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# The Relationship between Thoracic Kyphosis Angle and Respiratory Function Parameters in Young Adults

## Genç Yetişkinlerde Torakal Kifoz Açısı ile Solunum Fonksiyon Parametreleri Arasındaki İlişki

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## Abstract

**Aim**: Postural disorders represent prevalent health concerns. This study aims to examine the relationship between thoracic kyphosis angle and respiratory function parameters in young adults.

**Material and Method**: The research was conducted with 200 students enrolled in the Faculty of Health Sciences at a university between October 2024 and March 2025. The thoracic kyphosis angle was measured using the Flexicurve method, while respiratory functions were assessed via spirometry.

**Results**: The mean thoracic kyphosis angle of the participants was found to be 21.81±5.11°, and hypokyphosis was observed in 40% of participants. A significant relationship was found between body mass index (BMI) and thoracic kyphosis angle, with lower kyphosis angles observed in underweight students ($p<0.05$). However, variables such as gender, presence of chronic diseases, duration of mobile phone use, knowledge about spinal health, and sitting posture were not found to have a significant effect on the kyphosis angle ($p>0.05$). No statistically significant relationship was observed between thoracic kyphosis angle and respiratory function parameters ($p>0.05$). Additionally, no difference was found in respiratory functions between students with hypokyphosis and those with normal kyphotic curvature ($p>0.05$).

**Conclusion**: These findings suggest that variations in thoracic kyphosis angle do not significantly affect respiratory capacity in young and healthy individuals. The study highlights the importance of regular posture assessments, ergonomics education, and exercise programs.

**Keywords**: Thoracic kyphosis, respiratory parameters, young adults

## Öz

**Amaç**: Postür bozuklukları genç popülasyonda sık olarak karşılaşılan sağlık sorunlarıdır. Bu çalışmanın amacı, genç yetişkinlerde torakal kifoz açısı ile solunum fonksiyon parametreleri arasındaki ilişkiyi incelemektir.

**Gereç ve Yöntem**: Araştırma, Ekim 2024 – Mart 2025 tarihleri arasında bir üniversitenin Sağlık Bilimleri Fakültesi'nde öğrenim gören 200 öğrenci ile gerçekleştirilmiştir. Torakal kifoz açısı Flexicurve yöntemiyle, solunum fonksiyonları ise spirometre ile ölçülmüştür.

**Bulgular**: Katılımcıların ortalama torakal kifoz açısı 21,81±5,11° olarak bulunmuş ve %40'ında hipokifoz tespit edilmiştir. Vücut kitle indeksi (VKİ) ile torakal kifoz açısı arasında anlamlı bir ilişki saptanmış; zayıf öğrencilerin kifoz açısı daha düşük bulunmuştur ($p<0,05$). Ancak, cinsiyet, kronik hastalık varlığı, telefon kullanım süresi, omurga sağlığı bilgisi ve oturma postürü gibi değişkenlerin kifoz açısı üzerinde etkisi bulunmamıştır ($p>0,05$). Torakal kifoz açısı ile solunum fonksiyon parametreleri arasında istatistiksel olarak anlamlı bir ilişki gözlenmemiştir ($p>0,05$). Hipokifoz ve normal kifoz eğriliğine sahip öğrencilerin solunum fonksiyonları arasında da fark saptanmamıştır ($p>0,05$).

**Sonuç**: Bu bulgular, genç ve sağlıklı bireylerde torakal kifoz açısındaki farklılıkların solunum kapasitesini belirgin şekilde etkilemediğini göstermektedir. Çalışma, düzenli postür değerlendirmeleri, ergonomi eğitimi ve egzersiz programlarının önemini vurgulamaktadır. Gelecek çalışmaların daha geniş örneklemlerle ve ek parametrelerle yapılması önerilmektedir.

**Anahtar Kelimeler**: Torakal kifoz, solunum parametreleri, genç yetişkinler

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## INTRODUCTION

Thoracic kyphosis is the natural convex curvature of the spine in the sagittal plane of the human body. This curvature ensures balanced load distribution along the spine and plays a critical role in trunk stabilization.[1] The thoracic kyphosis angle is measured by drawing lines at the superior border of the fifth thoracic vertebra and the inferior border of the twelfth thoracic vertebra.[2] In the general adult population, a thoracic kyphosis angle between 20° and 40° is considered normal.[3] Measurements indicating an angle below 20° are defined as hypokyphosis, while angles above 40° are referred to as hyperkyphosis.[4] Alterations in the thoracic kyphosis angle can affect the spinal load distribution. This condition causes spinal curvature, which in turn affects the muscles and connective tissues in the thoracic region. Thoracic kyphosis causes impairments in daily living activities, quality of life, respiratory function, and lung capacity.[5-7]

Postural disorders are common health issues among young populations. University students frequently lead sedentary lifestyles, characterized by low levels of physical activity and extended periods of desk-based work.[8] Additionally, prolonged use of computers and mobile devices, driven by modern technological demands, contributes to postural imbalances. Alterations in thoracic kyphosis, whether increased or decreased, can result in various physiological consequences.[9] Changes in thoracic kyphosis may restrict thoracic cage mobility and weaken respiratory muscles. As a result, reductions in inspiratory and vital capacity may occur, accompanied by lower performance in respiratory function tests.[10]

Radiological assessments are considered the gold standard for evaluating the thoracic kyphosis angle. These evaluations provide detailed, accurate, and highly reliable measurements of spinal curvature.[11] However, in clinical and field research settings, the use of radiological techniques is limited due to cost, limited accessibility, and concerns over repeated exposure to radiation.[12] Therefore, non-invasive, low-cost, and portable alternative methods are preferred. The Flexicurve method is widely used for measuring thoracic kyphosis due to its ease of application, portability, low cost, and repeatability.[13] On the other hand, spirometry is a standardized tool used to assess respiratory functions associated with thoracic kyphosis.[14] Spirometry is a non-invasive method for measuring respiratory parameters and lung volumes. Parameters such as Forced Expiratory Volume (FEV), Forced Expiratory Volume in one second ($FEV_1$), Forced Vital Capacity (FVC), and Peak Expiratory Flow (PEF) can be accurately and reliably assessed using this method.[15]

A review of the current literature indicates that most studies investigating the relationship between thoracic kyphosis and respiratory function have predominantly focused on elderly or clinical populations.[16,17] However, there is a noticeable lack of research exploring this relationship specifically within younger populations, particularly university students. The aim of this study is to contribute to the literature in this field and to raise awareness and promote preventive approaches regarding spinal and respiratory health among young adults.

## MATERIAL AND METHOD

Ethical approval was obtained from the Sakarya University of Applied Sciences Ethics Committee (Date: 28.07.2022, Decision no: 20). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This descriptive and correlational study was conducted to determine the thoracic kyphosis angles of young adults and to examine the relationship between thoracic kyphosis angle, various variables, and respiratory function capacity. Within this scope, the study sought to answer the following research questions:

- What is the thoracic kyphosis angle among young adults?
- Which variables are associated with the thoracic kyphosis angle in young adults?
- Is there a relationship between the thoracic kyphosis angle and respiratory function parameters in young adults?

The population of the study consisted of students enrolled in the Faculty of Health Sciences at a university between October 2024 and March 2025. Convenience sampling was used; instead, the sample comprised students who met the inclusion criteria. Accordingly, the study was conducted with 200 students who were currently enrolled, had no prior medical diagnosis of spinal conditions such as kyphosis, lordosis, or scoliosis, had not undergone spinal surgery, had no medical diagnosis or surgical history affecting respiratory function (e.g., bronchiectasis, asthma), agreed to participate voluntarily, and completed the data collection forms in full.

Data was collected using a single structured data collection form consisting of three sections: Section 1 included 11 items on participants' personal characteristics (age, gender, height, weight), educational background (department, year), and general health status (smoking habits, presence of chronic illness, regular medication use, and perceived general health). Section 2 included four items on factors potentially associated with spinal health, such as daily phone usage duration, purpose of mobile phone use, perceived adequacy of knowledge about spinal health, and attention to spinal posture in daily life. Section 3 included the participants' thoracic kyphosis angles and respiratory function parameters (FEV, $FEV_1$, FVC, and PEF).

Thoracic kyphosis angle measurements were performed by a researcher specialized in physiotherapy and rehabilitation. The measurement employed the "Flexicurve" method, which is a flexible ruler capable of conforming to the shape of the human body and retaining that shape—an approach validated in the literature.[13] For hygiene and accuracy purposes, the Flexicurve ruler was replaced with a new one after every 10 measurements. To perform the measurement, the spinous processes of the 7th cervical (C7) and 12th thoracic (T12) vertebrae were palpated and marked on each participant who provided informed consent. The Flexicurve ruler was placed straightly between the two marked points and gently pressed to conform to the contour of the thoracic spine. The molded ruler was then carefully transferred onto a greaseboard without altering its shape, and the curve was traced with a pencil. The apex and the length of the curve were then measured using a standard ruler, and the thoracic kyphosis angle was calculated using a specific mathematical formula (**Figure 1**).[18] According to the literature, thoracic kyphosis angles between 20° and 40° are considered normal. An angle less than 20° is classified as hypokyphosis, and an angle greater than 40° is classified as hyperkyphosis.[19] In this study, thoracic curvature was evaluated according to these cutoff values.

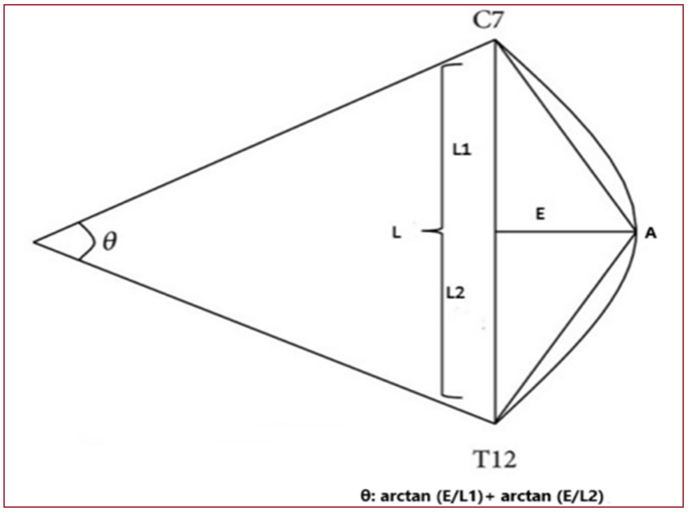


**Figure 1.** Mathematical Formula for Calculating the Kyphosis Angle
C7: 7th cervical vertebra; T12: 12th thoracic vertebra; Ɵ: thoracic kyphosis angle; A: apex of the thoracic curvature; E: width; L: length.

For the assessment of respiratory function, the MIR Spirolab 3 spirometer was used. The tests were administered by a researcher specialized in physiotherapy and rehabilitation. During testing, participants were seated upright in a comfortable chair to ensure correct posture, and a nose clip was used to obtain more accurate results. The respiratory function parameters measured included FEV, $FEV_1$, FVC, and PEF, and the values were recorded.[15]

Prior to data collection, participants were informed about the aim and significance of the study, and both verbal and written informed consent were obtained. Outside of lecture hours, students who volunteered were asked to complete the data collection forms. Following this, thoracic kyphosis angle measurements and spirometry tests were conducted by the researchers. In addition, participants' height and weight were measured, and body mass index (BMI) was calculated using the standard formula ($kg/m^2$) to categorize body composition. The entire process, including form completion and physical measurements, took approximately 25–30 minutes per participant.

Statistical analyses were performed using the SPSS version 29.00 software package (IBM Corp., USA). Descriptive statistical methods (percentages, means, standard deviations) were used to evaluate the distribution of students' personal characteristics and spinal health-related features, as well as thoracic kyphosis angles and respiratory function parameters. To compare thoracic kyphosis angle means across different student characteristics, Student's t-test, One-Way ANOVA, and Kruskal–Wallis test were used as appropriate. To examine the relationship between thoracic kyphosis angles and respiratory function parameters, Pearson correlation analysis was performed. A significance level of $p < 0.05$ was considered statistically significant in all analyses.

## RESULTS

The mean age of the students was 20.33±2.10 years, and 69.5% of them were female. Of the participants, 50.5% were studying in the Department of Physiotherapy and Rehabilitation, while 49.5% were enrolled in the Department of Nursing. The majority (49.5%) were first-year students, and 65.5% were residing in student dormitories. It was found that 14% of the students were current smokers, 19% had at least one chronic illness, 18.5% were on regular medication, and 72% rated their general health as good. Regarding daily phone usage, 65.5% of students reported using their phones for 4 to 7 hours per day, with 61.0% indicating that social media was their primary reason for phone use. In terms of spinal health awareness, only 13% of the students reported having sufficient knowledge, while 69.5% stated they had partial knowledge (**Table 1**).

**Table 1. Demographic and Health Characteristics of Participants (N=200)**

| Variables | n | % |
|---|---|---|
| Age (year) (Mean±SS) | 20.33±2.10 | |
| Gender | | |
| Female | 139 | 69.5 |
| Male | 61 | 30.5 |
| Body structure according to BMI* | | |
| Underweight | 33 | 16.5 |
| Normal weight | 115 | 57.5 |
| Overweight or obese | 52 | 26.0 |
| Smoking | | |
| Smoker | 28 | 14.0 |
| Never smoked | 166 | 83.0 |
| Quit smoking | 6 | 3.0 |
| Chronic Disease | | |
| Has chronic disease | 38 | 19.0 |
| Has no chronic disease | 162 | 81.0 |
| General health assessment | | |
| Good | 144 | 72.0 |
| Average | 53 | 26.5 |
| Poor | 3 | 1.5 |
| Daily phone usage duration | | |
| 1-3 hours | 33 | 16.5 |
| 4-7 hours | 131 | 65.5 |
| 8-11 hours | 33 | 16.5 |
| 12 hours and more | 3 | 1.5 |
| The most frequent purpose of mobil phone use | | |
| Social media | 122 | 61.0 |
| Conversation | 31 | 15.5 |
| Video, müsic | 25 | 12.5 |
| Study lesson/ Homework | 13 | 6.5 |
| Online game | 9 | 4.5 |
| Perception of having sufficient knowledge about spinal health | | |
| Yes | 26 | 13.0 |
| Partly | 139 | 69.5 |
| No | 35 | 17.5 |
| Self-reported attention to spinal health during sitting in daily activities | | |
| Yes | 31 | 15.5 |
| Partly | 125 | 62.5 |
| No | 44 | 22.0 |

*Body Mass Index

It was determined that the mean thoracic kyphosis angle measured among the young adults was 21.81±5.11°, and 40% of them had hypokyphotic curvature (**Table 2**).

**Table 2. Thoracic Kyphosis Angle and Respiratory Function Parameters of Participants**

| Variables | Mean±SD† | n | % |
|---|---|---|---|
| Thoracic kyphosis angle | 21.81±5.11 | | |
| Thoracic kyphotic curvature | | | |
| Hypokyphosis | | 80 | 40.00 |
| Normal | | 120 | 60.00 |
| Hyperkyphosis | | 0 | 0.0 |
| Respiratory Functions | | | |
| FEV* | 3.72±0.84 | | |
| FEV1** | 3.18±0.61 | | |
| FEV1/FVC*** | 87.39±6.69 | | |
| PEF**** | 5.95±1.66 | | |

*Forced Expiratory Volume, **Forced Expiratory Volume in one second, ***Forced Vital Capacity, ****Peak Expiratory Flow (PEF), †Standard deviation

When the students' thoracic kyphosis angle means were compared based on certain personal and spinal health-related characteristics, a significant difference was found in relation to body composition according to BMI; students who were underweight had significantly lower thoracic kyphosis angles ($p<0.05$). However, no significant differences were observed in thoracic kyphosis angle means with respect to variables such as gender, presence of chronic disease, daily phone usage time, perception of having sufficient knowledge about spinal health, and attention to spinal health while sitting in daily life ($p>0.05$) (**Table 3**).

**Table 3. Comparison of some characteristics of the participants with the mean thoracic kyphosis angle**

| Variables | Mean±SD** | Test | p |
|---|---|---|---|
| Gender | | | |
| Female | 21.70±5.10 | t=-0.467 | 0.641 |
| Male | 22.07±5.15 | | |
| Body structure according to BMI* | | | |
| Underweight | 19.20±5.53 | | |
| Normal | 22.25±4.83 | F=5.441 | 0.005† |
| Overweight | 22.50±5.00 | | |
| Chronic Disease | | | |
| Has chronic disease | 22.00±5.28 | F=0.252 | 0.801 |
| Has nı chronic disease | 21.77±5.08 | | |
| Daily phone usage duration | | | |
| 1-3 hours | 21.25±4.63 | | |
| 4-7 hous | 22.06±5.36 | F=0.460 | 0.632 |
| 8 hours and more | 21.42±4.59 | | |
| Perception of having sufficient knowledge about spinal health | | | |
| Yes | 21.79±5.43 | | |
| Partly | 22.02±5.19 | KW=1.202 | 0.548 |
| No | 20.98±4.54 | | |
| Self-reported attention to spinal health during sitting in daily activities | | | |
| Yes | 22.16±6.26 | | |
| Partly | 21.49±4.99 | F=0.698 | 0.499 |
| No | 22.48±4.55 | | |

*Body Mass Index; ** Standard deviation; † p<0,05, t:Student's t-test; F:One-Way ANOVA; KW; Kruskal–Wallis test

No statistically significant correlation was found between the students' mean thoracic kyphosis angle and respiratory function parameters ($p>0.05$). Additionally, no statistically significant differences were observed in respiratory function parameters between students with hypokyphosis and those with normal thoracic curvature ($p>0.05$) (**Table 4**).

**Table 4. Relationship Between Thoracic Kyphosis Angle, Thoracic Kyphosis Curvature Levels, and Respiratory Function Parameters**

| Respiratory Functions | Thoracic kyphosis angle | | Thoracic kyphotic curvature | | | |
|---|---|---|---|---|---|---|
| | r | p | Hypokyphosis | Normal | t | p |
| FEV* | -0.016 | 0.821 | 3.69±0.83 | 3.74±0.85 | -0.383 | 0.702 |
| FEV1** | 0.078 | 0.273 | 3.14±0.56 | 3.21±0.64 | -0.870 | 0.386 |
| FEV1/FVC*** | 0.055 | 0.438 | 87.61±6.98 | 87.24±6.52 | 0.381 | 0.704 |
| PEF**** | -0.037 | 0.599 | 5.98±1.69 | 5.93±1.64 | 0.221 | 0.825 |

*Forced Expiratory Volume, **Forced Expiratory Volume in one second, ***Forced Vital Capacity, ****Peak Expiratory Flow (PEF), t:Student's t-test

## DISCUSSION

In this study, the relationship between the thoracic kyphosis angle and respiratory function parameters in young adults was examined. The findings revealed that 40% of the sample exhibited below-average spinal curvature (hypokyphosis); however, no statistically significant relationship was found between the thoracic kyphosis angle and respiratory function test outcomes. Similarly, no significant differences in respiratory parameters were observed between individuals with hypokyphosis and those with normal thoracic kyphosis curvature. The study also showed that students with lower BMI had significantly lower thoracic kyphosis angles.

Increased thoracic kyphosis, especially in elderly or hyperkyphotic individuals, may restrict thoracic cage mechanics, thereby impairing ventilation capacity.[20,21] However, this effect appears to be more limited in young and healthy individuals. In our study, none of the participants demonstrated hyperkyphotic deformity, with the mean thoracic kyphosis angle measured at 21.81°, falling within the normal range. This suggests that postural alterations may need to surpass a certain threshold to have a measurable impact on respiratory parameters.[4] Aweto and Adodo (2021) reported that postural abnormalities associated with increased thoracic kyphosis in individuals with chronic obstructive pulmonary disease led to reductions in respiratory capacity.[22] These findings were supported by the study conducted by Bakırhan et al. (2021), which demonstrated a negative correlation between increased kyphosis angle and respiratory function parameters, suggesting that excessive kyphotic curvature may restrict lung expansion and capacity.[16] Similarly, Özler and Bakırhan (2020) identified a relationship between thoracic kyphosis angle and maximal voluntary ventilation, supporting the idea that postural deformities may impair effective respiration.[23] In contrast, our study found no statistically significant correlation between respiratory parameters and thoracic kyphosis angles. The lack of statistical significance may be attributed to the relatively young average age of the participant group and the fact that most kyphosis angles remained below clinical thresholds.

Thoracic kyphosis not only presents physical discomfort but can also have measurable impacts on quality of life and functional capacity. A systematic study by Yang[24] emphasized that in adolescents with thoracic kyphosis, abnormal thoracic spine flexion can hinder the development of internal organs and affect normal respiratory function. The same study indicated that physical activity levels are vital for maintaining lung health, and therefore, this may be effective in preventing thoracic kyphosis.[24]

The relationship between BMI and thoracic kyphosis is a notable area of inquiry within orthopedics and physical therapy. With rising global obesity rates, understanding the impact of high BMI on spinal alignment—especially thoracic curvature—is essential for the effective management of musculoskeletal disorders and associated health problems. Literature reviews suggest that there are various significant associations between BMI and thoracic kyphosis. For example, Popajewski et al. investigated this relationship during pregnancy and found that increasing BMI across trimesters led to significant changes in thoracic curvature.[25] These findings imply that excess weight and obesity may influence spinal curvature due to increased biomechanical load on the spine and surrounding musculature. Shehada et al. analyzed postural abnormalities among male university students and reported that thoracic kyphosis was associated with physical activity levels and BMI.[26] These findings emphasize the prevalence of thoracic kyphosis among sedentary and high-BMI individuals and underscore the importance of comprehensive musculoskeletal assessments for those at risk. In our study, a positive relationship was found between BMI and thoracic kyphosis angle, indicating that individuals with higher BMI tended to have increased thoracic kyphosis.

### Contributions and Limitations of the Study

Academically, this study provides novel data on the relationship between hypokyphosis, BMI, and respiratory parameters in a young population. Given that the effects of BMI and respiratory parameters on spinal curvature remain a topic of debate, comparative studies in different populations are warranted. Moreover, the Flexicurve method used in this study stands out as a low-cost, portable, and radiation-free tool with high applicability in field research and large-scale screenings. Especially in adolescents, early identification of hyperkyphosis and respiratory deformities through spinal and pulmonary measurements could inform physical therapy, postural correction strategies, and respiratory exercise programs—potentially reducing long-term morbidity risks.

Despite its contributions, this study has several limitations. First, variables that may affect respiratory function—such as physical activity levels, chest circumference, and respiratory muscle strength—were not evaluated. Additionally, the study was limited to students from a single university, and the sample consisted of young and healthy individuals, limiting the generalizability of the findings to broader age groups. Future studies should address these limitations through more comprehensive assessment protocols and diverse populations.

## CONCLUSION

In this study, the relationship between thoracic kyphosis angle and respiratory function parameters in young adults was investigated. The mean thoracic kyphosis angle was found to be 21.81°, and hypokyphotic curvature was identified in 40% of the participants. A significant relationship was observed between body mass index (BMI) and kyphosis angle, with lower kyphosis angles recorded in underweight students. In contrast, variables such as gender, presence of chronic illness, daily mobile phone usage, knowledge of spinal health, and attention to spinal posture during sitting were not found to have a significant effect on the kyphosis angle. No significant correlation was identified between thoracic kyphosis angle and respiratory function parameters. Additionally, respiratory parameters were similar between students with hypokyphosis and those with normal thoracic curvature. These findings suggest that variations in thoracic spinal alignment may not have a substantial impact on respiratory capacity in young and healthy individuals.

It is recommended that regular postural assessments be conducted among young adults, along with ergonomics education and the implementation of appropriate exercise programs. The Flexicurve method, a low-cost, portable, and reliable measurement tool, appears to be well-suited for use in field screenings. Future studies should include larger and more diverse samples encompassing various age and occupational groups, and adopt longitudinal designs to evaluate additional parameters such as muscle strength, flexibility, and physical activity levels. Such efforts would contribute to a better understanding of the relationship between thoracic kyphosis and functional outcomes. Longitudinal studies incorporating physical activity metrics are strongly recommended.

## ETHICAL DECLARATIONS

**Ethics Committee Approval**: Ethical approval was obtained from the Sakarya University of Applied Sciences Ethics Committee (Date: 28.07.2022, Decision no: 20).

**Informed Consent**: All patients signed the free and informed consent form.

**Referee Evaluation Process**: Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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**Author Contributions**: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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