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Differences Between Multicomponent Exercise and Concurrent Exercise on Reducing Frailty Risk in The Elderly in Karangasem

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ABSTRACT

The worldwide population of older adults is growing, which may yield a demographic bonus; yet, this growth simultaneously heightens frailty risk among the elderly. The dynamic and reversible nature of frailty provides opportunities and challenges in overcoming the aging process. Multicomponent exercise and concurrent exercise are two prominent forms of exercise in elderly exercise programs to reduce frailty risk. This research was to prove the difference in the effect of multicomponent exercise and concurrent exercise on reducing frailty risk in the elderly in Karangasem. Pre and post-test two group methods were used in this study's true experimental design. Twenty-two participants were chosen by a simple random sample technique and subsequently divided into two groups: the multicomponent exercise group (n = 11) and the concurrent exercise group (n = 11). The exercises were given 3 times for 8 weeks. Frailty risk was assessed based on the Fried's Frailty Phenotype criteria. The Paired Sample T-test results indicated a significant difference in frailty risk reduction before and after exercise in both the multicomponent exercise group ($p = 0.001$; $p < 0.05$) and the concurrent exercise group ($p = 0.001$; $p < 0.05$). The Independent Samples T-test results indicated no significant difference in frailty risk reduction between the multicomponent exercise group and the concurrent exercise group ($p = 0.318$; $p > 0.05$). Based on the study's findings, multicomponent exercise and concurrent exercise are equally good in reducing frailty risk in the elderly in Karangasem.

Keywords: Multicomponent Exercise, Concurrent Exercise, Frailty Risk, Elderly

1. INTRODUCTION

Indonesia is currently experiencing a population aging phenomenon, where a region is considered to have an elderly population structure if it exceeds 10 percent of the total population. This is based on data from the *Badan Pusat Statistik* (BPS), which shows that the proportion of the elderly population in Indonesia in 2023 is 11.75 percent, and specifically for Bali itself, it is approximatel 13.97 percent, making it the fourth province with an elderly population structure. Old age is a period of intensive and sensitive physical and psychological changes, in which degenerative processes reduce physical capabilities and health, thereby reducing productivity and quality of life. Consequently, the substantially old demographic in Indonesia may adversely affect the nation's social and economic conditions, as this age group is perceived as a "burden," relying on the productive age population for support. The burden is seen in the rise in the elderly dependence ratio relative to the productive-age population in 2020, increasing from 15.16 percent to 17.08 percent, indicating a growing financial obligation for the productive-age population to support the elderly [1]. In this case, physical fitness is considered a strong predictor of elderly health, which is determined by several components, such as muscle strength and endurance, cardiorespiratory fitness, body composition, and flexibility [2].

Muscle strength, a crucial factor in healthy aging, continues to decline in the number of motor units after the age of 60 years, leading to decreased muscle endurance, muscle contraction speed, and fatigue recovery. Decreased muscular strength and mass impair body functions, leading to difficulties in executing daily activities. This condition is commonly known as sarcopenia [3] and is a major contributor to frailty in the elderly[4]. Frailty is a geriatric symptom characterized by reduced resilience of the elderly to stress and various harmful agents that enter the body and disrupt the body's homeostatic balance [5]. Frailty is distinguished from disability but is conceptualized as a state of "predisability," which predicts a future decline in activities of daily living. Although the incidence of frailty increases with age, it is not considered equivalent to normal aging and is the result of multi system physiological dysfunction that reaches a threshold and becomes observable behaviour [6]. Based on reports covering 62 countries worldwide, the prevalence of frailty in the general population varies from 11% in people between the ages of 50 and 59 years to 51% in people aged 90 years or older [7]. Meanwhile, research by Pradana et al.[8] stated that among Indonesia's elderly population, the prevalence of prefrailty and frailty was 55.5% and 26.8%, respectively. Because prefrailty is an early but reversible sign of frailty, its high prevalence in Indonesia is especially concerning, as it can lead to negative health impacts such as increased immobility and risk of injury, as well as increased hospitalization and mortality rates in older adults.

Effective, time-efficient, and safe exercise protocols to improve these conditions should be designed for older individuals. Given that low muscle strength is a crucial factor owing to its strong correlation with sarcopenia and frailty, strength training has emerged as the most effective approach for increasing muscle strength and preventing sarcopenia[9], [10]. However, it should be noted that strength training alone may not yield significant benefits given that various physical abilities are crucial for maintaining functional independence in older adults[11]. Concurrent exercise, which combines strength and aerobic training, has been utilized extensively to improve muscle strength and cardiorespiratory fitness [7]. Research conducted by Cadore and Izquierdo [12] suggests that concurrent exercise is a more effective approach than strength or endurance training alone because of its potential to simultaneously impact multiple fitness components. In addition, Meng et al. [13] also demonstrated that concurrent exercise, whether supervised or home-based, can improve walking speed and muscle strength as well as reduce frailty risk in older adults.

It is crucial to remember that the risk factors included in the frailty concept also increase the likelihood of falls, which is a leading cause of impairment in the elderly[14]. Therefore, WHO advises integrating exercises for other physical components, such as balance training, in addition to strength and aerobic training [15]. Therefore, another approach to exercise programs is multicomponent exercise, which combines a wider variety of exercises (aerobic, resistance, balance, and flexibility exercises) and promises comprehensive improvement in overall physical fitness [16]. The lack of novelty (variety of exercises) in individual exercise routines may also be a major contributing factor to low participation in physical activity in the general population[17]. This vicious cycle may be overcome by providing a greater variety of multicomponent exercises. Furthermore, the benefits of multicomponent exercise programs in older adults have been extensively studied, including that conducted by Tarazona-Santabalbina et al.,[18] which showed a 31.4 percent reduction in the risk of frailty after a multicomponent exercise program and also found a significant decrease in the frailty biomarker (D-dimer) after the training program.

Despite some evidence highlighting the positive impact of both exercises on improving muscle strength in older adults, there is a lack of comparative research comparing multicomponent and concurrent exercises, particularly in reducing the risk of frailty. To date, no study has compared these two forms of exercise in terms of their effectiveness in reducing frailty risk in older adults. Furthermore, many exercise regimens currently developed in laboratory settings require costly equipment, which may limit their suitability for application in dynamic and diverse community situations[16]. Therefore, it is essential to understand the relative advantages of concurrent and multicomponent exercise programs in community settings to create evidence-based exercise recommendations for older adults[19]. Considering this context, the researchers were interested in further examining "Differences Between Multicomponent and Concurrent Exercise on Reducing Frailty Risk in the Elderly in Karangasem."

2. METHOD

The study had a pre- and post-test two-group randomized trial design and was approved by the Research Ethics Committee Faculty of Medicine Universitas Udayana with ethical clearance number 0859/UN14.2.2.VII.14 /LT/2025. Before the study began, all respondents received an explanation of the methods and advantages of the research. Participants in this study had to be around the ages of 60 and 74, have an MMSE score ≥ 24, be classified as pre-frail or frail based on the frailty phenotype (score 1–5), and be willing to be research subjects from start to finish by signing an informed consent form. Subjects who had medical conditions that hindered exercise and measurement, as determined by a physician regarding their medical history, such as grade 3-4 OA genu, cardiovascular disease, pain, as well as severe vision or hearing impairment, and currently participating in another training program were excluded from this study. Participants who meet the inclusion and exclusion criteria were selected as the research sample using a simple random sampling technique. The participants were allocated to a multicomponent exercise group or a concurrent exercise group using a stratified random assignment with characteristics of frailty risk status in group 1 being the same as in group 2.

Procedures

Each exercise began with a warm-up (range of motion exercises on the neck, shoulder, wrist, hip, knee, and ankle) for 5 minutes and ended with a cool-down (breathing exercise) for 5 minutes. The training session lasted approximately 70 min and was carried out three times per week for 8 weeks.

Multicomponent Exercise is a combination of four types of training consisting of aerobic, resistance, balance, and flexibility exercises performed in the same session by two physiotherapists. Aerobic exercise was performed by walking for 15 min at an intensity of approximately 50%–75% HRmax. Strengthening exercises for 20 min using a theraband and rubber ball with exercises consisting of crunch, leg press, lying leg curl, bicep curls, rowing, shoulder press, and hand grip exercises for 10 – 15 repetitions, 1 set, and 30 – 60 s rest intervals between sets [20], [21], [22]. Balance exercises for 15 minutes with exercises consisting of one-leg stand exercise (30 s × 2 sets), sit-to-stand (8 repetitions ×2 sets), tandem walking (6 m × 2 sets), side walking (6 m ×2 sets), and backward walking (6 m × 2 sets) [23]. Finally, stretching exercises were performed for 10 min, targeting the muscles of the neck, shoulder, elbow, wrist, back, abdomen, hip, knee, and ankle regions, with each stretching movement held for 10 s and 2 repetitions [18], [20].

Concurrent Exercise is a form of aerobic and resistance exercise performed in the same session by two physiotherapists. Aerobic exercise was performed by walking for 30 min at an intensity of approximately 50%–75% HRmax. and strengthening exercises are done for 30 minutes using theraband and rubber ball with exercises consisting of crunches, leg presses, lying leg curls, bicep curls, rowing, shoulder presses, and handgrip exercises for 10–15 repetitions, 1–2 sets and 30–60 seconds rest intervals between sets [20], [21].

Assessment

Frailty in the elderly is measured using a modification of Fried's frailty phenotype (FFP), which consists of five criteria: shrinking, exhaustion, weakness, slowness, and low physical activity. Shrinking/weight loss was assessed by self-reporting unintentional weight loss of 4.5 kg or more than 5% of the body mass in the past 12 months. Exhaustion criterion is based on the frequency of fatigue in the past week using two items from the Center for Epidemiological Studies-Depression Scale (CES-D), with at least one positive result from questions 7, "I felt that everything I did was an effort," and 20, "I could not get going.'' Weakness was assessed based on handgrip strength (GS) in kilograms, using a hand-held dynamometer adjusted for body mass index (BMI) and sex [24]. Slowness was assessed using the normal walking speed of 4.5 meters. Low physical activity was assessed by using the Indonesian version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF [25], [26].

Data analysis

Data analysis was performed using the statistical software SPSS version 25, where parametric testing was used for statistical analysis.

3. RESULTS AND DISCUSSION

3.1. Characteristics of research subjects

The initial characteristics of the research participants in the multicomponent exercise (ME) group and the concurrent exercise (CE) groups are shown in Table 1.

Table 1
Characteristics of research subjects

Characteristics	ME Group (n=11)	CE Group (n=11)	p-value
Age (years)			
(Mean ± SD)	66,64 ± 4,523	66,18 ± 4,238	0,758**
Gender, n (%)			
Male	4 (36,4)	5 (45,5)	1,000***
Female	7 (63,6)	6 (54,5)	
Cognitive Function (MMSE)			
(Mean ± SD)	26,73 ± 0,905	26,82 ± 0,874	0,813*
Weight (kg),			
(Mean ± SD)	51,00 ± 5,71	50,00 ± 6,841	0,714*
Height (cm),			
(Mean ± SD)	150,82 ± 6,4	150,73 ± 6,068	0,973*
Body Mass Index (kg/m^2)			
(Mean ± SD)	22,30 ± 1,21	21,88 ± 1,75	0,515*
Hand Grip Strength (kg)			
(Mean ± SD)	18,33 ± 5,93	18,34 ± 5,92	0,997*

Characteristics	ME Group (n=11)	CE Group (n=11)	p-value
Walking Speed (s)			
(Mean ± SD)	7,63 ± 1,24	7,02 ± 1,42	0,302*
Physical Activity (IPAQ-SF)			
(Mean ± SD)	496,09 ± 211,03	532,45 ± 210,24	0,690*
Fried's *Frailty* Phenotype			
(Mean ± SD)	2,36 ± 1,027	2,36 ± 1,027	1,000*
Pre-frail, n (%)	7 (63,6)	7 (63,6)	
Frail, n (%)	4 (36,4)	4 (36,4)	

* Independent Samples T-test
** Mann-Whitney U-test
*** Fisher's Exact test

Table 1 indicates that the subjects in both research groups had the same characteristics ($p > 0.05$). The age range of the participants in this study was between 60 and 74 years, which falls into the elderly category according to the WHO classification. An increase in a person's age affects the decline in physiological functions, and this significantly begins to occur at the age of 60. The prevalence for all frailty scales with a minimum age limit of ≥ 60 – 69 years results in an estimate of 16% for frailty and 45% for prefrailty; the age group 70 – 79 years had a prevalence of 20% for frailty and 49% for prefrailty; this proportion increased to 31% for frailty and 52% for prefrailty in the elderly aged 80 – 89 years. This proves that the degenerative processes associated with aging play an important role in the development of frailty in the elderly; therefore, age factors were considered in determining the age limits in this study [27].

The sex characteristics of the two groups in this study did not differ significantly. Differences in muscle strength and hormonal levels between women and men can affect frailty risk. This is evidenced by research showing that the prevalence of frailty among women is 15% (95% CI=14–17%) and that among men is 11% (95% CI=10–12%), indicating that women have a higher frailty risk compared to men [27].

From the perspective of cognitive function, the subjects in this study had normal cognitive function based on the MMSE assessment. Since frailty and cognitive impairment frequently coexist in the elderly, numerous studies have proven that frailty is a substantial predictor of future cognitive impairment, and that frailty and cognitive impairment are significantly correlated [28]. Based on these studies, it is important to determine the normal cognitive status of the elderly in this study, as normal cognitive function also greatly supports the elderly in understanding the instructions given during this study.

The average BMI of the study participants was within the normal range. Based on recent research, frailty is considered a wasting disorder, which aligns with the presence of weight loss in its evaluative criteria, because a significant pathophysiological characteristic of frailty is the reduction in skeletal muscle mass. Moreover, obesity and an increased waist circumference correlate with systemic inflammation and insulin resistance, all of which have been demonstrated to be associated with a heightened risk of frailty. This has been proven by Yuan et al.,[29] who showed that obesity and underweight are correlated with an increased frailty risk.

Based on the hand grip strength (HGS) measurement results, the study participants were classified as having weak muscle strength. Weak hand-grip strength is a key indicator of sarcopenia and is strongly linked to a number of clinical outcomes, such as overall morbidity and mortality [30], [31]. Age-related declines in muscle function are congruent with studies that indicate that low hand grip strength is present in 7.9% of males aged 60-69, rising significantly to 25% and 52.9% in the 70-79 and 80-89 age groups, respectively. Meanwhile, low hand grip strength is progressively more common among women, with proportions of approximately 10.4%, 29.7%, and 69% in the 60–69, 70–79, and 80–87 years age groups, respectively [30]. The research conducted by Seko et al.[32] found that hand grip strength was a significant factor associated with prefrailty (OR 0.92, 95% CI 0.88–0.97).

The average walking speed of the participants in this study fell into the low category. The proportion of older adults who went from being non-frail to frail based only on the slowness (walking speed) criterion increased from 15.8% to 18.1% in the general population and from 17.6% to 25% in those with impaired cognitive function [33]. The research conducted by Zhou et al.[34] also supported previous research demonstrating that the most significant predictor of frailty risk was walking speed (OR, 0.082; 95% CI, 0.0070.947).

Physical activity levels of the study participants ranged from low to moderate. Based on research conducted by Langhammer et al.,[15] physical activity is any movement of the body caused by skeletal muscles that requires a source of energy. Low physical activity levels cause skeletal muscles to experience decreased muscle mass (atrophy). Consequently, low physical activity and dependence on daily activities are more common among older adults. Physical activity that tends to decrease with age affects the physical fitness of the elderly, such as reduced aerobic endurance, muscle strength, and balance, which are related to increased frailty risk, higher fall risk, and decreased quality of life [35].

3.2. Multicomponent Exercise and Concurrent Exercise Can Reduce Frailty Risk in the Elderly

Data distribution before and after training in the multicomponent and concurrent exercise groups based on the McNemar Test are shown in Table 2.

Table 2
Distribution of Data Before and After Training in the Multicomponent Exercise and Concurrent exercise Group

Data Group	ME Group (n=11)			CE Group (n=11)		
	Pre-test	Post-test	p-value	Pre-test	Post-test	p-value
Frailty Criteria						
Shrinking	1 (9,1)	1 (9,1)	1,000	2 (18,2)	2 (18,2)	1,000
Exhaustion	6 (54,5)	2 (18,2)	0,125	7 (63,6)	2 (18,2)	0,063
Weakness	11 (100)	7 (63,6)	0,125	11 (100)	8 (72,7)	0,250
Slowness	6 (54,5)	1 (9,1)	0,063	6 (54,5)	5 (45,5)	1,000
Low Physical Activity	2 (18,2)	1 (9,1)	1,000	0 (0)	0 (0)	-

Based on the distribution of data before and after training in Table 2, each frailty criterion in the multicomponent exercise did not show significant differences before and after training ($p > 0.05$).

Analysis of the difference in frailty risk reduction results before and after treatment was conducted in each group using the paired sample t-test, and the results are shown in Table 3.

Table 3
Results of the Mean Difference Test of Frailty Risk Before and After Training

Data Group	Pre-test	Post-test	Mean Difference	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
ME Group (n=11)	2,36 ± 1,027	1,09 ± 0,944	1,27 ± 0,467	0,001
CE Group (n=11)	2,36 ± 1,027	1,55 ± 1,128	0,81 ± 0,603	0,001

Table 3 indicates that the elderly given the multicomponent exercise treatment showed a statistically significant reduction in frailty risk with a p-value of 0.001 ($p < 0.05$), as did the elderly given concurrent exercise treatment, which also showed a significant reduction in frailty risk with a p-value of 0.001 ($p < 0.05$).

Multicomponent exercises have been recommended for frail older adults [36], [37]. Chiu and Yu [38] showed that multicomponent exercise can reduce frailty risk by reducing frailty risk assessment scores in older adults. The proportion of frailty decreased from 13% to 8.7% after 3 months of intervention, then to 5.8% after 6 months of intervention. Furthermore, Chiu and Yu [38] found that multicomponent exercise performed for 12 weeks could improve physical performance indicators and increase cardiorespiratory endurance in older adults. Poli et al.[39] demonstrated that multicomponent exercise is more effective than aerobic exercise alone in increasing lower limb strength and handgrip strength. This is because multicomponent exercise can stimulate muscle hypertrophy and neuromuscular adaptations that lead to increases in lower limb and handgrip strength, along with improved motor unit recruitment and synchronization. Research conducted by Wolf et al.[40] compared multicomponent exercise (gait, strength, balance, aerobic, and stretching) with strengthening exercise alone in elderly women, and found that stride length and walking speed improved only in the multicomponent exercise group. Therefore, improvements in multicomponent exercise imply that training programs targeting many major muscle groups that are comparable to everyday activities may be more effective in enhancing functional capacity and, eventually, lowering the risk of frailty in older adults [39].

The results for the concurrent exercise group showed a significant difference in frailty risk before and after treatment ($p<0.05$). Research conducted by Slobodová et al.[41] demonstrated that three months of concurrent exercise and education about the health benefits of an active lifestyle led to a decrease in sedentary behavior by improving functional capacity and motivation to engage in more physical activity on a daily basis. Regular exercise may increase walking speed, because it can influence body weight, muscular mass, and metabolic and motor performance in various populations. This is in line with the results of the study by Meng et al.,which [13] compared concurrent home and supervised exercise and showed that both exercise programs improved walking speed and handgrip strength. Furthermore, Díaz et al.[42] found that the prevalence of frailty in older adults with diabetes can be decreased by combining aerobic activity (walking for 30 min) with strengthening exercise (using a Theraband). Thus, improvements in concurrent exercise suggest that training programs involving aerobic and resistance exercises can improve frailty in the elderly population.

3.3. Multicomponent Exercise and Concurrent Exercise Are Equally Effective in Reducing Frailty Risk in the Elderly

An Independent Samples T-test was conducted to test the significance of the reduction in frailty risk between the groups (Table 4).

Table 4
Results of the Mean Difference Test between Multicomponent Exercise Group and Concurrent Exercise Group

Variable	ME Group (n=11)	CE Group (n=11)	Mean Differences	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Fried's *Frailty* Phenotype (FFP)	1,09 ± 0,944	1,55 ± 1,128	0,45 ± 0,522	0,318

Table 5 indicates that multicomponent exercise and concurrent exercise are equally effective in reducing frailty risk in the elderly ($p = 0.318$; $p > 0.05$), demonstrating that broad-based physical exercise can be a suitable intervention strategy to enhance functional performance in older adults, thereby reducing the risk factors for frailty. To the best of our knowledge, no studies have compared multicomponent and concurrent exercise in reducing frailty risk in the elderly population. Another study comparing the effectiveness of both exercises was conducted by Rodrigues et al.[43], who demonstrated a positive response in women aged 50–75 years who underwent multicomponent exercise and concurrent exercise training in assessments of body mass, waist circumference, upper and lower limb endurance and strength, and mental domains related to quality of life. The frailty syndrome is affected by numerous factors that are essential for its development. Therefore, it is important to understand the components of frailty criteria to facilitate an understanding of the mechanisms for reducing frailty risk through interventions.[44]

Overall, multicomponent and concurrent exercise programs have similar effects in reducing frailty risk in older adults through improvements in handgrip strength and walking speed. Consistent with research indicating that weakness is the most prevalent initial symptom of frailty,[45] several studies have argued that muscle strength should be considered a key component for improving functional performance and other physical capacities[46]. Aerobic exercise focuses on pumping oxygenated blood from the heart to the working muscles, with the primary benefit of improving cardiovascular health. It has been demonstrated that aerobic exercise helps older adults maintain their strength, mobility, balance, and endurance, which are essential for carrying out everyday tasks safely[47]. Furthermore, as muscles adapt to aerobic exercise, their oxidative capacity increases, resulting in greater fatigue resistance or increased muscular endurance[48]. Talar et al.[10] demonstrated a positive effect of strengthening exercises on fat mass reduction, where increased muscle mass can lead to fat mass reduction as a result of increased energy expenditure. Furthermore, without increasing the maximum oxygen consumption, strengthening exercises can also improve aerobic endurance, as shown by the time to fatigue during a task[10].

Rodrigues et al.[19] showed that multicomponent exercise was more effective than concurrent exercise in increasing handgrip strength in the elderly population. However, this study did not find a significant difference between the two forms of training. Multicomponent exercise programs combining resistance/strength, aerobic, and balance exercises have been reported to provide a higher challenge to the muscles, requiring rapid force production and complex neuromuscular coordination [19], [49]. In frail and obese older adults, it increases the fractional synthesis rate of mixed muscle proteins. This change in muscle protein anabolism is accompanied by increases in muscle strength and VO2peak, which are important determinants of a reduced frailty risk [36]. This is consistent with studies demonstrating that a combination of aerobic, strengthening, and balancing exercises can boost muscle protein synthesis rates and assist frail older adults in increasing muscle strength.[49] An other study by Kusumowardani et al.[37] also indicated that serum IGF-1 levels increased significantly in the ME group, whereas previous studies found that diminished IGF-1 levels correlated with frailty-associated markers, including reduced handgrip strength, decreased walking speed, and impaired physical performance.

The benefits of these exercise programs are highly dependent on sustained participation[50]. However, participants' enjoyment has a significant impact on how they perceive an activity, which can either encourage (when viewed as interesting or enjoyable) or discourage (when viewed as uninteresting or boring), thereby influencing their commitment and engagement in the exercise program.Therefore, adherence to a physical activity program is closely linked to participants' enjoyment [51], [52]. A key approach to improving long-term commitment to exercise programs is to design exercise interventions that prioritize participant satisfaction, one of which is designing exercise programs that include a variety of exercise forms. Several studies have shown that combining various forms of exercise can result in better adherence rates than performing only one exercise [53], [54]. In this regard, the variety of exercise forms offered by multicomponent exercise can increase participation in exercise programs for the elderly. A study reported an excellent attendance rate of 99.2% for multicomponent exercise, indicating that the study participants were highly motivated to participate in the exercise program [55].

4. CONCLUSION

Multicomponent exercise and concurrent exercise programs have the same effect in reducing frailty risk in the elderly Recommendations for future research include; longer-duration training sessions are needed to further examine the differences in the effects of multicomponent exercise and concurrent exercise on reducing frailty risk in the elderly, longer-duration studies are needed to conduct regular follow-up measurements after the intervention to determine the long-term effects in the elderly, compliance assessments are needed to determine whether variations in exercise can affect the adherence of study subjects to the training program, and control the nutrition of study subjects to minimize confounding variables in the study.

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