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Sarcopenia Is Associated with Cognitive Decline and Falls but Not Hospitalization in Community-Dwelling Oldest Old in China: A Cross-Sectional Study

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Manuscript Preparation E
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Background: The aim of this study was to investigate the association between sarcopenia and cognitive decline, falls, and hospitalization in a Chinese elderly population.

Material/Methods: This cross-sectional survey was conducted between November 2018 and May 2019, and enrolled only older adults aged 80 years or over (oldest old). We diagnosed sarcopenia using the Asian Working Group for Sarcopenia criteria. Demographic characteristics, disease history, smoking status, drinking status, cognitive function, falls, and hospitalization events in the previous 12 months were acquired by face-to-face interview. Cognitive status was evaluated by the Montreal Cognitive Assessment. Falls was ascertained by the question "Have you fallen down in the last 12 months?" Hospitalization was ascertained by the question "Have you received inpatient care in the past year?"

Results: A total of 582 participants (aged 80–99 years and 42.3% male) were included. The prevalence of sarcopenia was 21.7% (95% confidence interval [CI]: 17.3–26.2%) and 33.3% (95% CI: 27.4–39.3%) for females and males, respectively. Among the study population, the prevalence of cognitive decline was 60.8%; the proportions of the oldest old who had falls or hospitalization in the past 12 months were 18.1% and 34.3%, respectively. Multivariate analyses showed that sarcopenia was significantly and independently associated with cognitive decline [odds ratio (OR)=1.96, 95% CI: 1.17–3.27] and falls (OR=2.00, 95% CI: 1.17–3.43) but not associated with hospitalization (OR=1.32, 95% CI: 0.83–2.08).

Conclusions: Our results showed that sarcopenia was significantly and independently associated with cognitive decline and falls, but not associated with hospitalization, in the community-dwelling oldest old.

MeSH Keywords: Accidental Falls • Mild Cognitive Impairment • Sarcopenia

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Background

Sarcopenia is a clinical syndrome that occurs with advancing age, and is characterized by progressive and generalized loss of muscle mass and corresponding decline in muscle and physical performance [1]. Muscle mass has been found to peak around age 24 years and starts to moderately decline between 24 and 50 years of age [2]. The decrease of muscle mass accelerates between 50 and 80 years of age [2]. In total, a decrease of 40% of muscle mass occurs between the ages of 24 and 80 years [2]. Accordingly, the proportion of elderly people with sarcopenia increases remarkably with aging, from about 1 in 10 people at age 65 years to 1 in 4 at age 75 years, and 1 in 2 at 85 years or over [3].

Sarcopenia can lead to increased risk of falls [4–6], functional decline [7–9], and mortality [10,11]. Although there is a wealth of literature on sarcopenia among older adults in different geriatric settings, few investigations have been conducted in the oldest old population (individuals aged ≥80 years) [12]. The oldest old are the most rapidly growing age group globally [12], which results in a higher burden of sarcopenia. The oldest old, especially those with sarcopenia, are more prone to experience hospitalization, disability, cognitive impairment/dementia, and death [12–14], which creates heavy burdens for families and society. Knowledge of the relationship between sarcopenia and poor health events in the oldest old population is useful for development of clinical and public health programs.

Therefore, we performed a cross-sectional study of a community-based sample of oldest old people in China to determine the associations between sarcopenia and 3 adverse health outcomes (cognitive decline, falls, and hospitalization).

Material and Methods

Study design and participants

This cross-sectional study was conducted in an urban community in Beijing between November 2018 and May 2019. The Ethics Board of the Chinese PLA General Hospital approved the study protocol (Ethics approval number: S2018-102-01). All study participants signed the informed consent.

The inclusion criteria were: 1) age 80 years or over and 2) voluntary participation in this study. The exclusion criteria were: 1) refused to take the handgrip strength test or 6-meter course usual gait speed test; 2) severe cognitive impairment, dementia, or a severe hearing problem and therefore an inability to communicate with interviewers; 3) had an implanted cardiac pacemaker; and 4) terminal cancer.

Definition of sarcopenia

According to the Asian Working Group for Sarcopenia (AWGS) criteria, sarcopenia was diagnosed if participants had low muscle mass plus low muscle strength or low physical performance [15].

Measurement of muscle strength

Handgrip strength (HS) was used to assess muscle strength. Participants were tested 2 times for each hand by a digital hand dynamometer, and the maximum value of 4 tests was analyzed. Sex-adjusted values recommended by AWGS consensus were used to defined low muscle strength (men: <26 kg, women <18 kg) [15].

Measurement of physical performance

Usual gait speed (GS) on a 6-meter course was measured objectively, and used to assess physical performance. Two trials were performed, and the shortest walking time was used to calculate GS and was used in the analyses. GS <0.8 m/s was classified as poor physical performance for both men and women [15].

Muscle mass determination

Skeletal muscle mass was estimated using the bioelectrical impedance analysis (BIA). Skeletal muscle index (SMI) was calculated using the equation: SMI=Appendicular skeletal muscle mass (ASM)/height^2 (kg/m^2). Low muscle mass was defined as SMI <7.0 kg/m^2 and <5.7 kg/m^2 for men and women, respectively [15].

Demography and clinical characteristics

Demographic variables (age, sex, education level, smoking status, drinking status, marital status, and physical activity status) were assessed with a face-to-face interview. Low physical activity was defined as a total walking time for exercise purpose less than 150 min and 120 min per week for men and women, respectively [16]. Diagnoses of specific chronic diseases (including coronary heart disease [CHD], chronic obstructive pulmonary disease [COPD], diabetes, hypertension, osteoarthritis, stroke/transient ischemic attack [TIA], chronic kidney disease [CKD], depression, and tumors of any type) were acquired from the participants and their spouses and children and through a careful review of medical documents.

Geriatric assessment

Difficulty in performing activities of daily living (ADLs) were ascertained by a standardized questionnaire [17]. Participants

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having difficulty in performing 1 or more ADL activities (bowels, toilet use, bladder, transfer, grooming, feeding, mobility, stairs, dressing, and bathing) were classified as having ADL disability. Cognitive function status was measured using the Montreal Cognitive Assessment (MoCA) [18].

Outcomes

Outcomes of interest included cognitive decline, falls, and hospitalization. Cognitive decline was defined as MoCA scores of ≤24 and ≤23 for participants aged 80–90 and ≥90, respectively [19]. A fall was defined as an accidental event that caused the participant to unintentionally fall to the floor or other lower levels, and not because of an intrinsic event [20]. Occurrence of falls was ascertained by the question "Have you fallen down in the past 12 months?" Hospitalization was ascertained by the question "Have you received inpatient care in the past year?"

Statistical analysis

We reported and compared baseline characteristics of included participants according to the presence or absence of sarcopenia, using the chi-square test for categorical data and one-way analysis of variance (ANOVA) or a nonparametric test for continuous data. We used logistic regression models to examine the associations between sarcopenia and each outcome (cognitive decline, falls, and hospitalization). We included age and sex in the minimally adjusted models, and we used education level, marital status, smoking status, drinking status in the past year, physical activity status, hypertension, diabetes, CHD, stroke/TIA, COPD, osteoarthritis, CKD, tumors of any type, depression, and BMI in the fully adjusted models. Statistical analyses were performed using SPSS 24.0 for Windows (SPSS, Inc., Chicago, IL).

Results

Characteristics of the participants

Overall, 582 participants were included in our study, including 246 men (42.3%) and 336 women (57.7%). The age range of the included participants was 80–99 years (mean=86.4, SD=3.5 years). Among the study population, the prevalence of cognitive decline was 60.8%; the proportions of the oldest old who had falls or hospitalizations in the past 12 months were 18.1% and 34.3%, respectively. Baseline characteristics of included participants are summarized in Table 1. In general, participants defined as having sarcopenia were found to be older, with a higher proportion of males, low physical activity, and COPD than in those defined as not having sarcopenia. We found no significant difference between the 2 groups in education level, smoking status, drinking status, marital status, CHD, diabetes, hypertension, stroke/TIA, osteoarthritis, tumors of any type, CKD, and depression. Additionally, participants diagnosed with sarcopenia had lower HS, GS, BMI, and MoCA scores. Furthermore, participants classified as having sarcopenia had a higher proportion of having an ADL disability, falls, and hospitalization in the previous 12 months. Subjects included in this study were comparable with those excluded (n=82) in terms of socio-demographic, lifestyle, and health characteristics (Table 2).

Prevalence of sarcopenia in total study population

A total of 155 (26.6%) oldest old participants were classified as having sarcopenia according to the AWGS algorithm (Figure 1). The prevalence of sarcopenia in males was higher than in females: 33.3% (27.4–39.3%) in males *vs.* 21.7% (17.3–26.2%) in females. The prevalence of sarcopenia increased remarkably with advancing age: 15.1%, 26.4%, 42.7%, and 63.6% of individuals aged 80–84, 85–89, 90–94, and 95+ years, respectively, had sarcopenia (Figure 2).

Association between sarcopenia and adverse health outcomes

After adjustment for multiple confounders, sarcopenia was significantly and independently associated with cognitive decline (odds ratio [OR]=1.96; 95% confidence interval [CI]: 1.17–3.27) and falls (OR=2.00; 95% CI: 1.17–3.43) (Table 3). Sarcopenia was associated with hospitalization in the crude analysis (OR=1.52; 95% CI: 1.04–2.23) but lost its statistical significance after the inclusion of potential confounders in the multivariate model (OR=1.32; 95% CI: 0.83–2.08) (Table 3).

Discussion

The present study explored the association between sarcopenia, as diagnosed by AWGS criteria, and cognitive decline, falls, and hospitalization in a community-based sample of the oldest old. We found that the odds of cognitive decline were nearly 2 times greater in the oldest old with sarcopenia than in those without. The oldest old with sarcopenia had a 2 times higher likelihood of experiencing falls in the past 12 months. The association between sarcopenia and hospitalization was not significant in our study population after multiple adjustment.

We found a higher prevalence of cognitive decline in the oldest old classified as having sarcopenia. This result is in accordance with a recent meta-analysis that indicated that sarcopenia may represent a risk factor for cognitive decline [21]. The pathological link between sarcopenia and cognitive decline remains unclear, but several mechanisms are speculated to be involved. One possible explanation for this association

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Table 1. Characteristics of study participants.

	Sarcopenia		Non-sarcopenic		P
N (%)	155	(26.6)	427	(73.4)	
Age, years	87.9±3.7		85.9±3.3		<0.001
Female, %	73	(47.1)	263	(61.6)	0.002
Education level, %					0.889
<High school	45	(29.0)	118	(27.6)	
High school	38	(24.5)	101	(23.7)	
>High school	72	(46.5)	208	(48.7)	
Marital status, %					0.468
Married	97	(62.6)	253	(59.3)	
Widowed and other	58	(37.4)	174	(40.7)	
Smoking status, %					0.838
Current	3	(1.9)	9	(2.1)	
Former	29	(18.7)	71	(16.6)	
Never	123	(79.4)	347	(81.3)	
Drinking status in past year, %					0.389
≤1 drink per week	3	(1.9)	17	(4.0)	
≥2 drinks per week	10	(6.5)	21	(4.9)	
Never	142	(91.6)	389	(91.1)	
Low physical activity, %	47	(30.3)	93	(21.8)	0.033
Chronic diseases, %					
CHD	81	(52.3)	229	(53.6)	0.769
Diabetes	46	(29.7)	129	(30.2)	0.901
Hypertension	110	(71.0)	318	(74.5)	0.397
Stroke/TIA	49	(31.6)	108	(25.3)	0.129
Osteoarthritis	52	(33.5)	176	(41.2)	0.094
Tumor of any type	35	(22.6)	82	(19.2)	0.369
CKD	20	(12.9)	58	(13.6)	0.831
COPD	41	(26.5)	76	(17.8)	0.021
Depression	5	(3.2)	19	(4.4)	0.512
BMI, kg/m^2	21.9±2.8		24.7±3.3		<0.001
HS, kg	20.7±5.5		24.4±6.7		<0.001
GS, m/s	0.7±0.2		0.9±0.2		<0.001
MoCA score	20.6±5.0		22.6±4.8		<0.001
ADL disability	118	(77.1)	275	(65.5)	0.008
Falls in the past 12 months	35	(22.6)	65	(15.2)	0.038
Hospitalization in the past 12 months	62	(40.0)	130	(30.4)	0.030

CHD – coronary heart disease; TIA – transient ischemic attack; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; BMI – body mass index; HS – handgrip strength; GS – gait speed; MNA – Mini-Nutritional Assessment; MoCA – Montreal Cognitive Assessment; ADL – activities of daily living.

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Table 2. Characteristics of the included and excluded participants.

	Total sample N=664		Included sample N=582		Excluded sample N=82		p Value Included *vs.* Excluded
Age, years, mean (SD)	86.5	(3.5)	86.4	(3.5)	86.7	(3.5)	0.554
Female, n (%)	387	(58.3)	336	(57.7)	51	(62.2)	0.443
Education level, %							
<High school	182	(27.4)	163	(28.0)	19	(23.2)	0.638
High school	159	(23.9)	139	(23.9)	20	(24.4)	
>High school	323	(48.6)	280	(48.1)	43	(52.4)	
Marital status, %							0.228
Married	405	(61.0)	350	(60.1)	55	(67.1)	
Widowed and other	259	(39.0)	232	(39.9)	27	(32.9)	
Smoking status, %							
Current	12	(1.8)	12	(2.1)	0	(0.0)	0.262
Former	118	(17.8)	100	(17.0)	18	(22.0)	
Never	534	(80.4)	470	(80.8)	64	(78.0)	
Drinking status in past year, %							0.283
≤1 drink per week	21	(3.2)	20	(3.4)	1	(1.2)	
≥2 drinks per week	33	(5.0)	31	(5.3)	2	(2.4)	
Never	610	(91.9)	531	(91.2)	79	(96.2)	
Low physical activity, %	173	(26.1)	139	(23.9)	34	(41.5)	0.001
Chronic diseases, %							
CHD	360	(54.2)	310	(53.3)	50	(61.0)	0.189
Diabetes	204	(30.7)	175	(30.1)	29	(35.4)	0.330
Hypertension	493	(74.2)	428	(73.5)	65	(79.3)	0.267
Stroke/TIA	186	(28.0)	157	(27.0)	29	(35.4)	0.113
Osteoarthritis	263	(39.6)	228	(39.2)	35	(44.3)	0.389
Tumor of any type	129	(19.4)	117	(20.5)	12	(15.2)	0.271
CKD	91	(13.7)	78	(13.4)	13	(15.9)	0.546
COPD	139	(21.2)	117	(20.2)	22	(27.8)	0.121
Depression	29	(4.4)	24	(4.2)	5	(6.3)	0.377
BMI, kg/m^2	24.0	(3.4)	23.9	(3.4)	24.7	(3.7)	0.082

SD – standard deviation; CHD – coronary heart disease; TIA – transient ischemic attack; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; BMI – body mass index.

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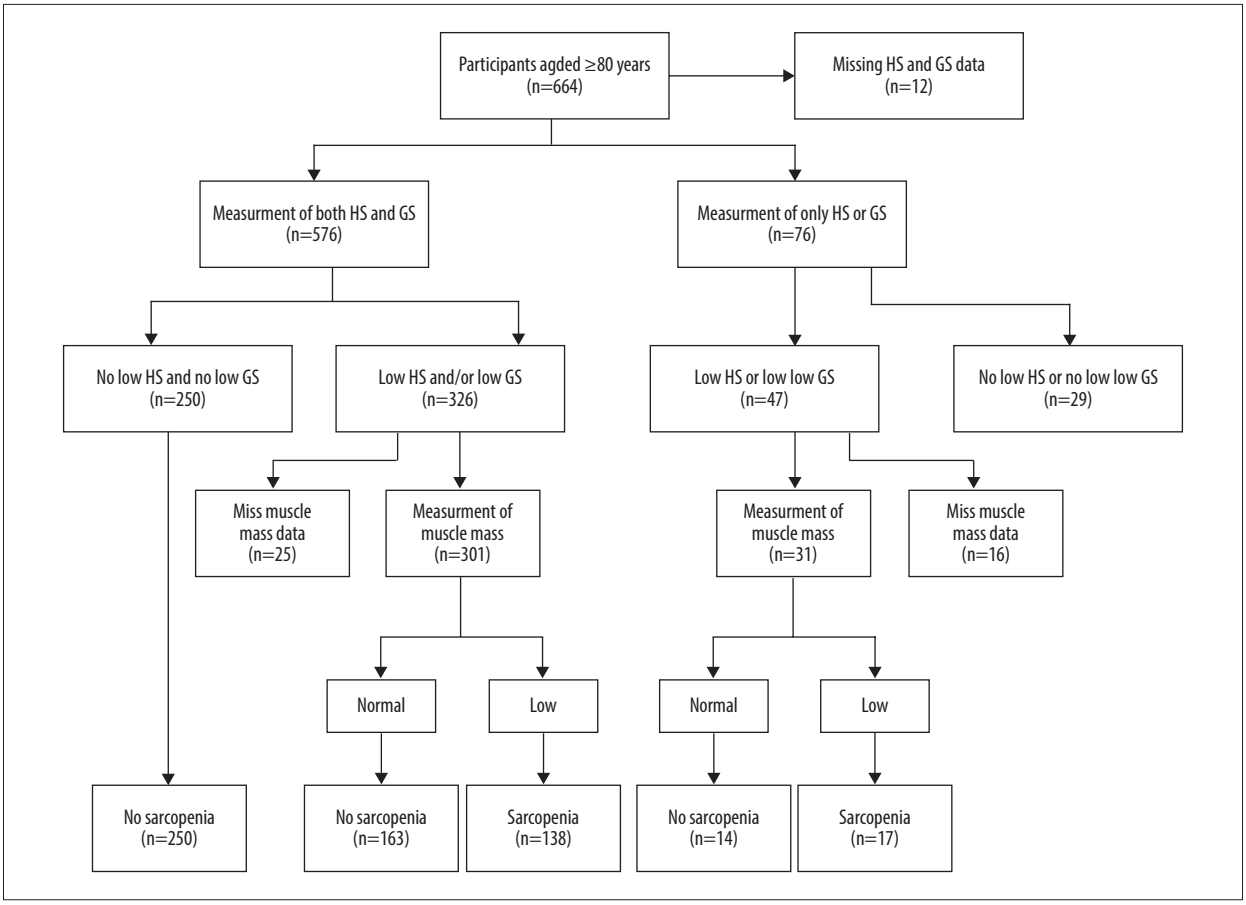

Figure 1. Application of the Asian Working Group for Sarcopenia criteria for diagnosing sarcopenia in the study sample. HS – handgrip strength; GS – gait speed.

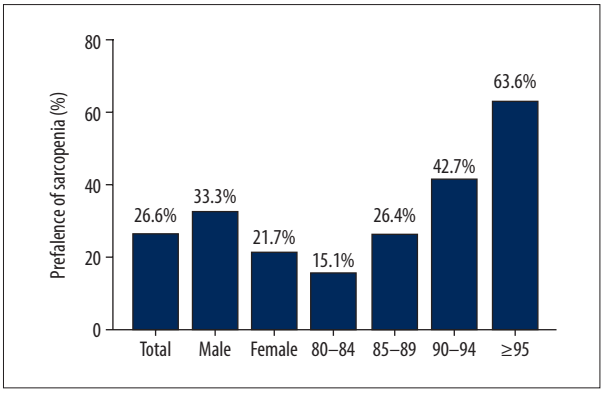

Figure 2. Crude prevalence of sarcopenia in total study population, male and female, and different age groups.

is that muscle performance may be a kind of indirect reflection of nervous system functional status, which could also be reflected by cognitive function. Salthouse et al. [22] found a significant relationship between slow reaction time and poor cognitive function. Additionally, a previous study [23] indicated that poorer physical performance was significantly associated with poorer cognitive performance in older adults. Another possible cause for the correlation between sarcopenia and cognitive decline is the possible existence of a common intervening factor, such as high oxidative stress status, high inflammatory markers levels, and low sex corticosteroid levels [24–27]. Previous studies showed that these blood markers were associated with both muscle loss and cognitive decline. However, recent studies exploring the association between sarcopenia and cognitive function decline mainly have had a cross-sectional design, from which we could not conclude the causal association. Therefore, studies using a prospective design are needed to clarify this association.

Falls in older adults can cause serious outcomes, such as femoral or hip fractures, which causes the patients to be bedridden and potentially cause further increased risks of deep venous thrombosis and pneumonia. We found that the oldest old with sarcopenia had a 2 times higher likelihood of falls than in those without. This result was in line with previous studies conducted in community-dwelling settings, which found that sarcopenia was a strong predictor of falls [4–6]. In an Italian oldest old study, sarcopenia was even associated with a nearly 3.5 times higher risk of falls [28]. These results support the

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Table 3. Association between sarcopenia and adverse health consequences.

	Unadjusted	Minimallya adjusted*	Fully adjusted**
Cognitive decline	2.07 (1.31–3.27)	2.09 (1.32–3.33)	1.96 (1.17–3.27)
Falls in past 12 months	1.62 (1.03–2.57)	1.90 (1.17–3.07)	2.00 (1.17–3.43)
Hospitalization in past 12 months	1.52 (1.04–2.23)	1.41 (0.94–2.10)	1.32 (0.83–2.08)

* Adjusted for age and sex; ** adjusted for age, sex, smoking status, drinking status in the past year, marital status, education level, physical activity status, coronary heart disease, stroke/transient ischemic attack, diabetes, chronic obstructive pulmonary disease, chronic kidney disease, hypertension, osteoarthritis, depression, tumor of any type, and body mass index.

view that aging-related loss of skeletal muscle mass is an independent risk factor of falls. Therefore, screening for sarcopenia should be considered when fall risk assessment is performed.

Results of studies investigating the association between sarcopenia with hospitalization have been controversial. Legrand et al. performed a study of 560 oldest old, and found that muscle mass was not associated with hospitalization during a mean follow-up period of 33.5 months [29]. Results from the InCHIANTI study showed that sarcopenia following the EWGSOP definition was associated with increased risk of hospital admission during a 55-month follow-up period [30]. Of note, only sarcopenia defined as low muscle mass plus low grip strength was associated with increased risk of hospital admission; sarcopenia defined as low muscle mass plus low gait speed was not correlated with increased risk of hospital admission [30]. In our study population of community-dwelling oldest old, sarcopenia was not associated with hospitalization. The different results across studies may be due to different sarcopenia diagnostic criteria or study samples (aged ≥80 or ≥65 years). Future research is needed to further examine the relationship between sarcopenia and hospitalization.

Our study results have several practical applications. First, the association between sarcopenia and cognitive decline may suggest a new pathophysiological mechanism of cognitive disease, and also suggests to geriatric clinicians that effective interventions to avoid or treat sarcopenia may also be helpful for cognitive function. Second, the association between sarcopenia and falls should remind geriatric clinicians that screening for sarcopenia can help identify the older adults at higher risk for falls, and that early interventions for sarcopenia are of great importance in reducing risk of falling in the elderly.

Our study has several limitations. First, this was a cross-sectional study; thus, we could not clarify the causal relationship between sarcopenia and cognitive decline. Future research with a prospective design is needed to substantiate this possible relationship. Second, the accuracy of muscle mass measurements through BIA is subject to participant conditions, such as dehydration, which is common among older adults. In dehydrated subjects, body fat might be underestimated and fat-free mass might be overestimated, leading to underestimation of the number of participants who have sarcopenia. Third, our study participants were enrolled from a high-income urban community and through a convenience sampling method, which limits the generalizability of our study results.

Conclusions

The oldest old with sarcopenia had a higher prevalence of cognitive decline and falls. Given the paucity of data on sarcopenia among the Chinese oldest old, our study may serve as a basis for future research aimed at identifying behavioral and psychosocial predictors of sarcopenia, and could help in designing interventions for treating sarcopenia in China.

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