prevalence of CVD mortality and morbidity (Young *et al.*, 2016; Ekelund *et al.*, 2019).

It is obvious that several research articles on sedentary behaviours among children and its effects on their health have been written in the academic space (Müller *et al.*, 2018; Yang *et al.*, 2022; Memon *et al.*, 2023). However, there are sparse literatures that have utilized bibliometric approach to discuss and describe the topic on sedentary behaviour among children and its current global status. Therefore, the present study aimed to present scholarly investigations on the global status of research and trending topics on sedentary behaviours among children. The objective of this study thus, was to use bibliometric data to provide a viewpoint of the global status of sedentary behaviour among children.

The use of bibliometric techniques in any study presentations is a distinct research instrument that permits the use of statistical and mathematical analysis as well as permutations to review global research results on a subject matter and how they perform in various nations, academic organizations and research scholars on the world stage for a particular niche area of study (Zou *et al.*, 2019). Adopting a bibliometric approach to discuss the global status on the incidences and prevalence of sedentary behaviours among children projects a unique platform different from other studies to discuss this area of discipline, hence further adding to the pool of scholarly knowledge in this field. Bibliometric assessment is a helpful strategy to comprehend research focus as well as publication outputs in a particular niche area, which is capable of determining research trends (Ellegaard and Wallin, 2015). Furthermore, bibliometric studies are used to determine most cited manuscripts in a niche area by quantifying them based on the number of citations (Pu *et al.*, 2017; Ahmad *et al.*, 2019). By categorizing the most cited papers in a research field, citation analysis can be beneficial in sourcing for knowledge gaps, which may ultimately assist move the research field forward in the right direction (Varela *et al.*, 2018; Ahmad *et al.*, 2019). In addition, the list of most cited manuscripts in a research field can be utilized as a guiding benchmark for growing scholars and emerging researchers (Shuaib *et al.*, 2015; Azer and Azer, 2016). The current study will further assist to generate academic profile capable of projecting future direction in the research domain of present discourse. These details are anticipated to be useful to policy makers, scholars as well as important stake-holders in addressing the issues and challenges of sedentary behaviours as it affects the health of children in the long run.

Materials and Methods

Bibliographical Dataset for the Study

The data for the study were extracted from the Scopus bibliographical data archive because Scopus is known to have broad coverage of research publications suitable for the present study (Meho and Yang, 2007; Baier-Fuentes *et al.*, 2020). On the other hand, Scopus database is extensive in coverage and easy to use in terms of search and analytical functions (Rojas *et al.*, 2023). Although other specialized datasets for sports and medical science such as SPORT Discus and PubMed exist, but using them may lead to incomprehensive search outcome (Yang *et al.*, 2022). Howbeit, with bibliometric analysis, employing the approach of gathering larger sample size with more inclusive and comprehensive search outcome would give a better outcome and comprehensive accuracy of the analysis (Rogers *et al.*, 2020). The choice of using Scopus for this study, thus, fulfil the purpose for the data search outcome. In addition, the common agreement for the utilization of one dataset (such as Scopus) for evaluating bibliometric studies is widely approved because of complexities of doing it with multiple dataset which may result into loss of some key articles that should be included in the investigation (Sweileh, 2020).

Search Method for Data Collection on Sedentary Behaviour Among Children

A search method that covers publications that are related to the present topic of investigation with the slightest false-positive out-come was done by browsing several publications on sedentary behaviours among children in order to align this study with the appropriate keywords as relates to the search topic. This method of search have previously been employed by other studies (Fesseha *et al.*, 2020; Idamokoro, 2023a). The study search was done using the search keyword string "sedentary AND behaviour* AND (child* OR children* OR pre-school*)" in information source titles, abstracts and keywords covered by Scopus from 1982-2023. Boolean permutations "AND" and "OR" were employed in the search so as to limit the scope and coverage of the results needed for this study. From the initial data search, all collected articles including research articles, reviews, proceedings, book chapters, and notes were gathered in the Scopus datasets from 1982 to 2023. However, every other literatures, apart from study research and review articles were left in order to reduce to the barest minimum any form of ambiguity during analysis of result. The total sum of articles used for analysis in this study comprises of 2187 documents.

Criteria for Inclusion and Exclusion of Unwanted Publications

Inclusion criteria

This study used the following inclusion benchmark for its bibliometric analysis:

1. Original peer-reviewed articles and literature reviews on research study done on sedentary behaviours among children including basic and clinical studies and
2. Articles published in Scopus dataset between 1982 and 2023

Exclusion Criteria

The exclusion benchmark for this study includes:

1. Unpublished articles
2. Publications involving plagiarism and retracted articles
3. Meeting summaries, technical notes, and errata documents
4. Unrelated articles
5. Articles not retrieved from Scopus dataset during the studied period

Earlier studies have also employed the afore-mentioned type of inclusion and exclusion stratagems to remove undesirable articles in bibliometric evaluations (King *et al.*, 2018; Fesseha *et al.*, 2020). Figure (1) further give an explanation about the inclusion and exclusion criteria utilized for the present study.

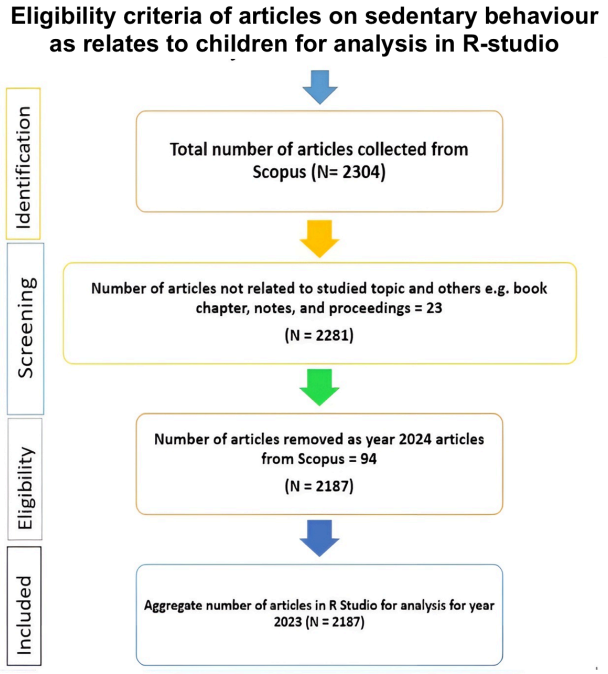

Fig. 1: The inclusion and exclusion of articles studied as relates to the studied topic

Bibliometric Evaluation of Data in R-Studio Software Package

All selected data from Scopus were analysed using R-Studio (version 4.3.0. 2023-04-21 ucrt) software with bibliometrix R-package for bibliometric evaluation (Aria and Cuccurullo, 2017). All data were inputted into R-Studio software for assessment and visualization of results. The bibliometrix R-package was also used (R-project web interface in Biblioshiny) to explain the results which comprise of citation analysis, single authors' performance, nations performance, relevant keywords, as well as scholarly collaboration by leading countries as well as authors in the research field. The statistical permutations of a typical bibliometric collaboration is as follows:

$$Collaboration\,(C) = \mathrm{O} \times TP$$

Where, the letter "C" represents Collaboration; "O" describes a bipartite composite matrix of research articles × attributes (e.g. keywords, affiliations, keywords plus, nations and citation of articles). The letter "C" further denotes symmetrical matric of $\mathrm{C} = \mathrm{T}^{\mathrm{P}}$.

Results

A total sum of 2187 research publications were collected for the present study between 1982–2023. The summary of the scholarly breakdown of the analysed documents are explained in Table (1). The number of authors that worked on sedentary behaviours among children during the studied years was 8107, meanwhile the aggregated number of single authors of the subject

matter is 64. There were 6.82% co-authors per document, and 39% international co-authorships. The total average citations per document is 52.23%, but the annual growth rate for this research subject matter is 13.23%. Figure (2) showed the analysis of the polynomial metric fitting curve. This analysis described the annual growth increase of the present study to have a positive correlation (R^2 = 0.7604; y = 4.9319x – 9824.1) between the cumulative article numbers and the years of article publications. The result again showed a trend in publications with some years having no single output (such as 1983, 1984, 1985, 1986, and 1987 among others). However, there was an appreciable rise in research articles on sedentary behaviours among children from 2002 (n = 3) to 2023 (n = 163). The yearly growth of articles is 13.23%. The highest number of article outputs on the subject matter was recorded in 2022 (n = 203).

Table 1: Summary on sedentary behaviour in children research from 1982-2023

Description	Results
Main Information About Data	
Timespan	1982:2023
Sources (Journals, Books, etc)	594
Documents	2187
Annual Growth Rate %	13.23
Document Average Age	7.58
Average citations per doc	52.23
Document Contents	
Keywords Plus (ID)	5056
Author's Keywords (DE)	2905
Authors	
Authors	8107
Authors of single-authored docs	64
Authors Collaboration	
Single-authored docs	71
Co-Authors per Doc	6.82
International co-authorships %	39
Document Types	
Article	1890
Review	299

Table (2) showed the results of leading and productive countries doing research on sedentary behaviour among children with respect to the research numbers and citations. Australia was placed in first position in terms of publication and citation numbers (n = 381; n = 22624). The other leading nations are UK (n = 324; n = 22502), Canada (n = 226; n = 17151), Spain (n = 109; n = 2627) and USA (n = 93; n = 4989) among others. The frequency of research results is different among the 25 leading nations from 0.174 to 0.007. The top globally rated nations with multiple country publications (MCP), include Australia (n = 165), UK (n = 123), Canada (n = 69), Spain (n = 40), Netherlands (n = 30) and USA (n = 29), respectively. The nations rated in top positions for Single Country Publications (SCP) of research include Australia (n = 216), UK (n = 201), Canada (n = 157), Spain (n = 69), USA (n = 64) and Netherlands (n = 56), respectively (Table 2).

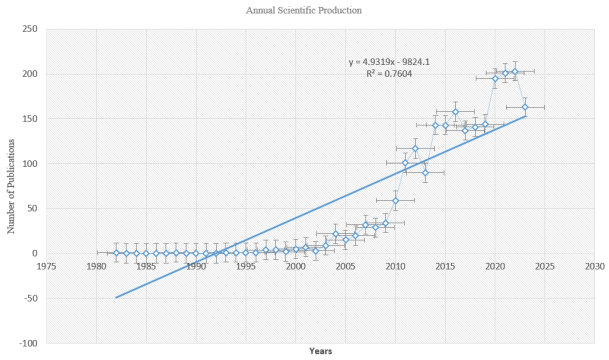

Fig. 2: Yearly number of publications on sedentary behaviour as relates to children from 1982 to 2023

The top ranked 25 keywords (author's keywords) by researchers in the studied field of sedentary behaviour among children include Physical activity (n = 797), next was sedentary behaviour (n = 498), followed by children (n = 368), and obesity (n = 285) among others (Table 3). The leading journals with the highest published articles in the studied field is tabulated in Table (4). The names of these journals include International Journal of Behavioural Nutrition and Physical Activity (n = 141; h_index = 49), BMC Public Health (n = 177; h_index = 43), Obesity Reviews (n = 68; h_index = 41), Plos ONE (n = 63; h_index = 29) and Public Health Nutrition (n = 45; h_index = 26), respectively. The top leading institutions with more than ninety (90) research publications are shown in Table (5). These universities includes; Deakin University (n = 265), University of Wollongong (n = 141), Ghent University (n = 131), University OF Sydney (n = 109), University of Bristol (n = 106), University of Ottawa (n = 104), University of Alberta (n = 91), respectively.

Table (6) presented the top 20 placed globally cited documents in sedentary behaviour among children research based on citation numbers from 1982 to 2023. The publication authored by Zimmet, P (2001) in the journal called Nature was ranked in the first position with 4792 citations. The second top rated article was written by Bull *et al.* (2020) in British Journal of Sports Medicine has a sum of 4614 citations. The third (n = 2023), fourth (n = 1543), fifth (n = 1521) and sixth (n = 1453) articles were written by Evenson , (2008); Tudor-locke C (2004); Biddle and Asare (2011); Tremblay *et al.* (2011), respectively.

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Table 2: 25 leading nations on sedentary behaviour in children based on number of articles and citation numbers from 1982-2023;

S/N	Country	Articles	SCP	MCP	Freq	MCP_Ratio	Country	TC	AAC
1	Australia	381	216	165	0.174	0.433	Australia	22624	59.40
2	UK	324	201	123	0.148	0.38	UK	22502	69.50
3	Canada	226	157	69	0.103	0.305	Canada	17151	75.90
4	Spain	109	69	40	0.05	0.367	Netherlands	5522	64.20
5	USA	93	64	29	0.043	0.312	USA	4989	53.60
6	Netherlands	86	56	30	0.039	0.349	Spain	2627	24.10
7	Germany	53	34	19	0.024	0.358	France	1901	47.50
8	Belgium	42	14	28	0.019	0.667	China	1777	43.30
9	China	41	22	19	0.019	0.463	Belgium	1569	37.40
10	France	40	19	21	0.018	0.525	Germany	1054	19.90
11	Italy	37	28	9	0.017	0.243	Norway	950	32.80
12	Portugal	35	22	13	0.016	0.371	New Zealand	904	30.10
13	Brazil	34	21	13	0.016	0.382	Italy	833	22.50
14	Finland	30	13	17	0.014	0.567	Sweden	778	27.80
15	New Zealand	30	17	13	0.014	0.433	Finland	726	24.20
16	South Africa	30	14	16	0.014	0.533	Ireland	709	41.70
17	Norway	29	14	15	0.013	0.517	Brazil	657	19.30
18	Sweden	28	19	9	0.013	0.321	Greece	608	32.00
19	Czech Republic	24	11	13	0.011	0.542	Portugal	552	15.80
20	Greece	19	11	8	0.009	0.421	South Africa	503	16.80
21	Poland	19	15	4	0.009	0.211	Denmark	416	34.70
22	Ireland	17	10	7	0.008	0.412	Switzerland	354	25.30
23	Thailand	17	1	16	0.008	0.941	Czech Republic	330	13.80
24	Malaysia	16	9	7	0.007	0.438	Poland	307	16.20
25	Singapore	16	4	12	0.007	0.75	India	301	21.50

SCA: Single Country Articles; MCA: Multiple Country Articles; TC: Total Citations; AAC: Average Article Citations

Table 3: The 25 most relevant words used by authors in sedentary behaviour as relates to children research from 1982-2023

S/N	Keywords (DE)	Occ.*	Keyword plus (ID)	Occ.*
1	Physical activity	797	Child	3286
2	Sedentary behaviour	498	Female	2760
3	Children	368	Male	2655
4	Obesity	285	Human	1971
5	Adolescents	183	Exercise	1862
6	Screen time	168	Sedentary lifestyle	1743
7	Sleep	118	Humans	1665
8	Exercise	103	Adolescent	1640
9	Overweight	99	Physical activity	1271
10	Child	95	Article	1262
11	Diet	87	Obesity	981
12	Youth	82	Health behaviour	712
13	Accelerometer	77	Controlled study	668
14	Accelerometry	75	Adult	648
15	Public health	73	Child behaviour	642
16	Adolescent	71	Body mass	577
17	Childhood obesity	65	Cross-sectional study	567
18	Television	53	Preschool child	534
19	Health	51	Major clinical study	510
20	Sedentary	51	Motor activity	501
21	Sedentary behaviours	46	Diet	491
22	Intervention	45	Accelerometry	490
23	Sedentary time	44	Preschool	482
24	Mental health	43	Cross-sectional studies	478
25	School	43	Questionnaire	464

**Occurrences*

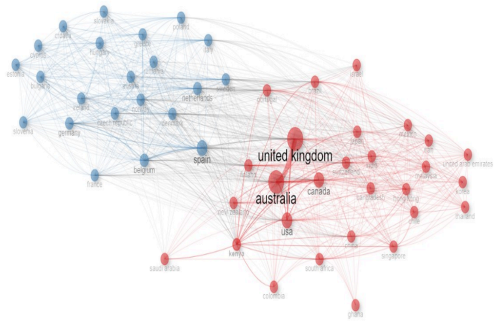

Fig. 3: Collaborative mappings of networking among nations doing research on sedentary behaviour as relates to children from 1982-2023

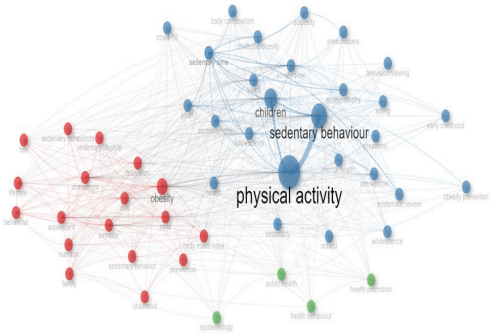

Fig. 4: Collaboration strength of keywords of global research on sedentary behaviour in children from 1982-2023

Table 4: The 25 most relevant journal source in sedentary behaviour as relates to children research from 1982 - 2023 based on article numbers and h_index;

S/N	Element	H	G	M	TC	NP	PY
1	International Journal of Behavioral Nutrition and Physical Activity	49	102	2.579	10900	141	2006
2	BMC Public Health	43	78	2.263	7309	177	2006
3	Obesity Reviews	41	68	1.708	6766	68	2001
4	PLOS ONE	29	53	2.071	2894	63	2011
5	Public Health Nutrition	26	39	1.182	1556	45	2003
6	BMJ Open	23	33	1.769	1442	75	2012
7	International Journal of Environmental Research And Public Health	23	48	1.769	2673	118	2012
8	British Journal of Sports Medicine	22	25	1.222	9478	25	2007
9	Journal of Science and Medicine in Sport	20	35	1.111	1252	39	2007
10	International Journal of Obesity	19	27	0.704	2125	27	1998
11	Journal of Sports Sciences	19	51	0.905	3818	51	2004
12	Pediatric Obesity	19	39	1.462	1582	43	2012
13	Applied Physiology, Nutrition and Metabolism	18	25	1.125	5231	25	2009
14	European Journal of Public Health	16	16	0.889	879	16	2007
15	Preventive Medicine	16	25	0.762	1486	25	2004
16	International Journal of Pediatric Obesity	15	19	0.789	811	19	2006
17	BMC Pediatrics	14	21	0.933	491	30	2010
18	Preventive Medicine Reports	14	20	1.273	432	20	2014
19	Child: Care, Health and Development	12	21	0.571	507	21	2004
20	Nutrients	12	20	1.2	428	22	2015
21	Sports Medicine	12	12	0.5	4121	12	2001
22	British Journal of Nutrition	11	16	0.579	436	16	2006
23	Canadian Journal of Public Health	11	15	0.611	320	15	2007
24	Journal of Paediatrics and Child Health	11	16	0.55	361	16	2005
25	Acta Paediatrica, International Journal of Paediatrics	10	21	0.625	468	21	2009

H: h-index; G: g-index; M: m-index; TC: Total Citation; NP: Number of Publications; PY: Publication Start Year

Figure (3), showed the network visualization map of countries co-operation. Each node indicates individual nation while the node radius depicts article number by individual nation. Again, the strokes shows the pathway of networking among the various countries and the thickness of the strokes indicates the degree of partnership among nations. The different colours depicts the partnership alignments of the different nations. Furthermore, Figure (4), showed the co-occurrence network and networking of the top leading keywords on sedimentary behaviour among children as employed by scholars. Individual circle with different colour indicates a cluster of terminologies and the lines represents the connection as associated with the keywords. The nearness of one keyword to another indicates the more probable their closeness is during the study span of 1992-2023.

Table 5: The 25 leading institutions in sedentary behaviour as relates to children research from 1982 - 2023 with 44 articles and above

S/N	Affiliation	Nations	Articles
1	Deakin University	Australia	265
2	University of Wollongong	Australia	141
3	Ghent University	Belgium	131
4	University Of Sydney	Australia	109
5	University OF Bristol	England	106
6	University Of Ottawa	Canada	104
7	University of Alberta	Canada	91
8	VU University Medical Center	Netherlands	85
9	University Of South Australia	Australia	82
10	University of Toronto	Canada	81
11	University College London	England	63
12	Loughborough University	England	62
13	University of Otago	New Zealand	57
14	CHEO Research Institute	Canada	56
15	University of British Columbia	Canada	55
16	Harokopio University	Greece	54
17	University of Newcastle	England	54
18	University OF Zaragoza	Spain	53
19	McMaster University	Canada	52
20	University of Cambridge	England	52
21	Queen's University	Ireland	50
22	University of Queensland	Australia	49
23	University of Strathclyde	Scotland	48
24	Flinders University	Australia	46
25	Curtin University	Australia	44

Figure (5) gives the authors' keywords through the thematic assessment diagram. This result show four (4) chief quadrants with respect to the authors' keywords and networking. This include the emerging theme, niche theme, basic theme as well as the motor theme. The motor themes had keywords grouped into words such as physical activities, sedentary behaviour and children. The basic themes had keywords including adiposity, sitting, body composition, obesity, overweight, child, mental health, covid-19, and health behaviours. The emerging themes had keywords such as public health, epidemiology and paediatrics. The niche themes had keywords such as pre-schoolers, toddlers, infants, validity, preventive medicine community child health, depression, and psychological distress. Furthermore, Figure (6) presented the conceptual frame work of the research niches explaining the k–means clustering with three clusters depicting the concepts of sedentary

behaviours among children. The result in Figure (7) explained the contents of the author keywords and giving scholars a good representation of sedentary behaviour among children. This result gave the topic trends of articles by promoting better keywords for assessing the means of the subject issues in R studio.

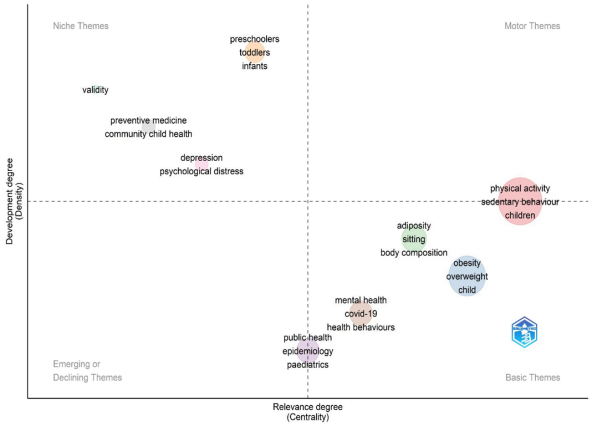

Fig. 5: Thematic map (author-keywords) in the research niche of sedentary behaviour in children research from 1982-2023

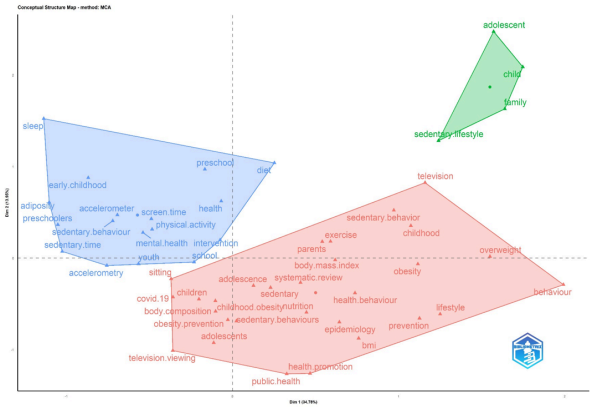

Fig. 6: Basic conceptual frames related to sedentary behaviour in children research. The retrieved articles exhibited K-means clustering with three (3) clusters showing models of different fields of the research areas

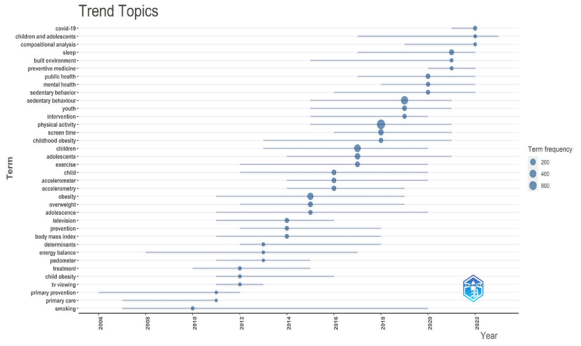

Fig. 7: Top trending topics of author keywords on sedentary behaviour in children research with high frequency terms over 200-600

Discussion

The current study employed the use of bibliometric approach to evaluate several global research publications on sedentary behaviours among children between 1982 and 2023 based on data retrieved from Scopus dataset. The number of publications on sedentary behaviours among children from the year 1982 showed a fluctuating trend with some years not recording a single research output. However, it was observed that from 2002, there was an appreciable rise in publication of research articles on sedentary behaviours among children till date. The increase in research outputs is indicative of a growing interest by scientists and other stakeholders on the subject matter. This finding was in line with previous studies that also observed increase in research publications on sedentary behaviours over the years (Yang *et al.*, 2022; Memon *et al.*, 2023). The negative repercussions of sedentary behaviour among children globally are far-reaching and severe and could result into long-term health problems for children, affecting both their academic performance as well as their general life satisfaction (Hanifah *et al.*, 2023). This alarming negative repercussions on children has led to the reason why there is increase in research and intervention programs to address the situation (Tremblay *et al.*, 2011). To tackle the issue of sedentary behaviours among children, a holistic approach that deals with both the individual, as well as environmental dynamics contributing to the issue needs to be dealt with (Idamokoro *et al.*, 2024). Some of these approaches might include promotion of regular physical activities, access to healthy balanced diets, and the implementation of sustainable education programs to sensitize parents, educators and other stakeholders about the significance of healthy eating lifestyle and physical activity and limited screen time (watching of TV) among children (Hanifah *et al.*, 2023).

A large number of research work with respect to sedentary behaviours among children were done in scientifically advance and financially stable countries like Australia, UK, Canada, Spain, USA, Netherlands, Belgium and China among others as observed in the current study. In line with this findings, earlier studies, have also reported that developed and economically stable nations from America (including Canada, USA and Brazil), European countries (Australia, Spain, Belgium, Netherlands among others) and China are among the leading countries doing research on sedentary behaviours among children (Wu *et al.*, 2017; Yang *et al.*, 2022; Memon *et al.*, 2023). Some few reasons for the increase in research work in advanced and financially stable nations may be linked to the understanding by researchers, government agencies and health practitioners of the fact that childhood is critical for developing social, physical, and cognitive competence of children (Hanifah *et al.*, 2023). The search by researchers and government parastatals in economically stable

nations to explore possible effective ways and intervention programs that will improve physical activities for the purpose of combating negative sedentary behaviours among 21et al., 2022). Furthermore, several research organizations from advance countries are heavily subsidized by global agencies or government institutions to do research that aligns with solving human problems (Peng *et al.*, 2015). st century children are part of the reasons why they are involved in lots of research work in this research field (Arocha Rodulfo, 2019; Yang

Research on reducing sedentary behaviour in children requires multifaceted approach and it is subjective by intricate interplays of societal, technological, educational, cultural, social and health interest by a nation's government. Most of the developed nations promoting this research niche have adopted workable instrument and interventions to tackle sedentary behaviours in children (Yang *et al.*, 2022; Memon *et al.*, 2023). These include effective government policy interventions by funding physical education programs and initiatives, supporting school and community programs through access to recreational equipment and active lifestyle, promoting active lifestyles within all family setups and providing funds and resources for parents to support children's active lifestyle, developing as well as promoting technologies that boost movement and lessen reliance on passive activities, and reducing any form of funding disparities to safeguard equitable access to funds that boost physical activity (Salmon *et al.*, 2005; Biddle *et al.*, 2014).

The present investigation also observed that there was only one African nation (South Africa) out of the 25 top leading countries that is doing active research in sedentary behaviours among children (Table 2). This observation should trigger a wake-up call to nations from this continent (Africa) and other developing nations that recorded no presence or few numbers of research work in this niche area. These nations can explore the need of doing more of this kind of research so as to reduce the risk and health implication of lack of physical activities and sedentary behaviours among children. Most importantly, more attention should be focused in this field of research by developing nations because sedentary lifestyle is regarded as a highly prevalent disease in the 21et al., 2019; Pereira *et al.*, 2020; Barone *et al.*, 2021).st century because of its severe risk to public health (Arocha Rodulfo, 2019). It is proposed that more nations of the world especially those from Africa can tap into the prospect of partnering with financially stable and scientifically advanced nations to do research in this field in order to tackle the menace of sedentary behaviours in children. Studies have shown that several intervention programs on public health based on behavioural change techniques as well as innovative technologies (such as wearable devices) have been used to reduce sedentary behaviour and these approaches have demonstrated effectiveness in reducing cardio metabolic risk factors in the adulthood phase of people thus, preventing cardiovascular diseases in humans (Roberts

Australia, UK, Canada, Spain, USA, Netherlands, Belgium and China were placed in the top spots of nations that are leading in studies on sedentary behaviours among children with respect to the numbers of citations and articles (Table 2). One of the reasons why a nation is ranked as top leading nations with high number of publications and article citations in a particular niche area has been ascribed to funding supports that they get from several institutions (Ekundayo and Okoh, 2018). Furthermore, the increase in research participation by the afore-mentioned financially stable nations in this type of investigations is ascribed to a possible high level of their participations in regional and international partnership with research-loving organizations and countries (Ekundayo and Okoh, 2020). This is an essential promoter that enhance research impact and frequency of nation's article citations (Altarturi *et al.*, 2023). On the other hand, the relatively low number of research on sedentary behaviours among children as observed in the present study for developing nations may be as a result of the fact that researches done in these nations are self-funded with several researchers in these countries not able to afford doing research that requires large financial involvement (Orimoloye and Ololade, 2021). Again another possible reason could be that scientists from these nations publish their findings in a non-indexed academic sources which are different from the indexed ones such as PubMed, WoS, and Scopus etc.

The 25 top rated nations with Multiple Collaboration Publications (MCP) on studies in sedentary behaviours among children indicates their collaborations are with fellow researchers from financially stable countries such as Australia, UK, Canada, Spain, Netherlands and the USA (Table 2). This observation is similar to the findings of other bibliometric assessments that also reported research partnerships among countries of financially stable economies (Smith *et al.*, 2022). Collaborations between economically stable nations and their developing counterparts is however observed to be scanty as seen in previous bibliometric studies (Ekundayo and Okoh, 2018; Orimoloye and Ololade, 2021). Research partnership among scientists from different nations is vital because it gives room for effective executions of innovative research that is global in nature and appropriate for comprehensive global impact and influence in the body of knowledge (Lloyd *et al.*, 2023). Lack of international networking among nations may affect citations of research findings from developing or low-income countries. Howbeit, global partnership in scholarly research is very significant as it further allows for intellectual exchange of inputs, resources as well as results from different customs, divers people and environments (Ekundayo and Okoh, 2018; Smith *et al.*, 2021; Idamokoro, 2023b).

Keywords are employed in research writing to address aspect of important issues of a discipline and to help other academics to comprehend key directions of a paper (Chen *et al.*, 2021). Keywords are also utilized by researchers to point cutting hedge illustrations of a research manuscript (Synnestvedt *et al.*, 2005). Academic journals often ask submitting authors to list and present their keywords during paper submission prior to the review. This is an indication of the essential role in the use of keywords in manuscript review process (Okaiyeto and Oguntibeju, 2021). The present study made use of both the singular (author keywords) and the plural (keywords plus) approach of the subject matter to explain the most occurring trends in research on sedentary behaviour as it relates to children. This approach has earlier been employed by fellow scientists and researchers to understand the scope of research trends that are emerging and current within a particular discipline (Cañas-Guerrero *et al.*, 2013). Using this approach is highly recommended for this kind of study because, author keywords are a collection of terminologies that narrates the exact story of a research findings; whereas keyword-plus gives various references for titles of papers (Zhang *et al.*, 2016).

The habitually used author keywords of a particular niche area illustrates the most discussed topics and subject matter over a period of time. Between the year 1982 and 2023, a sum of 2905 author keywords and 5056 keyword-plus were retrieved from Scopus dataset on sedentary behaviours among children (Table 1). These author keywords as well as keyword plus including physical activity, sedentary behaviour, children, obesity, screen time, child, female, male, human, exercise, sedentary lifestyle, sleep, overweight among others are relevant to the research field related to sedentary behaviours as relates to children (Table 3). In line with our report, it was observed in an earlier study by Yang *et al.* (2022) and Memon *et al.* (2023) that the most frequently used keywords were similar to the present findings. This further buttresses the significance of these keywords in explaining the scope of the present subject discourse and it use in researches done on sedentary behaviours among children.

The 25 top rated journal sources in Table (4) indicate that they are reliable outlets devoted to publishing academic findings as relates to sedentary behaviours among children and other related research in line with children's health and general wellbeing. These top rated journal sources include the following; International Journal of Behavioral Nutrition and Physical Activity (n = 141; h_index = 49), BMC Public Health (n = 177; h_index = 43), Obesity Reviews (n = 68; h_index = 41), and PLOS One (n = 63; h_index = 29) among others. With the calibre of research outputs produced by these journal sources and their h_index ratings, it is obvious that they have what it takes to publish research findings on sedentary behaviour among children for the promotion of healthy lifestyle in children. In accordance with our findings, these journal sources have also been listed as top rated journals for research work done on children and their active lifestyle (Müller *et al.*, 2018; Yang *et al.*, 2022; Memon *et al.*, 2023).

Table (5) presented top leading institutions that produced more research findings on sedentary behaviours among children with the nation of Australia having more institutions doing research in this niche area. Most institutions listed in this categories had over 40 research articles published from them with Deakin University (Australia) having the highest number of published articles (n = 265). In line with this observation, previous authors have also reported similar institutions as very active in doing research on sedentary behaviours among children (Yang *et al.*, 2022; Memon *et al.*, 2023). However, in contrast to our findings, other bibliometric studies in other discipline (such as computer science, medicine, microbiology, geography, technology and agriculture) have observed that institutions based in the USA and China make more contributions to academic knowledge when compared to other nations globally (Ekundayo and Okoh, 2020; Orimoloye and Ololade, 2021; Okaiyeto and Oguntibeju, 2021; Idamokoro and Hosu, 2022a).

With respect to citation numbers of articles and their significance on the world map, the general indices to rate article impact is through the number of times they attract citations over a given period and the number of downloads that they accumulated over the years. In addition, the citation number of a particular paper also depends on the academic strength/impact of the citing paper. A paper cited by a high index factor author always attracts the attention of other researches in the field, while the number of citation of that article draws to itself show the level of impact it has on the global stage. The scientific impact of a manuscript within a particular discipline is often based on how regularly it gained citation from intellectual peers (Tahim *et al.*, 2016; Idamokoro and Hosu, 2022b). Conversely, the impact of a good paper rises in its significance as citation increases.

The top 20 leading articles based on Total Citations (TCs) and total number of citations per year (TC/Year) in research on sedentary behaviours among children from 1982 – 2023 were listed in Table (6). Several authors including; Zimmet P, Bull FC, Evenson KR, Tudor-Locke C, Biddle SJH, and Tremblay MS, were among those who have published articles with more numbers of citations. Howbeit, the name Tremblay MS clearly stands out among the other authors because three (3) articles from this author were listed as part of the top 20 most cited articles on sedentary behaviours among children. In line with our present observation, Tremblay MS was mentioned as an author that have published credible articles on sedentary behaviours among children

(Memon *et al.*, 2023). The exploits of research by Tremblay MS on sedentary behaviours among children cannot be over-emphasized because the author have written several articles based on the present subject matter of discourse (Tremblay *et al.*, 2011; 2016; 2017). Meanwhile, it is possible that some top rated articles may be listed among highly cited papers in a particular discipline yet, attract negative intellectual criticisms because of result discrepancies with other results from other authors (Cheek *et al.*, 2006).

Table 6: Top 20 most cited articles on sedentary behaviour in children research from 1982-2023

S/N	Paper	DOI	TC	TC per Year	Normalized TC
1	Zimmet P, 2001, Nature	10.1038/414782a	4792	199.67	5.31
2	Bull FC, 2020, Br J Sports Med	10.1136/bjsports-2020-102955	4614	922.80	89.98
3	Evenson KR, 2008, J Sports Sci	10.1080/02640410802334196	2023	119.00	13.02
4	Tudor-Locke C, 2004, Sports Med	10.2165/00007256-200434010-00001	1543	73.48	4.73
5	Biddle and Asare, 2011, Br J Sports Med	10.1136/bjsports-2011-090185	1521	108.64	13.88
6	Tremblay MS, 2011, Int J Behav Nutr Phys Act	10.1186/1479-5868-8-98	1453	103.79	13.26
7	Tremblay MS, 2016, Apple Physiol Nutr Metab	10.1139/apnm-2016-0151	1196	132.89	20.82
8	Waters E, 2011, Cochrane Database Syst Rev	10.1002/14651858.CD001871.pub3	1168	83.43	10.66
9	Lubans DR, 2010, Sports Med	10.2165/11536850-000000000-00000	1066	71.07	8.76
10	Tremblay MS, 2010, Appl Physiol Nutr Metab	10.1139/H10-079	1017	67.80	8.36
11	Luttikhuis HO, 2009, Cochrane Database Syst Rev	10.1002/14651858.CD001872.pub2	965	60.31	11.13
12	Davison KK, 2001, Obes Rev	10.1046/j.1467-789x.2001.00036.x	955	39.79	1.06
13	Carson V, 2016, Appl Physiol Nutr Metab-a	10.1139/apnm-2015-0630	880	97.78	15.32
14	Prentice AM, 2006, Int J Epidemiol	10.1093/ije/dyi272	850	44.74	7.24
15	Pan XF, 2021, Lancet Diabetes Endocrinol	10.1016/S2213-8587(21)00045-0	806	201.50	34.42
16	Stockwell S, 2021, BMJ Open Sport Exerc Med	10.1136/bmjsem-2020-000960	789	197.25	33.69
17	Craigie AM, 2011, Maturitas	10.1016/j.maturitas.2011.08.005	774	55.29	7.06
18	Moore SA, 2020, Int J Behav Nutr Phys Act	10.1186/s12966-020-00987-8	725	145.00	14.14
19	De Rezende LFM, 2014, PLOS One	10.1371/journal.pone.0105620	671	61.00	13.30
20	Saris WHM, 2003, Obes Rev	10.1046/j.1467-789X.2003.00101.x	662	30.09	3.19

TC: Total Citations

Taking a look at one of the top cited research publication (Table 6), the authors gave some comprehensive guidelines for sedentary behaviours among children which included a preamble to give context, followed by the precise recommendations for sedentary behaviour in Canadian children (Tremblay *et al.*, 2011). In their study, Tremblay *et al.* (2011) spelt out the final parameter as recommendations for children in order to help improve their health benefits by minimizing the time that they spend being sedentary on a daily basis. This recommendations may be realized by:

1. Reducing recreational screen time to 2 h or less each day (lesser time allocated to screen time are associated with additional health benefits)
2. Limiting sedentary the use of frequent transport, extended sitting time, and time spent indoors throughout the day as contributes to improving health benefits in children

The work of Tremblay *et al.* (2011) appeared to be the foremost evidence-based study on sedentary behaviours (guidelines) for Canadian children; and this investigation offered vital as well as timely recommendations for the enhancement of public health based on scientific evidence. Other nations especially those that have not yet come up with such innovative recommendations for children in their regions are encouraged to do so for the health benefits of the children in their regions. This is because several factors (including feeding habits, access to exercise facilities, climatic conditions among others) may cause differences in recommendation guidelines for sedentary behaviours among children for different nations of the world.

In Table (7), the present study outlined the leading researchers in research on sedentary behaviours in children. The leading authors including Tremblay MS, Salmon J, Chaput JP, De Bourdeaudhuij I, Janssen I, Carson V, and Okely AD (n = 92; n = 76; n = 46; n = 43; n = 35; n = 48; n = 56) are ranked in their order of contributions in the present discipline of discourse, respectively. From the academic profile of these aforementioned authors, they had h-index of 48, 33, 30, 28, 27, 25, and 25 (with citation numbers; 14121, 4009, 11424, 2035, 5961, 5668 and 5526), respectively. The h-index is generally employed to evaluate how significant articles are rated at the global level (Huang *et al.*, 2019). The h_index is again used to show how productive and active researchers within a particular discipline is involved in research and this is done based on the number of articles they have produced as well as the citations of their articles over the years (Hirsch, 2005). The estimation of h_index is calculated through the h – algorithm (of the number of articles) on the minimum number of h times the article was cited by academic peers within the discipline (Hirsch, 2005). It is very vital to be aware that the h_index criteria for assessing any author's performance on the is an essential instrument in

bibliometric analysis due to the fact that it has a well-accepted level of accuracy to reproduces the need impact of a given author on their contributions scientific and basic knowledge in that field over the years (Guilak and Jacobs, 2011).

Table 7: 25 top leading authors on sedentary behaviour in children research from 1982-2023;

S/N	Element	H	G	M	TC	NP	PY
1	Tremblay MS	48	92	1.92	14121	92	2000
2	Salmon J	33	62	1.571	4009	76	2004
3	Chaput JP	30	46	2.308	11424	46	2012
4	De Bourdeaudhuij I	28	43	1.4	2035	43	2005
5	Janssen I	27	35	1.286	5961	35	2004
6	Carson V	25	48	1.667	5668	48	2010
7	Okely AD	25	56	1.316	5526	56	2006
8	Baur LA	23	36	1	1942	36	2002
9	Reilly JJ	23	42	1.095	3969	42	2004
10	Biddle SJH	22	30	1.048	5165	30	2004
11	Brug J	22	30	1.158	1792	30	2006
12	Cardon G	22	41	1.1	6547	41	2005
13	Manios Y	22	41	1.375	1721	45	2009
14	Jago R	21	37	1.4	6322	37	2010
15	Timperio A	21	34	1	1974	34	2004
16	Ekelund U	20	27	1.25	7425	27	2009
17	Hesketh KD	20	40	1.111	1626	46	2007
18	Katzmarzyk PT	20	26	0.952	9018	26	2004
19	Olds T	20	35	1.25	3158	35	2009
20	Maes L	19	24	1.118	1197	24	2008
21	Saunders TJ	19	24	1.267	6100	24	2010
22	Crawford D	18	21	0.9	1057	21	2005
23	Androutsos O	17	25	1.214	795	25	2011
24	Chinapaw MJM	17	28	1.063	1606	28	2009
25	De Craemer M	17	27	1.308	1019	27	2012

H: h-index; G: g-index; M: m-index; TC: Total Citation; NP: Number of Publications; PY: Publication Start Year

Another important aspect of bibliometric analysis of a research discipline is that of collaboration and networking among authors, countries and research agencies because it forms a standard required for advancing academic findings in any research field. Furthermore, collaboration and networking helps to increase partnership among scholars, research institutions or nations with common goal and interest in a related research discipline. Networking also gives room for inter-disciplinary exchange of innovative ideas from different perceptions among intellectuals with common interest in order to achieve loftier research goals (Wenwen *et al.*, 2019). Partnering and networking in research also boost the quality of research investigations. Other important profits of research collaboration includes ground-breaking innovations, publishing of results in high impact journals, local and international exchange of intellectual human potentials, and funds accessibility among others (Bozeman *et al.*, 2013). From the present study, the outcome of nation's collaboration is presented in Figure (3) with various colours indicating its different groupings in line with their networking with other countries of the world. The different nodes represents each nation. The lines joining the various nations together have different degree of thickness. These connection indicates the strength in ties and collaboration among these different nations. Australia had the most observed networking with other countries as a result of stroke thickness and the largeness of its node. The central placing of Australia is another indication of its rankings as the leading nation that has more networking with other nations. However, the present result is in contrast with reports from other bibliometric studies who have reported the USA as the nation with more networking in research for several disciplines with other nations of the world (Zyoud *et al.*, 2017; Aparicio-Martinez *et al.*, 2019; Baier-Fuentes *et al.*, 2020).

The keyword co-occurrence evaluation for this study was also investigated. This assessment helps to describe the different aspects of research that is in line with the research topic of the present discourse. Visualization of the result in Figure (4) shows the key author keywords in the research field using a threshold of co-occurrences and the fifty most-frequent coincidences of important keywords. This method provides a cue of the most recent concepts in relation to the research subject matter. The chief keywords employed in this research topic is "sedentary behaviour", "physical activity", and "children." Interesting to note that other related concepts that appeared to be derivatives to the concept of sedentary behaviour are those of prevention, early childhood, obesity, sedentary time, overweight, exercise, screen time, television viewing, health behaviour, health promotion, and public health among several other concepts. It is also of interest to state that several other concepts have been linked to sedentary behaviour in children quite often in recent years. This can be seen from other colours in Figure (4) (such as nutrition, BMI, covid-19, adiposity, accelerometry, interventions, family, and epidemiology among others). All these listed keywords points to the different conceptual frameworks used to explain the intersection of the current topic (sedentary behaviours in children). Similar findings have also been reported in other studies (Yang *et al.*, 2022; Memon *et al.*, 2023).

The result in Figure (5) again showed the authors' keywords using another analysis named the thematic evaluation map to describe the importance of the author's keywords that have been used during the study period (1982 to 2023). This type of bibliometric evaluation has earlier been employed to present the progression of keywords (Cobo *et al.*, 2011; Idamokoro and Hosu, 2022b; Altarturi *et al.*, 2023). This study presented the four (4) key themes model the authors' keywords clustering namely:

1. The top-right quadrant (motor theme) which describe the high centrality as well as the concentration keywords of sedentary behaviour as it relates to children. From these thematic map, the authors keywords such as physical activity, sedentary behaviour, children
2. The top-left quadrant (the niche theme) which describe themes such as pre-schoolers, toddlers, infants, preventive medicine, community child health, depression, psychological distress and validity. This theme is still evolving, but it has links with the other main keywords on the present subject of discourse
3. The bottom-right quadrant (the basic theme) which describe keywords such as adiposity, siting, body composition, obesity, overweight, child, mental health, covid-19, health behaviours
4. The bottom-left quadrant (the emerging themes) which describe keywords such as public health, epidemiology and paediatrics

This above grouped themes gives the degree of relevance (centrality) of the various keywords in the thematic chart map as linked to the main theme of the subject matter which is sedentary behaviours.

In recent years sedentary behaviours (also known as sedentarism) has increased immensely over the last few decades in several countries of the world, predominantly in developed nations, although of recent, it has also increased in developing nations as well (Tremblay *et al.*, 2010; Colley *et al.*, 2013). This issue have become a serious problem for public health as a result of the negative repercussions on cardiometabolic risk in the early life (children) which is linked to an array of chronic health conditions like high blood pressure, cardiovascular disease, and obesity and can further increase the risk of dying, either from heart or other medical complications (Nur Zati Iwani *et al.*, 2023). In fact, sedentary lifestyle has been recognized as the fourth principal risk factor for death globally with a proportion of 6% of the global death rate (Lee *et al.*, 2012). This scary statistics calls for the need for people to reduce the amount of time they waste being sedentary, especially during childhood so as to avoid the increase in cardiometabolic risk in their adulthood (Idamokoro and Goon, 2024).

Study Limitations

The data utilized for the bibliometric analysis of this study was exclusively from the Scopus dataset, thus it may not have captured all published literatures on sedentary behaviours among children research. Although, as earlier mentioned in the methodology section, Scopus dataset is a widely accepted knowledge base that is widely used as a data source among scientists as well as scholars globally. It is suggested that other possible alternative data sources such as Google Scholar, Web of Science (WOS) and PubMed should be utilized in the future for this kind of analysis on this subject matter. Regardless of the afore-mentioned limitation, the current study still offers great insights on research trends and directions in the field of sedentary behavior as relates to children health and well-being.

As inspiring and expository as the present study may have portrayed, it is important to highlight that there are several untapped areas of research on children sedentary behaviours that still needs investigations. Some of the grey areas that may still need to be addressed include that more research should be done in developing, low- and middle – income nations where cultural as well as environmental factors might impact activity patterns as compared to developed nations where more research on this subject is been done.

Another area that requires investigation is on the impact of virtual reality, and wearable instruments on sedentary behaviours for children as this area is still in its infancy stage. Adopting innovative technologies that could mitigate sedentary tendencies among children should be encouraged even though the long-term effects of such research in this area remains unclear. In addition, the research that report the mechanisms that exist in the relationship between sedentary behavior and mental health of children is still limited and requires investigations. Another important aspect that requires attention is in the area of how modern urbanization, structural designs, and accessibility to recreational centers influences the sedentary behaviours of children. Future research could explore how city design and neighborhood features impact the activity levels of children and young people.

Conclusion

Research findings on sedentary behaviours among children is presently gaining attention as observed from the yearly scientific production (ASP) from 1982 to 2023. This growth in research trend is encouraging due to the importance of the discussed subject matter especially as it relates to finding solution and possible intervention programs that will help in improving the physical activities and general well-being as well as health of children all over the world. Financially buoyant and scientifically advance nations showed higher involvements in research done on the current subject matter when compared to developing nations. Other nations (mostly developing ones) are encouraged to do more research in line with the discussed subject matter and to partner with advance nations that are already doing research in this niche area so that the menace of sedentary behaviours in the future implications and effects of lack of physical activities among children will not be grievous in their adulthood. It was further observed from the trending topic that author keywords such as “physical activity”, “childhood obesity”, “public health”, “overweight”, “obesity”, “sedentary behavior”,

"mental health" among others were mostly used by scientists in carrying out research on sedentary behaviours as relates to children, thus signifying the direction for future areas of investigations.

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