Comparison of Therapist-Supervised and Home Exercise Calisthenics Exercises in Post-Covid Syndrome: A Single Blind, Randomized Controlled Trial

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Abstract

Aim: Post-Covid syndrome (PCS) is a condition that becomes chronic after the acute phase of Covid-19 and affects systems such as respiratory, cardiovascular, nervous, and musculoskeletal, and negatively affects patients' quality of life (QoL). The aim of this study was to investigate the effect of calisthenics exercises on QoL in patients with PCS.

Method: A total of 176 patients (male: 82, female: 94) with PCS were included and randomized to therapist-supervised and home exercise groups in this study. The calisthenics exercise program was carried out for eight weeks in both groups. QoL was assessed by the European Quality of Life 5-Dimensional 3-Level (EQ-5D-3L) questionnaire at baseline and after eight weeks.

Results: Significant improvements were obtained in all parameters of the EQ-5D-3L scale, including mobility, self-care, usual activities, pain/discomfort, anxiety/depression and general health score ($p<0.05$) in both therapist-supervised and home exercise groups. When therapist-supervised and home exercise groups were compared in terms of EQ-5D-3L, no significant difference was found between these groups ($p>0.05$).

Conclusion: Calisthenics exercises cause a significant increase in the QoL in patients with Post-Covid syndrome when administered both as a therapist-supervised and home exercise program.

Keywords: Calisthenics, COVID-19, post-acute COVID-19 syndrome, long COVID, quality of life.

Post-Covid Sendromunda Terapist Gözetiminde ve Evde Yapılan Kalistenik Egzersizlerinin Karşılaştırılması: Tek Kör, Randomize Kontrollü Bir Çalışma

Öz

Amaç: Post-Kovid sendromu (PKS), Covid-19'un akut fazından sonra kronikleşen, solunum, kardiyovasküler, sinir ve kas-iskelet sistemlerini etkileyen ve hastaların yaşam kalitesini olumsuz yönde etkileyen bir durumdur. Bu çalışmanın amacı, PKS'li hastalarda kalistenik egzersizlerin yaşam kalitesi üzerindeki etkisini araştırmaktır.

Yöntem: Bu çalışmaya toplam 176 PKS'li hasta (erkek: 82, kadın: 94) dahil edilmiş ve terapist gözetiminde ve evde egzersiz gruplarına randomize edilmiştir. Her iki grupta da sekiz hafta boyunca kalistenik egzersiz

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ETHICAL STATEMENT: Ethical approval was obtained from Igdır University Non-Interventional Clinical Research Ethics Committee (Date of approval: 25.10.2023, Decision number: 2/3).

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programı uygulandı. Yaşam kalitesi, başlangıçta ve sekiz hafta sonra Avrupa Yaşam Kalitesi 5 Boyutlu 3 Seviye (EQ-5D-3L) anketi ile değerlendirilmiştir.

Bulgular: EQ-5D-3L ölçeğinin mobilite, öz bakım, olağan aktiviteler, ağrı/rahatsızlık, anksiyete/depresyon ve genel sağlık skorunu içeren tüm parametrelerinde hem terapist gözetiminde hem de evde egzersiz gruplarında anlamlı iyileşmeler elde edildi ($p<0.05$). Terapist gözetimindeki ve ev egzersiz grupları EQ-5D-3L açısından karşılaştırıldığında, bu gruplar arasında anlamlı bir fark bulunmamıştır ($p>0.05$).

Sonuç: Kalistenik egzersizler hem terapist gözetiminde hem de evde egzersiz programı olarak uygulandığında Post-Covid sendromlu hastalarda yaşam kalitesinde anlamlı bir artışa neden olmaktadır.

Anahtar Sözcükler: Kalistenikler, COVID-19, post-akut COVID-19 sendromu, uzamış COVID, yaşam kalitesi.

Introduction

Post-Covid syndrome (PCS) includes some symptoms that persist for twelve weeks or more after the acute phase of Covid-19 and are not associated with other health problems[1]. Time classification has been proposed for PCS; sub-acute Covid-19 symptoms refer to symptoms that occur four to twelve weeks after acute Covid-19, while chronic Covid-19 symptoms refer to symptoms that occur after twelve weeks and cannot be associated with any other health problems[2]. It should be emphasized that the findings can be seen not only in Covid-19 patients treated in the hospital but also in patients treated at home.

Previous research showed that long-term results affecting such as respiratory, cardiovascular, central nervous, and musculoskeletal systems may be encountered[3,4]. Although dyspnea, decreased exercise capacity, and hypoxia are among the most common symptoms, decreased glomerular filtration rate, subacute thyroiditis, palpitation, chest pain, fatigue, myalgia, headache, dystonia, cognitive impairment, anxiety, depression and sleep disorders may also be seen[5-7]. It investigated the effects of PCS on physical capacity, fatigue and quality of life (QoL) and reported that patients with PCS showed decreased physical capacity and QoL[8]. Similarly, it was suggested that more research is needed into multimodal treatment approaches for individual performance in order to decrease fatigue and thereby increase physical capacity and QoL[9].

Calisthenics is a type of exercise that uses body weight, usually without equipment. This type of exercise is highly effective in increasing muscle strength, endurance, and flexibility. Calisthenics are dynamic sets of exercises with rhythmic characteristics that can increase aerobic capacity and use agonist-antagonist muscle groups together[10]. As well as contributing to health-related physical capacity parameters (endurance, muscle strength, flexibility, posture), calisthenics has a positive effect on parameters such as balance, proprioception, agility, cognitive function and psychomotor skills. In addition, the fact that no special equipment is needed, that it can be done anywhere as a home exercise program, is one of the important advantages of calisthenics. At the same time, the rate of injuries caused by calisthenics is quite low[11].

Exercise interventions, which have been used for the decline in physical capacity and QoL, have also started to be used to combat the symptoms that occur after PCS[12]. For this purpose, home exercise training, tele-rehabilitation, robotic rehabilitation, and therapist-supervised exercise training have come to the fore[13-15]. The positive effects of

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exercise on both the cardiovascular system and the musculoskeletal system have led to studies on which exercise intervention will be more effective after PCS.

In this study, it was hypothesized that calisthenics may be effective on the QoL of patients with PCS. It was aimed to investigate the effect of calisthenics on QoL with therapist-supervised and home exercises in patients with PCS.

Materials and Methods

Study Design

Participants signed an informed consent form prior to enrolment and the details were clearly explained. This randomized controlled trial used a quantitative approach with a pre- and post-test design to compare the effect of calisthenics on QoL in patients with PCS in the form of a therapist-supervised and a home-exercise program.

Participants

Participants who had previously been infected with Covid-19 and had symptoms for twelve weeks or more despite resolution of the infection, and who presented to the clinic and met the eligibility criteria, were invited to participate in this study. Confirmation that participants had previously been diagnosed with Covid-19 and had a positive polymerase chain reaction (PCR) test was verified with patient consent through the national health system. Participants were informed of the content of the study and of their rights to withdraw from the study without giving a reason. Written informed consent was obtained from each patient prior to enrolment.

Inclusion and Exclusion Criteria

Inclusion criteria for the study: Aged between 18 and 65 years, with a history of Covid-19 infection and Post-Covid symptoms for 12 weeks or longer. Exclusion criteria: Pregnancy, having received physiotherapy within the last six months, having been diagnosed with another acute or chronic disease.

Randomization: Patients who met the study inclusion criteria were asked to choose a number between 1-176 from the numbered papers in a closed box, and the number chosen was recorded and then randomly distributed to both groups using computer software (www.randomizer.org). This process was completed by one of the researchers. This researcher was not involved in the assessment and intervention process. In this trial, the therapist-supervised and the home-based exercises were carried out by physiotherapists, while the assessment was carried out by a different physiotherapist at baseline and at the end of week eight, to ensure single-blinding (assessor blinding).

Assessment

The participants' physical characteristics, such as age, gender, height and weight, were first recorded and then their body mass index (BMI) was calculated. The symptoms experienced by the participants were also recorded. In this study, the EQ-5D-3L (European Quality of Life 5-Dimensional 3-Level) questionnaire was administered to the participants before and after the exercise intervention[16,17]. This questionnaire consists of five dimensions describing different aspects of health: Mobility, self-care, usual daily activities, pain/discomfort, and anxiety/depression). Each dimension has three levels and is completed by checking one of the boxes: no problems, some problems and extreme

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problems. Finally, patients were asked to rate the general health score out of 100. The Turkish validity and reliability study of the questionnaire was conducted by Kahyaoglu and Unsar (2011)[18].

Intervention

The American College of Sports Medicine (ACSM) guidelines for chronic obstructive pulmonary disease and cardiovascular diseases were used to determine type, duration and intensity of exercise intervention[19]. The exercise program was initially planned for three days per week, one session per day, with three repetitions of each calisthenics exercise. The number of repetitions was increased by one each week to gradually increase the calisthenics. At week eight, each exercise was performed with 10 repetitions. The exercise program included in both the therapist-supervised and home exercise groups is shown in Table 1.

Table 1. Exercise program for therapist-supervised and home exercise groups

Warm-up	Calisthenic Exercises	Cool-down
Stepping back with raised arms	Jumping Jack	Low pace walking
Chest expansion	Burpee	
Side jack	Mountain climber	
Hip rotations	Squat Thrust	
Arm circles	Squat	
Neck tilt	Jump squat	
	Split jump	
	Plank	

The exercise program consists of three phases: Warm-up period, calisthenics and cool-down period. The warm-up exercises consisted of stepping back and forth with raised arms, side jack, hip rotations, arm circles and neck tilt. Calisthenics consisted of jumping jacks, burpees, mountain climbers, squat thrusts, squats, squat jumps, split jumps, and plank. Cool-down exercises consisted of low-tempo walking for 5 minutes.

Pre-exercise warm-up exercises are performed to achieve optimum performance and maintain muscle temperature without burning energy reserves[20]. Warm-up exercises consisted of 5-minute dynamic warm-up exercises. The cooling exercise was determined as walking at a low pace for 5 minutes in the corridor. Active cool-down exercise is more effective than the passive cooling method to support recovery after exercise[21]. Therefore, the cool-down exercises were composed of dynamic exercises.

The Borg CR-10 scale was used to determine exercise intensity in the therapist-supervised and home exercise groups[22]. The Borg CR-10 scale is a numerical scale ranging from 0-10 (nothing to very difficult) and measures the exertional dyspnea experienced by patients during exercise[23]. Patients were fully instructed that the intensity of the exercise should be completed at level 5 (difficult) on the Borg CR-10 scale. In accordance with the Borg CR-10 scale, patients were allowed to slow down the pace of their exercise when they reached a level of 5 on this scale, focusing on feelings of exertion

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such as shortness of breath and exertion during exercise. The scale is easy to understand and can be maintained by the researcher or the patient.

A training program and booklet on how to do the exercises were produced for the home exercise group. The booklet included visuals of the exercises and detailed explanations of how to perform them. An exercise diary was provided for the participants to follow and they were asked to complete the exercise program. At the end of the study, the exercise diaries were submitted to the researchers by the participants. In order to verify the follow-up of the home exercise program, the participants were interviewed every week via video call on phones.

Ethical Statement

This prospective and randomized controlled trial was completed at the Physical Therapy Laboratory of Avrasya University between January and December 2024 in accordance with the Declaration of Helsinki. Ethical approval was obtained from Igdır University Non-Interventional Clinical Research Ethics Committee (Date of approval: 25.10.2023, Decision number: 2/3). The clinical trial number was NCT06568393.

Statistical Analysis

Sample size calculations were performed using G*power software (version 3.1.9.6). Effect size d:0.5, alpha level 0.05 and power: 95% were selected. At least 176 subjects were considered eligible for statistical analysis. The Statistical Package for the Social Sciences (SPSS) (version 28.0.1 MAC) was used for data analysis. Quantitative variables were expressed as mean ± standard deviation (SD) and qualitative variables as number (n) and percentage (%). Normality analysis was performed using the Kolmogorov-Smirnov test. When comparing two groups, the independent samples t-test was used if the parametric assumption was met. When comparing intra-group variables, the paired samples t-test was used when the parametric test assumption was met. The level of statistical significance was accepted as $p<0.05$.

Results

The random allocation of enrolled participants to groups, the number of participants who received treatment and were analyzed for the primary outcome, and the number of participants who were excluded and dropped out of the study is shown in Figure 1.

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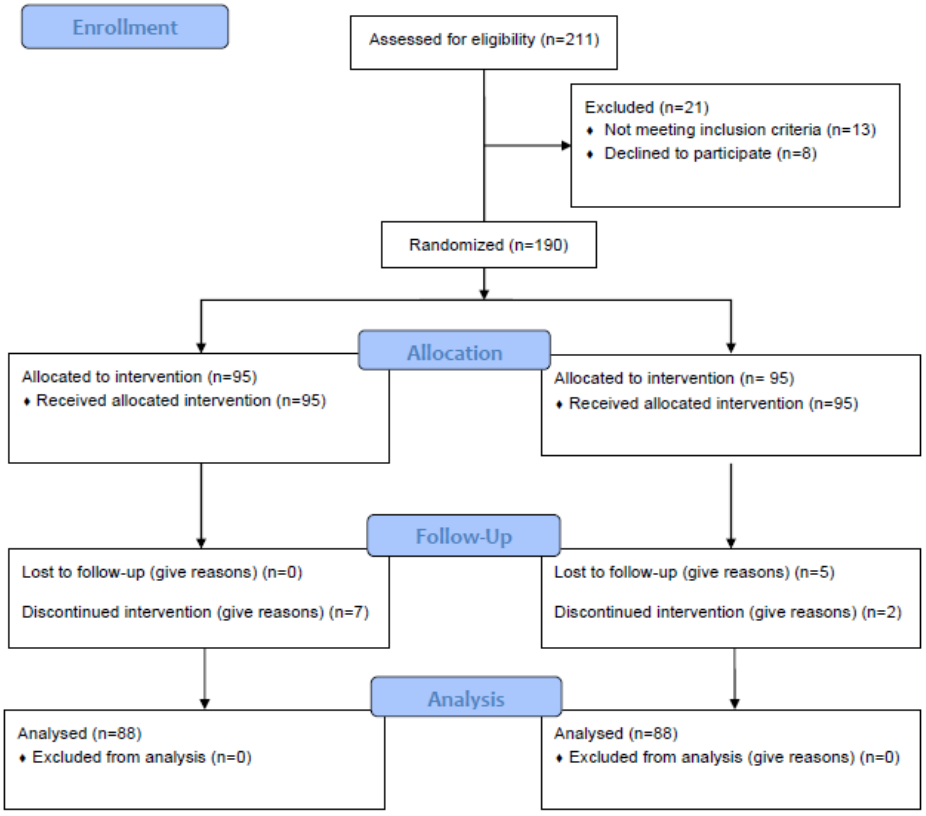
Figure 1. Flow diagram of the study.



The physical characteristics of the patients included in the study were shown in Table 2. The physical characteristics of the participants were similar (p>0.05) in this study.

Table 2. Physical characteristics of the participants

	Home exercises	**Calisthenic Exercises**		
Baseline	**n=88**	**n=88**		
Variables	**Mean ±SD**	**Mean ±SD**	**t**	**p**
Age (year)	33±6.56	35±7.04	1.220	.273
Height (cm)	168±7.95	167±7.19	.094	.759
Weight (kg)	61±10.89	60±8.73	1.178	.281
BMI (kg/m²)	21±2.72	21±7.78	1.193	.662
Gender	**n (%)**	**n (%)**	**X²**	**p**
Male	42 (52%)	40 (55%)	17.556	732
Female	46 (48%)	48 (45%)		

¹n: number of participants, X2: chi-square, t: independent samples t test, BMI: Body Mass Index, p>0.05

In Table 3, the EQ-5D-3L sub-parameters scores were compared between the therapist-supervised and the home exercise groups at baseline and after eight weeks. At baseline, the therapist-supervised exercise and home exercise groups were similar in terms of mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and general health score (p>0.05). After 8 weeks of exercise program, no significant difference was

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found between therapist-supervised exercise and home exercise programs in terms of mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and general health score (p>0.05).

Table 3. Comparisons of home exercises and calisthenics exercises groups

	EQ-5D-3L	**Group 1 Home exercises Mean ±SD**	**Group 2 Calisthenics Mean ±SD**	**t**	**p**
Before Treatment	**Sub-parameters**				
	Mobility	2.08±0.68	2.00±0.66	8.554	0.120
	Self-care	2.24±0.64	2.03±0.72	1.274	0.113
	Usual activities	2.27±0.5	2.14±0.63	7.174	0.063
	Pain/Discomfort	2.27±0.56	2.22±0.63	4.651	0.054
	Anxiety/Depression	2.22±0.67	2.27±0.69	5.052	0.072
	Score	58.54±18.88	57.97±22.84	-7.642	0.211
After Treatment	**Sub-parameters**	**Group 1 Home exercises Mean ±SD**	**Group 2 Calisthenics Mean ±SD**	**t**	**p**
	Mobility	1.32±0.58	1.30±0.46	5.265	0.869
	Self-care	1.16±0.5	1.19±0.39	6.159	0.058
	Usual activities	1.24±0.49	1.35±0.53	0.927	5.749
	Pain/Discomfort	1.49±0.6	1.49±0.5	5.556	0.870
	Anxiety/Depression	1.57±0.55	1.68±0.53	4.586	0.89
	Score	75.78±18.03	68.57±24.09	-1.959	0.982

P-values are derived from the Independent Samples T-test. Standard deviation (SD), p>0.05.

In Table 4, the EQ-5D-3L sub-parameters scores were compared between the therapist-supervised and home exercise groups at baseline and after eight weeks. In the home exercise group, a significant difference was observed in mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and general health score after an 8-week exercise program compared to baseline (p<0.05). In the therapist-supervised group, a significant difference was observed in mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and general health score after an 8-week exercise program compared to baseline (p<0.05).

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Table 4. Comparison of EQ-5D-3L parameters of the groups.

Group 1 Home exercises	**Baseline (Mean ±SD)**	**After treatment (Mean ±SD)**	**t**	**p**
Mobility	2.08±0.68	1.32±0.58	5.334	0.024*
Self-care	2.24±0.64	1.16±0.5	7.628	0.003*
Usual activities	2.27±0.5	1.24±0.49	9.687	0.012*
Pain/Discomfort	2.27±0.56	1.49±0.6	5.581	0.034*
Anxiety/Depression	2.22±0.67	1.57±0.55	4.998	0.025*
Score	58.54±18.88	75.78±18.03	-3.642	0.001*
Group 2 Calisthenics	**Baseline (Mean ±SD)**	**After treatment (Mean ±SD)**	**t**	**p**
Mobility	2.00±0.66	1.30±0.46	5.502	0.002*
Self-care	2.03±0.72	1.19±0.39	5.676	0.005*
Usual activities	2.14±0.63	1.35±0.53	6.354	0.001*
Pain/Discomfort	2.22±0.63	1.49±0.50	7.304	0.044*
Anxiety/Depression	2.27±0.69	1.68±0.53	3.782	0.001*
Score	57.97±22.84	68.57±24.09	-3.181	0.003*

P-values are derived from the Paired Samples T-test. Standard deviation (SD), *p<0.05

Discussion

In this study, there were some improvements in the therapist-supervised and home exercise groups after calisthenics compared to the baseline EQ-5D-3L scale. In general, there was no difference between the therapist-supervised and home exercise program in terms of EQ-5D-3L scores. This may be related to the fact that the physiotherapists explained the exercises practically to the home exercise group at the first interview and the exercise follow-up was done successfully with phone calls to the patients.

The decrease in functionality and QoL associated with reduced cardiorespiratory capacity and muscle strength in patients with PCS necessitates exercise intervention. Barbagelata et al. (2021) found that patients with PCS had a lower maximal oxygen volume and lower anaerobic threshold in cardiopulmonary exercise testing (CPET) compared to healthy individuals[24]. Aparisi et al. (2021) investigated the clinical sequelae of patients with PCS, using CPET, echocardiogram, pulmonary function test, six-minute walking test (6MWT) and QoL questionnaire for the patients. A significant decrease was found in maximal oxygen volume, 6MWT and QoL questionnaire in patients with PCS compared to healthy participants[25]. Tryfonos et al. (2024) compared the exercise test results of patients with PCS and healthy participants and similarly found decreased aerobic capacity and muscle strength in patients with PCS compared to healthy participants[26].

Previous studies have shown some improvements from exercise interventions in people with PCS[27-29]. Jimeno-Almazan et al. (2022) investigated the effects of a supervised resistance exercise program and an unsupervised aerobic exercise program on QoL,

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fatigue and depression in thirty-nine patients with PCS. One group received combined resistance training under the supervision of a therapist for eight weeks, while the other group was advised to perform unsupervised aerobic exercise five days a week and ten repetitions of strength exercises three times a week[30]. As a result of the study, significant improvements were obtained in QoL, fatigue, and perceived depression symptoms parameters in the therapist-supervised exercise training group compared to the unsupervised group. Compagno et al. (2022) found that exercise and psychological support training had positive effects on lower and upper extremity muscle strength, cardiopulmonary parameters, depression, and anxiety, in which exercise and psychological support training were given as a holistic rehabilitation program in patients with PCS in their study[31]. Similarly, significant improvements were obtained in the EQ-5D-3L scale in both the therapist-supervised and home exercise groups in this study.

The chronic inflammation in the formation of the PCS pathogenesis occurs when the post-infectious inflammation is considered as a multisystem inflammatory syndrome and explains the symptoms[32]. Serum levels of inflammatory cytokines have been found to be higher in patients with PCS, and there was an association between PCS-related chronic fatigue symptoms and an elevated neutrophil count[33]. The primary therapeutic effect of calisthenics is a decrease in inflammatory cytokine levels[34]. Regular exercises could reduce levels of pro-inflammatory cytokines and TNF-α[35]. Calisthenics may also increase levels of peroxisome proliferator-activated receptor-γ coactivator 1α (PGC-1α), which regulates human homeostasis[36]. Therefore, calisthenics exercises were chosen as a response to Post-Covid syndrome in this study.

Calisthenics have also been found to be effective on QoL in other diseases. Tıglı et al. (2020) investigated the effect of calisthenics on QoL after renal transplantation with the general QoL short form (SF-36) and renal disease QoL questionnaires (KDQOL-SF) in patients[37]. As a result of the eight-week exercise program, an increase was observed in the social function of QoL and patient satisfaction level. Probst et al. (2011) compared the effects of high-intensity endurance and strength programs with calisthenics and respiratory exercises on chronic obstructive pulmonary disease (COPD) and found that both exercise methods showed significant improvement in health-related QoL[38]. Another study investigated the effectiveness of hospital-based and home-based exercise programs in patients with multiple sclerosis[39]. It was found that there was a significant improvement in QoL at the end of the twelve-week exercise program in the therapist-supervised and home exercise groups, but no difference was found between the groups. In this study, similarly, significant improvements were observed in therapist-supervised and home exercise groups, but no difference was found between the therapist-supervised and home exercise groups.

Limitations

The strength of this study is that calisthenics exercises were actively practiced in the control group. However, our study has some limitations. The first limitation of the study was that a single scale was used to compare therapist-supervised and home exercise interventions. The second limitation is that blinding was done only during the assessment. The third limitation was the small number of participants.

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Conclusions

In this study, the provision of exercise training in the form of either therapist-supervised or home-based exercise training led to an improvement in patients' QoL. This also suggests that the correct delivery of home exercise training can be as effective as the therapist-supervised program. After the Covid-19 pandemic, we are still investigating the effects of PCS, and the use of different exercise methods will lead to selective behaviour in the choice of training in larger populations.

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