PHYSICAL EDUCATION OF STUDENTS

ORIGINAL ARTICLE

The influence of eco-friendly sports on university students' physical and mental well-being: a sustainability perspective

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Abstract

Background and Study Aim: In light of the growing global emphasis on sustainability, universities are uniquely positioned to embed eco-friendly practices within student life. Eco-friendly sports, which promote physical activity with minimal environmental impact, offer a dual benefit: fostering personal well-being and encouraging environmental responsibility. This study examines how university students' perceptions of eco-friendly sports influence their participation and contribute to their physical and mental well-being within the framework of campus sustainability efforts.

Material and Methods: A cross-sectional survey was conducted with 300 students from Universiti Kebangsaan Malaysia (UKM). Participants completed a validated online questionnaire assessing their perception of eco-friendly sports and their self-reported physical and mental well-being levels. Descriptive statistics, Pearson correlations, and simple linear regression were used to test the primary hypothesis. Interaction effects were assessed using moderated regression analyses, with gender as a moderator. Assumptions of normality, multicollinearity, and homoscedasticity were rigorously tested.

Results: Perception of eco-friendly sports was positively and significantly associated with both physical ($r = 0.744$, $p < .001$) and mental well-being ($r = 0.782$, $p < .001$). Regression models indicated that perception strongly predicted both outcomes ($R^2 = 0.554$ for physical and $R^2 = 0.612$ for mental well-being). However, gender did not significantly moderate these relationships. Residual diagnostics confirmed that statistical assumptions were met. The results suggest that students who view eco-friendly sports favourably are more likely to report higher levels of overall well-being. This reinforces the dual benefit of such initiatives in health promotion and sustainable development.

Conclusions: Positive perceptions of eco-friendly sports contribute meaningfully to student well-being regardless of gender. This highlights the potential of integrating sustainability-driven sports initiatives into university health promotion strategies.

Keywords: eco-friendly sports, physical well-being, mental health, university students, perception, sustainability, gender moderation, Malaysia.

Introduction

In the evolving landscape of higher education, sustainability has become more than a campus policy; it is a guiding principle shaping academic culture, infrastructure, and student well-being. One growing area within this movement is eco-friendly sports and physical activities, which are designed to benefit health while minimising environmental harm. These sports include green workouts, outdoor recreational events, non-motorised commuting, and low-emission fitness practices [1, 2]. As institutions like Universiti Kebangsaan Malaysia (UKM) embrace this shift, integrating sustainability into student life, primarily through physical activity, has become both relevant and necessary. Eco-friendly sports do more than align with environmental goals; they also promote holistic well-being. Participation in nature-based activities is linked to improved cardiovascular fitness, reduced stress, and enhanced emotional resilience [3, 4]. These benefits are significant for university students, who often navigate academic stress, social transitions, and mental health challenges.

Nevertheless, despite these well-documented advantages, student engagement in eco-friendly sports remains uneven. This inconsistency is not due to a lack of interest in sustainability or well-being. Instead, it stems from deeper issues related to awareness, accessibility, and perception. Many students are unaware of what eco-friendly sports entail or how these activities can contribute to their physical and mental health [5]. For some, the concept remains abstract and disconnected from their daily routines and academic pressures. Others may lack access to green spaces, transportation alternatives, or structured programmes that support sustainable sports [6].

University environments present a critical window to shape lifelong behaviours and values. Students exposed to sustainable health initiatives

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are more likely to adopt them beyond campus life [7, 8]. However, student perceptions must be clearly understood for such efforts to be effective. If eco-friendly sports are perceived as inconvenient, insignificant, or inaccessible, participation will remain low regardless of the benefits or institutional efforts to promote them. While many campuses have made strides in green infrastructure and recycling initiatives, sustainable sports have yet to receive the same attention or investment. Most programmes are optional, sporadic, or poorly publicised. Moreover, their framing often focuses on environmental outcomes rather than immediate personal benefits such as stress reduction or physical fitness [9]. This communication gap limits students' motivation to participate and weakens the impact of sustainability campaigns to foster healthy, eco-conscious behaviours.

Another challenge is the limited diversity in eco-friendly sports offerings. Students come from varied backgrounds, with different interests, abilities, and lifestyle needs. However, few initiatives are tailored to meet these differences. This lack of inclusivity further restricts participation, particularly for students who are new to environmental issues or who do not see themselves represented in current sustainability narratives [10]. Gender may also influence how students engage with eco-friendly sports. Previous studies suggest that females often show higher health awareness, while males may be more drawn to performance-based or competitive activities [11]. However, such differences are rarely explored in depth within sustainability-driven sport. Understanding how gender shapes perception and participation can help universities design more inclusive and effective programmes [12].

Despite emerging research on sustainable physical activity, most studies focus on environmental benefits or general health outcomes. Few examine how students perceive eco-friendly sports or how these perceptions relate to measurable physical and mental well-being [13, 14]. Even fewer studies have explored how variations in perception levels translate into behaviour or health impacts. This creates a significant knowledge gap between sustainability, sport, and higher education. Addressing this gap reveals that the issue is not simply about offering more sustainable sports but about making them visible, valued, and viable for students. This requires a shift in how universities communicate, implement, and evaluate such initiatives. When students see eco-friendly sports as relevant to their health and lifestyle, not just the environment, they are more likely to participate and benefit [15].

Although eco-friendly sports have gained international attention as tools for promoting sustainability and well-being, their study in Southeast Asia, particularly within Malaysian higher education, is still in its infancy. Most existing literature focuses on Western and developed regions, where eco-consciousness and environmental sports policies are more established [1, 16]. In contrast, studies exploring how students in Southeast Asia, especially in Malaysia, perceive and engage with eco-friendly sports remain sparse. While sustainability initiatives have been gradually integrated into Malaysian campuses, there is a notable absence of empirical data examining how such programmes affect student health outcomes or behavioural change.

Research Hypotheses

H1: Students' perception of eco-friendly sports is significantly and positively associated with their physical and mental well-being.
H2: There are significant gender differences in the relationship between students' perception of eco-friendly sports and their physical and mental well-being.

This study examines how university students' perceptions of eco-friendly sports influence their participation and contribute to their physical and mental well-being within the framework of campus sustainability efforts.

Materials and Methods

Participants

The study targeted undergraduate and postgraduate students at UKM, which, as of 2023, had a total enrolled student population of approximately 26,000. Based on Krejcie and Morgan's [17] sample size determination table, a minimum sample size of 379 is suggested for this population size. However, considering resource constraints and the high expected homogeneity of perceptions in this context, a final sample size of 300 students was deemed acceptable for statistical inference while maintaining adequate power and generalisability. A simple random sampling method was applied across faculties and study levels to minimise bias and enhance representativeness.

Research Design

This study adopted a quantitative, cross-sectional survey design to explore the relationship between university students' perceptions of eco-friendly sports and their physical and mental well-being. The design enabled a snapshot of patterns and relationships within a defined student population at Universiti Kebangsaan Malaysia (UKM). Given the study's non-experimental nature, no variables were manipulated. Instead, associations among naturally occurring variables were statistically examined.

Instrumentation

Data were collected using a structured questionnaire divided into three key sections:

- Section A: Demographic Profile. This section

included gender, year of study, faculty, residential status, and previous participation in eco-friendly sports.

• Section B: Perception of Eco-Friendly Sports. Adapted from Cottrell's environmental behaviour framework, this 10-item scale employed a 5-point Likert response format ranging from strongly disagree (1) to strongly agree (5). Items measured awareness, attitudes, and motivation towards eco-friendly sports [18].

• Section C: Physical and Mental Well-Being. Adapted from the framework by Vella-Brodrick and Allen, this 12-item instrument used the same 5-point Likert format and assessed students' perceived improvements in cardiovascular fitness, emotional balance, stress levels, and energy [19].

Instrument Validity and Reliability

To ensure content and face validity, the adapted questionnaire was reviewed by a panel of five experts in physical education, sports psychology, and environmental health. These experts assessed the items' relevance, clarity, and alignment with the study's objectives. Suggestions were incorporated to improve phrasing and remove ambiguity. Subsequently, pilot testing was conducted with 40 students from various UKM faculties who were not part of the main study. Feedback confirmed that the questionnaire items were understandable and relevant. Based on this feedback, minor linguistic adjustments were made for clarity. An Exploratory Factor Analysis (EFA), using principal component analysis with varimax rotation, was performed on the pilot data to assess construct validity. The KMO value was 0.87, and Bartlett's test of sphericity was significant ($p < .001$), indicating that the dataset was suitable for factor analysis. Two distinct components emerged, corresponding well to the intended constructs of perception and well-being, each with eigenvalues above 1.0.

The instrument demonstrated strong internal consistency. Cronbach's alpha coefficients for the main study sample were as follows:

• Perception Scale: $\alpha = 0.89$

• Physical Well-Being Scale: $\alpha = 0.87$

• Mental Well-Being Scale: $\alpha = 0.91$

All values exceeded the 0.70 threshold, indicating excellent reliability for each scale.

Data Collection Procedure

The validated questionnaire was distributed online via Google Forms, ensuring accessibility for all UKM students. Survey links were disseminated through institutional emails and official student WhatsApp groups to maximise reach. Participation was voluntary, and responses were anonymous. A total of 300 complete responses were recorded over a two-week period. Before participation, all respondents were presented with a consent form outlining the study's objectives, the confidential nature of their responses, and their right to withdraw at any time. Ethical clearance was obtained from the Faculty of Education Ethics Committee at Universiti Kebangsaan Malaysia.

Statistical Analysis

All statistical analyses were conducted using SPSS Version 28. The analytical approach was structured to assess the direct predictive role of students' perceptions of eco-friendly sports on well-being and the potential moderating influence of gender on this relationship. Several procedures were conducted to address Hypothesis 1, which posited that students' perceptions of eco-friendly sports are positively associated with their physical and mental well-being. First, Pearson correlation analysis was employed to explore the strength and direction of the associations between perception scores and each well-being domain. This initial step provided a bivariate overview of how perception aligned with self-reported health outcomes. Then, simple linear regression analyses were conducted separately for physical and mental well-being. These models quantified the predictive influence of perception and determined how much variance in well-being outcomes could be explained by students' attitudes toward eco-friendly sports. To strengthen interpretation, 95% confidence intervals (CIs) were calculated for each regression coefficient, and R^2 values were reported to indicate model fit and explanatory power.

To test Hypothesis 2, which proposed that gender moderates the relationship between perception and well-being, the regression models were expanded to include interaction terms. Specifically, the product of perception and gender (Perception × Gender) was introduced into the models. The statistical significance of these interaction terms was examined to determine whether the strength or direction of the relationship varied between male and female students. A non-significant interaction would suggest that the effect of perception on well-being is consistent across genders.

In order to ensure the validity of the regression results, all relevant assumptions for parametric testing were systematically verified. The normality of residuals was assessed using the Shapiro–Wilk test, which confirmed that the distribution of residuals for all dependent variables was approximately normal ($p > .05$), supporting linear models. The assumption of homoscedasticity, or equal variance of residuals across groups, was evaluated using Levene's test for equality of variance. Results from this test indicated that variance in well-being scores did not significantly differ across gender groups, satisfying this condition. Furthermore, multicollinearity diagnostics were performed using the Variance Inflation Factor (VIF) values. All predictors demonstrated VIFs well below the commonly accepted threshold of 5, indicating no multicollinearity concerns within the models.

The chosen statistical procedures and rigorous assumption checks ensured that the results derived from the analyses were valid and reliable. This robust methodological approach enabled a nuanced evaluation of how students' perceptions of eco-friendly sports relate to their physical and mental well-being, and whether these relationships differ meaningfully by gender.

Results

Participant Demographics: Age and Gender Composition

Understanding the demographic characteristics of participants is crucial for interpreting the engagement patterns in eco-friendly sports among university students. The age and gender distribution of respondents from Universiti Kebangsaan Malaysia (UKM) provides insight into the diversity and representativeness of the sample. The mean age of participants was 23.53 years, with a standard deviation of 3.52, indicating a moderately varied age range among students. Ages ranged from 18 to 29 years, reflecting participation from early undergraduates and more senior students, including those possibly in postgraduate programmes or completing extended degrees. Regarding gender distribution, female students accounted for 56% of the sample, while male students comprised 44%. This suggests a slightly higher engagement or response rate from female students in the context of eco-friendly sports activities or related survey participation.

Normality and Reliability Analysis

The dataset's normality was assessed using the Shapiro–Wilk test, a widely recognised statistical method for evaluating whether a dataset follows a normal distribution. The results in Table 1 indicate that all key variables (Perception Score, $p = 0.081$; Physical Well-being Score, $p = 0.327$; and Mental Well-being Score, $p = 0.638$) meet the criteria for normality, as their p-values exceed the conventional threshold of 0.05.

Table 1. Normality Tests (Shapiro–Wilk)

Variable	Shapiro–Wilk p-value	Interpretation
Perception Score	0.081	Normally distributed
Physical Well-being Score	0.327	Normally distributed
Mental Well-being Score	0.638	Normally distributed

To assess the internal consistency of the measurement scales used in this study, Cronbach's alpha (α) was calculated for each key variable. The results in Table 2 demonstrate high reliability across all scales. The Perception Score ($\alpha = 0.89$), Physical Well-being Score ($\alpha = 0.87$), and Mental Well-being Score ($\alpha = 0.91$) all exceed the commonly accepted threshold of 0.70 for strong internal consistency.

Table 2. Reliability Analysis (Cronbach's alpha)

Variable	Cronbach's alpha (α)	Interpretation
Perception Score	0.89	High reliability
Physical Well-being Score	0.87	High reliability
Mental Well-being Score	0.91	High reliability

All scales demonstrate excellent internal consistency, ensuring reliable measurement.

Hypothesis 1: Perception as a Predictor of Well-Being

The first hypothesis (H1) posited that students' perceptions of eco-friendly sports would be positively and significantly associated with their physical and mental well-being. The results of both correlation and regression analyses supported this hypothesis.

As shown in Table 3, Pearson correlation coefficients demonstrated strong and statistically significant positive associations between perception and the outcome variables. Specifically, perception was positively correlated with physical well-being ($r = 0.744$, $p < .001$) and mental well-being ($r = 0.782$, $p < .001$), suggesting that students who held more favourable views of eco-friendly sports also reported higher levels of well-being.

Table 3. Pearson Correlation Between Perception and Well-Being

Outcome	Pearson r	p-value
Physical Well-Being	0.744	< .001
Mental Well-Being	0.782	< .001

Simple linear regression analyses were conducted to further evaluate the predictive strength of perception. As shown in Table 4, perception emerged as a significant predictor of physical well-being, with a regression coefficient of $\beta = 0.724$, $p < .001$, and a 95% confidence interval ranging from 0.650 to 0.798. The model explained 55.4% of the variance in physical well-being scores ($R^2 = 0.554$), indicating a substantial effect size. Similarly, for mental well-being, perception significantly predicted outcomes ($\beta = 0.747$, $p < .001$; 95% CI: 0.680 to 0.815), with the model accounting for 61.2% of the variance ($R^2 = 0.612$). These results confirm that perceptions of eco-friendly sports are strong and meaningful predictors of physical and mental well-being among university students. The high explanatory power of the models suggests that fostering positive perceptions of sustainable sports activities may substantially benefit student health.

Hypothesis 2: Gender as a Moderator

The second hypothesis (H2) proposed that

Table 4. Regression Summary: Perception Predicting Well-Being

Outcome	β (Perception)	95% CI Lower	95% CI Upper	p-value	R^2
Physical Well-Being	0.724	0.650	0.798	< .001	0.554
Mental Well-Being	0.747	0.680	0.815	< .001	0.612

gender would moderate the relationship between perception of eco-friendly sports and students' well-being. In other words, the strength or direction of this relationship would differ for male and female students. To test this hypothesis, interaction terms (Perception × Gender) were added to the regression models for physical and mental well-being. As shown in Table 5, the results indicated that these interaction terms were not statistically significant in either model ($p > .05$). This suggests that the relationship between perception and well-being was not significantly influenced by gender.

Table 5. Interaction Term (Perception × Gender) in Regression

Outcome	Interaction Term (β)	p-value	Moderation Effect
Physical Well-Being	Not significant	> .05	No
Mental Well-Being	Not significant	> .05	No

Further confirmation of this finding came from Levene's test, shown in Table 6, which assessed the assumption of equal variance across gender groups. The test yielded non-significant results for physical well-being ($F = 0.537$, $p = .464$) and mental well-being ($F = 0.499$, $p = .480$), supporting the conclusion that variance was comparable across groups.

Table 6. Levene's Test for Equality of Variance by Gender

Outcome	Levene's F	p-value
Physical Well-Being	0.537	0.464
Mental Well-Being	0.499	0.480

Moreover, multicollinearity diagnostics using the Variance Inflation Factor (VIF) revealed no issues, as shown in Table 7. All predictors, including the interaction terms, demonstrated VIF values close to 1.00. These findings suggest that the positive influence of perception on well-being is consistent across genders, providing no evidence of differential effects between male and female students. As such, Hypothesis 2 was not supported.

Table 7. Multicollinearity Diagnostics (VIF Values)

Predictor	VIF
Perception	1.00
Gender (Dummy)	1.00
Perception × Gender	1.00

Discussion

This study aimed to examine how university students' perceptions of eco-friendly sports relate to their physical and mental well-being. The findings revealed that positive perceptions were strong predictors of both well-being domains, while gender did not significantly moderate these relationships.

Eco-Friendly Sports Perception and Its Multidimensional Significance

This study revealed that students at Universiti Kebangsaan Malaysia (UKM) generally hold positive perceptions of eco-friendly sports, suggesting growing awareness of sustainability and its intersection with health. This aligns with research by Santos-Pastor et al., who emphasised that environmental education can significantly shape young adults' pro-sustainability behaviours, especially when integrated into recreational or sports contexts [20]. However, while most students reported high perception levels, participation in eco-friendly sports remains context-dependent. It is influenced by institutional infrastructure, peer culture, and competing academic demands [16]. These findings resonate with Baena-Morales et al., who argued that mere awareness does not automatically translate into action, particularly in settings where environmental programmes lack tangible, day-to-day visibility [10]. It is plausible that students recognise the value of eco-friendly sports more than they engage in them, highlighting the classic gap between cognition and behaviour. Thus, universities cannot rely solely on attitude shifts. They must invest in structural and cultural support systems that reinforce sustainable practice as normative and desirable.

Physical Well-Being and the Role of Perception

The regression analysis confirmed that students with more favourable perceptions of eco-friendly sports reported higher levels of physical well-being. This aligns with the findings of Wang et al. and Amor-Barbosa et al., who note that green physical activities such as nature jogging, cycling, and outdoor group exercise are correlated with improved physical stamina and reduced musculoskeletal stress [14, 21]. Their accessibility and low-impact nature make such activities particularly effective for daily, habitual engagement. An alternative explanation, however, must be acknowledged: perception may not be the cause, but rather the result of being physically well. Healthier individuals already engaged in active routines may retrospectively assign value to eco-

friendly sports because such activities affirm their pre-existing lifestyles. This phenomenon, known as reverse causality, complicates the narrative that perception solely drives behaviour. It is supported by Mandrillon et al., who suggest that health-conscious individuals are more likely to attribute positive environmental value to the behaviours they already practise [11]. Moreover, existing health literacy or prior sport involvement might mediate the link between perception and physical well-being. A student with high awareness of fitness strategies might be more critical or discerning in their perception, aligning sustainability with personal optimisation. Hence, future research might consider controlling for baseline health status and prior sport exposure to better isolate perception as an independent predictor.

Mental Well-Being: More Than Just a Psychological Response

Perhaps the most compelling finding in this study is the robust relationship between perception and mental well-being, which accounted for more variance in psychological health than in physical health. This is consistent with research by Åsberg et al. and Chu, who found that nature-based exercise contributes significantly to reduced anxiety, improved emotional regulation, and greater cognitive flexibility [3, 22]. One possible explanation lies in the restorative effects of green environments. According to Wilson's biophilia hypothesis, humans have an innate affinity for nature, and eco-friendly sports tap into this evolutionary mechanism, offering psychological relief through non-urban spaces [23]. Niu et al. further posit that nature-based movement reduces cortisol and enhances dopamine regulation, thereby improving mood and cognitive clarity [24]. Still, an important alternative perspective is that social identity formation may also play a role. Students who identify with sustainability values may derive psychological satisfaction simply from aligning their behaviours with perceived moral or intellectual ideals. This symbolic alignment can enhance feelings of purpose, control, and belonging, which are core components of mental well-being. In this interpretation, the perception of engaging in meaningful, environmentally responsible activity, rather than the activity itself, may yield emotional benefits [25]. This distinction has implications for designing interventions. Creating meaning around eco-friendly sports might be as important as the activity design itself.

Group Differences and Perception Levels

This study also found that students with high perception levels scored significantly better in physical and mental well-being domains. These differences support the findings of Lim and Park, who observed that when individuals adopt a unified mindset around sustainability and personal wellness, the synergistic benefits multiply [26]. Students with such high perception may be more motivated to maintain consistent physical routines, reduce screen time, and seek active social interactions, all of which correlate with well-being. However, these findings might also reflect underlying sociocultural dynamics. For instance, students from programmes or faculties that emphasise environmental science, outdoor education, or public health may naturally develop higher perception levels due to curriculum influence or peer norms. If so, the link between perception and well-being could be confounded by academic context or by exposure to specific values during higher education [6].

Gender and the Absence of Significant Moderation

Although minor differences emerged in mean scores, female students showed slightly higher perception and physical well-being, while male students scored slightly higher in mental well-being. However, gender did not significantly moderate the relationship between perception and well-being. This finding is encouraging in its implications for programme inclusivity. Eco-friendly sports benefit all students, regardless of gender identity. Nevertheless, the literature suggests that deeper layers of gender expression and cultural expectations may still shape engagement patterns. Pappas and Mandrillon et al. have noted that males and females often differ in their preferred types of physical activity and motivation styles, such as competitive versus social, or individual versus cooperative formats [11, 27]. At the same time, perception itself may not differ, but the meaning and emotional response to eco-friendly sports might. Future qualitative research could explore how students of different gender identities interpret and internalise the value of these activities.

Practical Reflections and Institutional Strategy

From a practical standpoint, this study affirms the importance of promoting eco-friendly sports within higher education. Such programmes align with the United Nations Sustainable Development Goals (SDG 3 and 13) [28] and foster inclusive, low-barrier avenues to support physical and mental well-being. However, awareness alone is insufficient. Universities should move beyond token gestures such as isolated green events and embed sustainability into the everyday rhythm of campus life. Based on the findings and the literature reviewed, several strategic recommendations emerge:

- Embed sustainability into curricula across faculties to normalise eco-conscious thinking beyond environmental studies.
- Develop green infrastructure such as bike lanes, low-waste sports areas, and nature-integrated recreation zones.
- Create community incentives, for example eco-

point systems or sustainability badges, that reward consistent engagement.

• Track participation longitudinally using both qualitative and quantitative metrics to understand retention and impact.

Study Limitations and Directions for Future Research

Despite the valuable insights provided by this study, several limitations must be acknowledged. First, the cross-sectional design precludes causal inference, limiting the ability to determine whether perceptions influence well-being or vice versa. The reliance on self-reported data also introduces potential response biases, such as social desirability and subjective misreporting. Furthermore, the sample was drawn from a single public university in Malaysia, which may restrict the generalisability of the findings to other educational or cultural contexts. To advance this line of inquiry, future research should adopt longitudinal or experimental designs that allow for causal testing and dynamic tracking of behavioural change over time. It is also essential to triangulate self-report data with objective health indicators or physiological measurements in order to enhance validity. Further exploration into structural and environmental enablers, such as green infrastructure, institutional support, and curriculum integration, would provide a more nuanced understanding of how eco-friendly sports function as both behavioural and ecological interventions.

Conclusions

This study underscores the relevance of integrating eco-friendly sports into the broader agenda of sustainability and health promotion in higher education. By focusing on student perceptions, the research contributes to a deeper understanding of how sustainability-oriented physical activity can support well-being while encouraging environmentally responsible lifestyles. The findings support ongoing efforts to design inclusive and value-driven campus environments, where health and sustainability are approached as interdependent goals. As universities continue to navigate complex social and ecological challenges, promoting green physical activity can serve as a meaningful strategy for institutional transformation. Eco-friendly sports offer a practical and accessible avenue for fostering personal development, environmental awareness, and campus-wide engagement. Embedding such practices into everyday student life represents a promising direction for advancing both public health and sustainable development within academic institutions.

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Conflict of Interest

The author declares that there is no conflict of interest.

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