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An Investigation on the Effect of Smartphone Use on Morphological and Radiological Changes of the Fifth Finger

Akıllı Telefon Kullanımının Beşinci Parmağın Morfolojik ve Radyolojik Değişikliklerine Etkisinin İncelenmesi

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Abstract

Aim: The purpose of this study is to describe the macroscopic and radiological changes on the fifth finger related to mobile phone use and to evaluate the effect of size and weight of the device and the average time spent using the smartphone on these morphological changes.

Material and Method: A total of one hundred and one patients were enrolled in the study. Data including age, weight, height, education level, mobile phone usage, and digital photographs were collected through interviews conducted with participants in an outpatient orthopedics clinic. Digital images of the dorsal aspects of both hands were captured using an iPhone X® equipped with a dual 12-megapixel wide camera. The angle of the distal interphalangeal (DIP) joint of the fifth finger was measured using computer software (Image J® version 1.46, National Institute of Health, Bethesda, MD) from both digital photographs and anteroposterior (AP) hand X-rays separately.

Results: The proportion of smartphone usage time exceeding 4 hours was significantly higher among patients with complaints compared to those without complaints ($p < 0.05$). Similarly, the mean duration of smartphone usage exceeding 4 hours was significantly greater in patients with shape discrepancy than in those without shape discrepancy ($p < 0.05$).

Conclusion: Taking into account all the data from our study, it is evident that even in cases where no radiological findings are detected in individuals who use their phones for more than 4 hours daily, shape deformities in soft tissue may still result in clinical discomfort for the patient.

Keywords: Smartphone, radiological, morphological, pinky, fifth finger, mobile phone

Öz

Amaç: Bu çalışmanın amacı, cep telefonu kullanımına bağlı olarak beşinci parmakta meydana gelen makroskobik ve radyolojik değişiklikleri tanımlamak ve cihazın boyutu, ağırlığı ile akıllı telefonda geçirilen ortalama sürenin bu morfolojik değişikliklere etkisini değerlendirmektir.

Gereç ve Yötem: Çalışmaya 101 hasta dahil edildi. Bu kesitsel çalışmada kullanılan yaş, kilo, boy, eğitim, cep telefonu verileri ve dijital fotoğraflar, bir ortopedi kliniği ortamında katılımcılarla yapılan görüşmelerden elde edilmiştir. Her iki elin sırt kısmının dijital fotoğrafları bir iPhone X ® (çift 12 megapiksel geniş kamera) ile çekildi. Beşinci parmağın DIP eklem açısı bilgisayar yazılımında (Image J® versiyon 1.46, Ulusal Sağlık Enstitüsü, Bethesda, MD) dijital fotoğraflar ve AP el röntgenleri için ayrı ayrı ölçüldü.

Bulgular: Şikayeti olan hastalarda 4 saatten fazla akıllı telefon kullanım süresi şikayeti olmayan hastalara göre anlamlı olarak daha yüksekti ($p<0,05$). Şekil farklılığı olan hastalarda ortalama 4 saatten fazla akıllı telefon kullanma süresi, şekil farklılığı olmayan hastalara göre anlamlı olarak daha yüksekti ($p<0,05$).

Sonuç: Çalışmamızın tüm verileri göz önüne alındığında günlük 4 saatten fazla telefon kullananlarda radoyolojik bulgular saptanmasa bile yumuşak dokuda görülen şekil bozukluğu sonucu hastada klinik rahatsızlıklar görülebilmektedir.

Anahtar Kelimeler: Akıllı telefon, radyolojik, morfolojik, serçe parmak, beşinci parmak, cep telefonu

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INTRODUCTION

The global proliferation of smartphones has experienced a rapid escalation, mirroring the evolution of these devices from simple cell phones to portable computers. Currently, the worldwide tally of smartphone users has soared to 6.92 billion, comprising 86.41% of the global population as smartphone owners. Smartphones provide a diverse array of features through software applications, spanning entertainment, email, online messaging, and social media.

Turkey, boasting a relatively young population, foresees a surge in smartphone users, expected to reach 84.07 million by the year 2029. Despite the convenience these devices bring to work and daily life, there is a growing concern about the adverse effects of excessive smartphone usage on mental and physical health. Various studies have delved into the connection between smartphone usage and musculoskeletal problems.

Injuries related to overuse of the hand and wrist, including tendinitis, trigger finger, and nerve entrapment syndromes, have been associated with smartphone use.[5-10] In addition to symptoms such as pain and paresthesia, smartphones are now being accused of causing morphological alterations, particularly in the upper extremities. Various methods of holding a smartphone exist, with one common technique involving grasping the device with one hand and utilizing the radial surface of the DIP joint of the fifth finger as a support under the device.[11] Recently, smartphone users have started claiming that the shape of their fifth finger has altered due to excessive smartphone use, sharing images of their so-called "smartphone pinkies" on social media. Despite the prevalence of this topic on social platforms, limited evidence exists regarding smartphone-related alterations to bones and soft tissues. While macroscopic morphological changes in the fifth finger due to smartphone use have been demonstrated, attention has not been given to the radiological bone and joint structure of the hands.[11]

This study aims to investigate both the morphological and radiological changes in the fifth finger caused by smartphone use. The objective is to describe the macroscopic and radiological alterations in the fifth finger related to mobile phone use and assess the impact of device size and weight, as well as the average time spent using the smartphone, on these morphological changes.

MATERIAL AND METHOD

After obtaining approval from the local ethics committee (2019/11-17), the institutional radiological database was searched for hand AP x-rays taken within the last two months. A retrospective database search revealed 158 hand x-rays. Patients with congenital or acquired deformities, hand or wrist fractures, and those under the age of 18 were excluded from the study. Out of the remaining 109 patients, 101 agreed to participate. Data including age, weight, height, education, mobile phone usage, and digital photographs were obtained through interviews with participants in an outpatient orthopedic clinic setting for this cross-sectional study.

The authors provided detailed information by directly explaining the survey to the participants. In addition to assessing their smartphone attitudes, patients were also asked about the brand and model of their mobile devices. Data regarding device size and weight were sourced from each manufacturer's official website.

Data on the daily time spent using mobile phones were also collected from existing smartphone "screen time" applications. Regarding complaints related to the assessment of the fifth finger, participants were asked to indicate whether they experienced pain, numbness, or any discomfort in their dominant hand, specifically in the fifth finger. Participants were instructed to place their hands in a neutral position on the table without applying pressure. A scale (ruler) was placed next to each hand, and digital photographs of the dorsum of both hands were captured using an iPhone X® (dual 12-megapixel wide camera). The DIP (Distal Interphalangeal) joint angle of the fifth finger was measured separately for digital photographs and AP (Anteroposterior) hand x-rays using computer software (Image J® version 1.46, National Institutes of Health, Bethesda, MD). To determine the DIP joint angle from digital photographs, examiners selected four points: two visual separation points for the head and base of the fifth distal phalanx, and two visual separation points for the head and base of the fifth intermediate phalanx (**Figure 1A**). Two lines were carefully drawn between each pair of points, and the software utilized these lines to calculate the DIP joint angle, which represents the angle formed by the intersection of the longitudinal axis of the fifth distal and middle phalanges. Radiological measurements were conducted by a musculoskeletal specialist radiologist following direct radiographs taken in full anteroposterior view. The angle between the line drawn from the proximal and distal midpoint of the fifth distal phalanx and the line passing through the distal and proximal of the 5th finger midphalanx was determined (**Figure 1B**).

The study recorded the age, gender, and education status of the patients, as well as the weight and screen width of the phones they used, their daily phone usage (in hours), and angle measurements calculated from separate photographs and direct radiography. The results were categorized demographically, and the reported effects were analyzed based on whether the patients had finger deformities and whether they spent more or less than 4 minutes on the phone per day. Given that the global average for smartphone usage is 3 hours and 45 minutes, while the Turkish average is 4 hours and 16 minutes, an average of 4 hours was utilized as a reference in the analysis.

Figure 1a: The picture shows the measurement technique of the angulation of fifth finger by using the photo (a).

Figure 1b: The picture shows the measurement technique of the angulation of fifth finger by using the X-ray (b).

Statistical Analysis

Descriptive statistics, comprising mean, standard deviation, median, minimum and maximum values, frequency, and ratio values, were utilized to summarize the data. The distribution of variables was assessed using the Kolmogorov-Smirnov test. The analysis of quantitative independent data was performed using the Mann-Whitney U test, while the Chi-square test was employed for the analysis of qualitative independent data. Statistical analysis was carried out using the SPSS (Statistical Package for the Social Sciences, IBM, New York®, NY) version 26.0 program.

RESULTS

The average age of the patients was 28.7 years. The mean weight of smartphones carried by the patients was determined to be 161.5 grams, with an average screen size of 5.4 inches. Among the participants, 37 spent less than 4 hours on their smartphones, while 64 spent more than 4 hours daily. The distribution of radiography photographs was 4.2, and the distribution was measured as 7.0. Regarding complaints about the fifth finger, 25 participants (24.8%) reported having such complaints, and 9 patients showed a noticeable change in the shape of their finger (**Table 1**).

Tablo 1. Demographic characteristics of the patients

	Complaint (-)		Complaint (+)		p
	Mean±s.s./n-%	Median	Mean±s.s./n-%	Median	
Age	28.4±7.1	27.5	29.5±8.3	30.0	
Gender					
Female	21	27.6%	10	40.0%	0.452 m
Male	55	72.4%	15	60.0%	0.245 x2
Height	173.0±7.0	174.0	172.6±8.1	173.0	0.668 m
Weight	76.7±12.0	76.5	70.8±22.0	70.0	0.046 m
BMI* (kg/m2)	25.6±3.3	25.3	23.7±6.6	23.1	0.038 m
Educational status					0.707 x2
Highschool	47	61.8%	14	56.0%	
College	11	14.5%	3	12.0%	
Faculty	18	23.7%	8	32.0%	
Smartphone Weight (gr)	161.1±20.2	167.0	162.6±21.3	163.0	0.679 n
Smartphone Display Size (Inch)	5.4±0.8	5.5	5.4±0.5	5.5	0.714 n
Daily smartphone usage time (per day)	3.8±1.5	4.0	5.8±2.9	6.0	0.000 n
Daily smartphone usage time					0.014 x2
< 4 hours	33	43.4%	4	16.0%	
≥ 4 hours	43	56.6%	21	84.0%	

m Mann-Whitney U test / x2 Chi-square test, BMI*: Body mass index

There was no significant difference between the groups with and without complaints in terms of diseases, age, gender problems, and height (p>0.05). However, the weight and BMI values of individuals with complaints were significantly lower than those without complaints (p<0.05). There was no significant difference between educational status, smartphone weight and size angle between the two groups (p>0.05). However, the group with complaints had a significantly higher daily smartphone usage time (p<0.05). Additionally, the number of patients with complaints who used their smartphone for more than 4 hours daily was significantly higher than those without complaints (p<0.05) (**Figure 2a**) (**Table 2**). Patients with shape differences in their fifth fingers were found to be older than those without shape differences, and this difference was statistically significant (p<0.05). However, there was no difference between these two groups in terms of gender, male, weight, and BMI (p>0.05). Additionally, there was no difference between the groups with and without shape differences regarding the duration of education and the weight and size of the smartphone (p>0.05). In contrast, the average smartphone usage time of more than 4 hours in the patient group with shape differences was significantly higher than in the patient group without shape differences (**Figure 2b**) (p<0.05). Furthermore, there was no significant difference between patients with and without shape differences in terms of the degree of DIP angulation on the radiograph or the angle of DIP angulation in the photograph (p>0.05) (**Table 2**). There was no significant difference in terms of education level, smartphone weight, or smartphone size in patients with smartphone usage time <4 hours and ≥4 hours (p>0.05). Additionally, using 4 or more smartphones did not show a significant difference in terms of the angulation angle seen in radiography and photography (p>0.05) (**Table 3**).

DISCUSSION

The most significant finding of this study was the association between daily smartphone usage time and the discrepancy in the shape of the fifth finger. Our results suggest that using a smartphone for over 4 hours per day increases the risk of a shape discrepancy in the fifth finger, resulting in asymmetry. However, no observable changes were detected on radiography.

The global surge in smartphone usage has been remarkable, prompting numerous published articles investigating musculoskeletal disorders linked to smartphone use.[5-8] The existing literature, in particular, has focused on injuries affecting the upper extremities. In a comprehensive review, Etivipart et al. identified the most affected body regions as the head-neck, shoulder-arm, and hand-thumb.[12] They also established a correlation between musculoskeletal symptoms around the hand-thumb and one-handed smartphone use. Several authors have categorized the relationship between symptoms and the use of smart devices into various syndromes, such as "overuse injury," "repetitive strain injury," "nintendinitis," "Blackberry thumb," and "Whatsappitis.".[9,13-16] However, many of these authors did not extensively investigate morphological changes in the hand. Fuentes-Ramirez et al. conducted a study to assess the role of the fifth finger in manipulating smartphones and investigated whether asymmetry was being induced in the fifth finger.[11] They specifically evaluated photographs of fifth fingers but were limited to assessing soft tissue changes. In our study, we extended the analysis by incorporating X-rays to examine both bony structures and soft tissue. Interestingly, our results did not reveal any bony changes, contrary to the observed soft tissue asymmetry. In a separate experimental study, Gustafsson et al. identified differences in typing style among young adult patients with and without musculoskeletal symptoms.[17] However, Fuentes-Ramirez et al. did not report any statistical significance between holding techniques and the area of asymmetry.[11]

Tablo 2. Evaluation of parameters according to whether patients had finger related complaints.

	Shape discrepancy of finger (-)		Shape discrepancy of finger (+)		p
	Mean±s.s./n-%	Median	Mean±s.s./n-%	Median	
Age	28.1±7.2	27.5	34.3±7.2	38.0	0.013 m
Gender					
Female	27	29.3%	4	44.4%	0.349 x2
Male	65	70.7%	5	55.6%	
Height	173.0±7.1	174.0	168.8±7.9	170.0	0.122 m
Weight	75.4±15.2	76.0	74.2±15.9	70.0	0.445 m
BMI* (kg/m2)	25.0±4.4	24.9	26.0±5.0	26.8	0.655 m
Educational status					
Highschool	55	59.8%	6	66.7%	
College	12	13.0%	2	22.2%	0.338 x2
Faculty	25	27.2%	1	11.1%	
Smartphone Weight (gr)	161.2±20.7	167.0	164.7±17.8	167.0	0.962 m
Smartphone Display Size (Inch)	5.4±0.7	5.5	5.5±5.5	5.5	0.538 m
Daily smartphone usage time (per day)	4.1±2.0	4.0	6.1±2.6	6.0	0.007 m
Daily smartphone usage time					
< 4 hours	37	40.2%	0	0%	0.017 x2
≥ 4 hours	55	59.8%	9	100%	
DIP- Radiography (Degree of angulation)	4.2±3.5	3.7	3.3±1.7	2.7	0.659 m
DIP- Photo (Degree of angulation)	7.3±3.6	6.4	6.6±2.3	5.5	0.866 m

m Mann-Whitney U test / x2 Chi-square test, BMI*: Body mass index

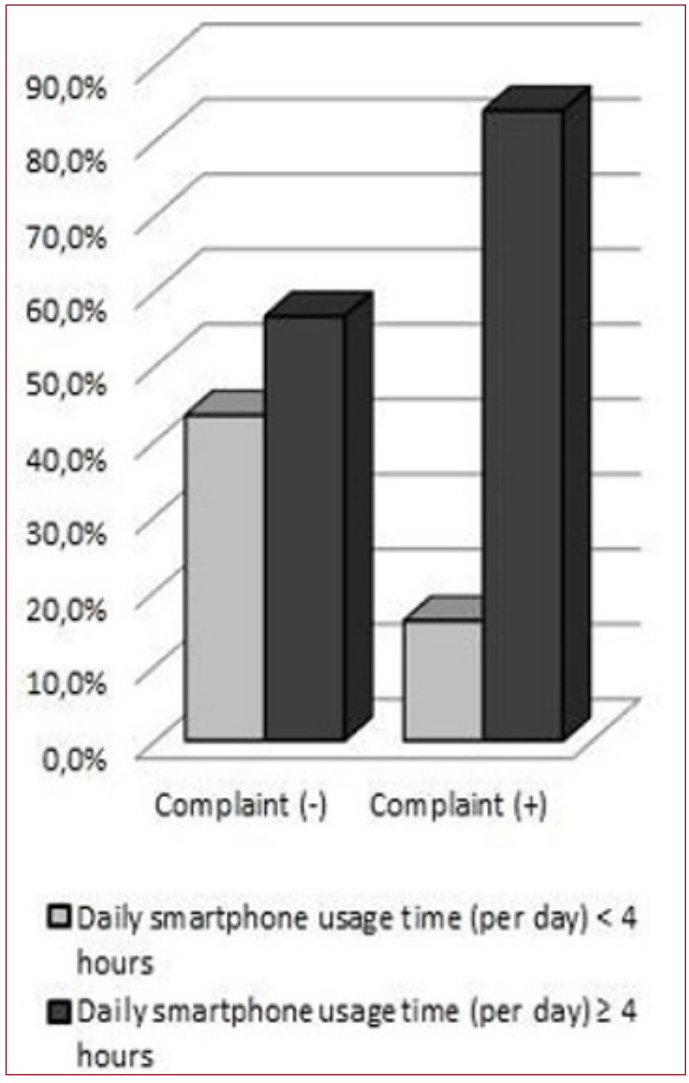

Figure 2a: The graph comparing daily smartphone usage time of patients with and without complaints related fifth finger.

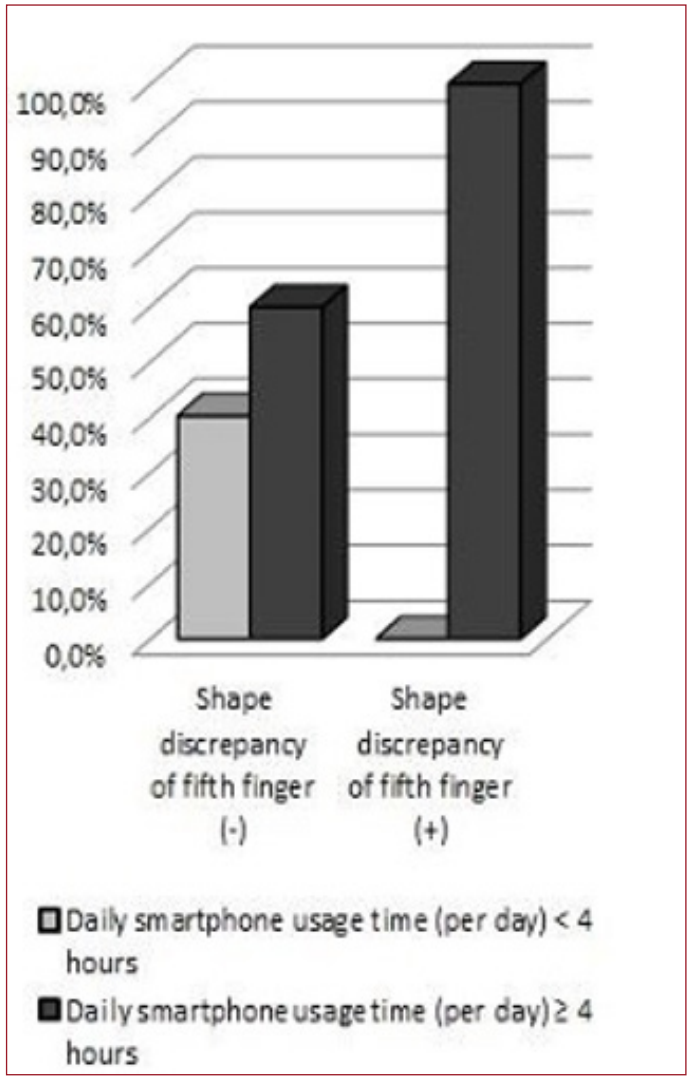

Figure 2b: The graph comparing daily smartphone usage time of patients with and without shape discrepancy of little finger.

Tablo 3: Relationship between parameters and daily smartphone usage time.

	Daily smartphone usage time (per day) < 4 hours		Daily smartphone usage time (per day) ≥ 4 hours		p
	Mean±s.s./n-%	Median	Mean±s.s./n-%	Median	
Age	29,6±7,1	32,0	28,1±7,5	27,0	0,366 m
Gender					
Female	9,0	24,3%	22,0	34,4%	0,291 x2
Male	28,0	75,7%	42,0	65,6%	
Height	174,5±6,8	174,0	172,0±7,4	172,5	0,101 m
Weight	76,6±16,3	78,0	74,5±14,5	75,0	0,178 m
BMI* (kg/m2)	25,1±4,8	25,4	25,1±4,2	24,9	0,485 m
Educational Status					
Highschool	27,0	73,0%	34,0	53,1%	
College	5,0	13,5%	9,0	14,1%	0,085 x2
Faculty	5,0	13,5%	21,0	32,8%	
Smartphone Weight (gr)	161,3±19,3	167,0	161,6±21,2	167,0	0,930 m
Smartphone Display Size (Inch)	5,4±0,9	5,5	5,4±0,6	5,5	0,465 m
DIP- Radiography (Degree of angulation)	4,2±3,9	3,6	4,2±3,2	3,7	0,472 m
DIP- Photo (Degree of angulation)	4,3±1,7	4,3	7,3±3,1	6,5	0,207 m

m Mann-Whitney U test / x2 Chi-square test, BMI*: Body mass index

One holding technique, where the smartphone is supported by the medial border of the fifth finger, might contribute to the observed discrepancy. In our study, we did not investigate holding techniques, and participants were not asked about their preferred holding technique, representing a limitation of our research. Contrary to Fuentes-Ramirez et al., who found no significant differences between the asymmetry of the fifth finger and daily usage time or years of ownership,[11] our study revealed a significant association between daily smartphone usage time and the shape discrepancy of the fifth finger.

In a recent study conducted by Toh et al., the association between mobile touch screen devices (smartphones, tablets) and musculoskeletal symptoms and visual health was investigated in participants under 18 years old.[18] The authors reported that increased smartphone or tablet usage duration did not predict a higher risk of experiencing musculoskeletal symptoms, contrary to some previously published articles.[19-21]

In our study, participants with a shape difference in their fifth finger had significantly longer daily smartphone usage time than those without. A difference in shape was observed in 9 out of 64 participants who used a smartphone for more than 4 hours a day. Unlike other studies, our sample consisted of participants over the age of 18.

Amjad et al. investigated the frequency of wrist pain among students who use mobile phones.[22] They concluded that the duration of phone usage had a significant association, while screen size did not. Similarly, in our study, we found significance in smartphone usage time exceeding 4 hours. No significant difference was found between smartphone size and weight and the discrepancy of the fifth finger.

A study conducted by Berolo et al. reported musculoskeletal symptoms in the thumb among a university population who spent over 3.5 hours/day on their smartphones.[9] The study primarily focused on university students, including some staff and faculty members. Participants were asked about the duration of time spent on their phones on a typical day.

In addition to daily usage time, the participants in our study were not asked about the number of years they had been using their smartphones. Although we included participants who had used a smartphone for at least one year, we did not conduct a statistical evaluation based on the total number of years the phone had been used, representing another limitation of our study. Nevertheless, the observation that the average age was higher in participants with shape discrepancies suggested that individuals who use smartphones for a longer duration might be at a higher risk, albeit indirectly.

Furthermore, we investigated whether educational status affects the shape discrepancy of the fifth finger. Although the average daily phone use was higher among high school graduates, this difference was not statistically significant.

Limitations of the Study

The sample size was small. We did not investigate the holding technique, and we also did not conduct a statistical evaluation based on the total number of years the phone had been used. Additionally, participants were not asked which holding technique they used most frequently, which is another limitation of our study.

CONCLUSION

Taking into consideration all the data from our study, it can be observed that, even if no radiological findings are detected in individuals who use their phones for more than 4 hours daily, shape deformities in soft tissue may lead to pain and visual discomfort in the patient. New studies correlating muscle strength, grip force measurements, and various imaging techniques will guide us in this regard..

ETHICAL DECLARATIONS

Ethics Committee Approval: This study was approved by the Kutahya Health Sciences University Faculty of Medicine Non-interventional Clinical Researches Ethics Committee (Decision No: 2019/11-17, Date: 05.11.2019)

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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