# Operative Management versus Non-Operative Management of the Fifth Metatarsal Base Fracture: Systematic Review and Meta-Analysis

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## Abstract

**Background:** The fracture of base of fifth metatarsal is one of the most common fractures of the foot. It usually presents in sports and sedentary setting. The most common cause of this fracture is axial loading during inversion of the ankle joint. **Objective:** The aim of the present study was to outline the recent trends in the treatment of the base of fifth metatarsal bone fractures. **Methods:** A retrospective observational secondary study of published research and a meta-analysis were done after approval of the research ethics committee. The literature research was performed through PubMed (Medline), Cochrane Central Register of Controlled Studies (CENTRAL), and Scopus (ELSEVIER) and Egyptian Knowledge Bank databases using the following terms in every possible combination of keywords including foot, base of fifth metatarsal bone, stress fracture, mini-open, treatment outcome, and outcome. All data was analyzed using meta-analyst software using the Mantel-Haenszel method. **Results:** The most common complications of this fracture in non-union and delayed union. The best treatment of the fracture of fifth metatarsal base is operative by intramedullary screw or k-wires or tension band and the meta-analysis confirmed that operative management is better than non-operative management. There is significant reduction in VAS distribution and significant enhancement in AOFAS score in operative technique. So in this meta-analysis, the operative management is much better than non-operative management. **Conclusion:** The operative interventions in the treatment of base of fifth metatarsal bone fracture to reduce the rate of non-union, duration of union, duration of return to normal activities and duration of return to sports as compared to non-operative interventions.

**Keywords:** Fifth Metatarsal Base Fracture; Operative; Non-Operative Management

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## Introduction

One of the most common fractures of the lower extremities is fracture of base of fifth metatarsal bone **(1)**. 40-75% of the fractures of the foot is fracture of fifth metatarsal base **(2,3)**. It is a disruption of diaphyseal and metaphyseal junction of the proximal one third of the fifth metatarsal bone **(4)**. It usually presents in sports and sedentary settings **(5,6)**.

One of the most common causes of this fracture the biomechanical insufficiency of the fifth metatarsal in axial-loading during inversion of the ankle joint. Lower levels of bone mineral density that present in osteoporotic patients and post-menopausal women also contribute in this fracture **(7,8)**. This fracture can be managed by operative or non-operative. Operative by bicortical screw and bone graft, non-operative by immobilization cast **(9)**.

The decision making depends on the site of the fracture due to the difference of the vascularity between the zones of the fracture, so the fracture in zone 1 will be treated by conservative treatment due to good vascularity and the fracture in zone 2 will be treated by operative treatment **(10)**. There is a debate in the decision making in management of this fracture. A group agrees with operative management due to the success rate of union and the duration of union in this fracture, while the other group agrees with non-operative management due to complications and discomfort associated with the surgery **(5,11,12)**.

Therefore, this study aimed to review the literature in order to outline the recent trends in the treatment of the base of fifth metatarsal bone fractures.

## Patients and Methods

A retrospective observational secondary study of published research and a meta-analysis were done after approval of the research ethics committee. The duration of this study from 6 – 12 months.

### Search Strategy and Articles Selection:

The literature research was performed through PubMed (Medline), Cochrane Central Register of Controlled Studies (CENTRAL), and Scopus (ELSEVIER) and Egyptian Knowledge Bank databases using the following terms in every possible combination of keywords: foot, base of fifth metatarsal bone, stress fracture, mini-open, treatment outcome, and outcome.

### Inclusion criteria:

Original articles having the following criteria: written in the English language, published from 2005 to 2020, conducted on human subjects, articles include Patients with young and old patients with this fracture, articles that compare patients who underwent operative and non-operative management of this fracture, and articles with a mean follow up duration up to 40 months.

### Exclusion criteria:

Patients less than 18 years old. Studies wrote in languages other than English.

### Ethical Consideration:

An approval of the study was obtained from Helwan University Academic and Ethical Committee. Written informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

### Evaluation of articles:

1. Relevancy
2. Study design

### Data Extraction:

After exclusion of the duplicates, two investigators independently screened the titles and abstracts to enable exclusion of irrelevant studies and identify relevant articles for the full-text review. Then, two reviewers independently reviewed the full text of the remaining articles and evaluated them against the inclusion/exclusion criteria described above to select articles for inclusion in this review.

**Statistical Analysis:**

All data was analyzed using meta-analyst software using the Mantel-Haenszel method. Outcomes from a meta-analysis include a more precise estimate of the outcomes, than any individual study contributing to the pooled analysis. The examination of variability or heterogeneity in study results is also a critical outcome. The specification of the outcome and hypotheses that are tested is critical to the conduct of meta-analyses, as is a sensitive literature search. Data entered organized in Microsoft excel 2010 then export to comprehensive meta-analysis software version 3; pooled for analysis of multiple studies, and adjusted accumulative outcome, Z score method: to test difference in mean. Test for heterogeneity: Cochran's Q test and I2: Under null, it is approximately distributed as a chi-square with k-1 degrees of freedom for test heterogeneity and homogeneity of studies results and finding.

## RESULTS

The patient ages are applicable in 4 studies and the age ranges from 20 years old to 45 years old in both operated and non-operated groups. Age distributed was nearly matched between groups **(Table 1).**

The distribution of gender is applicable in three studies. Total number of males in operated group in all studies is 37 and total number of females in operated group in all studies is 18. While total number of males in non-operated in all studies 37 and total number of females 19 **(Table 2).**

The assessment outcome via American Orthopedic Foot and Ankle Scale was done in 4 studies and the AOFAS was significantly higher among operated except Park et al. (2017) and also at pooled analysis significantly higher among operated **(Table 3).**

American Orthopedic Foot and Ankle score was reported no significant difference in operated compared to non-operated group. Homogeneity among studies were founded. No bias account for differences in results among studies, which are not due to chance, after quantify all factors. We found no significant heterogeneity and we found agreement between studied **(Figure 1)**.

VAS was applicable in 3 studies and there was significantly lower in VAS among the operated group compared to non-operated group and also at pooled analysis significantly lower among operated group to non-operated group **(Table 4).**

**Table (1): Distribution of Age among different studies**

| | Operated | | Non operated | |
|---|---|---|---|---|
| **Study** | **N** | **AGE** | **N** | **AGE** |
| **Demel et al.(2019)** | 15 | 32.11±5.32 | 12 | 31.31±4.96 |
| **Mologne et al.(2005)** | 19 | 30.2±9.65 | 18 | 32.12±10.25 |
| **Wu et al.(2017)** | 21 | NA | 20 | NA |
| **Chuckpaiwong et al>(2008)** | 18 | NA | 17 | NA |
| **Park et al. (2017)** | 22 | 45.36±7.63 | 24 | 42.36±8.69 |
| **Sokkar et al.(2016)** | 12 | 28.7±8.8 | 12 | 29.5±7.9 |
| **Ekstrand et al.(2013)** | 28 | NA | 9 | NA |

**Table (2): Distribution of gender among different studies**

| **Study** | **Control** | | **Case** | |
|---|---|---|---|---|
| | **N** | **Male / female** | **N** | **Male / female** |
| **Demel et al.(2019)** | 15 | NA | 12 | NA |

| | | | | |
|---|---|---|---|---|
| **Mologne et al.(2005)** | 19 | NA | 18 | NA |
| **Wu et al.(2017)** | 21 | 13/8 | 20 | 13/7 |
| **Chuckpaiwong et al>(2008)** | 18 | NA | 17 | NA |
| **Park et al. (2017)** | 22 | 12/10 | 24 | 12/12 |
| **Sokkar et al.(2016)** | 12 | 12/0 | 12 | 12/0 |
| **Ekstrand et al.(2013)** | 28 | NA | 9 | NA |

**Table (3): AOFAS distribution between Operated and non-operated among all studies (6 months)**

| Study | Operated | | Non operated | | Z | P |
|---|---|---|---|---|---|---|
| | N | mean±SD | N | mean±SD | | |
| Demel et al.(2019) | 15 | 89.23 ± 5.2 | 12 | 83.41±4.96 | 2.95 | 0.008* |
| Mologne et al. (2005) | 19 | NA | 18 | NA | ---- | ---- |
| Wu et al.(2017) | 21 | 87.33 ±3.89 | 20 | 84.15 ± 3.75 | 2.13 | 0.031* |
| Chuckpaiwong et al.(2008) | 18 | NA | 17 | NA | ---- | ---- |
| Park et al. (2017) | 22 | 96.85±8.3 | 24 | 94.32±9.21 | 1.291 | 0.321 |
| Sokkar et al.(2016) | 12 | 98.3±3.9 | 12 | 93.9±6.61 | 2.232 | 0.018* |
| Ekstrand et al.(2013) | 28 | NA | 9 | NA | ---- | ---- |
| Pooled | | 94.63±5.21 | | 87.63±5.78 | 3.44 | 0.007* |

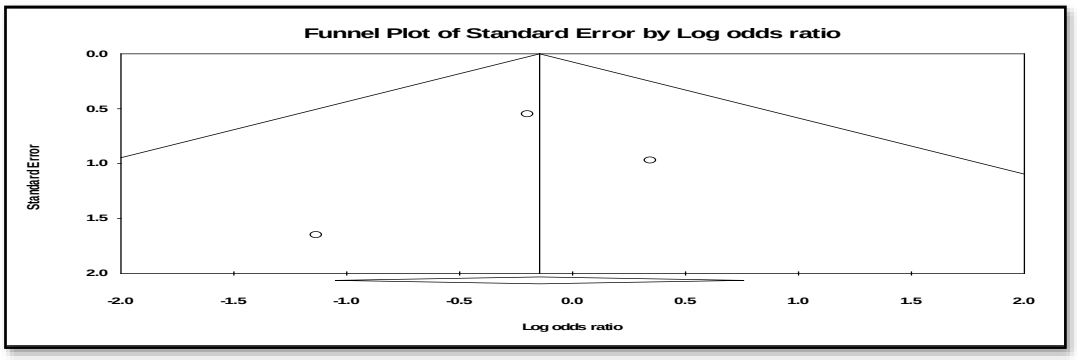



**Figure (1): Heterogeneity and asymmetry founded and illustrated in funnel plot.**

**Table (4): VAS distribution between Operated and non-operated among all studies (12 months)**

| Study | Operated | | Non operated | | Z | P |
|---|---|---|---|---|---|---|
| | N | mean±SD | N | mean±SD | | |
| Demel et al. (2019) | 15 | 0.44 ± 0.17 | 12 | 1.39 ± 0.352 | 3.741 | 0.002* |
| Mologne et al. (2005) | 19 | NA | 18 | NA | ---- | ---- |
| Wu et al.(2017) | 21 | 0.65 ± 0.22 | 20 | 1.85 ± 0.521 | 5.32 | 0.00** |
| Chuckpaiwong et al. (2008) | 18 | NA | 17 | NA | ---- | ---- |
| Park et al. (2017) | 22 | 0.0±0.0 | 24 | 0.30±0.15 | 1.741 | 0.085 |
| Sokkar et al. (2016) | 12 | 0.50±0.17 | 12 | 1.12±0.41 | 4.561 | 0.00** |
| Ekstrand et al. (2013) | 28 | NA | 9 | NA | ---- | ---- |
| Pooled | | 0.42±0.14 | | 1.05±0.29 | 4.22 | 0.00** |

There are 2 studies (Demel et al.,2019; Mologne et al.,2005) with P<0.05 and significant effect of operative interventions to reduce the rate of non-union while managing the fifth metatarsal bone fracture as compared to non-operated group , and there are 2 studies

(Wu et al.,2107; Ekstrand et al.,2013) with weak significant effect of operative interventions to reduce the rate of non-union as compared to non-operated group. Regard pooled analysis non-union distributed with no significant difference between two techniques with pooled OR 2.55 (0.8-7.52). Homogeneity among studies was founded. No bias account for differences in results among studies, which are not due to chance, after quantify all factors. We found no significant heterogeneity and we reported agreement between studied **(Table 5; figure 2).**

Duration of union was significantly shorter in operative group in Demel et al.,2019, Mologne et al.,2005 and Sokkar et al.,2016 also in pooled analysis **(Table 6).**

**Table (5): Nonunion distribution between groups**

| Study | Operated | | Non-operated | | OR (CI 95%) | Z | P |
|---|---|---|---|---|---|---|---|
| | N | N % | N | N % | | | |
| Demel et al.(2019) | 15 | 0 0.0% | 12 | 6 50.0% | 5.33 (1.55-11.2) | 8.52 | 0.00** |
| Mologne et al.(2005) | 19 | 1 5.2% | 18 | 8 44.4% | 4.85 (2.2-9.63) | 8.52 | 0.00** |
| Wu et al. (2017) | 21 | 0 0.0% | 20 | 3 15.0% | 3.11 (0.88-17.3) | 3.19 | 0.072 |
| Chuckpaiwong et al.(2008) | 18 | 2 11.1% | 17 | 3 17.6% | 0.62 (0.17-2.1) | 1.58 | 0.58 |
| Park et al. (2017) | 22 | 0 0.0% | 24 | 1 4.1% | 1.79 (0.57-4.2) | 1.25 | 0.798 |
| Sokkar et al. (2016) | 12 | NA | 12 | NA | ---- | ------ | ------ |
| Ekstrand et al. (2013) | 28 | 0 0.0% | 9 | 1 11.1% | 1.12 (0.41-2.63) | 3.19 | 0.07 |
| Pooled | | | | | 2.55 (0.8-7.52) | 2.52 | 0.092 |

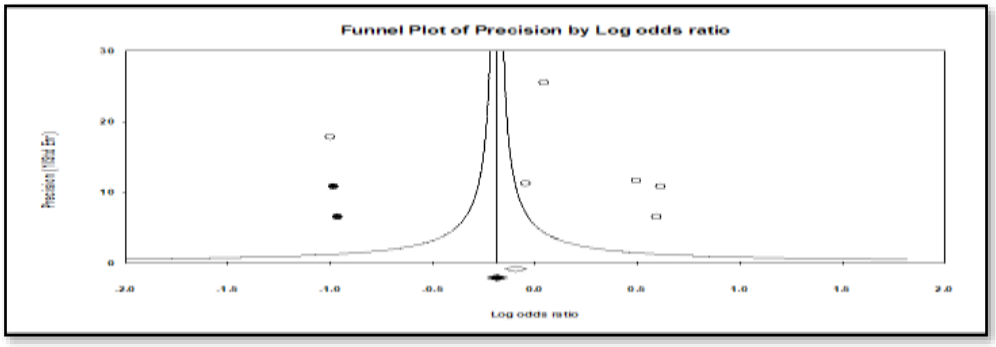



**Figure (2): Heterogeneity and asymmetry founded and illustrated in funnel plot.**

**Table (6): Duration of union (Weeks) distribution between Operated and non-operated among all studies**

| Study | Operated | | Non operated | | Z | P |
|---|---|---|---|---|---|---|
| | N | mean±SD | N | mean±SD | | |
| Demel et al.(2019) | 15 | 6.52 ± 2.11 | 12 | 12.52±3.21 | 7.69 | 0.00** |
| Mologne et al.(2005) | 19 | 7.05 ± 1.85 | 18 | 15.87±4.21 | 8.11 | 0.00** |
| Wu et al.(2017) | 21 | 7.14 ± 2.11 | 20 | 8.14 ± 2.14 | 1.58 | 0.095 |
| Chuckpaiwong et al. (2008) | 18 | 7.0 ± 1.85 | 17 | 6.02± 1.52 | 1.62 | 0.088 |
| Park et al. (2017) | 22 | 6.0±1.88 | 24 | 7.11±2.32 | 1.469 | 0.102 |
| Sokkar et al.(2016) | 12 | 4.0±1.22 | 12 | 7.50±1.85 | 2.232 | 0.018* |
| Ekstrand et al. (2013) | 28 | NA | 9 | NA | ---- | ---- |
| Pooled | | 6.02±1.85 | | 10.22±2.69 | 4.85 | 0.00** |

The assessment was applicable in 2 studies with no significant difference between operated and non-operated group **(Table 7).**

Duration return to sport was significantly shorter in operated cases except in Ekstrand et al. (2013) also in pooled analysis it was shorter as it was applicable in 4 studies. Homogeneity among studies was founded. No bias account for differences in results among studies, which are not due to chance, after quantify all factors. We found no significant heterogeneity and we found agreement between studied **(Table 8; figure 3).**

**Table (7): Duration of return to work (Weeks) distribution between Operated and non-operated among all studies**

| Study | Operated | | Non operated | | Z | P |
|---|---|---|---|---|---|---|
| | N | mean±SD | N | mean±SD | | |
| Demel et al.(2019) | 15 | NA | 12 | NA | ---- | ---- |
| Mologne et al.(2005) | 19 | NA | 18 | NA | ---- | ---- |
| Wu et al.(2017) | 21 | 8.42 ± 2.01 | 20 | 9.13 ± 2.54 | 1.49 | 0.112 |
| Chuckpaiwong et al.(2008) | 18 | 8.0 ± 1.85 | 17 | 7.02± 1.52 | 1.55 | 0.101 |
| Park et al. (2017) | 22 | NA | 24 | NA | ---- | ---- |
| Sokkar et al.(2016) | 12 | NA | 12 | NA | ---- | ---- |
| Ekstrand et al.(2013) | 28 | NA | 9 | NA | ---- | ---- |
| Pooled | | 8.21±2.05 | | 8.43±2.54 | 1.23 | 0.321 |

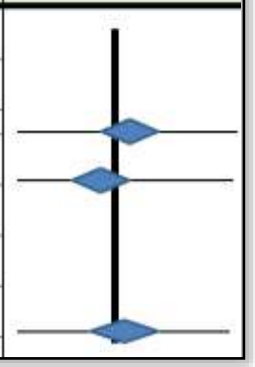
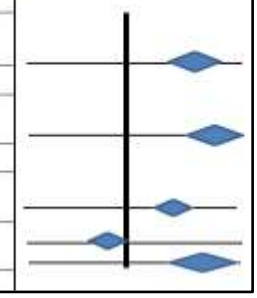


**Table (8): Duration return to sport (Weeks) distribution between Operated and non-operated among all studies**

| Study | Operated | | Non operated | | Z | P |
|---|---|---|---|---|---|---|
| | N | mean±SD | N | mean±SD | | |
| Demel et al.(2019) | 15 | NA | 12 | NA | ----- | ------ |
| Mologne et al. (2005) | 19 | 8.0 ± 2.0 | 18 | 15.99±2.36 | 8.85 | 0.00** |
| Wu et al.(2017) | 21 | NA | 20 | NA | ----- | ------ |
| Chuckpaiwong et al. (2008) | 18 | 15.0 ± 4.23 | 17 | 30.0± 4.69 | 10.36 | 0.00** |
| Park et al. (2017) | 22 | NA | 24 | NA | ----- | ------ |
| Sokkar et al. (2016) | 12 | 7.0±1.58 | 12 | 10.25±1.85 | 2.232 | 0.018* |
| Ekstrand et al. (2013) | 28 | 11.0±2.32 | 9 | 10.0±2.04 | 1.645 | 0.089 |
| Pooled | | 10.52±3.21 | | 15.88±2.36 | 4.77 | 0.00** |



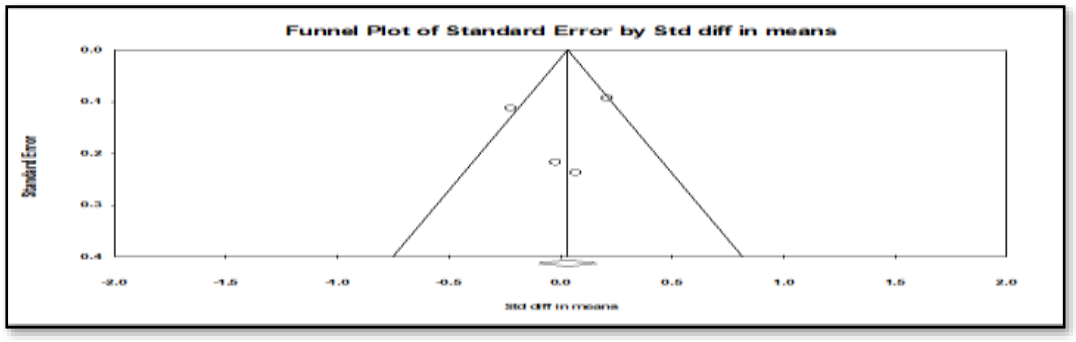



**Figure (3): Heterogeneity and asymmetry founded and illustrated in funnel plot.**

## DISCUSSION:

This review studies the difference between operative and non-operative outcomes in treatment of fracture of base of fifth metatarsal. Meta-analysis reported the effects of

operative and non-operative interventions in non-union rate, duration of union, duration of union, duration of return to normal activity and duration of return to sports. The determination of the treatment of fracture of base of fifth metatarsal is challenging for orthopedic surgeons because of its special vasculature, it is reported that there is marked reduction in union especially in non-operative intervention in watershed region. So, in past orthopedic surgeons preferred the operative intervention in treatment base of fifth metatarsal bone fracture. The invasive interventions are favored because of its rigid fixation and preserving the retrograde of blood supply to the insufficient areas of vascularity.

**Porter (13)** preferred the fixation by screw due to its resistance to the bending moment at the fracture site and also increase the vascularity especially in avascular part of the fracture site because of drilling that is used for intramedullary screw insertion increase the vascular access that improve the healing and outcome.

**Wu et al. (14)** made the research with 1 year follow up in patients with avulsion fracture with displacement of 2, 3 mm and reported that internal fixation is much better than non-operative treatment by plaster cast in outcomes. **Mologne et al. (15) and Sokkar &Abdelkafy (16)** reported that the success is increased in operative interventions than non-operative interventions. Meta-analysis confirm statistically the results that operative intervention is more effective that non-operative intervention in reduction the duration of union and rate of non-union.

According to our met-analysis, in sportive patient operative intervention is better than non-operative intervention because of early weight-bearing and early return to sports with operative intervention. **Sokkar& Abdelkafy (16)** reported reduction in duration of return to sports in operative group (7 weeks) to non-operative group (10 weeks). The reason of this is the ability of operative fixation to resist the torsional strain at the fracture site while promote equalized load dispersion. **Wu et al. (14), Mologne et al. (15), Chuckpaiwong et al. (17), and Ekstrand et al. (18)** reported that there is reduction in duration of return to sports in operative group to non-operative group. Weight bearing also reduces the bone resorption that will lead to strong union as reported in **Park et al. (19).** In this meta-analysis, we confirm that return to sports is quicker in operative interventions than non-operative interventions and also return to normal activities.

In contrary to the reports in literature, which recommend the conservative treatment than surgical treatment to reduce the discomfort and pain suffered post-operatively, in this review reports a reduction in the level of discomfort and pain assessed by visual analog scale for the operative group and also this meta-analysis reports large effect size reduction in the levels of visual analog scale score for the operative group as compared to the non-operative group. **Wu et.al (14)** proposed that the main underlying mechanism behind the onset of pain could be possibly an improper alignment of the fracture margins, which further can promote abnormal pressure distribution on planter surfaces. The authors mentioned that in comparison of cohorts getting operative and non-operative interventions, they observed higher rates of malunion in non-operative group. **Wu et.al (14)** added that this higher rate of non-union could affect the mid-foot alignment or increase the risk of re-fracture, thereby causing an increased level of pain.

In this review we have to put in our mind some limitations. We didn't depend in this review on unpublished papers to reduce bias, but it doesn't prevent that some results could be missed so we recommend readers to consider this in interpretation the results. We didn't make our study based on the zones of the fracture of base of fifth metatarsal bone on determination the difference between operative and non-operative interventions to get the best choice to

treat the fifth metatarsal base fracture, we recommend in future studies to see the difference of operative intervention in different zones. In our review we include one study of avulsion fracture with knowing that it isn't affected by the special vascularity of base of fifth metatarsal bone , so this could biased our research and recommend readers to consider this in analyzing the results.

There is lack of statistical data that will lead to bias especially the duration of return to normal activity and there are only two studies that represent the difference of operative intervention and non-operative intervention in duration of return to normal activities , this may lead to type 2 error due to small sample size. We weren't able to know the cost-benefit analysis between the two types of interventions, so we recommend in future studies to evaluate the cost-benefit analysis and duration of return to normal activities. This will be beneficial for health and community especially in low and middle income countries.

## Conclusion:

The operative interventions in the treatment of base of fifth metatarsal bone fracture to reduce the rate of non-union, duration of union, duration of return to normal activities and duration of return to sports as compared to non-operative interventions.

**Conflict of interest:** The authors declare no conflict of interest.
**Author contribution:** Authors contributed equally in the study.

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