

# Physical Activity Promotion in Schools Using Theoretically Designed Mobile Phone Application

## Abstract

**Background:** Regular physical activity for adolescents has many health benefits, many of which also affect adulthood. Physical activity is a behavior that requires planning and choosing an appropriate educational method, model, or theory. However, mobile phone applications are known as a suitable method to increase physical activity according to the guidelines. This study aims to increase physical activity in female students based on the theory of planned behavior using mobile phone applications.

**Methods:** This quasi-experimental study was implemented on 220 high school students (110 people in each group). The samples were selected by a multi-stage cluster method and their information was collected by the International Physical Activity Questionnaire (IPAQ) and the Theory of Planned Behavior (TPB) questionnaire whose validity and reliability were confirmed. The intervention group received 8 sessions of education through a mobile phone application that was designed by the constructs of the theory of planned behavior. The samples were evaluated in three stages, through a pre-test, post-test, and two-month follow-up. **Results:** The results showed a significant difference in the post-test and two months after the intervention between intervention and control groups in terms of attitude, perceived behavioral control, intention, and physical activity. There was a significant difference between intervention and control groups in subjective norms in the post-test, but there was no significant difference in the two-month follow-up compared to the post-test ( $P = 0.08$ ).

**Conclusions:** An educational intervention based on the theory of planned behavior using mobile phone applications led to an increase in the physical activity of girl high school students. However, to determine the full effectiveness of this study, it is recommended to implement this intervention in all schools.

**Keywords:** Exercise, mobile application, students, theory of planned behavior

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## Introduction

A healthy lifestyle should be promoted at all ages, but the earlier a habit is formed, the more likely it is to become stabilized.<sup>[1]</sup> Decreasing the level of physical activity among adolescents is a growing problem that increases the risk of health problems for the rest of life.<sup>[2]</sup> About 81% of adolescents (11–17 years old) are insufficiently physically active globally.<sup>[3]</sup> In a study in Iran, the prevalence of physical activity recommended by the World Health Organization among high school students is approximately 27.8%, about 72.2% of whom were not physically active, and the girl's physical activity was lower than boys'.<sup>[4]</sup>

Physical activity is a behavior that requires planning and choosing the appropriate educational method, model, or theory.<sup>[5]</sup>

Behavioral models and theories can act as a guide in physical activity interventions, so researchers have used them in various physical activity interventions.<sup>[6]</sup> The theory of planned behavior (TPB) is an extended theory of reasoned action that is essential in dealing with behaviors over which people have incomplete voluntary control. According to this theory, the main determinant of a behavior is the intention, which is the result of a person's desire to perform a behavior.<sup>[7]</sup> Attitudes express positive or negative evaluations of the results of performing a behavior and subjective norms show whether important people in social environments believe that a behavior should be performed or not.<sup>[8]</sup> Subjective norms express the social pressures that are felt to perform or not to perform a behavior.<sup>[9]</sup> Perceived behavioral control expresses past experiences as well as external factors such as barriers, resources, and opportunities that are likely

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to affect behavior.<sup>[10]</sup> In general, the theory of planned behavior is a theoretical framework that is often used to design behavior change interventions. Ideally, interventions that target the constructs of this theory to change behavior should lead to changes in these constructs.<sup>[11]</sup>

Using a mobile phone application is known as a suitable method to increase action according to physical activity guidelines,<sup>[12]</sup> which provides quality education with more student control over educational content, time and place of learning<sup>[13,14]</sup> and compared to traditional face-to-face interventions, it allows more access.<sup>[15]</sup> According to the surveys, many physical activity applications are available in English,<sup>[16]</sup> which reduces their use by Persian-speaking people. Moreover, Studies have also shown that teenagers do not receive enough education and need resources to adopt a healthy lifestyle. If sufficient training and information are given to teenagers, they will be better prepared for adulthood.<sup>[17]</sup> So an application with such a feature is necessary to promote physical activity among Iranian students. Therefore, this study aims to determine the effect of an educational intervention based on the theory of planned behavior on students' physical activity using a mobile phone application.

## Methods

### Participants and sampling

This quasi-experimental study was conducted among 220 students of Sarpol-e Zahab city, Kermanshah province in 2022. The sampling method was a multi-stage cluster. First, four schools were randomly selected among five female high schools, two schools as the intervention group and the other one as a control group. Second, in each school, two classes were randomly selected in such a way that there was one class from each grade (first and second grades). All the students in those classes were considered samples.

In this study, 220 students were enrolled (110 people in each group). Considering that the students were under 18 years old, their parents' consent was required, so an informed consent form was signed by their parents. The needed sample size was obtained 104 students using the Solhi *et al.* intervention (using behavioral intention variable ( $SD = 3.6$ )).<sup>[18]</sup> and the following formula (power = 0.8 and  $\alpha = 0.05$ ,  $SD = 3.6$  and the desired mean difference between two groups to be equal to 1.4), considering a five percent attrition rate.

$$N = \frac{\left( Z_{1-\alpha/2} + Z_{1-\beta} \right)^2 \left( S_1^2 + S_2^2 \right)}{(\mu_1 - \mu_2)^2} = \frac{(1/96 + 0/84)^2 \times 2(3/6)^2}{(1/4)^2} = 104.$$

### Inclusion criteria

- Students' willingness to participate in the study
- Having a smart mobile phone owned by either the student or at least one of the parents.

### Exclusion criteria

Withdrawal from the cooperation in the study.

### Measurement tools and methods

Data were collected based on demographic information, the theory of planned behavior questionnaire, and the International Physical Activity Questionnaire (IPAQ). The TPB questionnaire of Solhi *et al.*'s intervention, which was conducted on high school students, was used.<sup>[18]</sup> The content and structure of the questionnaire were validated by experts in health education and health promotion under direct supervision, and the reliability of the questionnaire was confirmed by conducting a pilot study and using Cronbach's alpha test as follows: Behavioral intention (0.72), attitude (0.70), subjective norms (0.73), and perceived behavioral control (0.75). This questionnaire includes attitude constructs (9 questions), subjective norms (6 questions), perceived behavioral control (4 questions), and intention (4 questions). The questions of each construct are designed based on a five-point Likert scale (strongly disagree with score 1 to strongly agree with score 5). IPAQ, which is indeed a self-report tool, measures the amount of physical activity done in the last seven days<sup>[19]</sup> and also the intensity of each activity separately (light, moderate, and intense). The questionnaire's validity and reliability have already been confirmed in Iran.<sup>[20]</sup>

### Educational intervention

This study obtained an ethical research code (IR.SBMU.PHNS.REC.1400.091) from the Ethics Committee of Shahid Beheshti University of Medical Sciences. Following ethical approval, arrangements were made with the education officials and schools were selected. Students of the intervention group and control group were added to their corresponding groups on Shad; that is, a communication and educational network that was launched by the Ministry of Education to organize the students' virtual education following the Coronavirus epidemic, so students can enter their virtual classrooms.<sup>[21]</sup> The students were provided with questionnaires on an online survey platform (<https://survey.porsline.ir>) whose links were sent in Shad class groups. The content used in this study, which was provided to the participants through an installable educational application in the form of an eight-session plan, is called "Be Active." This application is made by an Android Studio compiler and Java programming language based on the theory of planned behavior and pre-test results. The pretest results revealed that many students had a low attitude score toward the importance, enjoyment, and entertainment of physical activity. However, the impact of the important people of the students should also be taken into account. Furthermore, the pre-test showed a low score for the intention and the perceived behavioral control toward physical activity, particularly, regarding the impossibility of doing physical activity (barriers) and

low intention to do physical activity in the upcoming days. These results required an intervention to remove barriers, change attitudes, and increase the intention to do physical activity.

This educational application was provided with the cooperation of a panel of computer engineers who were responsible for designing the application and the research team in health education and health promotion, as well as physical education experts who were in charge of preparing the appropriate content. Initially, when the application was opened, there was a menu including an “Explanation about the intervention,” “training sessions,” “ application usage guide,” and “a warm-up video before starting the activity (including static and dynamic stretching movements)” also “contact with us.” Each training session had cognitive, emotional, and behavioral aspects. In the first week of the intervention, the students were only able to see the first session’s training plans and activities. Other sessions were unfolded to be used gradually at the beginning of each week. The prepared contents were loaded into the application, according to the results of the pre-test and students’ educational needs in all sessions. The installation and activation of the application were also ensured by the direct supervision of the researcher. In addition, an online meeting was held for the intervention group on Shad regarding how to work with the application,

and the students were encouraged to use it. The educational intervention through the application was conducted in 8 sessions for 8 weeks. Since this educational application is based on the theory of planned behavior, the constructs of this theory should be taken into account. Each session includes items, each of which is designed according to the constructs of TPB [Table 1].

Attitude is one of the constructs of this theory, which includes beliefs and evaluation of results<sup>[22]</sup> and must bring about positive changes in participants’ beliefs and opinions toward physical activity and its importance, these components also need to discuss the positive results of students’ involvement in physical activity.<sup>[23]</sup> Therefore, the educational videos were uploaded into the application with two physical education specialists (Three two-minute videos) addressing the benefits of physical activity to influence the students’ attitudes and create positive changes. Considering the importance of attitude and its impact on subjective norms and perceived behavioral control,<sup>[24]</sup> these videos were uploaded into different sessions, including the first, third, and sixth.

In this study, normative beliefs were targeted as one of the components of subjective norms. These beliefs themselves are divided into two categories: Descriptive and prescriptive norms. Descriptive refers to what is important others accept the desired behavior, while prescriptive refers to what is

**Table 1: Intervention activities**

Construct	Session	Behavioral goals for each session	Method of training	Educator	Evaluation method
Attitude	Session 1	• Creating a positive attitude toward physical activity	Video (2 min)	Physical education experts	Questionnaire
	Session 3	• Creating a positive attitude towards daily walking	Video (2 min)	Physical education experts	
	Session 6	• Creating a positive attitude towards aerobic exercises and its benefits	Video (2 min)	Physical education experts	
Subjective norms	Session 1	• Helping students believe that the important people support their self-efficacy in physical activity	Video (1 min)	Physical education instructor of school	Questionnaire
	Session 4	• Helping students believe that the important people emphasize on doing physical activity	Video (1 min) Video (3 min)	School medalist Friends, teachers, and parents of students	
Perceived behavioral control	Session 1	• Understanding the barriers of doing physical activity and solving it	Video (10 min)	A psychologist	Questionnaire
	All sessions	• Being able to do physical activity by low-impact and moderate-impact movements	Video (from 10 to 20 min)	Physical education experts	
	All sessions	• Doing physical activity by high-impact movements	Gifs and images (The benefits of each movement are also mentioned)	...	
Behavioral intention	All sessions	Doing physical activity according to the daily schedule based on the all activities that have been provided in the study (from 25 minutes in the first session to 60 minutes in the last session)	Image (table of the daily schedule for a week)	...	Questionnaire
	All sessions	• Doing physical activity as an entertainment	Video, gift	...	

important others do.<sup>[25]</sup> Regarding the subjective norms, to encourage and emphasize doing physical activities, two one-minute videos from the school's physical education instructor and the school's sports medalist as people who are physically active themselves (descriptive norms) in the first session, as well as a video from friends, teachers and some parents of the students, as people who can influence students (prescriptive norms) in the fourth session were loaded in the application.

As regards to behavioral intention some suggestions in the forms of videos, images, and gifs on how to turn a physical activity into entertainment to increase behavioral intention<sup>[23]</sup> were uploaded in all sessions into the application (including challenges with a plastic bag, jumping robe, box (pillow) jumping, jumping jack, challenge with a ball, challenge with two plastic bags, walking and jogging, respectively). Moreover, a weekly schedule of physical activities that could be easily done during the day was uploaded into the application after being approved by the physical education expert in all sessions.

Concerning control beliefs as a component of perceived behavioral control, a ten-minute video of a psychologist was uploaded into the application in the first session, who discussed the factors that facilitate or inhibit behavior. Indeed perception of these factors is control beliefs.<sup>[26]</sup> Perceived control power is another component of perceived behavioral control in which each control belief contributes to perceived behavioral control in interaction with perceived power to facilitate the performance of physical activity or hinder it.<sup>[22]</sup> With the approval of a physical education expert, we prepared 8 aerobics videos (including aerobic fitness, walking, and jogging) by two physical education instructors, which incorporated training methods such as breaking down behavior into small steps, modeling, and stress management to modify perceived behavioral control,<sup>[27]</sup> gifs and images of suitable movements for each physical activity accompanying with an explanation of how to do them were uploaded into the application in all sessions (including walking high knees, mountain climber, burpee, roll up, bear crawl, flutter kicks, straight leg raise, climbing stairs, respectively). Meanwhile, the control group did not receive any education.

During the two-month follow-up, students were sent short reminder messages in students' groups on Shad monthly to be reminded of being active. Also, immediately after the educational intervention and two months after the intervention, the questionnaires were completed online by both groups.

### Statistical analysis

Statistical data analysis in this study was done using SPSS 16 (SPSS Inc., Chicago, Illinois, United States). The histogram and Kolmogorov-Smirnov test were used to verify the normality data, which confirmed that the data

were normally distributed ( $P > 0.05$ ). Furthermore, since the sphericity assumption was violated for the repetitive measure ANOVA, the Greenhouse-Geisser correction was applied. Descriptive statistics (mean and standard deviation) were used to describe quantitative variables whereas the number and relative frequency were applied to describe qualitative variables. To compare the demographic characteristics, the independent T-tests were used to examine the mean of students' age and the Chi-square test for the other ones. In addition, the independent T-tests were applied to compare the mean of TPB components in the pre-test and Repeated Measure ANOVA to compare the mean of TPB components in two studied groups over time. Since the variables of physical activity were ordinal, Mann-Whitney and Friedman tests for the intervention and control groups were used.

### Results

Overall 220 students participated in this study, the average age of the participants in the intervention group was 16.27 (95% CI: 16.13-16.40) and in the control group was 16.35 (95% CI: 16.23-16.47). There was no significant difference in demographic information between the intervention and control groups and the results illustrate that all demographic variables of both groups were homogeneous [Table 2].

The mean of TPB constructs in the intervention group compared to the control group was significant at post-test and after the two-month follow-up compared to pre-test ( $P < 0.0001$ ) except subjective norms, which was not significant in two-month follow-up compared to post-test ( $P = 0.08$ ) [Table 3].

The physical activity level of students in the intervention group compared to the control group increased at both post-test and two-month follow-up ( $P < 0.0001$ ). However, no significant difference was observed in the pre-test ( $P = 0.404$ ). The level of physical activity in the intervention group increased immediately after the intervention compared to the pre-test and sustained the same amount at a two-month follow-up, while no meaningful changes were observed in the control group [Table 4].

### Discussion

This study was to examine the theory-based intervention using a mobile phone application, which has not been done in Iran so far. A mobile phone application called "Be Active" was used, which was designed based on the theory of planned behavior.

The use of this application led to a rise in the constructs of the theory of planned behavior including the attitude that significantly increased in the intervention group compared to the control group at post-test compared to the pre-test and this increase was sustained at the two-month follow-up. The results of this study were consistent with the studies of Solhi *et al.*<sup>[18]</sup> and Gabbadini and Greitemeyer.<sup>[28]</sup> However,

**Table 2: Comparison of the demographic information in the intervention (n=110) and control group (n=110) at baseline**

Variable	Group	Mean±SD	No (%)	P
Age	Intervention	16.27±0.7		0.369 <sup>a</sup>
	Control	16.35±0.64		
Grade	Intervention	First grade	59 (53.6)	0.418 <sup>b</sup>
		Second grade	51 (46.4)	
	Control	First grade	53 (48.2)	
		Second grade	57 (51.8)	
Father's job	Intervention	Unemployed	15 (13.6)	0.513 <sup>b</sup>
		Civil servant	23 (20.9)	
		Self-employment	72 (65.5)	
	Control	Unemployed	11 (10)	
		Civil servant	29 (26.4)	
		Self-employment	70 (63.6)	
Mother's job	Intervention	Employment	99 (90)	0.304 <sup>b</sup>
		Unemployment	11 (10)	
	Control	Employment	94 (85.5)	
		Unemployment	16 (14.5)	
History of sports club membership	Intervention	Yes	46 (47.3)	0.416 <sup>b</sup>
		No	64 (52.7)	
	Control	Yes	52 (41.8)	
		No	58 (58.2)	

a: Independent T-test, b: Chi-square

**Table 3: Comparison of the TPB structures in the intervention (n=110) and control group (n=110) at pre-test, post-test, and two-month follow-up**

Variable	Group	Pre-test Mean±SD	Post-test Mean±SD	Two-month follow-up Mean±SD	P <sup>a</sup>		
					pre-test and post-test	pre-test and 2 months follow up	post-test and 2 months follow up
Attitude	Intervention	35.15±4.65	37.84±3.06	37.67±3.2	<0.0001	<0.0001	0.982
	Control	34.64±4.47	34.86±4.2	34.53±3.05	0.89	1.0	0.192
		<i>P</i> <sup>b</sup>					
Subjective norms	Intervention	21.5±3.49	23.36±2.54	22.11±2.7	<0.0001	0.001	<0.0001
	Control	21.63±3.82	21.39±3.56	21.41±3.17	0.417	0.556	1.0
		<i>P</i> <sup>b</sup>					
Perceived behavioral Ccontrol	Intervention	13.4±3.06	15.53±1.95	15.4±1.91	<0.0001	<0.0001	0.460
	Control	13.59±2.43	13.86±2.06	13.7±1.87	0.316	1.0	0.318
		<i>P</i> <sup>b</sup>					
Intention	Intervention	143.05	15.59±2.10	15.68±1.80	<0.0001	<0.0001	0.997
	Control	14.07±2.77	14.22±2.46	14.03±2.09	0.997	1.0	0.128
		<i>P</i> <sup>b</sup>					

a: Repeated Measure ANOVA with Bonferroni correction. b: Independent *t*-test

the results of Ahmadi's study<sup>[29]</sup> are not consistent with the results of this study. It seems that the attitude of the participants towards physical activity was high before the intervention. Also, in the study of Zhang,<sup>[30]</sup> there was no significant increase in students' attitude scores after the intervention. It seems that in Zhang's intervention, there was no intervention regarding attitude, as a result, the attitude score of students in the intervention group regarding physical activity did not change.

In this intervention, subjective norms have increased significantly in the intervention group compared to the control group immediately after the intervention compared to the pre-test. However, it is not consistent with the results of Araban's study.<sup>[31]</sup> It seems that there was no emphasis on involving important people related to the participants in Araban's study. Social pressure from important people is effective in increasing subjective norms.<sup>[22]</sup> In Taghipour's<sup>[32]</sup> intervention Solhi<sup>[18]</sup> and Zhang,<sup>[30]</sup> there was a significant

**Table 4: Comparison of the physical activity level in the intervention (n=110) and control group (n=110) at pre-test, post-test, and two-month follow-up**

Group	Physical activity	Pre-test	Post-test	Two-month follow-up	P <sup>b</sup>
		No (%)	No (%)	No (%)	
Intervention	Light	47 (42.7)	20 (18.2)	18 (16.4)	<0.0001
	Moderate	51 (46.4)	49 (44.5)	54 (49.1)	
	Intensive	12 (10.9)	41 (37.3)	38 (34.5)	
Control	Light	42 (38.2)	46 (41.8)	41 (37.3)	0.554
	Moderate	60 (54.5)	55 (50)	59 (53.6)	
	Intensive	8 (7.3)	9 (8.2)	10 (9.1)	
P <sup>a</sup>		0.779	<0.0001	<0.0001	

a: Mann-Whitney. b: Friedman

increase in subjective norms in the intervention group after the intervention compared to the pre-test. However, in this study, subjective norms did not increase at the two-month follow-up compared to the post-test, since the two-month follow-up was in the summer it seems that being among friends, teachers, and being in the school environment can be effective in subjective norms. In fact, in schools, pressure from others, especially peers and teachers have a stronger effect on physical activity behavior.<sup>[33]</sup> In a study by Tsorbatzoudis,<sup>[34]</sup> which was done without involving the important people for students and emphasizing more on the attitude, the subjective norms in the intervention group did not increase significantly compared to the control group after the intervention and follow-up. Important people involvement seems to be effective.

The perceived behavioral control in this study at post-test and two-month follow-up compared to the pre-test in the intervention group had a significant increase compared to the control group. In the study of MohammadniaMotlagh *et al.*<sup>[35]</sup> and Parrott *et al.*,<sup>[36]</sup> the perceived behavioral control increased after the intervention compared to the pre-test. In Kelley's intervention,<sup>[37]</sup> the perceived behavioral control after the educational intervention in the intervention group increased significantly compared to the control group, and it sustained after the follow-up. However, in the study of Asa-kohnfiroody,<sup>[38]</sup> the perceived behavioral control after the educational intervention and three months after the intervention in the intervention group did not increase significantly compared to the control group. It seems that the cultural belief that it is inappropriate for girls to do physical activity in the streets is the reason for the decrease in people's understanding of physical activity, which leads to a decrease in perceived behavioral control. Recognizing barriers and providing solutions for them has a great effect on perceived behavioral control.<sup>[39]</sup>

Changes in the intention level show the positive effects of the educational intervention in increasing students' physical activity intention at post-test and two-month follow-up compared to the pre-test in the intervention group compared to the control group. Asa-kohnfiroody's study<sup>[38]</sup> is also

similar to the results of this study. Similarly, in the study of Hill *et al.*<sup>[40]</sup> and Jafarpour *et al.*,<sup>[41]</sup> there was a significant increase in the intention after the educational intervention in the intervention group compared to the control group. In Parrott's study,<sup>[36]</sup> the intention after the educational intervention in the intervention group increased compared to the control group immediately after the intervention, but it decreased in the follow-up. It seems that the e-mail-based study, which emphasized more on attitude compared to other constructs of the theory of planned behavior, leads to a decrease in intention, and conducting an intervention that also targets other constructs of this theory is effective.

The changes in the level of physical activity in the intervention group compared to the control group indicate the effectiveness of the educational intervention in improving students' physical activity. The study of Mirzaei *et al.*<sup>[6]</sup> and Shafieinia *et al.*<sup>[42]</sup> also showed a significant increase in participants' levels of physical activity in the intervention group compared to the control group after the educational intervention. Gholamnia-Shirvani's study<sup>[43]</sup> was also consistent with the results of this intervention. In Lubans's study,<sup>[44]</sup> the students' level of physical activity in the intervention group increased after the intervention compared to the control group, but there was no significant difference between the intensity of physical activity of the control and intervention groups in the follow-up. The results of this study showed a significant difference in the level of physical activity in the intervention group compared to the control group in the two-month follow-up, and it seems that the present study was effective in contrast to the Lubans' study, the student's level of physical activity in the intervention group increased after the intervention compared to the control group, which was followed up during the students' exams. In addition in Zhang's study,<sup>[30]</sup> the level of light physical activity in students increased after the intervention, but there was no increase in the level of intense and moderate activity of students, it seems the focus was on increasing light physical activity and making it easier for students, and it did not emphasize on increasing the intensity of physical activity, and however,

it was a school-based physical activity intervention and it was not planned for physical activity outside of school.

### Recommendation

School setting is considered crucial in implementing effective changes to adolescents' behaviors. The findings of this study demonstrated that intervention in the form of an educational mobile phone application in schools raised adolescents' physical activity. Since a physical activity intervention by mobile phone application had never been conducted in schools and this study had been implemented among female students, it might provide the foundation for future studies to investigate the effectiveness of this approach, particularly, in the case of all schools.

### Limitations and strengths

The limitations of the study include the intermittent closure of schools because of the prevalence of COVID-19. Another limitation is the impossibility of carrying out the study on a long-term basis. Nevertheless, this study benefited from some strengths including providing a mobile phone application to improve the physical activity of female students and having a control group to make a better comparison in the educational intervention.

### Conclusions

The results of this study indicate the effectiveness of the theory of planned behavior in increasing physical activity among students using an educational application called "Be Active." Therefore, making appropriate interventions based on behavior change theories is effective.

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### Ethical considerations

The Ethics Committee of Shahid Beheshti University of Medical Sciences approved this study. The institutional ethical committee at Shahid Beheshti University of Medical Sciences approved all study materials (ethics code: IR.SBMU.PHNS.REC.1400.091). In addition, written informed consent was taken from the parents of all participants (in the sense that they were under the age of 18) before any intervention.

Ethical issues (including plagiarism, data fabrication, and double publication) have been completely observed by the authors.

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### Conflicts of interest

There are no conflicts of interest.

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