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Research Article

Detection of Pain Severity with the Full Cup Test in Knee Osteoarthritis and Its Relationship with Knee Function and Quality of Life

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ABSTRACT

Objective: The aim of this study was to evaluate pain severity using the Full Cup Test (FCT) in patients with knee osteoarthritis (OA) and its relationship with knee function and quality of life.

Methods: This multicenter, prospective, cross-sectional study was conducted between July 2024 and October 2024. Ethical approval was obtained from the University Non-Invasive Clinical Research Ethics Committee prior to the commencement of the study (2024-GOKAEK-248_105). All patients' demographic characteristics, general health data, and Kellgren-Lawrence staging were recorded. The following assessments were administered to all patients: the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for evaluating knee pain and functionality; the Visual Analog Scale (VAS) and FCT for pain intensity at rest, and during movement; and the Short Form-36 (SF-36) for quality of life.

Results: A total of 108 participants (90% female; mean age: 57 years) were included. The majority were housewives, and approximately 25% were illiterate. FCT-rest scores demonstrated a strong correlation with VAS-rest and a weak negative correlation with the SF-36 bodily pain, vitality, and social functioning (SF) subscales ($P < 0.01$). FCT-motion scores were strongly correlated with VAS-motion, moderately positively correlated with WOMAC pain, stiffness, and total scores, and negatively correlated with SF-36 bodily pain, general health, mental health, and SF.

Conclusion: To our knowledge, this is the first study in the literature evaluating the utility of FCT in knee OA. FCT was found to be a valid, simple, and comprehensible tool for assessing pain in patients with knee OA. The results also demonstrated a meaningful association between FCT and both functional status and quality of life, indicating its broader clinical utility. Given its ease of use, FCT may be particularly beneficial in routine clinical practice, especially among elderly individuals and those with low educational attainment or cognitive decline.

Keywords: Full cup test, knee osteoarthritis, pain intensity, quality of life

INTRODUCTION

Knee osteoarthritis (OA) is a degenerative joint disease characterized by subchondral sclerosis, cartilage erosion, osteophyte formation, and both biochemical and morphological alterations in the synovial membrane of the articular cartilage.[1] It is the most prevalent joint disorder globally, affecting approximately 302 million individuals, and is a leading cause of physical disability, particularly among older adults.[2] The incidence and prevalence of chronic OA are steadily increasing in parallel with global population aging, making it a significant public health concern.[3] Additionally, around 25% of individuals over the age of 55 report at least one episode per year, and approximately 13% of elderly individuals have been diagnosed with knee OA for over seven years.[4] Risk factors for knee OA include advancing age, female sex, genetic predisposition, obesity, elevated bone mineral density, previous trauma, physical

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inactivity, certain occupational exposures, joint misalignment, ligamentous laxity, proprioceptive deficits, muscular weakness, and smoking.[5] Common clinical manifestations encompass morning stiffness, reduced joint range of motion, crepitus, joint instability, swelling, decreased muscle strength, fatigue, and pain. Radiological grading of knee OA is performed using the Kellgren-Lawrence (KL) classification system.

Despite its high prevalence, current treatments for knee OA primarily focus on symptom relief. These strategies include exercise, physiotherapy, assistive devices such as canes and splints, home modifications, self-management education programs, pharmacologic interventions, intra-articular injections, and surgical options like joint replacement.[6] The American College of Rheumatology highlights the importance of non-pharmacological approaches, such as weight reduction and aerobic exercise, in alleviating symptoms.[7]

Pain severity and treatment efficacy in knee OA are commonly assessed using patient-reported outcome measures. Frequently utilized tools include the Visual Analog Scale (VAS), Lower Extremity Functional Scale, Oxford Knee Scale, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).[8] However, these instruments may pose challenges for older adults, particularly those with limited literacy or cognitive decline, as they contain complex or lengthy questions. A 2020 study from China demonstrated that increased age and decreased educational attainment were associated with greater difficulty in accurately assessing pain using standard scales.[9] These findings underscore the need for a simple, non-verbal, and easily applicable pain assessment tool tailored to this population.

The Full Cup Test (FCT), developed by Ergün et al.[10], was designed specifically to measure pain severity among patients with limited education. This method was initially applied in dental contexts to assess toothache and post-procedural pain.[11-13] FCT has since been utilized in evaluating musculoskeletal conditions. For example, a 2020 study assessing 43 patients, (74.4% female, mean age ~62) diagnosed with painful diabetic peripheral neuropathy via clinical examination and the Douleur Neuropathique 4 questionnaire found a strong correlation between VAS and FCT scores.[14] Similarly, in 69 electrodiagnostically confirmed carpal tunnel syndrome patients (87% female, mean age ~42), FCT scores were positively correlated with the Boston Carpal Tunnel Questionnaire (BCTQ) and with electrodiagnostic findings, indicating that FCT effectively reflects symptom severity.[15] In a 2022 study on 100 individuals with chronic low back pain (70% female, mean age ~56), FCT scores were significantly associated with VAS, the Oswestry Disability Index (ODI), and the Nottingham Health Profile, supporting its validity for both pain and functional evaluation.[16]

Despite the high prevalence of advanced age and low educational attainment among patients with knee OA, no previous study has examined the application of FCT in this population. This study aimed to evaluate pain severity using the FCT in individuals with OA and to investigate its relationship with knee function and quality of life.

MAIN POINTS

- To our knowledge, this is the first study to evaluate the Full Cup Test (FCT) in patients with knee osteoarthritis (OA).
- FCT was found to be a valid, simple, and comprehensible tool for assessing pain severity in knee OA.
- Beyond pain assessment, FCT also demonstrated significant associations with knee function and quality of life.
- Given its visual and intuitive format, FCT may be particularly useful in routine practice for older adults and patients with low literacy or cognitive limitations.

MATERIAL AND METHODS

Study Design

This multicenter, prospective cross-sectional study was undertaken between July 2024 and October 2024. Permission was obtained from the Yozgat Bozok University Non-Invasive Clinical Research Ethics Committee prior to the study (decision number: 2024-GOKAEK-248_105, date: 05.09.2024). Written and verbal informed consent was obtained from all patients. The study was conducted in accordance with the 1964 Helsinki Declaration.

Patients

Patients who applied to the city hospital and university hospital physical medicine and rehabilitation outpatient clinics for knee pain present for at least six months, received knee radiography, and were diagnosed with OA between July 2024 and October 2024, were included in the study. All the participants were aged 40 to 65 years. Patients with a history of malignancy, vasculitis, or neurological conditions that could influence pain perception; lumbar discopathy; those with a previous history of fracture or surgery in the knee area; or rheumatic diseases that may affect pain, such as rheumatoid arthritis, ankylosing spondylitis, or fibromyalgia were excluded from the study. All patients' personal information (age, gender, occupation, education), general health information [smoking and alcohol use, known chronic diseases, body mass index (BMI)], severity of knee pain, onset, and KL stage were recorded. The WOMAC, which evaluates pain and the functionality of the knee, the VAS rest, VAS motion, and FCT rest, FCT motion, which evaluate pain intensity, and the Short Form-36 (SF-36), which evaluates quality of life, were applied to all patients. The details of the implementation of the instruments are as follows:

The KL system was used to classify the radiographic severity of knee OA. There are four stages in total, from Stage 0 to Stage 4, and OA worsens as the stages progress. While there are no osteophytes and no narrowing of the joint space in Stage 0, there are prominent osteophytes in Stage 4, and the joint space is almost completely closed.

VAS for the Evaluation of Pain and Fatigue

For this evaluation, the patient is asked to mark his/her severity of pain and fatigue on a horizontal 10-cm line with number 0 on one end representing "no pain or no fatigue" and number 10 on the other end indicating "very severe pain or very severe fatigue".

FCT: Patients were shown a picture of an empty glass and told that if their pain is very severe, the glass will be completely full, and if they have no pain, the glass will be completely empty. They were asked to draw a line on the glass with their fingers to show the severity of their pain. The FCT score was calculated using the formula "length of line (cm) / height of glass (cm) × 100". A Turkish validity study was conducted in chronic low back pain.[16]

WOMAC is a scale that enables the evaluation of functional disability due to OA in patients with knee OA. The scale consists of 24 questions and three main headings: pain, stiffness, and physical function. Each question is scored between 0 and 4 (0 = none, 4 = very severe). High WOMAC values indicate an increase in pain and stiffness and deterioration in physical function. A Turkish validity study was conducted by Tüzün et al.[17]

SF-36 is a scale that consists of 36 multiple-choice questions. The SF-36 measures eight domains of health-related quality of life, including physical functioning, role limitations due to physical health, bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems, and mental health (MH). In this scale, which examines eight dimensions of health-related quality of life, high scores indicate a better level of health, while low scores indicate deterioration in health.

Statistical Analysis

Power analysis was performed using G*Power version 3.1.9.4. For a correlation analysis assuming an assumed medium effect size ($r = 0.518$), an alpha of 0.05, and a power of 0.95, the required sample size was calculated to be 42 participants. Numerical variables with non-parametric distribution between the groups were compared with Mann-Whitney U tests. To determine the construct validity, Spearman's correlation coefficients were used to analyze the relationships between FCT and the VAS, WOMAC, and SF-36 scales, the correlation between FCT and VAS scores was illustrated with a simple scatterplot.

RESULTS

A total of 108 individuals, 90% female and with an average age of 57, were included in the study. Demographic and clinical characteristics of the individuals are presented in Table 1. The median age was 58 years. The majority of the participants were housewives, and approximately 25% were illiterate. The mean BMI was quite high at 31.80 kg/m^2 (Table 1). Most of the patients had bilateral knee pain. KL stage was stage 2 for almost half of the patients (Table 2). Pain, function, and daily life assessment scale scores are shown in Table 3.

Table 1. Demographic Characteristics of the Patients

Age (median-IQR)	58.0 (12.0)
Gender (n/%)	
Female	98 (90.7)
Male	10 (9.3)
Occupation (n/%)	
Housewife	92 (85.2)
Officer	9 (8.3)
Worker	3 (2.8)
Retired	4 (3.7)
Marital status (n/%)	
Married	99 (91.7)
Single	3 (2.8)
Widow	6 (5.6)
Education (n/%)	
Illiterate	28 (25.9)
Primary school	58 (53.7)
Secondary school	3 (2.8)
Highschool	15 (13.9)
University	4 (3.7)
Smoking (n/%)	16 (13.0)
BMI (mean ± SD)	31.80 ± 7.0

IQR, interquartile range; BMI, body mass index; SD, standard deviation.

FCT-rest showed a strong positive correlation with VAS-rest. A weak negative correlation was also observed between FCT-rest and SF-36 subdomains including BP, VT, and SF ($P < 0.01$). FCT-motion was strongly correlated with VAS-motion, and there was a fair positive correlation between FCT-motion and WOMAC-pain, stiffness, and total scores. Therefore, a fair negative correlation was found between FCT-motion and SF-36 BP, GH MH, and SF. The correlation of FCT and VAS scores with each other and WOMAC and SF-36 scale scores was presented in Table 4.

VAS-rest and FCT-rest scores did not significantly differ by gender, ($P = 0.566$ and $P = 0.756$, respectively), whereas VAS-motion and FCT-motion scores were significantly higher in females, ($P = 0.044$ and $P = 0.015$, respectively). VAS-rest, FCT-rest, VAS-motion, and motion scores were similar in illiterate and literate patient groups ($P = 0.470$, $P = 0.733$, $P = 0.059$ and $P = 0.075$). Similarly, VAS-rest, FCT-rest, VAS-motion, and motion scores were similar in the patient groups aged 0-60 years and greater than 60 years ($P = 0.622$, $P = 0.169$, $P = 0.610$, $P = 0.790$) (Table 4).

The correlation graphic between FCT-rest and VAS-rest scores was shown in Figure 1, and the correlation graphic between FCT-motion and VAS-motion scores was shown in Figure 2.

Table 2. Clinical Characteristics of the Patients

Systemic disease	
HT	40 (37.0)
DM	32 (29.6)
CAD	6 (5.6)
Other	4 (3.7)
Taking NSAIDs in the previous week for knee pain	93 (86.1)
Side of knee pain	
Right	7 (6.5)
Left	27 (25.0)
Bilateral	74 (68.5)
Duration of pain	36.0 (48.0)
Kellgren-Lawrence stage (right knee)	
Stage	
2	48 (43.5)
3	57 (50.7)
4	3 (2.8)
Kellgren-Lawrence stage (left knee)	
Stage	
1	2 (1.9)
2	48 (44.4)
3	55 (50.9)
4	3 (2.8)

HT, hypertension; DM, diabetes mellitus; CAD, coronary artery disease; NSAID, non-steroidal anti-inflammatory drug.

Table 3. Pain and Daily Life Assessment Scale Scores

	Median-IQR or mean and SD
VAS-rest	6.0 (1.5)
FCT-rest	62.5 (17.5)
VAS-motion	7.0 (2.0)
FCT-motion	72. (17.5)
WOMAC-pain	12.0 (5.0)
WOMAC-stiffness	4.0 (2.0)
WOMAC-functional	43.34 ± 13.71
WOMAC-total	57.73 ± 23.13
SF-36 physical function	25.0 (20.0)
SF-36 role physical	0.0 (0.0)
SF-36 bodily pain	22.5 (12.5)
SF-36 general health	29.79 ± 17.91
SF-36 vitality	33.86 ± 17.10
SF-36 social functioning	37.5 (25.0)
SF-36 role emotional	0.0 (0.0)
SF-36 mental health	48.47 (15.17)

IQR, interquartile range; SD, standard deviation; VAS, visual analog scale; FCT, functional cup test; SF-36, short form-36; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

DISCUSSION

A total of 108 individuals, 90% of whom were female with a mean age of 57 years, were included in this study. The majority were housewives, and approximately 25% were illiterate. FCT-rest was strongly correlated with VAS-rest, while weak negative correlations were observed between FCT-rest and SF-36 subdomains: BP, VT, and SF ($P < 0.01$). FCT-motion was strongly correlated with VAS-motion, moderately positively correlated with WOMAC-pain, stiffness, and total scores, and moderately negatively correlated with SF-36 subdomains including BP, GH, MH, and SF.

The demographic findings of this study are consistent with the literature, indicating that knee OA is more prevalent among women (90.7%) and that the average age of affected individuals is around 57 years.[5,18] Similar to previous reports,[19,20] most participants in our study were housewives and a significant proportion (25.9%) were illiterate. The mean BMI was elevated at 31.80 kg/m^2, aligning with prior studies.[21,22] Moreover, bilateral knee pain was common, and nearly half of the patients were classified as KL stage 2, corroborating previous findings.[23,24]

Previous studies have established that low educational attainment is associated with increased pain severity in knee OA.[25-27] In a study involving 114 patients with low education and without dementia who reported headache or rheumatologic pain, 21.4% were unable to comprehend the VAS, whereas all patients successfully completed the FCT, with no significant difference found between VAS and FCT scores.[10] In another study from 2020, 43 patients (74.4% female, mean age ~62) with painful diabetic peripheral neuropathy were assessed using both VAS and FCT, among them, 76.7% had low education levels. A strong correlation was observed between VAS and FCT, and no significant relationship was found between education level and FCT scores.[14]

In a 2020 study of patients with electro diagnostically confirmed carpal tunnel syndrome (mean age ~42, 87% female), 50.72% had five or fewer years of education. FCT scores showed significant correlations with the Symptom Severity Scale, a BCTQ subscale, and were reported to be easy to understand among patients with low literacy levels.[15] Similarly, a 2022 study on chronic low back pain (70% female, mean age ~56) revealed that 17% of participants were illiterate. FCT scores were higher among illiterate patients, though not statistically different from VAS scores, suggesting FCT's suitability in this population.[16] In our study, 25.9% of patients were illiterate, and while FCT scores tended to be higher in this group, the difference was not statistically significant. This finding may reflect that using a visual and intuitive scale like the FCT allows for better self-expression of pain.

FCT has also been employed to assess pain severity in dental and oral/maxillofacial surgery settings, in addition to musculoskeletal disorders.[11-13] In a 2016 study in Iraq, postoperative dental pain was evaluated using five scales including FCT, and FCT was reported as the easiest and fastest to use.[11] A 2018 review from Thailand examining ten different pain measurement tools concluded that FCT was particularly applicable and reliable for assessing acute pain.[28] Similarly, a

Table 4. Correlation Analysis of FCT, VAS, WOMAC and SF-36 Scales

		FCT-rest	FCT-motion	VAS-rest	VAS-motion
VAS-rest	Rho	**0.806**	**0.504**	1.000	**0.496**
	P	**< 0.001****	**< 0.001****	.	**< 0.001****
FCT-rest	Rho	1.000	0.420	0.806	425
	P	.	< 0.001**	< 0.001**	< 0.001**
VAS-motion	Rho	**0.425**	**0.970**	**0.496**	1.000
	P	**< 0.001****	**< 0.001****	**< 0.001****	.
FCT-motion	Rho	0.420	1.000	0.504	970
	P	< 0.001**	.	< 0.001**	< 0.001**
WOMAC-pain	Rho	0.166	**0.542**	**0.283**	**0.529**
	P	0.101	**< 0.001****	**< 0.01****	**< 0.001****
WOMAC-stiffness	Rho	0.065	**0.431**	0.163	0.**426**
	P	0.525	**< 0.001****	0.108	**< 0.001****
WOMAC-functional	Rho	0.090	**0.450****	**0.255**	**0.450**
	P	0.375	**<0.001**	**0.011***	< 0.001**
WOMAC-total	Rho	0.141	**0.560**	**0.301**	**0.555**
	P	0.165	**< 0.001****	**< 0.01****	**< 0.001****
SF-36 physical function	Rho	-0.017	-0.295	-0.150	**-0.297**
	P	0.869	< 0.01*	0.138	**< 0.01****
SF-36 role physical	Rho	-0.023	-0.211	-0.112	-0.242
	P	0.823	0.028*	0.270	0.011*
SF-36 bodily pain	Rho	**-0.240**	**-0.563**	-0.395	-0.560
	P	**0.017***	< 0.001**	< 0.001**	< 0.001**
SF-36 general health	Rho	-0.083	**-0.323**	-0.194	**0.307**
	P	0.415	**< 0.001****	0.054	**< 0.01****
SF-36 vitality	Rho	**-0.235**	-0.367	**-0.305**	**-0.368**
	P	**0.019***	< 0.001**	**< 0.01****	**< 0.001****
SF-36 social functioning	Rho	**-0.263**	**-0.501**	**-0.351**	**-0.477**
	P	**< 0.01****	**< 0.001****	**< 0.001****	**< 0.001****
SF-36 role emotional	Rho	-0.111	-0.134	0.012	-0.176
	P	0.274	0.166	0.908	0.068
SF-36 mental health	Rho	-0.139	**-0.277**	**-0.211**	**-0.263**
	P	0.242	**< 0.01****	**0.036***	**< 0.01***

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). VAS, visual analog scale; FCT, functional cup test; SF-36, short form-36; WOMAC: Western Ontario and McMaster Universities Arthritis Index; Rho P, Spearman's rank correlation coefficient.

2018 Malaysian study comparing FCT, VAS, and the numerical rating scale for postoperative dental pain found that FCT was the second most user-friendly scale after the numerical rating scale.[12] In our study involving patients with knee pain (90.7% female, mean age 57, age range 40-65), FCT was strongly correlated with VAS, consistent with these findings.

Although FCT is frequently compared with VAS, which primarily assesses pain severity, few studies have examined its relationship with functional status or quality of life. Two studies evaluated the association between FCT and functional capacity, while only one investigated its relationship with quality of life. In the 2020 carpal tunnel syndrome study, FCT was significantly correlated with the Symptom Severity and Functional Status subscales of BCTQ.[15] In a 2022 study on patients with chronic low back pain (mean age 56, 70% female), FCT scores were significantly associated with VAS, the ODI, and the Nottingham Health Profile.[16] Similarly, our study demonstrated significant associations between FCT and VAS, WOMAC, and SF-36, supporting its validity in assessing not only pain intensity but also functional limitations and quality of life in patients with knee OA. The demographic profile of our cohort, particularly the high female-to-male ratio, parallels previous studies and may reflect the higher prevalence of obesity and OA among women, as compared to men, as well as the prevalence of low back pain.

Study Limitations

This study has several limitations. First, mood disorders such as sleep disturbances, anxiety, and depression, which are known to influence pain perception and quality of life, were not evaluated. Second, the cross-sectional design limits the ability to infer causal relationships between the FCT and clinical outcomes. Third, although the study included a diverse group

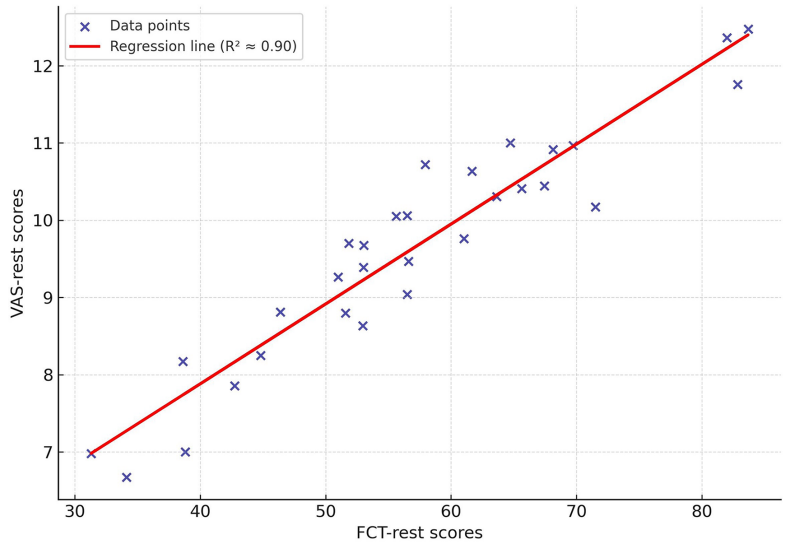

Figure 1. Correlation between FCT-rest and VAS-rest scores.

FCT, functional cup test; VAS, visual analog scale.

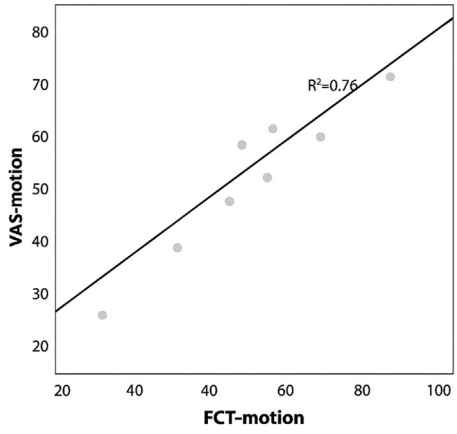

Figure 2. Correlation graphic between FCT-motion and VAS-motion scores-1.

FCT, functional cup test; VAS, visual analog scale.

in terms of literacy, the sample was predominantly female, which may limit the generalizability of the findings to male populations. Lastly, although FCT was correlated with well-established measures, its test-retest reliability and sensitivity to change over time were not assessed. Future longitudinal and multicenter studies are needed to confirm these findings and evaluate the responsiveness of FCT to clinical changes.

CONCLUSION

To our knowledge, this is the first study in the literature to evaluate the utility of the FCT in patients with OA. The findings suggest that FCT is a valid, simple, and comprehensible tool for assessing pain severity in this population. Importantly, FCT was not only associated with pain intensity but also demonstrated meaningful correlations with knee function and quality of life. Given its intuitive format and visual nature, FCT may be particularly beneficial in routine clinical practice for older adults and individuals with low literacy or cognitive limitations where traditional scales like VAS may be less applicable. Future studies should further examine its responsiveness to clinical change over time.

Ethics

Ethics Committee Approval: The study protocol was approved by Yozgat Bozok University Non-Invasive Clinical Research Ethics Committee with decision number 2024-GOKAEK-248_105, date: 05.09.2024.

Informed Consent: Written and verbal informed consent was obtained from all patients.

Footnotes

Author Contributions

Concept Design - G.D.K., E.Ş.B.; Data Collection and/or Processing - G.D.K., E.Ş.B.; Analysis and/or Interpretation - G.D.K., E.Ş.B.; Literature Search - G.D.K., E.Ş.B.; Writing, Reviewing and Editing - G.D.K., E.Ş.B.

Declaration of Interests: All authors declare that there is no conflict of interest.

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