An Outlook to Childhood Obesity in Saudi Arabia using VOSviewer

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Abstract

Childhood Obesity (CHO) is a global epidemic that has increased in recent years. According to the World Health Organization (WHO), 39 million children under five will be overweight or obese in 2020. In Saudi Arabia, the prevalence of obesity reached its peak at 35.5%. WHO also anticipated that by 2030, 30% of all deaths worldwide would be caused by lifestyle diseases. Extensive studies have been published on the fundamental causes of obesity, its treatment, and its prevention. As a result of the efforts and resources invested in childhood obesity research, control, and prevention, it is necessary to assess and analyze these studies and provide valuable insights to public health officials and healthcare institutions. Using the Scopus database, this paper uses bibliometric analysis to evaluate and identify trends and studies in childhood obesity in Saudi Arabia based on VOSviewer. Results revealed that the top 5 active affiliations in childhood obesity are King Saud University (165 documents), King Abdulaziz University (139), King Saud University for Health Sciences (47), Imam Abdulrahman Bin Faisal University(42), and Princess Nourah

Bint Abdulrahman University (39). King Saud University sponsored the highest number of published documents. Out of 643 documents retrieved from the Scopus database, 42.5% were in Medicine and 11.8% in biochemistry. Understanding state-of-the-art childhood obesity is critical in planning future measures to control and prevent high-risk children early and future obesity complications. This study aims to provide insight for Saudi Arabian authorities to consider boosting health measures to reduce the incidence and prevalence of CHO.

Keywords
Obesity, Childhood, Saudi Arabia, VOSviewer, Bibliometric Analysis.

1. Introduction
Health and wellbeing at all ages are the keys to building prosperous societies. However, despite the increasing awareness among people, obesity remains a global challenge. Obesity is a global epidemic, and millions of people suffer from its complications (*Obesity* n.d.). Recently recognized uniquely as an issue of grown-up health, obesity among youngsters is progressively turning into a worry (Reilly JJ 2005). Obesity and overweight are defined as the excessive accumulation of fat that presents a risk to health (*Obesity* n.d.). Body mass index (BMI) is a measure used to determine childhood overweight and obesity. It is calculated by dividing a person's weight in kilograms by the square of height in meters.

An adult is classified as obese if they have a BMI over 30 and overweight if it is above 25. Early childhood is defined as the age from birth to 8 years old. According to CDC growth charts (CDC 2021b), overweight is defined as a BMI at or above the 85th percentile and below the 95th percentile for children and teens of the same age and sex. obesity is defined as a BMI at or above the 95th percentile for children and teens of the same age and sex. The causes of early childhood obesity and adult obesity are similar, including behavior and genetics (CDC 2021a). Table 1 shows the classification of adults' BMI according to WHO standards (WHO 2021). Table 2 shows children's weight category classification according to CDC standards (CDC 2021b). Behaviors like an unhealthy diet and lack of physical activity cause an imbalance in calorie intake and consumption, which causes obesity. Furthermore, living in an environment that does not support healthy habits increases the challenges faced by the children.

Table 1. BMI classification of adults.

BMI (KG/M^2)	**CLASSIFICATION**
< 18.5	Underweight
18.5 – 24.9	Normal Weight
25 – 29.9	Overweight
>= 30	Obese
30.0 – 34.9	Obese I
35 – 39.9	Obese II
>= 40	Obese III

Table 2. Classification of weight status category of children.

WEIGHT STATUS CATEGORY	CLASSIFICATION
underweight	Less than the 5th percentile
healthy weight	5th percentile to less than the 85th percentile
overweight	85th to less than the 95th percentile
obesity	95th percentile or greater

Worldwide, the prevalence of obesity has tripled from 1975 to 2016. More than 650 million adults over the age of 18 were obese in 2016. Also, 36% of adults were overweight. Over 340 million children and adolescents aged 5-19 were overweight or obese in 2016. Overall, about 13% of the world's population were obese in 2016 (Obesity and Overweight n.d.). In 2019, an estimated 38.2 million children under the age of 5 years were overweight or obese.

Obesity is the cause for several non-communicable diseases such as cardiovascular diseases, mainly heart disease and stroke, diabetes, musculoskeletal disorders (especially osteoarthritis – a highly disabling degenerative disease of the joints), some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon). The risk for these non-communicable diseases increases with increases in BMI (Obesity and Overweight n.d.). Also, childhood obesity is linked with a greater chance of obesity, premature death, and disability in adulthood. In addition to increased health complications in the future, obese children experience hypertension, insulin resistance, breathing difficulties, psychological effects, increased risk of fractures, and early markers of cardiovascular disease.

In Saudi Arabia, the rate of obesity among adults over 18 is 35.5% (Obesity - Adults (18+ Years) | EMRO Regional Health Observatory n.d.). Past research (Al-Nuam and Bamgboye 1998) found that obesity happens in all provinces of Saudi Arabia. Saudi and non-Saudi identities had similar conveyance of BMI. The rate of obesity has been gradually increasing over the years from 1975 to 2016, as shown in figure 1. According to Al Hussaini et al. (Al-Hussaini et al. 2019), the prevalence of childhood obesity has reached 18.2%. Furthermore, childhood obesity is the main cause of adulthood obesity, and in most cases, if the child is obese at a young age, they stay obese for most of their lives (Al-Hussaini et al. 2019). Worldwide, Saudi Arabia is the 14th most obese country and the 3rd most obese Arab country by obesity rate (*Global Obesity Levels - Obesity - ProCon.Org* n.d.). Saudi Arabia is facing a challenge in trying to control this epidemic.

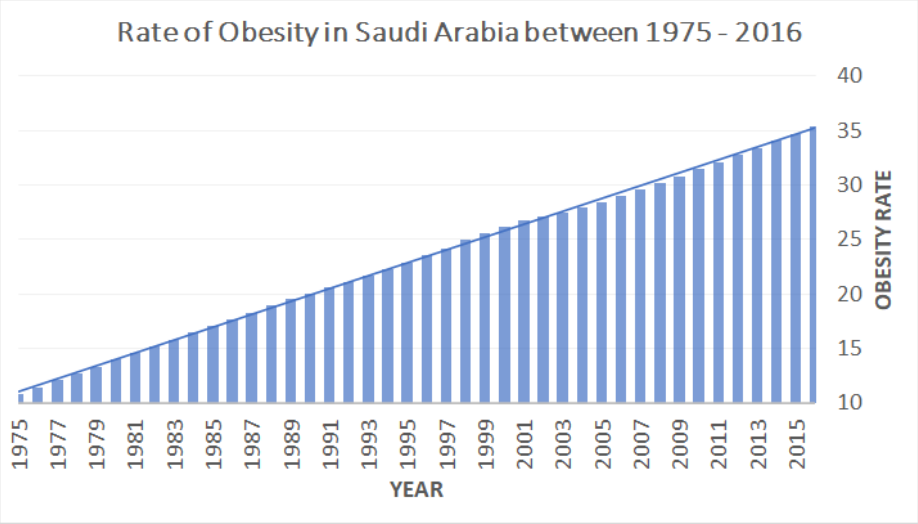

Figure 1. The rate of obesity in Saudi Arabia between 1975 to 2016.

Recently, bibliometric analyses, data visualization, and mapping have been used successfully to study statistical behavior and assess scientific activity in a variety of technology and healthcare fields, including Covid-19 and artificial intelligence (Alcalá-Albert and Parra-González 2021; Anon n.d; Gao et al. 2021; de las Heras-Rosas and Rodrguez-Fernández 2021). Many visualization tools such as VOSviewer (van Eck and Waltman 2009), and databases, such as the Web of Science (WoS), Scopus, or lens.org, have contributed to the rise in popularity of bibliometric analysis.

Using articles from these databases, a quantitative output can be constructed for various bibliometric visualizations and trends to extract relevant information from the databases. The objective of the present study is to conduct a bibliometric analysis for evaluating trends and future research avenues in childhood obesity. The rest of the paper is divided as follows: section 2 examines relevant literature review on childhood obesity; section 3 outlines the research methodology approach used in this study; section outlines the findings and discussion; and section 5 highlights the major conclusions of the study.

2. Literature Review

In the last few decades, research has been done on the fundamental causes of obesity. The internal human body physiology imbalances between calories consumed and the calories expended causes obesity and overweight (*Obesity* n.d.). A global study (Sahoo et al. 2015) explores the causes and consequences of childhood obesity. The authors state that the mechanism of childhood obesity is not completely understood, and it is a combination of different causes. Some of the causes include the tendency of children to stay inside, playing video games, rather than playing outdoor games. This has resulted in a decline in the children's physical activity, which causes them to gain weight. Also, genetics play an important role, and the family history is directly linked to the child's health status. Other causes include sugary beverages, snack foods, portion sizes, socio-cultural factors, and psychological factors. As a result, childhood obesity's consequences are not only limited to physical issues; it exceeds that scope to social and emotional wellbeing, poor academic performance, and a lower quality of life (Sahoo et al. 2015).

Worldwide, the rate of obesity is rising. However, some countries' rates have remained constant or showed a slight decrease (Farrag et al. 2017; World Health Assembly 2015; Ng et al. 2014). For instance, in the USA a study (Odgen et al. 2014) found that the prevalence of CHO in 2011 - 2012 remained constant compared to the prevalence in 2003 - 2004. Furthermore, a study conducted in Germany targeting children aged 4 to 16 found a decrease in the prevalence of obesity from 2008 to 2004. However, in Saudi Arabia, a recent study by Al-Hussaini et al. (Al-Hussaini et al. 2019) determined a rising trend in childhood obesity in the city of Riyadh over the past 20 years. The overall prevalence of overweight is 13.4% and obesity is 18.2%, double the WHO-based national prevalence rate of obesity (9.3%) reported in 2004. Also, that rate is similar to pediatric obesity in the USA. This shows that the number of overweight and obesity among Saudi children has risen alarmingly over the past decade. The authors recommend initiating and monitoring effective obesity prevention measures to control the situation based on the reported statistics.

A cross-sectional study (Al-Othaimeen et al. 2007) analyzes the prevalence of obesity using data from the national nutrition survey. It shows that many participants between 18 and 65 had a BMI of more than 25. This trend is explained by Saudis' high consumption of high-calorie food and their sedentary lifestyle, which tends to be based on indoor activities more than outdoor activities. Compared to other countries, females have a much higher prevalence of obesity than males in the same age group. This should point the authorities to form a plan (e.g., a campaign) to target females' health and lifestyle. Furthermore, in Saudi Arabia, a trend shows that children and adults tend to consume unhealthy food (Al-Othaimeen et al. 2007; Sahoo et al. 2015), which negatively affects their nutrition.

Further research (Memish et al. 2014) shows that obesity is strongly linked with diabetes, hypercholesterolemia, and hypertension in Saudi Arabia. However, there are some different characteristics of obesity that differ according to gender. For instance, men's obesity is associated with diet, physical activity, diagnosis of diabetes and hypercholesterolemia while women's obesity was associated with education, history of chronic conditions, and hypertension. Both genders' obesity were associated with marital status and hypertension.

In addition, some regions show a higher prevalence of obesity than others. According to research by Althumiri et al. (Althumiri et al. 2021), the Eastern Region has the highest prevalence at 29.4%, whereas Baha has the least rate at 14.3%. The same research shows that people between 50 to 59 have the highest prevalence and that females experience more obesity than males. However, the authors found that the overall prevalence of obesity decreased compared to previous years and is less than neighboring countries such as UAE and Kuwait. This trend was explained by the new regulations imposed in Saudi Arabia, such as the 100% tax on energy drinks, the introduction of female fitness classes in schools, vision 2030 health, and wellbeing goals, etc.

Another study (Alqarni 2016) reviewed past research to observe the prevalence of obesity in Saudi Arabia. The rates differ among different age groups, genders, occupational fields, and areas within the country. Males are more obese in rural locations, but overall, obesity is more prevalent among females, as previous research (Al-Othaimeen et al.

2007) stated. Determining factors include genetics and family history, diet patterns, age, education, marital status, physical activity, and sleeping interruptions. And consequences include diabetes, cancers, and cardiovascular diseases. A research paper (DeNicola et al. 2015) states that competing cultures are to blame for the westernization and persisting economic prosperity promoting these sedentary lifestyles and weight gain. And one of the reasons why obesity is more prevalent in Saudi women is because there aren't a lot of gyms for them, and those that do exist are expensive. So, as an intervention strategy, the country can target the environment by supplementing affordable sports facilities for both males and females to promote a healthier lifestyle.

Another cross-sectional study (Al Shaikh et al. 2020) investigates the relationship between children's vitamin D intake and obesity. The study shows a high prevalence of obesity and overweight in schoolchildren aged between 6 – 19 years, and the rate of obesity increases by increasing age. Moreover, there is a strong correlation between obese children and vitamin D deficiency. The results are considered worrying, and it should lead the officials into taking control of the situation by applying intervention methods, especially ways to increase vitamin D intake.

A study (Aljassim and Jradi 2021) evaluated the risk factors contributing to childhood obesity. It showed that paternal BMI is linked to the child's obesity risk. This is explained by the gender segregation of the society in Saudi Arabia. The father is the person who makes most of the decision-making and is the primary provider for the family (Aljassim and Jradi 2021; Pyper et al. 2016). Also, the study (Aljassim and Jradi 2021) showed that screen time is associated with an increased risk of obesity. Parents need to stick to regulations about suitable screen time for children according to age. Farsi and Elkhodary (2017) highlighted the difference in obesity between students attending private or public schools. In Jeddah, the study reported that obesity was more prevalent in students attending private schools than in public schools. This shows that people attending private schools have higher socioeconomic standards and fewer food restrictions. Therefore, a higher socioeconomic standard is linked with obesity.

According to (T. M. Dugan, S. Mukhopadhyay, A. Carroll and S. Downs 2015), a child isn't considered obese until roughly two years old. At that point, Body Mass Index (BMI) percentiles can't be dependably determined because of the inconsistency of growth patterns in newborn children. Nevertheless, it is additionally noticed that being exceptionally tall before a half year old has all the characteristics of being fairly defensive against obesity. Before two years, children who are overweight and obese have a 72% shot at being obese later, yet if they are exceptionally tall before a half year, that hazard is diminished to 63%. According to research by (Al-Dossary et al. 2010) the dissemination of weight classifications among the youngsters by age groups and sex uncovered that a bigger number of males than females were overweight in the age group 2–4 years (19.6% versus 16.3% individually). This was turned around in the age group 14–18 years, by which age the extent of overweight females was greater than overweight guys (23% versus 16.7% individually).

3. Methodology

Published documents about obesity were obtained from the Scopus database published between 2017 and 2021. Citation information such as the author, author ID, year, abstract and keywords, affiliation, language, and publishers were retrieved from the database. The open-source tool VOSviewer (version 1.6.17) (www.vosviewer.com) has been used to obtain a deeper insight and evaluate current research trends on childhood obesity.

VOSviewer uses a co-occurrence matrix to create a map. The process of making a map is broken down into three phases. The co-occurrence matrix creates a similarity matrix in the first phase. The similarity matrix is used to create a map using the VOS mapping approach in the second phase. Finally, the map is translated, rotated, and reflected in the third phase (van Eck and Wlatman 2010). Step one and step two use the following equations with the similarity s_{ij} given by

$$s_{ij} = \frac{c_{ij}}{w_i w_j}, \tag{1}$$

where w_i and w_j represent either the total number of occurrences of items i and j or the total number of co-occurrences of these items, and C_{ij} represents the number of co-occurrences of items i and j. The number of objects to be mapped is denoted by n. The VOS mapping approach creates a two-dimensional map in which the items 1,...,n are placed so that the distance between any two items i and j properly represents their similarity s_{ij}.

$$V(x_1, \ldots, x_n) = \sum_{i<j} \quad s_{ij}\|x_i - x_j\|^2 \tag{2}$$

$$\frac{2}{n(n-1)} \sum_{i<j} \quad \|x_i - x_j\| = 1 \tag{3}$$

where $\| \bullet \|$ represents the Euclidean norm and $x_i = (x_{i1},\ x_{i2})$ signifies the position of item *i* in a two-dimensional map. The objective function is minimized while keeping the limitation in mind.

4. Results and Discussion

This study uses the Scopus database, retrieved on October 29, 2021. Scopus database retrieved 7020 documents. The retrieved papers were then refined based on the last five years (2017-2021), source type (journals, books, book series, and conference proceedings), and document type (articles and conference paper), which were reduced to 2689 documents. Finally, by limiting the output to include Saudi Arabia only, the Scopus database returned 643 documents. The nearest matching publication was conducted using the keywords: childhood" and ("obesity" or "obese" or "overweight") and ("Saudi" or "Saudi Arabia" or KSA) and (limit-to (pubyear , 2022) or limit-to (pubyear , 2021) or limit-to (pubyear , 2020) or limit-to (pubyear , 2019) or limit-to (pubyear , 2018) or limit-to (pubyear , 2017)) and (limit-to (doctype , "ar") or limit-to (doctype , "cp")) and (limit-to (affilcountry , "Saudi Arabia")). Figure 1 shows the distribution of the retrieved documents by affiliation. The top 5 are King Saud University (165 documents), King Abdulaziz University (139), King Saud University for Health Sciences (47), Imam Abdulrahman Bin Faisal University(42), and Princess Nourah Bint Abdulrahman University (39). Compared to the previous year, the number of documents published in 2020 was almost double compared to 2019. This distribution development may imply that this examination region is of non-stop concern. Also, the rapid increase of CHO prevalence in Saudi Arabia may be a reason for the increase in the number of publications as the rate has reached 18.2% (Al-Hussaini et al., 2019). The highest numbers of the published document were sponsored by King Saud University, Deanship of Scientific Research, National Institutes of Health, King Abdulaziz City for Science and Technology, and King Abdulaziz University, respectively, as shown by figure 2. Out of 643 documents retrieved from the Scopus database, figure 3 shows 42.5% were in Medicine and 11.8% in biochemistry, Agricultural and Biological Sciences 7%, Nursing (5.7%), and Environmental Science (4.3%).

The graphical maps in figures 4 and 5 were built using VOSviewer according to the author's affiliation, co-authorship, and co-occurrence. The document labels represent items in the network visualization using a circle. The weight of the item being labeled determines the label's size and the size of the circle encircling the label. Some items may not appear on the map due to overlapping labels. According to figure 4, obesity, children, and childhood, physical activity was the top keywords. Body mass index (BMI) is also featured among the keywords with the most co-event among the dissected articles. The highest total link strength (TLS) and the number keywords for the top 5 in figure 4 are distributed as follows: Obesity (147 TLS202), Children (54, TSL=70), Overweight (23, TLS=63), Body Mass Index (30, TLS=51), prevalence (20, TLS=51). Figures 5 and 6 show the co-authorship density and network visualization of countries' co-authorship. It is interesting to note that Saudi Arabia collaborates with countries from the Arab World, North America, Europe, Africa, and Asia. But, the top ones are the United Kingdom, Egypt, the USA, Australia, and Canada.

With the help of these bibliometric analyses, health care can inspect the current situation regarding CHO in full detail, as each of the maps can display the publications in various ways. This study could help authorities to understand the current full picture of CHO in Saudi Arabia. It also demonstrates the trends in the field of CHO in Saudi Arabia. Moreover, it uncovered creators with the most significant associations. This data could be useful to future scientists in this field to recognize obesity rapidly. It can also deliver fundamental authorities for expected associations and point authorities to the weak links that they should target to reduce CHO and obesity in general. As past research (Al-Othaimeen et al. 2007; Althumiri et al. 2021; Alqarni 2016, DeNicola et al. 2015; Al-Dossary et al. 2010) showed, females tend to have a higher prevalence of obesity in Saudi Arabia, and this was explained by the shortage of affordable sports facilities for them and the nature of the community where women tend to stay mostly indoors. Therefore, this should give authorities insight into promoting health programs to curb the incidence and prevalence of CHO in Saudi Arabia. Figure 5 shows the density map with various countries collaborating with Saudi Arabia and Figure 6 shows us with the Network visualization of countries co-authorship.

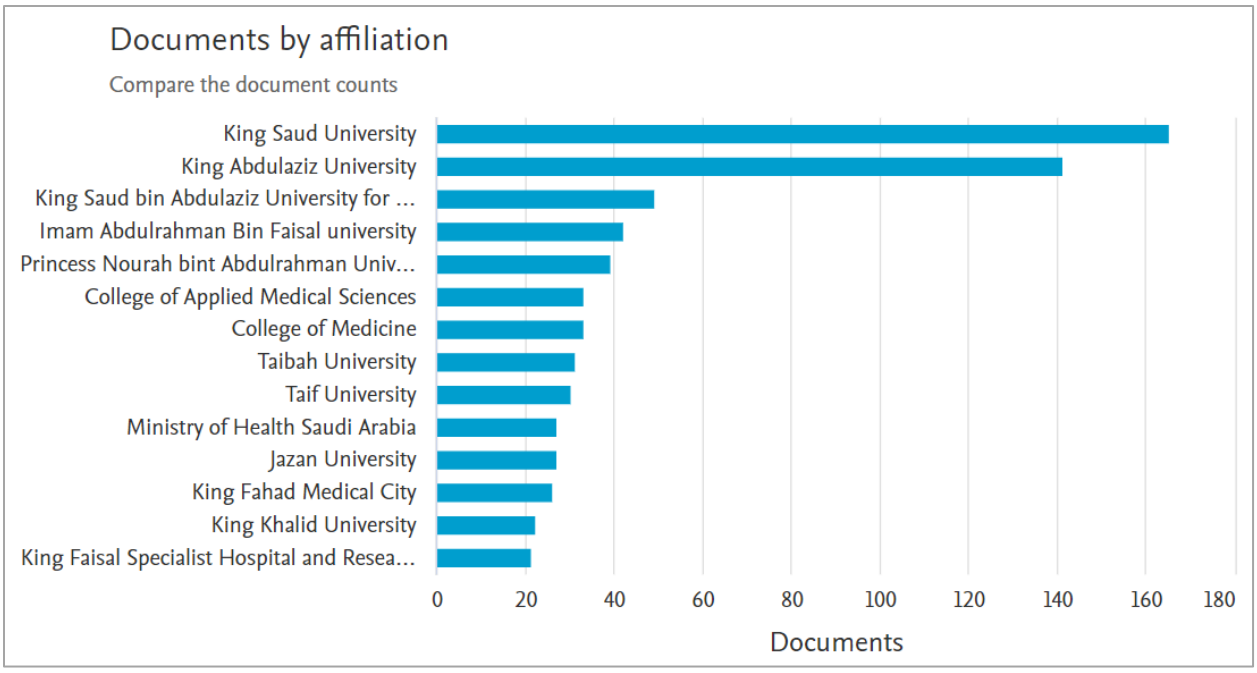

Figure 1. Distribution of published documents by affiliation in Saudi Arabia.

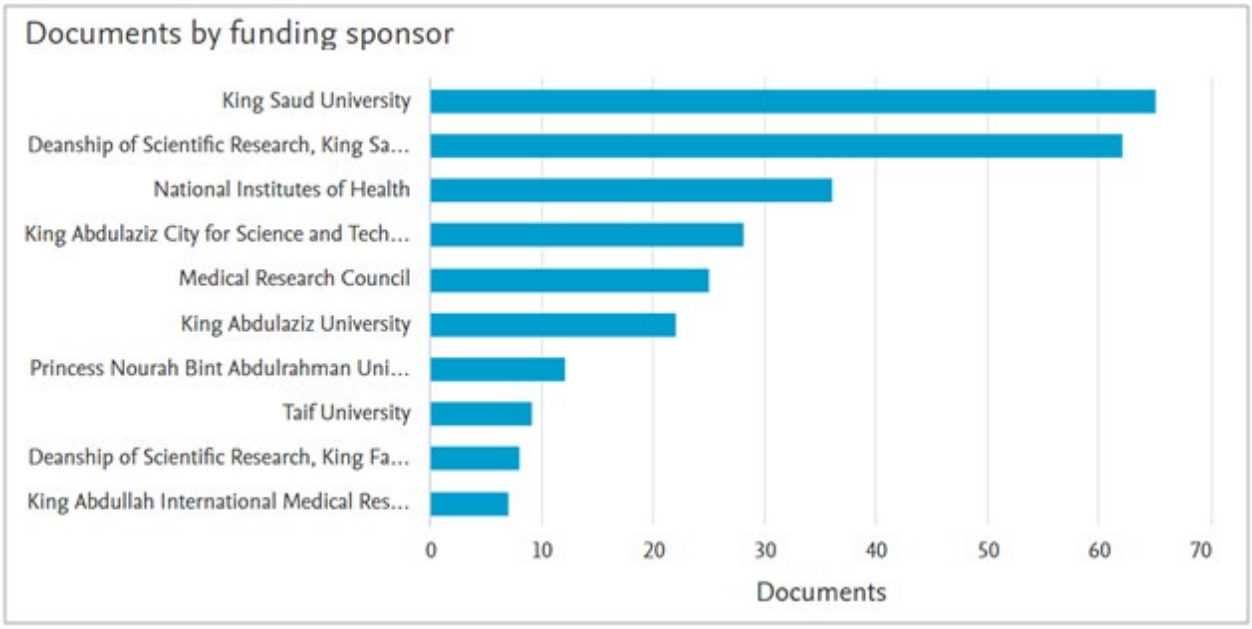

Figure 2. Distribution of published documents by funding sponsor in Saudi Arabia.

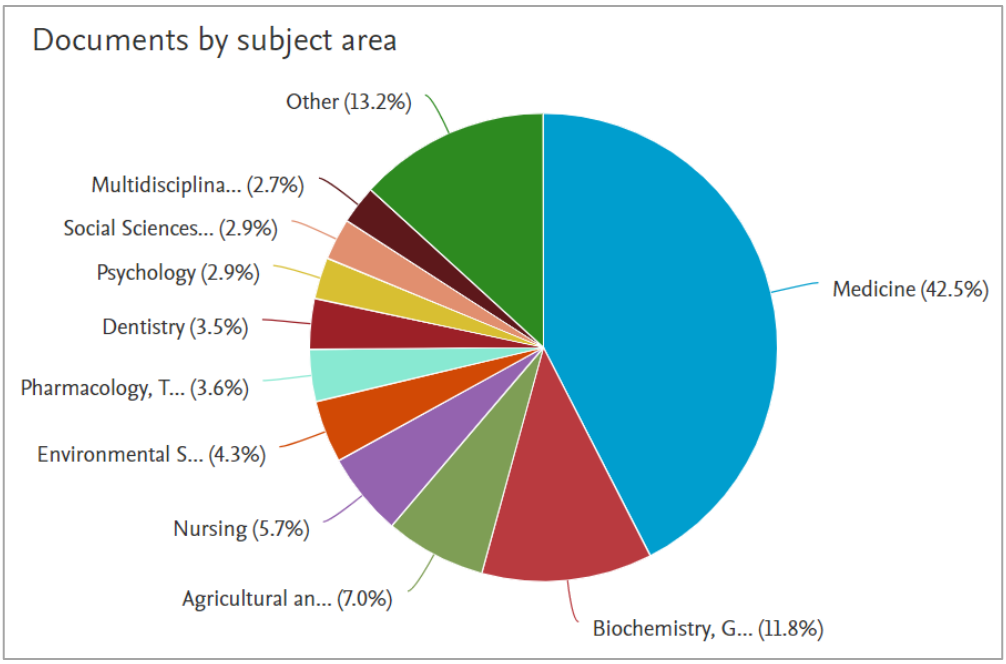

Figure 3. Distribution of published documents by subject area.

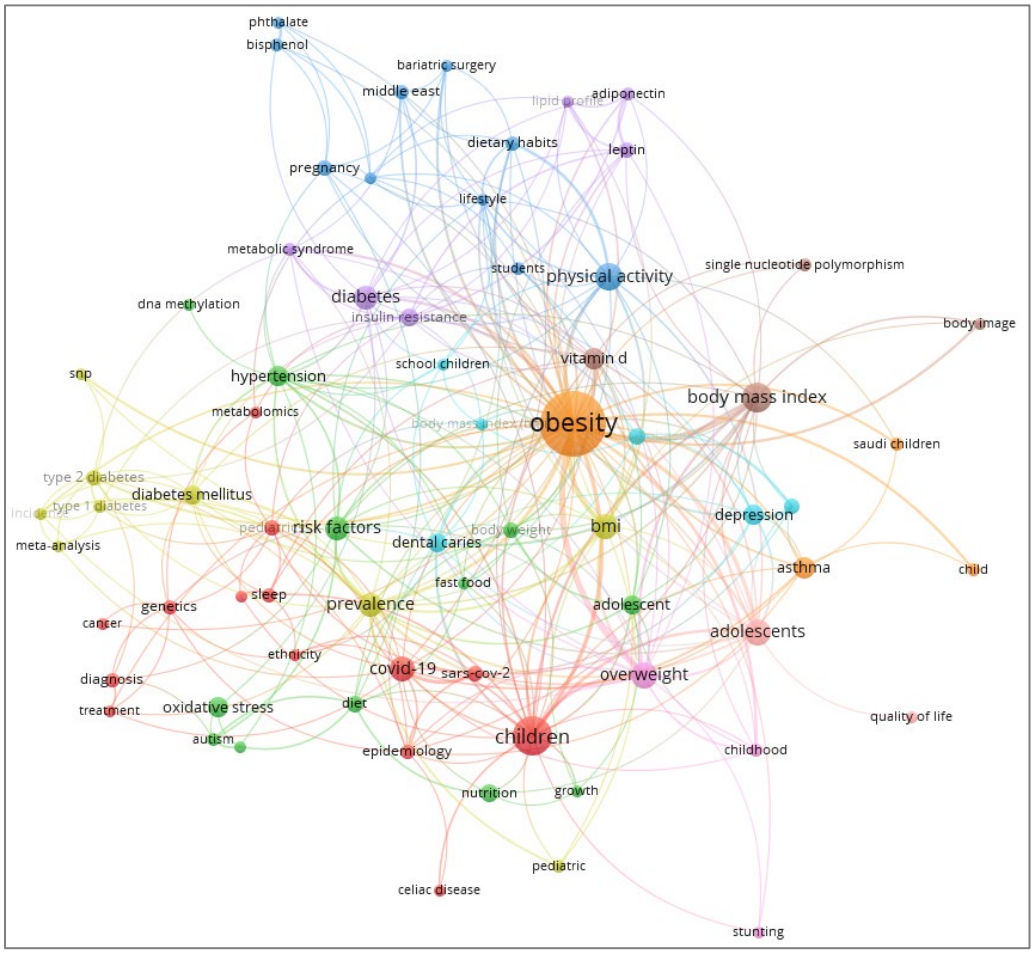

Figure 4. Keywords clusters overview related to obesity in Saudi Arabia

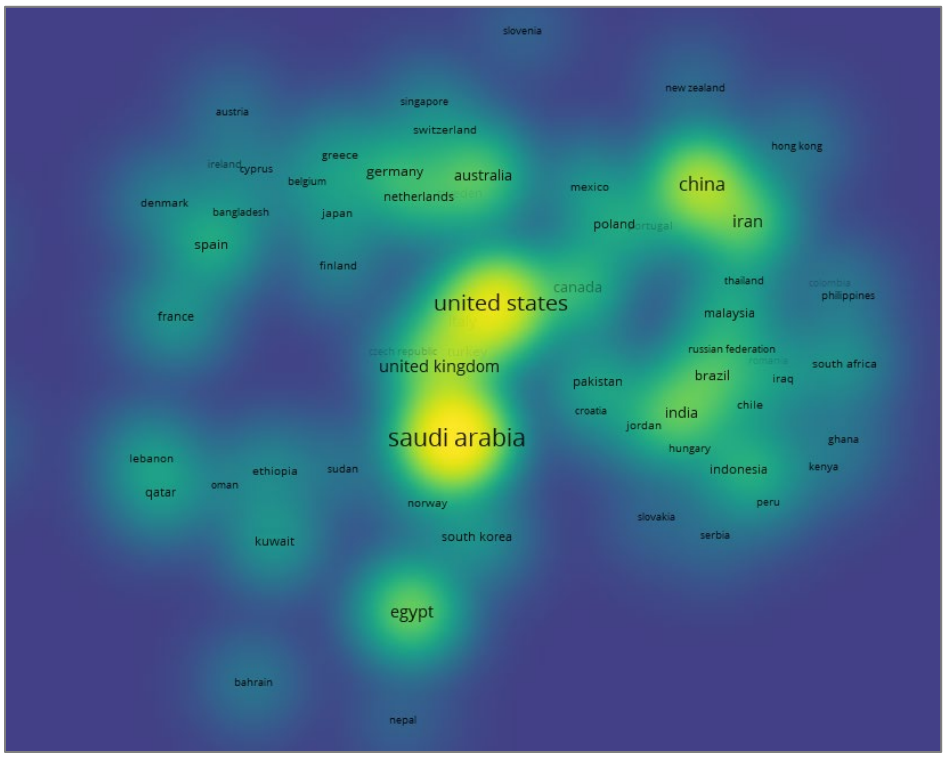

Figure 5. Density map. Countries collaborating with Saudi Arabia

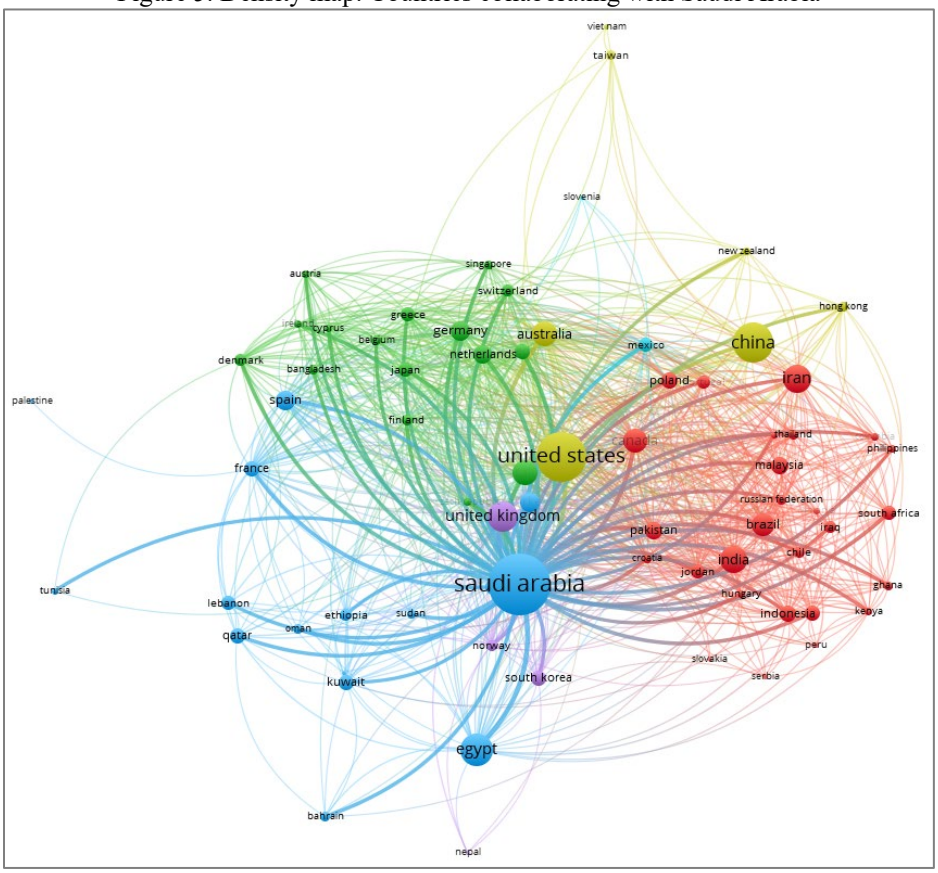

Figure 6. Network visualization of countries co-authorship.

5. Conclusion

An outlook of the scientific output of publications related to CHO in Saudi Arabia has been investigated in this study. Publication year, journal name, author, affiliation, keywords, document type, abstract, and the number of citations for each document that fit the requirements were all exported into CSV format. The retrieval date was performed on October 29, 2021. Quantitative information, trends, and relevance of published scientific articles were highlighted and identified using bibliometric analysis. The investigation includes geographic location, author co-authorship, research institutions, research category, and citations. Due to the efforts and resources invested in childhood obesity research, control, and prevention, it has become vital to evaluate and analyze these studies to give valuable insights for public health officials and healthcare providers.

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Biographies

Dr. Tayeb Brahimi, Assistant Professor at the College of Engineering, Effat University, Jeddah, Saudi Arabia, received his Ph.D. (1992) and Master's degree (1987) Ecole Polytechnique, University of Montreal, Canada. He has worked as Research Scientist under Bombardier Chair/Canadair from 1992-1998. In 1998, he joined Jeppesen DataPlan in California, then Peregrine System as a TS Analyst, Quality Assurance Engineer, and Consultant for Electronic data interchange (EDI) in Dallas, Texas. Dr. Tayeb Brahimi has been a consultant at IONPARA Inc. for wind energy and aeronautics. He published more than 100 articles in scientific journals and international conferences on renewable energy, aircraft icing, sustainability, artificial intelligence, and the use of technology to support learning. Among other activities, he is a reviewer for many international journals, invited speaker by the Japan Society of Mechanical Engineering, the Gulf Educational Conference, and the Int. Conference on Eng. Education & Research. He also participated in Public Debate on Energy organized by the Government of Quebec, Canada. Current research interest relates to renewable energy (solar, wind, wave, and waste to energy), simulation, sustainability, artificial intelligence, machine learning, and engineering education.

Hala Haneya is a computer science undergraduate student at Effat University in Jeddah, Saudi Arabia. Her current research interests involve the application of machine learning and artificial intelligence healthcare. Her most recent article is "A Meta-Analysis of AI Applications for COVID-19 Tracking: The UAE Case," presented at the "18th International Conference on Learning and Technology" in Jeddah on January 28, 2021. She and her team were nominated as one of the thirty teams participating in Makkah Days for Programming and Artificial Intelligence in Jeddah, Saudi Arabia, between 13 - 15 June 2021. Hala and her colleagues are currently focusing on machine learning applications in Covid-19 and obesity.

Hanin Balbaid is an undergraduate student studying computer science at Effat University in Jeddah, Saudi Arabia. Her primary area of study is the application of machine learning and artificial intelligence in healthcare. As a result, Hanin and her team are now working on machine learning applications for obesity.

Hafsah Ranjha is a computer science undergraduate student at Effat University in Jeddah, Saudi Arabia. She is a determined hardworking student with great interest in the field of Technology and Artificial Intelligence. Her current research interests involve the application of machine learning and artificial intelligence healthcare. Hafsah and her team are currently working on machine learning applications in obesity.

Dr. Kholoud Khateeb is an assistant professor in the Natural Science, Math and Technology Unit of Effat University. She is a volunteering ambassador for Women in Data Science (WiDS) at Stanford University and an advisory board member. She was appointed as a postdoctoral R&D associate specialist at Nestle Institute of Health Sciences (NIHS) in Switzerland. Khateeb interned at the Partners HealthCare Connected Health Center and Massachusetts General Hospital (a Harvard Medical School teaching hospital in Boston, USA). Khateeb was a telecommunication project manager in the National Commercial Bank in Saudi Arabia (currently SNB). Before this, she was a computer science lecturer at Effat University and CISCO Systems regional academy instructor.

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