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The effects of active video games and selected movement games on physical literacy components and self-concept in 8-12-year-old children

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Abstract

Background: Rapid modern world changes have impacted efforts to educate children with abilities and skills suitable for societal goals.

Aims: The aim of the study was to investigate the effects of active video games and selected movement games on children's physical literacy and self-concept.

Materials and Methods: Sixty 8-12-year-old children from Ahvaz City were selected and assigned into three experimental and one control groups. Physical literacy and self-concept were assessed in pretest. The active video game group played Xbox Kinect bowling, athletics, tennis, soccer, volleyball, basketball games. The selected movement game group played researcher-designed games. The mixed game group engaged in both activities over 12 video and 12 movement game sessions for 8 weeks, with 30-minute per session. Data were analyzed by MANOVA and student t-test.

Results: The results showed that active video games and selected movement games influenced children's physical literacy and self-concept. Further, significant differences were found between the experimental groups' physical literacy and self-concept outcomes. The selected movement game and mixed game groups performed better in these measures than other groups.

Conclusion: Results suggest parents and teachers consider implementing the selected movement games and active video games to bolster physical literacy and self-concept in children.

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1. Introduction

Technological advances and extensive societal changes have increased the role of education mixed with entertainment and technology in child and adolescent development. Various studies show that utilizing innovative and interactive methods in education has created significant differences in youth upbringing [1]. Such methods not only present concepts more attractively, but also provide more experiential and interactive learning opportunities through modern technologies and tools [2].

One topic attracting substantial education research attention currently is physical literacy– defined as the motivation, confidence, competence, knowledge, and understanding to appreciate and take responsibility for lifelong physical activity participation [3]. More specifically, physical literacy represents mastery of fundamental movement and basic sports skills enabling youth to interact with their environment and make appropriate decisions. This allows them to participate across a wide range of physical activities and sports situations with control and confidence [4]. It also presents a powerful instrument to investigate physical activities, motor skills, environmental context, broader social and affective learning process in children [5].

Research demonstrates that movement ability and skill development (e.g. gross and fine motor skills) from infancy through adulthood is impacted by concurrent development across all domains– including psychological, self-concept, morphological, and neuromuscular facets [6]. Self-concept represents individuals' perceptions of themselves, built via lived experiences and interpretations within their environments over time [7].

As youth progress from childhood into adulthood, evolving physical and movement changes occur in tandem with the formation of human self-perception and self-concept patterns. This self-concept causes individuals to continually draw self-comparisons with others and shape shifting self-images through ongoing mental review and imagination [6].

Research also identifies high body weight as related to poorer movement skills and body satisfaction, with overweight children at greater risk for underdeveloped skills [8].

Play constitutes an integral and meaningful part of childhood learning, and appropriately structured play may provide the most effective means of boosting physical activity and learning in youth [9]. Video games incorporating information technology have additionally received attention for their emergent benefits [10].

Relevant research by Barnett et al. (2008, 2015) yielded interesting findings. Their first study found children frequently performing basic object control skills like catching, throwing, and kicking in childhood maintain a more positive perception of their physical and athletic competence into adolescence– a key subcomponent of physical self-concept. This positive perception of sports competence significantly predicts both physical fitness and physical activity levels, while reciprocally impacting movement skill and body mass index [11]. Their second study concluded active video games may help introduce exercise to children but are unlikely to improve object control skills substantially. However, children enjoyed the gaming interventions [12].

Reviews demonstrate various training methods, including active video gaming, may influence physical literacy [10, 13] and

self-concept development [14]. Existing evidence reveals positive impacts of movement games on physical literacy and self-concept [10, 15]. Active video games demonstrate more varied effects on cognitive and movement functions– with studies showing positive [16, 17, 18] and negative [19, 20] outcomes.

Overall, despite extensive research across areas of movement function and physical literacy components, contradictions persist throughout these investigations. Additionally, the specific video games used in studies have been inconsistent. Separate research indicates primary school students unfortunately fail to achieve adequate physical literacy levels [21]. This worrying fact signifies that without concerted attention, future movement and physical health issues may emerge in children, alongside psychological risks. This study and future research with more rigorous, applied approaches can help address the aforementioned gaps and contradictions. Notably, existing studies largely explore impacts of active computer games and movement games on physical literacy and self-concept in isolation.

Therefore, the current study aimed to investigate the comparative effects of active video games and selected movement games on physical literacy components and self-concept development in 8-12-year-old children.

2. Materials and Methods

2.1. Participation

The statistical population comprised 8-12-year-old male students across 8 districts in Ahvaz City during the 2022-2023 academic year. Using convenience sampling, 60 subjects were recruited from two districts (Districts 2 and 3; the G*power software supports sample size) and randomly divided into four groups (n=15 per group): selected movement games, active video games, mixed games, and control. Participants were randomly assigned to one of four groups.

2.2. Instrument

First, all participants (n=60; mean age 9.43±.99 years) completed pre-test assessments including Canadian Assessment of Physical Literacy second edition (CAPL-2), with Motivation and Confidence; Physical Confidence; Knowledge and Understanding; and Daily Behavior subscales. Motivation and Confidence is measured by twelve items including internal motivation (three items), competence (three items), physical activity (PA) is fun (three items), PA self-competence (three items). Physical Confidence subscale consists of three protocols: 1. The Canadian Agility and Movement Skills Assessment (CAMSA), 2. The Progressive Aerobic Cardiovasular Endurance Run (PACER), and 3. The Isometric Plank Hold. The subscale of Knowledge and Understanding consists of recommended daily physical activity; terminology related to aerobic endurance; terminology related to muscular endurance, and methods to enhance physical competence. Daily behavior is measured by pedometer wearing for seven days (a week) subsequently. Reduction of rater and subject burden, and quality and accuracy of CAPL-2 has reported [22]. The Persian version of CAPL-2 was used [23, 24]. Its validity and reliability was confirmed by Nikkhoo and Imani (2020) [25], and the Piers Harris self-concept evaluations [26]. Test-retest reliability and internal consistency (Cronbach's alpha) of Persiant version of the instrument have confirmed by some studies [27, 28].

2.3. Procedure

Before initiating the intervention, trainers and examiners thoroughly explained the research processes to participants and guardians, obtained informed consent and health history forms, and gathered participant demographic information. The three experimental groups underwent 8 weeks of gaming interventions, with three 30-min weekly sessions (totaling 24 sessions and 720 min). This allocated training duration aligned with recommendations for fundamental skill development in motor learning literature [18]. The control group received no interventions and maintained their regular activity levels.

Multipurpose room and gymnasium spaces facilitated the interventions. The active video game group played Xbox Kinect bowling, athletics, tennis, soccer, volleyball and basketball games following a specific training protocol. A trained supervisor leveraged the available devices to provide each participant a full 30-min gaming session across the 4-hour complete training block. Instructional strategies included demonstration of games, verbal explanations, performance feedback, task modifications, and manipulation of gaming factors like object-goal distances [18]. The selected movement game group played researcher-designed games within a 20x40m gymnasium. These games comprised physical fitness and movement activities targeting fundamental skills (running, jumping, sliding, balancing, hopping, galloping) alongside foundational sports abilities featured in the video games (bowling, athletics, tennis, football, volleyball, basketball). An experienced children's coach (8 years of experience) delivered the games over 24 sessions, assisted by a coach with MA in motor development for controlling the class.

The mixed group engaged in both the active video games and selected movement games per the protocols of the respective intervention groups (twelve video game sessions, twelve movement game sessions total). Post-intervention, all participants completed the same battery of assessments administered at baseline: The CAPL-2 [24], and Piers Harris self-concept evaluations. The research ethics committee at the Sports Sciences Research Institute approved all study protocols and procedures under reference number SSRI.REC-2208-1821 (R1).

2.4. Statistic

Descriptive statistics including means and tables summarized data. The Shapiro-Wilk test evaluated data normality and Levene's test assessed homogeneity of variances to uphold assumptions. To test study hypotheses, analysis of composite variance examined differences between groups across the training timeline and independent samples t-tests compared differences between two groups at each time point (pre-test, post-test). Bonferroni post hoc tests identified the specific locations of statistically significant differences. Analyses employed SPSS Statistics Version 25, with significance set at $P \leq 0.05$. Microsoft Word 2016 and Excel 2016 facilitated manuscript preparation.

3. Results

Table 1 shows the demographic characteristics of the participants including age, height and weight in the studied groups.

Table 2 shows the mean ± standard deviation of physical literacy scores and its components and self-concept scores in the four groups.

Table 1. Mean ± standard deviation of participants' demographic characteristics

Variable	Groups			
	Selected games	Video games	Mixed game	Control
Age (years)	9.53±0.99	9.20±1.01	9.53±1.06	9.46±0.91
Height (cm)	136.8±5.9	137.66±6.66	135.73±4.87	135.06±5.31
Weight (kg)	35.93±6.21	35.13±5.99	35.06±5.35	34.26±4.35

Table 2. Mean ± standard deviation of physical literacy and self-concept scores

Variable	Stages	Groups			
		Movement games	Video games	Mixed game	Control
Physical literacy	Pre-test	36.76±1.72	36.94±2.42	37.42±2.33	37.11±2.38
	Post-test	67.78±1.69	41.21±1.98	64.66±2.31	37.18±2.12
***P* (pretest-posttest)**		0.0001	0.005	0.0001	0.785
Physical fitness	Pre-test	11.06±0.67	11.13±0.67	11.16±0.61	11.1±0.63
	Post-test	19.09±0.96	12.65±0.15	16.86±0.51	11.01±0.46
***P* (pretest-posttest)**		0.0001	0.001	0.0001	0.512
Knowledge and Perception	Pre-test	4.48±0.29	4.5±0.28	4.5±0.33	4.54±0.3
	Post-test	6.99±0.41	4.57±0.41	6.44±0.59	4.66±0.31
***P* (pretest-posttest)**		0.0001	0.36	0.0001	0.099
Motivation and Confidence	Pre-test	13.72±0.45	13.93±1.13	14.08±1.08	14.08±1.06
	Post-test	18.92±1.04	16.21±1.09	18.65±0.84	14.1±1.02
***P* (pretest-posttest)**		0.0001	0.005	0.0001	0.886
Daily behavior	Pre-test	7.45±0.88	7.35±0.97	7.67±1.02	7.38±1.03
	Post-test	22.78±0.6	7.7±0.96	22.70±1.54	7.40±0.93
***P* (pretest-posttest)**		0.0001	0.169	0.0001	0.823
Self-concept	Pre-test	50.2±3.05	52.53±1.81	52.73±5.66	51.33±5.99
	Post-test	81.73±3.47	57.40±4.17	79.8±4.45	51.53±4.17
***P* (pretest-posttest)**		0.0001	0.003	0.0001	0.823

According to Table 2, the pre-test scores of the four groups in the variables of physical fitness, knowledge and understanding, motivation and self-confidence, daily behavior, physical literacy and self-concept are not significantly different, but in the post-test stage, the scores of the test groups in the variables of physical fitness, knowledge and understanding, motivation and confidence, daily behavior, physical literacy and self-concept are higher than the control group.

The distribution of pre-test and post-test data in each group was normal by Shapiro-Wilk test, with (P>0.05). Additionally, according to Levene's test, homogeneity of variance was confirmed. Based on the fulfilment of these assumptions, analysis of composite variance (MANOVA) revealed significant between the four groups at post-test (P<0.001).

Physical literacy: main effect of stage (P=0.0001, η2=0.992, F=6776.22), group (P=0.0001, η^2=0.925, F=229.659) and stage in the group (P=0.0001, η=0.989, F=1713.04).

Physical fitness: main effect of stage (P=0.0001, η2=0.98, F=2709/08), group (P=0.0001, η^2=0.899, F=167/028) and stage in the group (P=0.0001, η=0.972, F=657.943).

Knowledge and Perception: main effect of stage (P=0.0001, η2=0.931, F=756.277), group (P=0.0001, η^2=0.713, F=46.417) and stage in group (P=0.0001, η=0.922, F=221.587).

Motivation and Confidence: main effect of stage (P=0.0001, η2=0.913, F=584.701), group (P=0.0001, η^2=0.559, F=23.709) and stage in group (P=0.0001,

η=0.827, F=89.31).

Daily behavior: main effect of stage (*P*=0.0001, η2=0.981, F=2921.042), group (*P*=0.0001, η2=0.955, F=393.933) and stage in the group (*P*=0.0001, η=0.98, F=919.751).

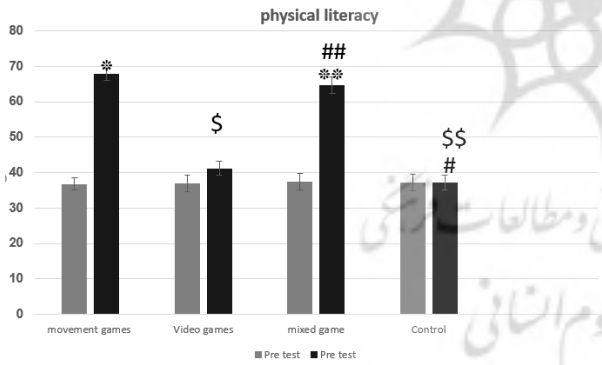
Self-concept: main effect of stage (*P*=0.0001, η2=0.889, F=467.534), group (*P*=0.0001, η2=0.826, F=88.459) and stage in the group (*P*=0.0001, η=0.851, F=106.947).

Multiple pairwise comparisons using the Bonferroni post-hoc test revealed statistically significant differences between some groups which is shown in Figures 1 (physical literacy), 2 (Physical fitness), 3 (Knowledge and perception), 4 (Motivation and confidence), 5 (daily behavior), 6 (Self-concept). Also, the post-test and pre-test comparisons are presented in Table 1.

4. Discussion

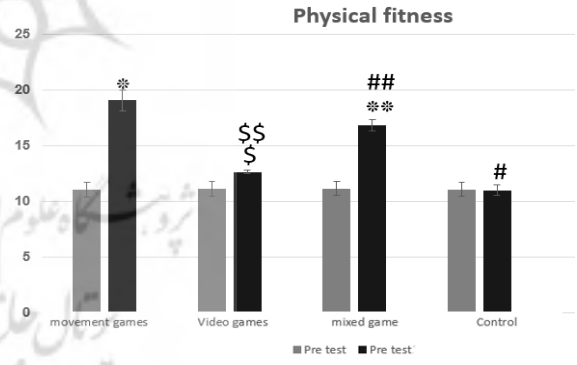
In this research, our aim was to investigate the effect of selected movement games, active video games, and mixed games on physical literacy and self-concept in children aged 8-12 years. The results of our research showed that selected movement games, active video games, and combined games have a positive effect on the physical literacy of children aged 8-12 years.

In examining the effect of each independent variable (movement games and active video games) on the components of physical literacy separately, we came to the conclusion that selected movement games, active video games, and combined games have a positive effect on the subscales of physical competence, motivation, and confidence in children aged 8 to 12 years. Also, in the subscales of knowledge and understanding and daily behavior, only selected movement games and combined games were effective.



* Significant difference between the movement games group and the active video games group
** Significant difference between the movement games group and the mixed games group
# Significant difference between the movement games group and the control group
$ Significant difference between the video game group and the mixed group
$$ Significant difference between the video game group and control group
Significant difference between the mixed games group and the control group

Figure 1. Multiple pairwise comparisons using the Bonferroni post-hoc test between groups for physical literacy



* Significant difference between the movement games group and the active video games group
** Significant difference between the movement games group and the mixed games group
# Significant difference between the movement games group and the control group
$ Significant difference between the video game group and the mixed group
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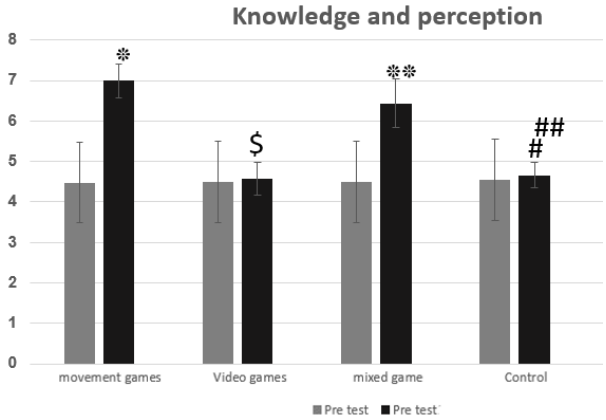
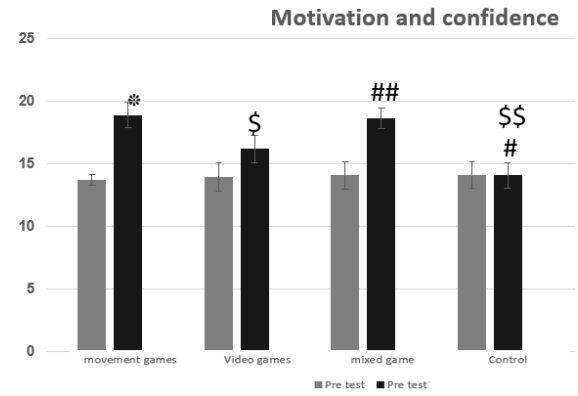
Significant difference between the mixed games group and the control group

Figure 2. Multiple pairwise comparisons using the Bonferroni post-hoc test between groups for physical fitness



* Significant difference between the movement games group and the active video games group
** Significant difference between the movement games group and the mixed games group
# Significant difference between the movement games group and the control group
$ Significant difference between the video game group and the mixed group
Significant difference between the mixed games group and the control group

Figure 3. Multiple pairwise comparisons using the Bonferroni post-hoc test between groups for Knowledge and perception



* Significant difference between the movement games group and the active video games group
# Significant difference between the movement games group and the control group
$ Significant difference between the video game group and the mixed group
$$ Significant difference between the video game group and control group
Significant difference between the mixed games group and the control group

Figure 4. Multiple pairwise comparisons using the Bonferroni post-hoc test between groups for Motivation and confidence

The results of this research are consistent with the findings of George et al. (2016), Bremer et al. (2020), Campelo et al. (2023), Vernadakis et al. (2015), and Telford et al. (2021) [10, 29, 30, 18, 31]. They stated that active video games (such as Xbox) and movement games play an effective role in improving children's physical literacy and motor skills. However, our results are not consistent with the research of Barnett et al. [11] and Lu et al. (2016) [32], perhaps due to some reasons such as research methodology, and quantity and quality of interventions.

Physical literacy refers to a person's ability to recognize, understand and use the principles and concepts related to physical and sports activities [3]. Among the aspects of interest in physical literacy, we can mention the principles of exercise, understanding the effects of exercise on health, proper nutrition and weight management, principles of safety in sports activities, and abilities related to participation in games and competitions [33].

Learning and demonstrating basic movements and sports skills and having self-confidence are among the basic requirements of a child's development [34]. Games are one of the most complete and meaningful ways of education and learning for children. If used properly, games can be the most effective way of enhancing children's learning and increasing their physical activity [9]. Using games as a tool for learning is known as "game-based learning" [35].

Research has shown that teaching basic motor skills is effective in creating positive changes in the development of children's motor skills [36]. George et al. (2016) investigated the effect of active video games (Nintendo Wii) on the physical

literacy of children aged 6 to 12 years. They concluded that there is generally a positive effect of the intervention with active video games on physical literacy components, as well as motivation. There was no significant difference in confidence between the mobile games group and the active video games group [10].

The social domain of physical literacy focuses on the ability to interact with others in relation to movement. This framework helps people understand how to progress on physical, mental, social, and cognitive levels to enjoy lifelong participation in movement and physical activity [3]. Also, the cognitive domain focuses on developing the knowledge and understanding needed for movement and physical activity. This framework helps people progress across physical, mental, social, and cognitive levels and enjoy lifelong participation in movement and physical activity [3]. Children's perceived competence may be enhanced by active video gaming, as easily mastered "virtual" sports and games may give children an optimistic bias regarding their potential to successfully engage in these activities [36]. Movement games can also help children better understand scientific concepts. For example, conducting experiments related to body movements and laws in games allows children to experience scientific principles practically and understand them better [37].

A common misconception is that children naturally acquire physical literacy through growth and maturation. However, to develop fundamental skills, children need appropriate practice opportunities and skill-specific feedback [38].

Therefore, according to the results of the present research, movement games provide a comprehensive method for children's movement experiences and participation in daily activities with full motivation, confidence, as well as understanding and knowledge regarding their own body and physical activities. In fact, active video games aimed primarily at "playing" for skill acquisition should be based on learning-oriented design principles [39].

Another result of the current research showed that selected movement games, active video games, and combined games have a positive effect on self-concept in children aged 8 to 12 years.

These results are inconsistent with the findings of Sum et al. (2018) [34] and the results of Lee et al. (2012) [34, 14], perhaps due to some factors such as research methodology, nature and duration of interventions, and quantity and quality of intervention programs.

Research evidence has demonstrated that children constantly compare themselves to others. In both games and everyday situations, they often compare themselves to peers. For this reason, children's self-concepts are formed based not only on personal experiences and observations, but also on the feedback and opinions they receive from others [40]. If children repeatedly encounter negative feedback about sports activities, these experiences may become internalized, leading to the creation of a negative self-concept. This can prevent approaching new challenges in future situations [41].

On the other hand, children possessing a positive self-concept move forward in responding to new challenges with motivation and self-confidence. Through successful physical experiences, they gain stronger self-confidence allowing them to benefit from flexibility and a positive attitude in various areas of life. Therefore, self-esteem in children primarily relates to

motor capabilities [42].

According to the findings here, 8 weeks of selected movement games, active video games, and combined games impacted self-concept in children aged 8 to 12 years. In this regard, Sum et al. (2018) showed teachers' physical literacy and self-concept may be the most significant determining factor. Effective physical education teaching should be considered as it, in turn, assists students' physical literacy and participation in physical activity [34].

Research on the impact of electronic games (video games and touch screen tablet games) on player behavior presents a mixed picture. Some studies report negative consequences, such as increased aggression, and various medical and psychosocial effects [14]. However, other research highlights positive outcomes, including improved hand-eye coordination, decreased reaction time, and increased self-esteem [14].

Zarotis (2019) specifically suggest that the active physical engagement required by some video games enhances children's learning, play composition, and promotes a positive self-concept [41]. One reason for the potential benefits of active video games lies in their accessibility for children who, for various reasons, cannot or do not want to participate in traditional physical activities. For example, overweight children who enjoy playing but feel hesitant to join sports teams or children confined to their homes due to various circumstances might find solace in active video games. Given the identified effects of active video games on physical literacy, they could serve as a temporary solution in such situations [14]. However, traditional movement games in real environments offer far greater benefits for physical literacy [13], and motor performance [38], which in turn, contribute to a positive self-image and a stronger self-concept [43].

Considering the limitations of the present study, future research should investigate larger and more diverse samples in terms of age, gender, and geographical region. Additionally, this study solely evaluated the short-term effects of the games. Given the importance of examining long-term effects, future research should also investigate the long-term impact of these games on physical literacy indicators to obtain more comprehensive and insightful results.

Overall, despite limitations, the findings of this study suggest that selected movement games and active video games can be effective non-pharmacological interventions for improving children's physical literacy. Utilizing these games, particularly movement-based activities, can contribute to children's physical literacy development by enhancing movement skills, motivation, knowledge, and behaviors related to physical activity. However, further research with a long-term approach and greater sample diversity is necessary to comprehensively identify the nuances of these games' impact. Nonetheless, the present study suggests that active movement and video games can be beneficial for children's motor skills, physical literacy, and self-concept.

5. Conclusion

Therefore, we recommend that parents, teachers, and sports organizations consider leveraging these types of games to:

- Introduce children to specific activities or sports. Active video games can act as a gateway, sparking an interest in real-world physical activities.
- Motivate children to participate in sports and/or physical activity. The engaging

nature of these games can foster a love for movement and encourage children to be more active overall.

- Create a complementary sports participation. Active video games can supplement traditional sports participation, particularly for children who face barriers to participation or seek additional challenges.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to analysis of the results and to the writing of the manuscript.

Ethical considerations

The authors have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc. The research has been conducted based on ethical committee Permission of Sport Science Research Center Code: SSRI.REC-2208-1821 (R1).

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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