

## Evaluation of plyometric training with bibliometric data: A descriptive study

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# **Evaluation of plyometric training with bibliometric data: A descriptive study**

## **Abstract**

Plyometric training is a training method that includes a stretch-shortening cycle and is designed with exercises that require explosiveness. Sports science has studied this training method for many years, and a great deal of research has been done at various levels. This study aims to evaluate the research articles on plyometric training in the field of sports sciences with bibliometric data and to reach specific norm values within the study's limitations. The study was carried out with a bibliometric analysis design, one of the quantitative research methods, and the Web of Science database was used as a data collection tool. The database related to the study; was included in the category of sports sciences; 358 research articles scanned in any of the SSCI, ESCI, or SCI-Expanded indexes were had. Statistical analyzes of the study were performed with the programming language R (ver. 4.2.2), and the biblioshiny function was used. The findings of this study revealed that the most influential researcher on the subject is Rodrigo Ramirez Campillo, and the journal that most accepts plyometric training research is the Journal of Strength and Conditioning Research. However, there is a need to examine the effects of plyometric training on agility, change of direction, and sprint performance, to conduct more research on children and youth and to address the issue from different perspectives, especially on football players. As a result, the findings may be necessary for researchers and field experts who will research the subject of plyometric training. Furthermore, the study's findings can offer an idea to the researchers studying the topic.

**Keywords:** Strength training, stretch-shortening cycle, performance, exercise

## **Bibliyometrik verilerle pliometrik antrenmanın değerlendirilmesi: Tanımlayıcı bir çalışma**

### **Özet**

Pliometrik antrenman, gerilme-kısalma döngüsü içeren ve patlayıcılık gerektiren egzersizler ile tasarlanan bir antrenman yöntemidir. Bu antrenman yöntemi uzun yıllardan beri spor bilimi alanında incelenmekte olup, konu üzerine çeşitli seviyelerde çok sayıda araştırma yapılmıştır. Bu çalışmanın amacı, spor bilimleri alanında gerçekleştirilen pliometrik antrenman konulu araştırma makalelerini bibliyometrik veriler ile değerlendirmek ve çalışmanın sınırlılıkları kapsamında belirli norm değerlere ulaşmaktır. Çalışma, nicel araştırma yöntemlerinden bibliyometrik analiz deseni ile gerçekleştirilmiş olup, veri toplama aracı olarak Web of Science veri tabanı kullanılmıştır. Çalışmaya ilgili veri tabanında yer alan; spor bilimleri kategorisine dahil olan; SSCI, ESCI veya SCI-Expanded indekslerinden herhangi birinde taranan 358 araştırma makalesi dahil edilmiştir. Çalışmanın istatistiksel analizleri R (ver. 4.2.2) programlama dili ile gerçekleştirilmiş ve biblioshiny fonksiyonu kullanılmıştır. Bu çalışmanın bulguları, konu üzerine en etkili yayım yapan araştırmacının Rodrigo Ramirez Campillo olduğunu ve pliometrik antrenman araştırmalarını en çok kabul eden derginin Journal of Strength and Conditioning Research olduğunu ortaya çıkarmıştır. Bununla birlikte pliometrik antrenmanın çeviklik, yön değiştirme ve sprint performansı üzerine etkisinin incelenmesine, çocuklar ve gençler açısından daha fazla araştırma yapılmasına ve özellikle futbolcular üzerine konunun farklı açılardan ele alınmasına ihtiyaç duyulmaktadır. Sonuç olarak elde edilen bulgular pliometrik antrenman konusu üzerine araştırma gerçekleştirecek araştırmacı ve alan uzmanları için önem taşıyabilir. Çalışmanın bulguları konu üzerine araştırma gerçekleştirecek araştırmacılara fikir sunabilir.

**Anahtar Kelimeler:** Kuvvet antrenmanı, gerileme-kısalma döngüsü, performans, egzersiz

## **Introduction**

Athletic strength requires the athlete to resist his body weight in different sports, win double battles in training and competition, and perform various movement actions at an optimal level. As a bio-motor feature, strength directly affects performance parameters, and researchers state that strength development and the development of bio-motor abilities are related (Alemdaroğlu, 2012; Sleivert & Taingahue, 2004). Training is applied at different loading intervals to improve strength (Dündar, 2012). Many training methods are developed to achieve maximum performance output (Docherty, Robbins & Hodgson, 2004; Elbadry, Hamza, Pietraszewski, Alexe & Lupu, 2019).

One of the training methods designed to develop strength is plyometric training. The definition of this training method is derived from the words plio and metric and is applied through exercises that include stretch-shortening cycles to increase muscle strength and endurance (Patel, 2014; Slimani, Chamari, Miarka, Del Vecchio & Chéour, 2016). While the history of the training method dates back to the 1960s (Radcliffe & Farentinos, 1985), this training method developed by the Russian scientist Yuri Verkhoshansky was defined primarily as shock training (Verkhoshansky, 2006). Today, explosive strength training is being investigated by researchers as ballistic training or plyometric training (Pancar, Biçer, & Özdal, 2018; Pretz, 2004; Yıldız et al., 2018).

Researchers state that plyometric training positively affects performance in sports such as football, basketball, volleyball, and handball (Chelly et al., 2010; Ramirez-Campillo, 2020; Slimani et al., 2016; Silva et al., 2019). Moreover, plyometric training is a required strength training method for athletic performance (Slimani et al., 2016). Improving the stretch-shortening cycles of the athletes may allow them to improve their strength, sprint, and jump performance (Radcliffe & Farentinos, 1985). In many meta-analyses, researchers have stated that plyometric training positively affects athletic performance levels (Asadi, Land, Young, & de Villarreal, 2016; de Villarreal, Requena, & Cronin, 2012; Stojanović, Ristić, McMaster, & Milanović, 2017).

Plyometric training is examined within the scope of sports science with many athletic performance parameters such as power, strength, sprint, and vertical jump. However, it continues to be the subject of research in different disciplines. Indeed, its effect on ankle sprain and joint power absorption in orthopedics (Ismail, Ibrahim, Youssef & Shorbagy 2010; Van Lieshout, Anderson, Shelburne & Davidson, 2014); In the field of physiotherapy and

rehabilitation, the effect of athletes on injuries (Chmielewski, Myer, Kauffman & Tillman, 2006) and the effect of plyometric training on the human body in many other areas are investigated.

This research aims to present bibliometric data from the literature on plyometric training, a research topic in the sports sciences, to relevant researchers. This study aims for researchers who will research the subject to gain information about the literature more quickly. The study is essential because it contains primary sources about plyometric training, evaluates it in the historical process, determines the most influential researchers on the subject, and offers suggestions to researchers on a scientific publication.

## **Method**

### *Research Model*

This research was carried out with the bibliometric study design, one of the quantitative research methods. The bibliometric study design evaluates scientific research published by mathematical or statistical methods (Kırpık & Dönbak, 2021). Performance analysis, network analysis, and science map analysis can be performed within the scope of bibliometric studies, which are also accepted as a literature compilation method (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). Within the scope of this research, research was carried out with the following problem statement: What bibliometric data can be presented to researchers on plyometric training?

### *Research Sample*

While the universe of this research was composed of studies on plyometric training, the research sample consisted of research articles indexed in the Web of Science database, included in the category of sports sciences, and included in any of the SSCI, ESCI, or SCI-Expanded indexes. In this context, a total of 358 studies were included. The table containing descriptive information about the studies is given below.

**Table 1.** Basic information about plyometric training exercises

<b>Primary Information About the Studies</b>	<b>Results</b>
Time Range	1986-2022
References (Journals, Books, etc.)	62
Documents	358
Average citations per document	33.57
The annual average number of citations per document	3.087
References	6801
<b>Document Types</b>	
Articles	342
Articles; early access	9
Articles; conference paper	3
Articles; book section	4
<b>Authors</b>	
Authors	1170
Author Views	1579
Authors of single-author documents	15
Authors of multi-author documents	1155
<b>Collaboration of the Authors</b>	
Single-author studies	18
Number of studies per author	0.306
Author per research	3.27
Co-authors per research	4.41
Collaboration Index	3.40

### *Data Collection Tools*

This study used the Web of Science database as a data collection tool. The database was searched using the keywords plyometric training and plyometric exercises. Studies indexed in the relevant database from 1986 to 2022 were included according to the inclusion criteria.

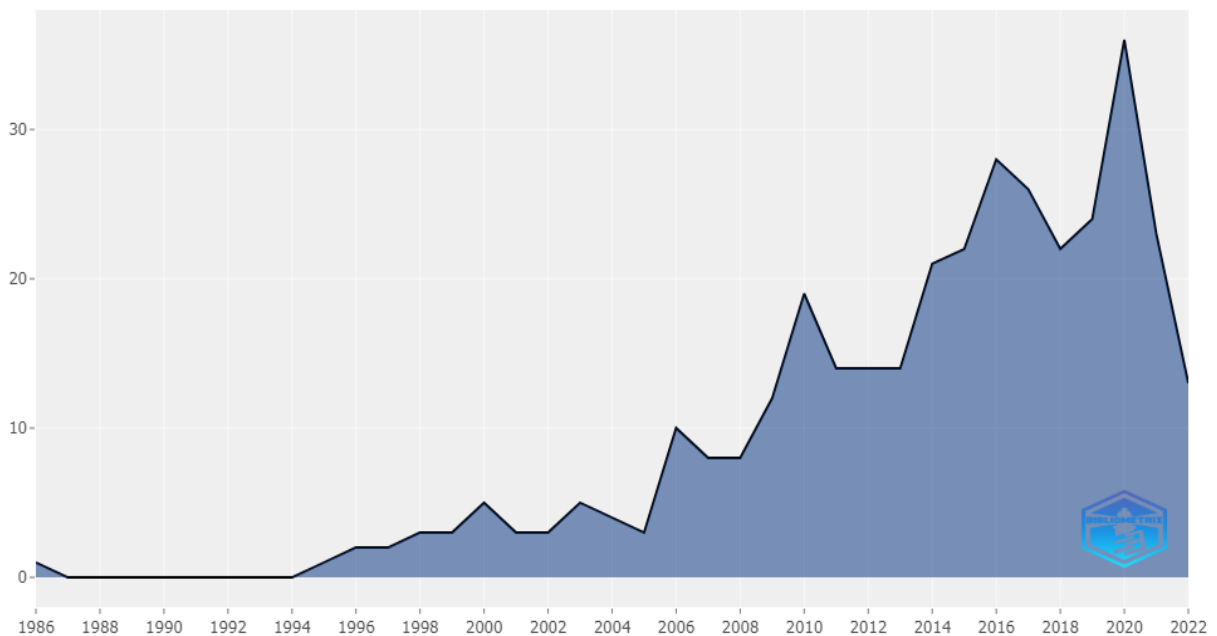
### *Analysis of Data*

In this study, the R (Ver. 4.1.0) programming language was preferred for statistical analysis. The bibliometrics package was designed for bibliometric analysis in the R programming language (Aria & Cuccurullo, 2017). With the Bibliometrix package, analyses of various variables such as publication, researcher, keyword, scientific productivity, and journal were applied to create a literature map for the subject area.

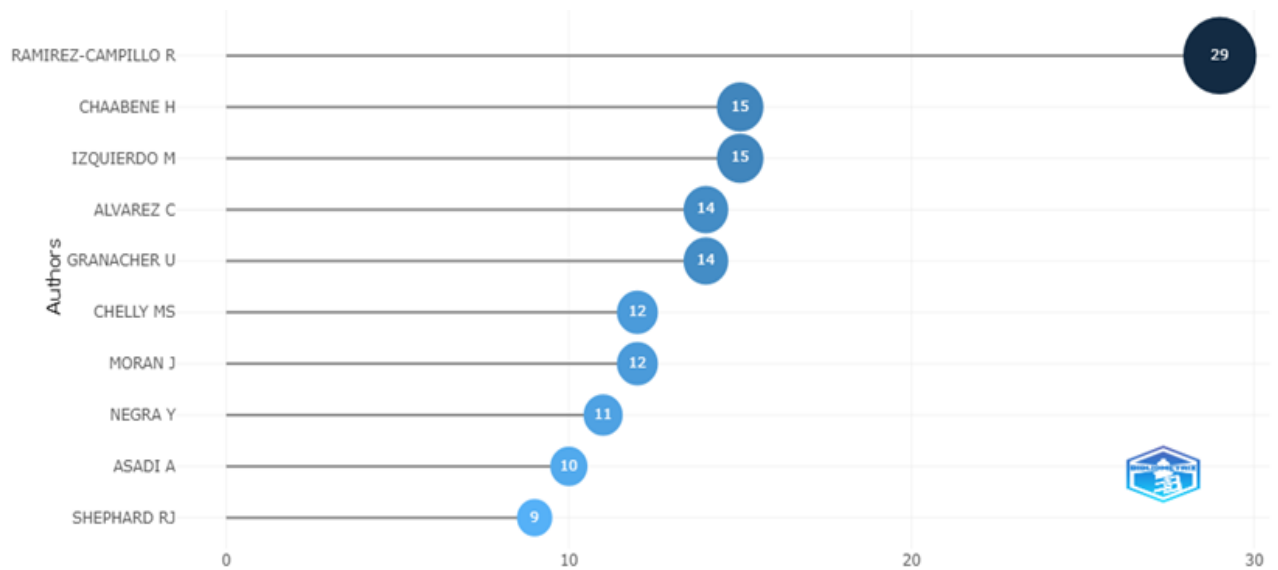
### **Results**

In this study, the scientific productivity rates of researchers on the subject were first examined within the scope of bibliometric analysis. It was determined that the first research indexed on the topic in the Web of Science database dates to 1986 (Figure 1). Researchers have carried out a limited number of studies from this date until 1994, and since 1994, research on plyometric training has continued with certain breaks every year. Plyometric training, designed as strength training in the early 1960s, continues to increase yearly, with a growth rate of 9.59% today. A template showing the scientific productivity rate from 1986 to 2022 is given in Figure 1.

One of the bibliometric data, which is thought to be useful for researchers who want to research the subject, is the determination of the researchers who have done the most research on plyometric training. In this context, ten studies indexed



**Figure 1.** Annual scientific production rates of plyometric training research



**Figure 2.** List of researchers who have done the most research on plyometric training in the Web of Science database were included in the study. As a result of the analysis, it was concluded that the researcher who did the most research on plyometric training was Rodrigo Ramirez Campillo. Information on the relevant data is given in Figure 2.

**Table 2.** Characteristics of the ten most influential researchers about plyometric training

Authors	H Index	G Index	M Index	Total Citation	Number of Publication	Time to start
Ramirez-Campillo R	16	27	1,6	888	27	2013
Izquierdo M	14	14	0,824	917	14	2006
Alvarez C	12	14	1,333	556	14	2014
Chaabene H	10	14	1,667	241	14	2017
Chelly Ms	10	12	0,769	397	12	2010
Granacher U	10	13	1,111	280	13	2014
Negra Y	9	11	1,286	196	11	2016
Moran J	8	11	1,333	140	11	2017
Nakamura Fy	8	8	1,143	194	8	2016
Shephard Rj	8	9	0,615	267	9	2010

H index values of the researchers were evaluated to determine the researchers working on plyometric training and having the highest author effect level. In this context, citation numbers to the studies and index values of the researchers were accepted as a quality standard. In addition, ten researchers who carried out the most qualified studies on plyometric training are given in Table 2. As a result of the analysis, it was concluded that Rodrigo Ramirez Campillo carried out the most qualified studies on the subject.

Keyword selection in research is a factor that affects the visibility of the published article. The compatibility and similarity of the keywords with the article content can enable the articles published in databases controlled by automation systems to be displayed in the foreground. Within the scope of this research, the most preferred keywords about plyometric training are included. In the analysis, the following criteria were used to identify the most frequently used words; (1) To be used in at least 20 research per year, (2) to be used as a keyword an average of 20 times per year. The keywords used in line with the determined criteria are given in Figure 3. The size of the fonts indicates the frequency of the keywords used. As a result of the analysis, it was determined that the most preferred keywords in plyometric training studies were words such as performance, strength, power, program, and exercise.



**Figure 3.** The most frequently used keywords in plyometric training research

Numerous studies have been conducted on plyometric training since the 1960s. This may cause a problem in accessing studies that guide the subject. For this reason, the top 10 most cited studies in the Web of Science database in the historical process are included in the research. As a result of the analysis by Spurs et al. (2003), it was determined that the plyometric training study received the most citations. The study was undertaken to examine the effect of plyometric training on running performance and explosive movement actions. Spurs et al. (2003) investigated the effects of six weeks of plyometric training on participants' CMJ, maximum



isometric power, strength development speed, five-step jump, lactate threshold, three km test time, and Vo2max performances. At the end of six weeks, improvement was observed in many performance parameters, especially the Vo2max level of the participants. Detailed information about the most cited studies on the subject and their DOI numbers are given in Table 3.

**Table 3.** List of authors directly cited in the historical process

Authors	Title	DOI	Year	Number of Local Citations	Global Citations
FATOUROS I. G.	Evaluation of plyometric exercise training, weight training, and their combination on vertical jumping performance and leg strength	-	2000	46	191
SPURRS R. W.	The effect of plyometric training on distance running performance	10.1007/s00421-002-0741-y	2003	42	292
HERRERO J. A.	Electromyostimulation and plyometric training effects on jumping and sprint time	10.1055/s-2005-865845	2006	31	108
MILLER M. G.	The effects of a 6-week plyometric training program on agility	-	2006	31	179
KOTZAMANIDIS, C,	Effect of plyometric training on running performance and vertical jumping in prepubertal boys	10.1519/00124278-200605000-00034	2006	43	130
MARKOVIC G.	Effects of sprint and plyometric training on muscle function and athletic performance	10.1519/00124278-200705000-00044	2007	42	169
MEYLAN C.	Effects of in-season plyometric training within soccer practice on explosive actions of young players	10.1519/JSC.0b013e3181b1f330	2009	53	178
THOMAS K.	The effect of two plyometric training techniques on muscular power and agility in youth soccer players	10.1519/JSC.0b013e318183a01a	2009	45	196
RAMIREZ-CAMPILLO R.	Effects of plyometric training volume and training surface on explosive strength	10.1519/JSC.0b013e318280c9e9	2013	31	86
RAMIREZ-CAMPILLO R.	Effects of in-season low-volume high-intensity plyometric training on explosive actions and endurance of young soccer players	10.1519/JSC.000000000000284	2014	34	96

After the research is carried out, the publication process can take months. For this reason, choosing journals with a high acceptance tendency on publication may provide an advantage to researchers in writing to publish. For this reason, the journals that mainly included the issue of plyometric training were analyzed. The top 10 journals scanned in the Web of Science database

and showing the most acceptance tendency on the subject are given in Table 4. As a result of the analysis, it was determined that the Journal of Strength and Conditioning Research published the most significant number of studies on plyometric training.

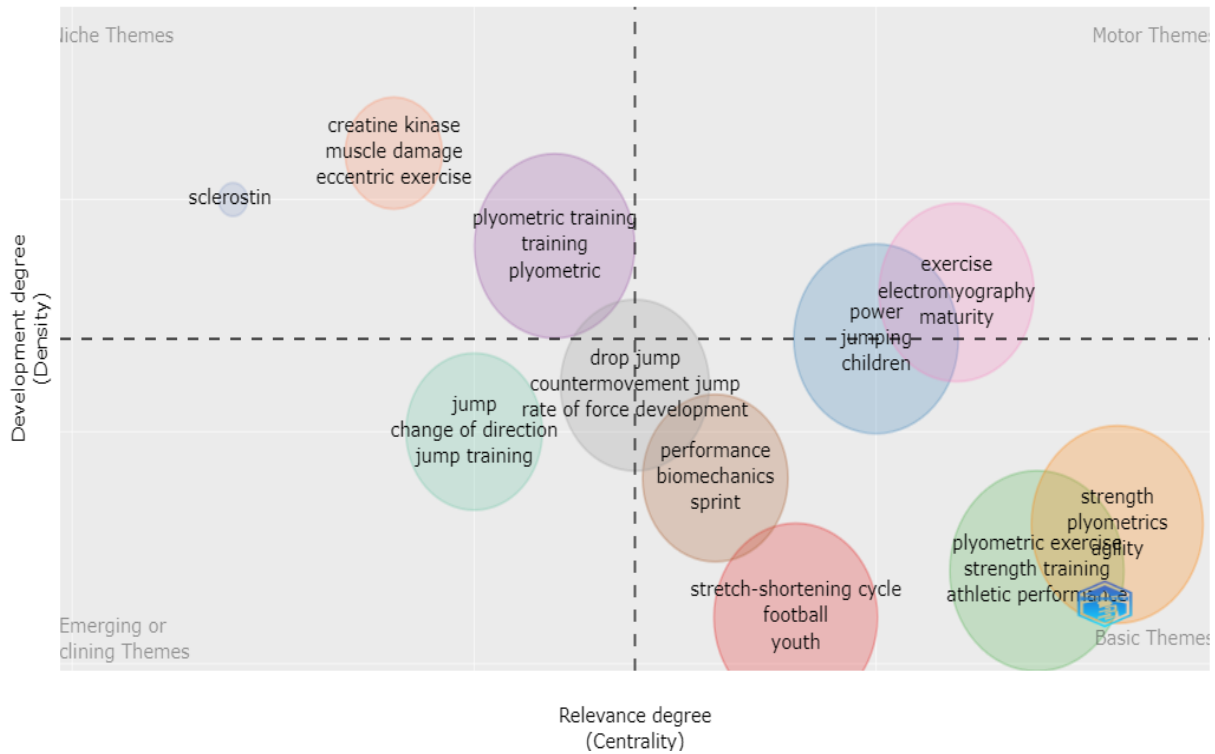
**Table 4.** Journals with the most publications on plyometric training

<b>Journals</b>	<b>Article acceptance count</b>
Journal of Strength and Conditioning Research	117
Journal of Sports Medicine and Physical Fitness	23
International Journal of Sports Medicine	12
Journal of Human Kinetics	10
Journal of Sports Science and Medicine	10
Journal of Sports Sciences	10
International Journal of Applied Exercise Physiology	9
Pediatric Exercise Science	9
European Journal of Sport Science	8
International Journal of Sports Physiology and Performance	8

Identifying the weak and vital aspects of a subject area may enable more qualified studies to be carried out and these studies to be accepted at higher rates in journals with high impact factors. Therefore, the thematic map related to plyometric training was created in the research. The deficiencies and strengths of the subject were determined within the scope of 358 studies included. The thematic map is the coordinate that consists of a plane and an axis as centrality and density. It enables the determination of the strengths and weaknesses of a subject area (Seyhan & Özzeybek Taş, 2021). Each part of the thematic map, which consists of four different positions, provides information about the subject area. The upper right of the thematic map covers essential research topics, is well-developed, and is linked to other sections.

On the other hand, the upper left part of the thematic map represents specialized research topics related to plyometric training (Cobo, López-Herrera, Herrera-Viedma & Herrera, 2021; Nasir et al., 2020). However, the lower left part of the thematic map includes research topics that are

not well-developed and do not directly represent the subject area. The lower right part includes research topics that are not well-developed but are directly related to plyometric training (Cobo et al., 2021; Nasir et al., 2020). The thematic map created because of the analysis is given in Figure 4. In this context, it can be said that the effect of plyometric training on exercise selection, power and jump issues is frequently studied.



**Figure 4.** Plyometric training with thematic map

On the other hand, the effect of plyometric training on physiological parameters has been frequently investigated, but the impact of research topics in different sections has not been discussed. Furthermore, although the effect of plyometric training on change of direction performance has been discussed, there has not been enough research on this subject. Finally, researchers have not sufficiently investigated the impact of plyometric training on children, youth, football players, and sprint and agility performance.

## Conclusion

Although the effect of plyometric training on performance has been researched for more than 50 years, it continues to be studied with different topics. Most of the studies on the subject are carried out by multiple authors. In the field of sports sciences, the effect of plyometric training on motor abilities is focused. However, there is a need for a clearer understanding of the effect of populations on sports branches. Research on this subject tends to be primarily accepted in

American journals. The fact that plyometric training is being studied with more and more research every year shows that it is a subject area that keeps up-to-date, and more research is needed for the related subject area.

## **Suggestions**

As a result of the bibliometric analyzes, researchers who want to research plyometric training may consider the following suggestions:

- (1) The works of Rodrigo Ramirez Campillo can be followed to have an idea about the subject area.
- (2) Journal of Strength and Conditioning Research may be preferred for article publication.
- (3) In terms of bio-motor properties, the effect of plyometric training on agility, change of direction, and sprint performance can be examined. Children and young people can be preferred in terms of population, and the effect on football players can be discussed.
- (4) Keywords such as performance, strength, and exercises can be preferred in plyometric training research.

## **Author Contribution**

Uysal, H.Ş. (Research concept and study design), Uysal, S.N. (Literature review), Uysal, S.N. (Data collection), Uysal, H.Ş. (Data analysis and interpretation of statistics), Uysal, H.Ş. ve Uysal, S.N. (Article writing), Uysal, H.Ş. ve Uysal, S.N. (Reviewing/editing the manuscript)

## **Conflicts of Interest**

There is no conflict of interest between the authors of this study.

## **Ethical Statement**

Subjects such as humans or animals were not used in this study. Therefore, an ethics committee is not required for the study.

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