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Original Article

Straight and Curved Walking Abilities and Walking Self-Efficacy in Community-Dwelling Older Women with High Social Functioning: Comparison of Young-Old and Old-Old Adults

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SUMMARY

Background: The characteristics of both straight- and curved-path walking abilities and walking self-efficacy among older women aged ≥ 75 years with high social functioning are not clear. This study aimed to clarify the characteristics of walking ability and self-efficacy among young-old (age 65–74 years) and old-old women (age ≥ 75 years) with high social functioning.
Methods: The participants in this cross-sectional study were 36 community-dwelling older women (mean age ± standard deviation: 73.4 ± 5.2 years) recruited using a convenience sampling method. The 5-m and Figure-of-8 Walk Tests were used to evaluate straight- and curved-path walking abilities. Waking self-efficacy was evaluated using the modified Gait Efficacy Scale. The participants were divided into two age groups: 65–74 (n = 22) and ≥ 75 years (n = 14). The results of the 5-m and Figure-of-8 Walk Tests and the modified Gait Efficacy Scale were compared between groups using an unpaired *t*-test and the Mann–Whitney *U* test. The relationships between the evaluation items were analyzed using Pearson's product-moment correlation coefficient and Spearman's rank correlation coefficient.
Results: Significant differences were found between the two groups in the 5-m Walk Test (p = 0.011) and Figure-of-8 Walk Test (p = 0.016); however, no significant differences were seen in modified Gait Efficacy Scale scores (p = 0.311). The correlation coefficients between modified Gait Efficacy Scale scores and walking abilities were lower in the group aged ≥ 75 years.
Conclusions: The present study found that, compared with women aged 65–74 years, those aged ≥ 75 years with high social functioning showed no decline in walking self-efficacy or straight- and curved-path walking abilities.

1. Introduction

Lawton developed a model composed of the following seven stages (in order of simplicity) to define social functioning in older adults: life maintenance, functional health, perception–cognition, physical self-maintenance, instrumental self-maintenance, effectance, and social behavior.[1]

In older adults with social functioning levels corresponding to Stage 4 or 5 of this model (physical or instrumental self-maintenance), reduced confidence can affect physical performance and activities of daily living (ADL).[2] Mullen et al.[2] examined 884 community-dwelling older adults through a pathway analysis, and revealed that reduced confidence in walking may lead to a decrease in lower limb functional performance, consequently negatively affecting lower limb functional limitations. This suggests the importance of maintaining both physical performance and confidence in performing ADL among community-dwelling older adults.

A discrepancy between physical function and confidence in performing ADL may also lead to a decrease in walking speed.[3] Liphart et al.[3] examined patients with post-stroke hemiplegia to clarify the influence of the discrepancy between balance and balance confidence on walking speed, reporting that patients with higher balance scores and lower balance confidence scores showed significantly lower walking speeds than patients with higher scores on both at 12 months after baseline. Maintaining physical function and confidence in performing ADL may be essential to health preservation because a decrease in walking speed is associated with falls among older adults[4] and reduced survival rates.[5]

Straight-path walking speed is frequently used in assessments of community-dwelling older adults, because it accurately represents health status in older adults. However, performing ADL typically requires walking in many curves (e.g., around tables and obstacles, navigating street corners). Curved-path walking has been reported to be kinematically[6,7] and cognitively[8,9] different from straight-path walking. Thus, it may be defined as an applied walking pattern. The Figure-of-8 Walk Test[10] was developed to assess curved-path walking using a course with curved sections that simulates the environments of daily and social life. The Figure-of-8 Walk Test has been shown to predict falls,[11] and because it allows walking assessments under similar conditions to daily and social life, it may be a useful tool for assessing older adults with higher walking

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abilities who can walk independently in daily life.

The modified Gait Efficacy Scale developed by Newell et al.[12] measures the degree of confidence in accomplishing a gait task. The modified Gait Efficacy Scale has been correlated with life-space assessment[13] and the fear of falling.[12,13] Thus, the ranges/levels of performing ADL are likely to be wider/higher in older adults with confidence in their walking ability.

Physical function and self-efficacy are correlated in older adults with social functioning levels corresponding to Stage 4 or 5 of Lawton's model (physical or instrumental self-maintenance), influencing lower limb function.[2] However, few studies have examined physical function and self-efficacy in older adults with social functioning levels corresponding to Stage 6 or 7 of Lawton's model (effectance or social behavior); therefore, the characteristics of older adults aged ≥ 75 years with high-level social functioning remain unclear. As the ability to go out may be especially needed by older adults who play social roles, clarifying the association between their curved-path walking ability under conditions similar to those in their daily and social lives and their confidence in walking safely both indoors and outdoors may provide a basis to develop preventive measures.

Since self-efficacy is associated with participation in social activities and decreased walking ability with aging,[15,16] we hypothesized that the relationship between curved-path walking ability and walking self-efficacy in old-old adults (age ≥ 75 years) with high-level social functioning would be weaker than that in young-old adults (age 65–74 years) with high-level social functioning. The present study examined the characteristics of curved-path walking ability and walking self-efficacy in community-dwelling older women aged ≥ 75 years with high-level social functioning through a comparison with women aged 65–74 years.

2. Materials and methods

2.1. Study design and participants

The participants in this cross-sectional study were community-dwelling older women. All participants were recruited with co-operation from three municipalities in Gunma Prefecture, Japan. We asked each municipality to advertise publicly for the recruitment of study participants among community-dwelling older women who participated in a health promotion project. Figure 1 showed participants selection flow chart.

Among the women who visited the venue on the day of measurement and consented to participate, those satisfying the following inclusion/exclusion criteria were studied. The inclusion criteria were: age ≥ 65 years, able to walk indoors and outdoors independently with or without the use of a walking aid; answering "Yes" to all five of the following questions on the instrumental self-maintenance domain of the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC):[17] "Can you use public transportation (bus or train) by yourself?", "Can you shop for daily necessities?", "Can you prepare meals by yourself?", "Can you pay bills?", and "Can you handle your own banking?", and to all four of the following questions on the social roles domain: "Do you visit the homes of your friends?", "Are you sometimes called on for advice?", "Can you visit sick friends?", and "Do you sometimes initiate conversations with young people?". The exclusion criteria were: identified as a care-dependent person based in Japan's Long-term Care Insurance system; and hospitalized within the last 6 months. This study was conducted from October 2017 to November 2017.

The study was approved by the Research Safety Ethics Committee, Tokyo Metropolitan University Arakawa Campus, in FY2017 (approval No.: 17043). The study objectives were fully explained to all participants before written consent was obtained.

2.2. Main outcome and study items

The relationship between curved-path walking ability and walking self-efficacy in community-dwelling older women aged ≥ 75 years with high-level social functioning was compared with that of community-dwelling older women aged 65–74 years with high-level social functioning. To assess the participants' walking abilities, the 5-m and Figure-of-8 Walk Tests were carried out by trained physical therapists. All participants performed both tests twice at maximum walking speed to provide a mean value. Self-efficacy levels were measured using the Japanese version of the modified Gait Efficacy Scale as a self-administered questionnaire. Similarly,

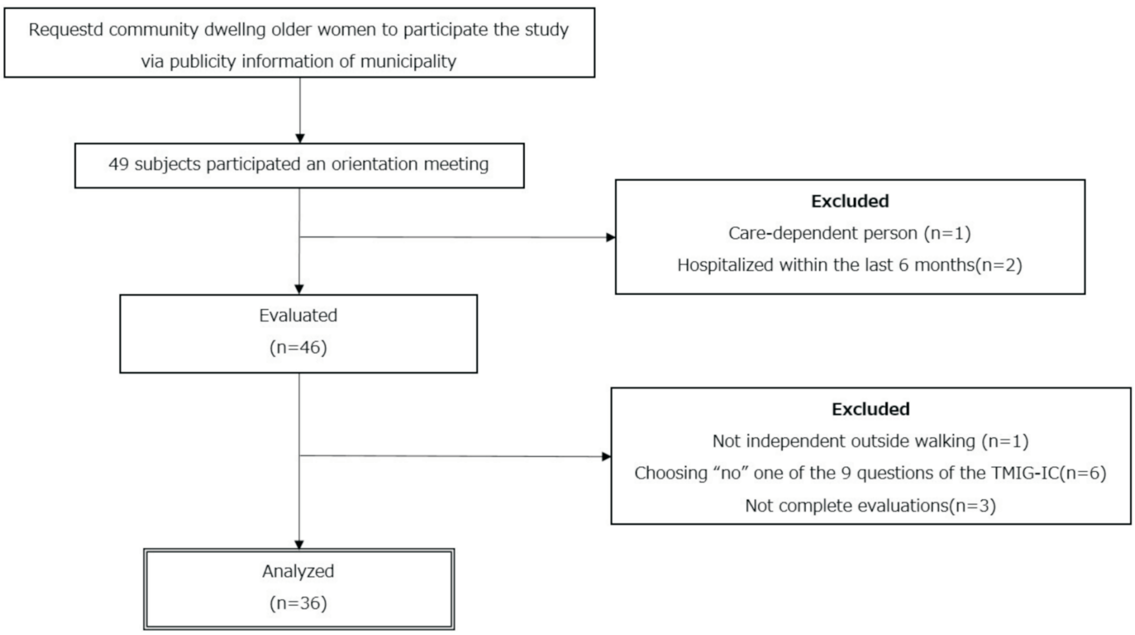

Figure 1. Participants selection flow chart.

social functioning levels were measured using the TMIG-IC as a self-administered questionnaire.

2.2.1. Walking abilities

The participants' straight-path walking ability was assessed based on the results of their 5-m Walk Test.[18] The test was conducted on a walking course with a total length of 11 m, consisting of a 5-m measurement section between two 3-m sections. The participants were instructed to start walking at their own pace, and their times were measured.

Curved-path walking ability was assessed based on the results of the Figure-of-8 Walk Test.[10] The Figure-of-8 Walk Test measures the ability to walk in a figure eight pattern between two cones placed approximately 1.5 m apart. This test has been shown to have high retest (intra-class correlation coefficient [ICC] = 0.783) and inter-rater (ICC = 0.95–0.99) reliability.[10] The present study measured times using the method previously described.[10]

2.2.2. Gait self-efficacy

The participants' levels of walking self-efficacy were measured using the Japanese version of the modified Gait Efficacy Scale.[13] The modified Gait Efficacy Scale clarifies the degree of confidence in walking safely indoors and outdoors in daily life environments. It consists of 10 questions rated on a 10-point Likert scale (from 1: no confidence to 10: complete confidence), from which, the total score is calculated (range: 10–100). A higher total scores indicates a higher degree of walking self-efficacy. The modified Gait Efficacy Scale has been shown to have high test–retest reliability (ICC = 0.945) in previous studies involving community-dwelling older adults.[13] It has also been shown to be a valid scale for measuring the degree of confidence in daily walking.[13]

2.2.3. Social function

The participants' social functioning levels were assessed using the TMIG-IC,[17] which quantitatively assesses instrumental activities of daily living (IADL) and two higher-level abilities. Respondents answer "Yes/No" to 13 questions, and then their total scores are calculated. Total scores range from 0 to 13, with a higher total score indicating a higher level of social functioning. The TMIG-IC has been shown to have high reliability in terms of alpha and test–retest coefficients, and high validity in terms of construct, discriminant, and predictive validity.[17]

2.3. Data analysis

The normality of the data for each item in each group was confirmed using the Shapiro–Wilk test. Parametric and nonparametric tests were conducted when the data were normally and not normally distributed, respectively.

To clarify the characteristics of straight- and curved-path walking abilities and walking self-efficacy among older adults aged ≥ 75 years, the participants were divided into two age groups based on Japan's Long-term Care Insurance system: 65–74 and ≥ 75 years. An unpaired *t*-test and the Mann–Whitney *U* test were used to compare straight- and curved-path walking abilities and walking self-efficacy level between the two groups. The relationships were analyzed using Pearson's product-moment and Spearman's rank correlation coefficients. SPSS Statistics (ver. 25.0; IBM Japan, Tokyo, Japan) was used for the analysis, with the significance level set at 5%.

3. Results

The participants' mean age ± standard deviation was 73.4 ± 5.2 years. Table 1 shows the results of the 5-m and Figure-of-8 Walk Tests, modified Gait Efficacy Scale, and TMIG-IC. In total, 22 participants were aged 65–74 years (70.0 ± 2.1 years) and 14 were aged ≥ 75 years (78.9 ± 3.8 years).

3.1. Correlations between the 5-m and Figure-of-8 Walk Tests and the modified Gait Efficacy Scale

Table 2 shows the results of the correlation analysis between the 5-m and Figure-of-8 Walk Tests and modified Gait Efficacy Scale. Scores on the modified Gait Efficacy Scale were significantly correlated with the results of both the 5-m (ρ = –0.64, p < 0.01) and Figure-of-8 Walk Tests (ρ = –0.55, p < 0.01). A significant correlation was also found between the results of the 5-m and Figure-of-8 Walk Tests (r = 0.82, p < 0.01).

3.2. Age-based comparison

Significant differences were observed between the two groups in the 5-m (p < 0.05, d = 0.93) and Figure-of-8 Walk Tests (p < 0.05, d = 0.93) (Table 1); however, not significant differences were seen on the modified Gait Efficacy Scale (p = 0.311, r = –0.17).

Table 2
Correlations among 5mWT time, F8W time, and mGES score overall (N = 36).

	Age (years)	5mWT (sec)	F8W (sec)	mGES
Age (years)	1.00	0.52[§]**	0.48[§]**	–0.25[§]
5mWT (sec)		1.00	0.82[†]** (0.66; 0.90)	–0.64[§]**
F8W (sec)			1.00	–0.55[§]**
mGES				1.00

* p < 0.05, ** p < 0.01.
Values are presented as correlation coefficient (95% confidence interval: lower; upper).
[†] Pearson's product-moment correlation coefficient, [§] Spearman's rank correlation coefficient.
Notes. 5mWT: 5-m walk test; F8W: Figure-of-8 Walk Test; mGES: modified Gait Efficacy Scale.

Table 1
Characteristics of 36 participants and comparison of aged 65–74 group and aged ≥ 75 group.

	Overall (N = 36)	Aged 65–74 (n = 22)	Aged ≥ 75 (n = 14)	p-value	Effect size
Age (years)	73.4 ± 5.2[a] (65–89)	70.0 ± 2.1	78.9 ± 3.8	–	–
5mWT (sec)	2.8 ± 0.6[a] (2.06–4.72)	2.6 ± 0.4	3.1 ± 0.7	0.011[b†]	d = 0.93
F8W (sec)	4.9 ± 1.2[a] (3.4–7.9)	4.5 ± 0.9	5.5 ± 1.3	0.016[b†]	d = 0.93
mGES	78.0 ± 19.3[a] (35–100)	80.3 ± 19.7	74.4 ± 18.8	0.311[b§]	r = –0.17
TMIG-IC	12.8 ± 0.4[a] (12–13)	13.0 ± 0.4	13.0 ± 0.5	–	–

[a] Mean ± SD (min-max), [b] Comparison of aged 65–74 group and aged ≥ 75 group.
[†] Unpaired t-test, [§] Mann-Whitney U-test.
Notes. 5mWT: 5-m walk test; F8W: Figure-of-8 Walk Test; mGES: modified Gait Efficacy Scale; TMIG-IC: Tokyo Metropolitan Institute of Gerontology, Index of Competence.

3.3. Correlations between the 5-m and Figure-of-8 Walk Tests and the modified Gait Efficacy Scale in each group

A significant correlation between the results of the 5-m and Figure-of-8 Walk Tests and the modified Gait Efficacy Scale was observed in the group aged 65–74 years (r = 0.66, $p < 0.01$). A significant negative correlation was observed between both the 5-m (ρ = –0.69, $p < 0.01$) and Figure-of-8 Walk Tests (ρ = –0.74, $p < 0.01$) and the modified Gait Efficacy Scale (Table 3). In the group aged ≥ 75 years, a significant correlation was seen between the 5-m and Figure-of-8 Walk Tests (r = 0.86, $p < 0.01$), but no significantly correlation was observed with the modified Gait Efficacy Scale (Table 4).

4. Discussion

This study examined the characteristics of curved-path walking abilities and walking self-efficacy among community-dwelling older women aged ≥ 75 years with high-level social functioning through a comparison of these items and their associations between those aged 65–74 and ≥ 75 years, respectively.

A correlation was observed between the participants' straight- and curved-path walking abilities and walking self-efficacy. The mean TMIG-IC score was 12.8 (range: 12–13), and the mean 5-m Walk Test time was 2.8 s. The latter value aligns with a previous study,[19] indicating that both social functioning level and walking abilities were relatively high in the present study. The participants may therefore be considered to be a valid sample of community-dwelling older women with high-level social functioning.

A comparison of straight- and curved-path walking abilities between the two groups showed that the times on both the 5-m and Figure-of-8 Walk Tests were significantly longer in those aged ≥ 75 years, revealing decreased walking abilities. Walking speed decreases with age, and becomes marked from 75 years onward.[16] This explains the significant differences observed between the two groups in the 5-m and Figure-of-8 Walk Tests, because walking abilities may also have decreased with age in the old-old adults with high-level social functioning. Furthermore, in a previous study, the mean time required for community-dwelling older adults without gait disturbance to complete the Figure-of-8 Walk Test at maximum walking speed was 5.1 ± 1.2 s,[20] whereas in the present study, the mean time for women aged ≥ 75 years was 5.5 ± 1.3 s. Although this was reduced compared with the mean time of those aged 65–74 years, the walking abilities of those aged ≥ 75 years maintained a level similar to that of the group without gait disturbance.

No significant differences in walking self-efficacy according to the modified Gait Efficacy Scale were observed between the two groups. The modified Gait Efficacy Scale have been correlated with life-space assessment,[13] suggesting that community-dwelling older women with high-level functioning, such as the participants in the present study, have high levels of walking self-efficacy, as well as the ability to walk indoors and outdoors independently. This may also explain why no significant differences were seen in modified Gait Efficacy Scale scores between the two groups. In a previous study,[13] the mean modified Gait Efficacy Scale score of non-care-dependent community-dwelling older adults with a mean walking speed of 1.19 m/s was 80.2 ± 20.7. In the present study, women aged ≥ 75 years showed a mean score of 74.4 ± 18.8. Although this value did not differ markedly from that in women aged 65–74 years, it was lower than that reported in the previous study. Thus, walking self-efficacy clearly decreased undeniably, even in community-dwelling older women aged ≥ 75 years who maintained their social function.

Regarding the correlations between straight- and curved-path walking abilities and walking self-efficacy in each age group, both the 5-m and Figure-of-8 Walk Tests showed a significant negative correlation with scores on the modified Gait Efficacy Scale in the women aged 65–74 years, but not in those aged ≥ 75 years. Considering that the values of community-dwelling older women aged ≥ 75 years may not have reached the significance level because the sample size was too small, the correlation coefficient was used as an effect size to compare the two groups. Consequently, the correlation coefficients among the straight- and curved-path walking abilities and walking self-efficacy level were lower in the women aged ≥ 75 years. However, physical function in older adults declines with age, and Stephen et al.[21] reported that older adults with lower physical function tended to overestimate their physical function greatly. This indicates a dissociation between physical and psychological function with age. Therefore, it is possible that self-confidence or self-perception, like self-efficacy, may not be related to physical abilities in the older age group.

Curved-path walking requires motor skills and is correlated with neurological impairments,[10] which are increasingly common with age.[22] Based on these findings, curved-path walking may be affected by such impairments more markedly than straight-path walking in older adults aged ≥ 75 years. Furthermore, because walking self-efficacy did not vary significantly between the two groups, and it is likely that their activity levels were generally high, and thus, the influence of aging on walking self-efficacy was not an overall tendency in the present study. Thus, the lower correlation coefficients seen among straight- and curved-path walking abilities and walking self-efficacy in the group aged ≥ 75 years compared with those aged

Table 3
Correlations among 5mWT time, F8W time, and mGES score aged 65–74 group (n = 22).

	Age (years)	5mWT (sec)	F8W (sec)	mGES
Age (years)	1.00	0.22† (–0.22; 0.59)	0.26§	–0.17§
5mWT (sec)		1.00	0.66†** (0.32; 0.84)	–0.69§**
F8W (sec)			1.00	–0.74§**
mGES				1.00

* $p < 0.05$, ** $p < 0.01$.
Values are presented as correlation coefficient (95% confidence interval: lower; upper).
† Pearson's product-moment correlation coefficient, § Spearman's rank correlation coefficient.
Notes. 5mWT: 5-m walk test; F8W: Figure-of-8 Walk Test; mGES: modified Gait Efficacy Scale.

Table 4
Correlations among 5mWT time, F8W time, and mGES score aged ≥ 75 group (n = 14).

	Age (years)	5mWT (sec)	F8W (sec)	mGES
Age (years)	1.00	0.63§*	0.49§	–0.29§
5mWT (sec)		1.00	0.86†** (0.60; 0.95)	–0.44† (–0.78; 0.12)
F8W (sec)			1.00	–0.15† (–0.63; 0.41)
mGES				1.00

* $p < 0.05$, ** $p < 0.01$.
Values are presented as correlation coefficient (95% confidence interval: lower; upper).
† Pearson's product-moment correlation coefficient, § Spearman's rank correlation coefficient.
Notes. 5mWT: 5-m walk test; F8W: Figure-of-8 Walk Test; mGES: modified Gait Efficacy Scale.

65–74 years may have represented their walking self-efficacy and walking abilities, which were less and more markedly affected by age, respectively. However, because fall-related self-efficacy has been reported to decrease with age,[23] further examination of age-related changes in walking self-efficacy is needed.

The characteristics of the walking abilities and walking self-efficacy of community-dwelling older women aged ≥ 75 years with high-level social functioning compared with those aged 65–74 years can be summarized in the following three points: 1) the walking abilities of those aged ≥ 75 years were reduced compared with those aged 65–74 years, but were similar to that of a group without gait disturbance; 2) the walking self-efficacy of those aged ≥ 75 years maintained a level similar to that of those aged 64–75 years; and 3) the correlation coefficients between walking abilities and walking self-efficacy were lower in those aged ≥ 75 than in those 65–74 years, and the difference was marked for the correlation between curved-path walking ability and walking self-efficacy. Since providing social support to others and being a member of any association have protective effects on IADL disability,[24] and social capital is associated with physical activity in older adults,[25] maintaining social function is important for preventive care in older adults. The results of this study support the effectiveness of maintaining both walking abilities and walking self-efficacy as preventive approaches for older adults with high-level social functioning to maintain their social function after the age of 75 years. Because the correlation between walking abilities and walking self-efficacy became weaker after this age, approaches that simultaneously improve both parameters may also be desirable. VanSwearingen et al.[26] evaluated goal-oriented, progressively more difficult stepping and walking pattern methods to improve the walking skills of community-dwelling older adults through a comparison with standard physical therapy approaches (e.g., walking, endurance, balance, muscle training); they reported improvements in not only walking speed, but also walking self-efficacy. Such interventions are also effective in improving curved-path walking.[27] Based on these findings, goal-oriented stepping and walking training may be useful to prevent care dependency and promote health among community-dwelling older women with high-level social functioning.

The present study did have some limitations. First, the small sample size of women may have affected the generalizability of the results. Second, because a convenience sampling method was used in the present study, there is some possibility of a sampling bias. Third, there is a high probability of an experiment Type I error in the correlation analysis, because many univariate analyses were conducted. Further studies with a larger sample using a random sampling method are needed. Fourth, the present study focused on the relationship between walking ability and walking self-efficacy; we did not consider social, clinical, or functional characteristics, or comorbidities that could affect the main outcome. Future studies should address these factors.

An examination of the characteristics of the curved-path walking ability and walking self-efficacy among community-dwelling older women aged ≥ 75 years with high-level social functioning revealed that while walking self-efficacy was maintained, curved-path walking ability was reduced, and the associations between these items were weak. Although walking abilities were lower among those aged ≥ 75 than among those aged 65–74 years, a high level was maintained. To preserve social function, maintaining both walking abilities and walking self-efficacy may therefore be essential. Diane et al.[28] reported that both walking self-efficacy and lower-extremity physical function affect dual-task performance, which influences fall risk in older adults.[29] A prospective study examining the preventive effects of high walking self-efficacy on falls in community-dwelling older women aged ≥ 75 years is therefore needed. In the future, the characteristics of community-dwelling older adults with high-level social functioning should also be examined from perspectives other than walking abilities and walking self-efficacy.

Declaration of conflicts of interest

None.

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