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Physical training tennis serve performance on adolescent: A systematic review

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Abstract

Physical training on improving court tennis service skills in adolescent athletes is one part of mastering skills for teenagers. However, not all exercises that have been done by teenagers can be successful in mastering tennis serve skills. The main objective of this study is to explain physical training to support service skills in tennis. This study follows the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) and Meta-analysis. Scientific articles are obtained from Elsevier, Pubmed, Science Direct, Web of Science, National Index, Google Scholar, and Journal of Sports Coaching. After following the exclusion criteria, only 8 articles remain. The review successfully showed that most research, and quantitative approaches are the methods and types of research used. One important aspect of physical training is support for service skills on the tennis court. The practice study program lasts 3 weeks to 12 weeks. They do one to > two days per week. Conclusion The findings suggest that physical exercise can increase the speed of tennis serves. Recommended physical exercises to improve tennis serve include Exercises, Core Legs, Stability, and Arms. Further research can be continued by mapping research analysis on this topic using other methods to explore various forms of exercises for mastering skills in sports. This literature review can also be continued by discussing other topics related to mastery of skills.

Keywords: Physical Training, tennis, serve, adolescent.

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Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version

INTRODUCTION

The serve has been identified as one of the factors that will affect the performance of junior athletes in competition (Fitzpatrick et al., 2019). Serving tennis is very difficult, especially for adolescent athletes (Ali & Supriono, 2021). Physical attributes strongly influence youth tennis performance, especially arm and wrist strength (Girard et al., 2009).

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Physical ability significantly influences service speed in tennis, especially factors related to upper body strength and endurance (Ulbricht et al., 2016). Anthropometric factors also affect service results, and service speed can be determined by a combination of skill, height, hip movement, and upper and lower extremity strength (Palmer et al., 2018). In addition, junior tennis athletes require good fission conditions and high-intensity training (Björklund et al., 2020). Therefore, the influencing factors in tennis are accurate serviceability, upper body physical ability, and anthropometry, and success in tennis requires superior technical and tactical skills and optimal physical condition.

The serve is a very complex tennis stroke and a significant tennis stroke, here are the service steps in tennis A) Start, (B) Release, (C) Loading, (D) Cocking, (E) Acceleration, (F) Contact, (G) Decelera-Tion, And (H) Finish (Kovacs et al., 2011). Implementing an 8-week exercise program using excess weights, medicine balls, and elastic bands significantly improved service speed and one- and two-arm (2 Kg) drug ball throwing capacity. These results justify the introduction of strength training programs for young tennis players, as this increases their general and specific strength levels. (Terraza-Rebollo et al., 2017), Other results show that servicing physical exercises using different upper and lower body weight resistance exercises (HLRE), these results suggest that complex exercises using HLRE are not a useful method to bring out the post-activation potentiation effect on tennis serves and do not have any effect on serve accuracy in young competition tennis players (Terraza-Rebollo & Baiget, 2020). Training with heavier or lighter weights is an option that can improve serve when the athlete performs the desired maximum execution speed. Based on the current literature on exercise methods to improve serve, examples of exercise programs are presented to support strength and conditioning trainers in improving these key factors (Colomar et al., 2023). Training with heavier or lighter weights is an option that can improve serve when the athlete performs the desired maximum execution speed. Based on the current literature on exercise methods to

improve serve, examples of exercise programs are presented to support strength and conditioning trainers in improving these key factors (Colomar et al., 2023).

Various studies have highlighted the significant impact of physical exercise on tennis serves, through special training programs for 6 weeks, service speed can be increased, and training programs 3 times in 1 week for 1 year can improve physical fitness (Yefremenko et al., 2021), because physical fitness is the foundation for the performance of a tennis athlete, regular, planned tennis practice, along with resistance training, positively affects athletes' physical parameters, including leg strength, hand grip strength, and agility. Important role of physical strength in servicing, suggesting the use of specific physical measurements as indicators for improvement. These studies, as a whole, show that physical exercise plays a crucial role in improving tennis serves. Some types of physical training that can be used to improve ability and speed on serve are resistance training for tennis players, especially in improving service performance, the importance of a well-designed resistance training program, which specifically highlights the effectiveness of the new model in increasing service speed (Kumar et al., 2017). The impact of resistance training on tennis serve performance: Researchers found that resistance training can improve service speed, with studies specifically highlighting the effectiveness of resistance-based models (Behringer et al., 2013; Dewanti et al., 2020), lower body training can improve serviceability (Deng et al., 2022; Williams, 2021) however, further research discussing the potential of specific resistance training methods, such as strength-based programs and post-activation potentiation, in increasing serve speed found no significant impact on service speed or accuracy, (Colomar et al., 2023; Terraza-Rebollo & Baiget, 2020), seeing such differences suggests the need for further research in this area.

When training service skills in adolescent athletes, it is necessary to think about a breakthrough, especially the physical ability of a let as a support for athlete performance, physical is a component that can support

all forms of skills in sports (Berhimpong et al., 2023; Guillot et al., 2013). Every athlete needs to acquire forms of training to master skills, whether the training is related to the physical and technical components according to the specifications of the characteristics of the sport. The goal of any workout is to prepare each athlete to compete and achieve their best performance. For athletes to benefit from any exercise, it is very important for coaches and athletes to understand any form of exercise that can improve athlete performance especially in skill mastery (Putra et al., 2017). In addition, it is very important for coaches to also avoid mistakes in the selection of exercise forms by reviewing each form characteristic of the technique in the related sport, supporting physique before and after the match, and contributing to the performance and skill mastery process (Mawarda & Nurhidayat, 2021). The maturity of adolescent athletes depends on mastering the techniques in each sport. Physical performance in technical training in sports also improves performance during training and competition, which can accelerate skill mastery. Building champion athletes starts with providing programs that can truly improve athletes' performance (Mawarda & Nurhidayat, 2021).

In several previous research articles, the author has yet to find an article that explains the physical aspects that need to be considered in supporting the mastery of tennis skills, especially service skills. The purpose of regulating forms of physical exercise is to find the best training pattern and increase efficiency in mastering tennis serve skills as a supporting form in every match (Budi et al., 2020). Several articles/studies were found separately discussing physical exercise as support for court tennis but touched on certain specific aspects that need to be considered. The article should answer questions about the aspects that must be considered in meeting the needs of physical training to support mastery of tennis services in the category of youth athletes.

METHOD

This study follows Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis (Page et al.,

2021), The analytical structure used in this study is in line with several database studies. The number of books and articles obtained is 361, published from 2007 to 2023. This strategy is used to find articles using PICO. Methods of collecting library data or research whose research objects are explored through various sources of library information (books, scientific journals). Population/problem, population or problem to be analyzed in scientific papers with a theme or topic: physical exercise mastery of service skills in tennis. An intervention is an action taken on a problem, a comparison with comparisons from other similar studies. Results of the study: several forms of physical exercise, specifically supporting service skills and adolescents.

Search Strategy

This database on systematic review research contains information on high-quality multidisciplinary research published in scientific journals with significant global impact and allows the integration of records to facilitate this research. A literature search is systematically limited from 2007 to 2023 and uses two electronic databases, namely Scopus and Web of Science (WoS). Both databases are considered the leading citation indexing systems (Farid et al., 2020) and are most frequently visited by previous researchers worldwide (Perdima et al., 2022; Sweileh, 2020; Yang et al., 2021). The search strategy carried out is a systematic investigation of this topic carried out using OR operations. The keywords training", "exercise," "intervention," "physical training," "strength training," "aerobic exercise," "fitness training," and "Resistance Training." An example of a PubMed search "training_tittle OR "exercise_tittle*" OR "intervention_title" OR "physical training_Title" OR "exercise training_tittle" OR"resistance training_tittle" OR "strength training_title OR "aerobic exercise_tittle" OR "power training_tittle" OR "fitness training_tittle" OR "fitness training_tittle," OR "Resistance Training_tittle ."Using reference management software, endnote X9 is used to collect data that has criteria, title, author type, and year of publication. Data that have duplicates/are the

same and are not available in complete documents will be deleted. The selected data will be filtered again using inclusion and exclusion criteria.

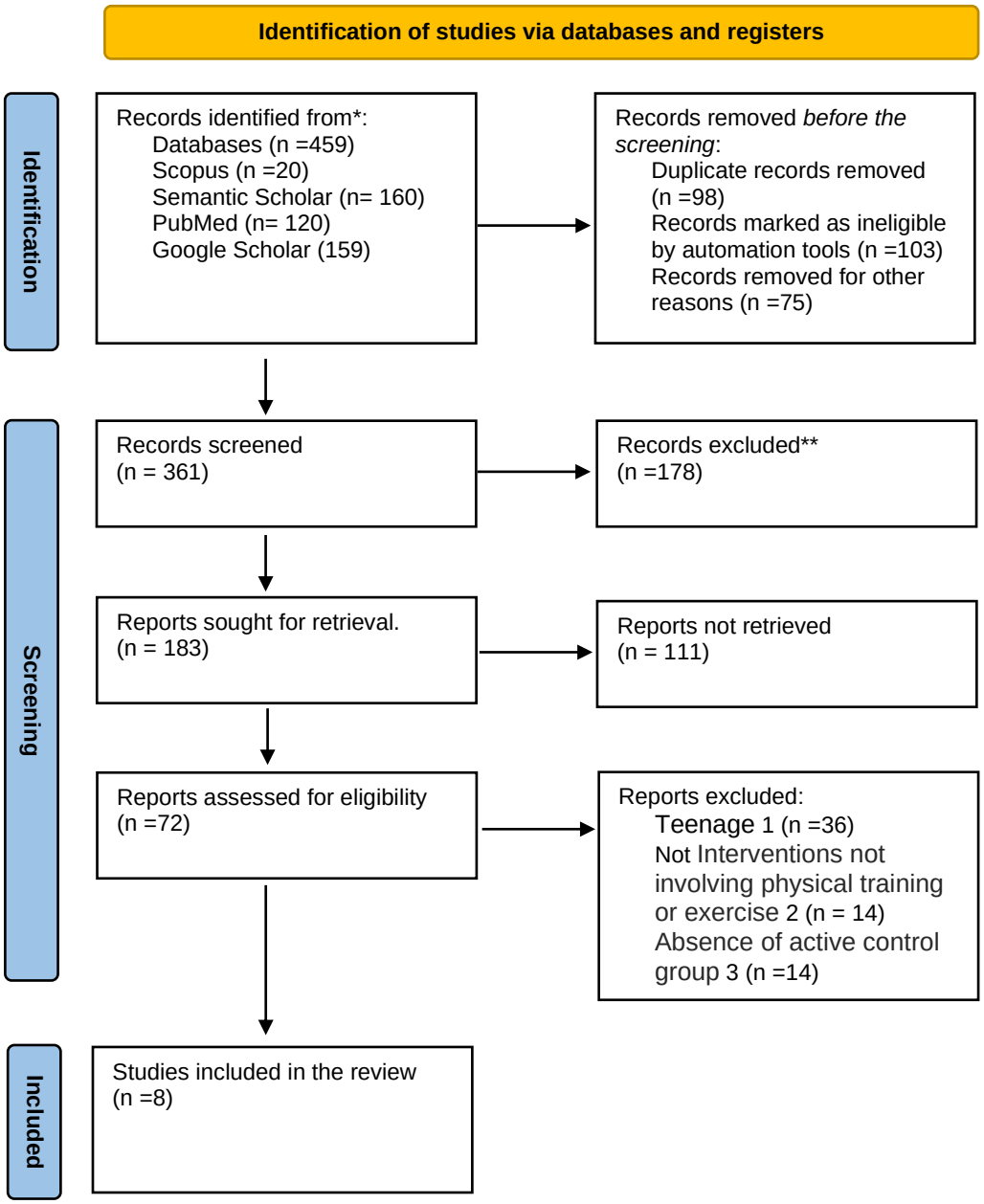

Figure 1. PRISMA Flow Diagram

*Consider reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

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Eligibility Criteria

The research study must meet the requirements listed in the PICOS framework to be considered for further analysis (McKenzie et al., 2019). The exclusion criteria used are as follows: (1) Duplicate articles, (2) Articles not published in Journal Citation Report (JCR) or Scimago Journal Rank (SJR) indexed journals, (3) Articles published under 2007, (3) Articles in easy-to-understand language, articles in Indonesian or English, (4) Journal articles with selected empirical data which means review articles, Book series, books, chapters in books and conference proceedings are all excluded, (5) Articles included only in the field of sports coaching education. It can be seen in the table below:

Table 1. Eligible criteria PICOS

Criteria	Inclusion criteria	Exclusion criteria
Population	adolescent	Teenage (Elite athlete, Elite professional)
Intervention	Physical Training min 2 week	Interventions not involving physical training or exercise
Comparator	Two or more groups and single-group trials	Absence of active control group
Outcome	VC	Physical Fitness
Study Design	RCT or non-RCT	Cross-sectional studies, case studies

*RCT : Randomized Contro Trial *Non-RCT :Non-Randomized Control Trial *VC:Velocity Serve

A systematic review of this study of several important components will be presented, including:

1. Young men and women will be analyzed under the age of 16 years (Cools et al., 2014).
2. Using physical exercise as a form of intervention is given for at least 2 weeks. However, if it is irrational to provide training during the experiment, then we will eliminate the study.
3. Take data on pretest and post-test results from each group to see the mean difference from the exercises used.
4. Taking only the difference in service speed results from a given training method, this study did not notice physical condition.
5. Taking a study design that meets the requirements of the experimental design.

Research Procedure

Initially, 459 articles were obtained from two databases (Scopus: 20 articles), (Semantic Scholar: 160), (PubMed: 120) and (Google Scholar: 159 articles). All articles are retrieved from the database and analyzed through Mendeley software to remove duplicate articles. After following the exclusion criteria, only 7 manuscripts remained. Most of the items were discarded because the filter was applied in the last five years (2007-2023), and only articles were in English and duplicate articles.

RESULT

Based on the study's results, several components will be presented, including the study, population (number of samples, sex, and age), research design, number of intervention duration, comparators from each group given physical exercise, measurement procedures, and research results. The results of the systematic literature review are in Table 3.

Tabel 3. Result systemtic literatur review

Study	Population			Desain Research	Duration Treatment	Type Training	Measurement	Result
	N	Gen	Age					
(Ferrauti & Bastiaens, 2007)	13	7=M 6 = F	12.3 (0.8) years old	Preetest-Postest design	3 days separated by 1 week 3-week/grup	LI Ball 200 Gram HI Ball 600 Gram	A radar gun (Stalker, Plano, Texas, USA)	1. Heavy ball throwing does not improve service velocity in young elite tennis players. 2. Complex training methods for post-activation potentiation show no short-term benefits. 3. Service precision and touch remain unaffected by light or heavy interventions.
(Behringer et al., 2013)	36	M	5.03 ± 1.64 years old	Preetest-Postest design	8 week	Plyometric and Resistance Training	Speed Trac X, EMG Companies, Inc. Outer Limits Sports, Prescott WI, USA	1. Plyometric resistance training enhances tennis serve velocity in youth players. 2. Machine-based resistance training did not show significant improvements in serve velocity.
(Malliou et al., 2010)	60	31= M 29 = F	13 to 14 years old	Preetest-Postest design	7 week	exercises for both shoulders	serving velocity and technique	1. Significant improvement in service performance and technique in young tennis players. 2. Strength training and service practice enhance service ball speed. 3. Qualitative findings showed significant improvement in service technique in the group. 4. Strength training can increase internal rotator strength and range of motion.
(Fernandez-Fernandez et al., 2018)	16	M	12.9 6 0.4 years old	Preetest-Postest design	5 week	Plyometric Speed/agility Medicine Ball Before Tennis (BT)-specific training After Tennis (AT) - specifi training	A radar gun (Stalker Professional Sports Radar, MN, USA)	1. BT group showed positive effects in serve velocity 2. AT group positive effects in serve velocity. 3. Sequencing NMT before tennis training led to performance serve velocity
(Fernandez-Fernandez, Ellenbecker, Ulbricht, & medicine,	30	M	age 14.2 ± 0.5 years old	Randomized Preetest-Postest design	6 week	core strength, elastic resistance, and	A radar gun (Stalker Professional Sports Radar,	combining core-strength, elastic resistance, and medicine ball exercises resulted in improved tennis

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2013)						medicine ball exercises	Radar Sales, Plymouth, MN)	performance (i.e., serve velocity)
(Dewanti et al., 2020)	60	M	9-to 12-year old	Preetest-Postest design	12 week	Resistance-based strength training: Leg Core Stability Arm	Collang Smart Tennis Racket Sensor Tracker Motion Analyzer	Resistance-based strength training has been tested to improve the performance of junior tennis athletes in doing serve more effectively than the conventional model did.
(M Terraza-Rebollo et al., 2017)	20	15=M 5=F	15.5 ± 0.9 years old	Randomized Preetest-Postest design	8 week 3 day/week	Medicine Ball Elastic Band	A radar (Stalker Pro, USA)	Implementing an 8-week training program using overloads, medicine balls, and elastic bands significantly improved the serve speed.
(E. Baiget, Colomar, & Corbi, 2022)	16	M	15.6 ± 1.1-year-old	pretest, intertest and postte	6 Week	isometric strength training (IST) Shoulder Internal Rotation (SHIR) or Shoulder Flexion (SHF)	A hand-held radar gun (Stalker ATS II, United States, frequency: 34.7 GHz134 (Ka-Band) +/- 50 MHz)	To combine 6 weeks of upper-limb specific-joint IST with the habitual tennis workouts results in significant increases in Service Velocity

**N : Sampel Gen: Gender M:Man F: Female*

The tennis serve is undoubtedly one of the most challenging tennis strokes to master, but it can contribute significantly to victory or points advantage (Guillot et al., 2013). Here are the results of our review, which will provide the right type of training and training duration for junior athletes to improve serve speed. Several types of exercises can be used in general for serve training as follows:

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Table 2. Physical exercise recommendations for junior serve athletes

Study	Duration Training	Type Training Intervention
(Ferrauti & Bastiaens, 2007)	3 days separated by 1 week 3-week/grup	4 Set 5 Service with LI Ball 200 Gram 10 s Recovery 2 min between Set 4 Set 5 Service with HI Ball 600 Gram 10 s Recovery 2 min between Set
(Behringer et al., 2013)	8 week 2 training sessions per week	12-20 x 2-4 with t 60 s rest 6 type plyometric and 65%-85% RM with 60 s rest Resistance Training
(Malliou et al., 2010)	7 week 3 time per week 15 minutes per session	2 sets of 10-15 repetitions with 0.5-1.0 kg free weights. Exercise strength for both shoulders. Rest for one day between practice days.
(Fernandez-Fernandez et al., 2018)	5 week Before Tennis (BT)-specific training After Tennis (AT) -specifi training	2-3 set x10 repetitive 5 type Plyometric 60 s rest 1-3 set x 3-5 repetitive Speed/agility 30 s (reps); 90 s (sets) 3 set x 8-10 repetitive Medicine Ball rest 25 s (reps)
(Fernandez-Fernandez et al., 2013)	6 week 3 session	2 set x 20 repetitive core strength, elastic resistance, and medicine ball exercises in the first three 2 set x 20 s repetitive core strength, elastic resistance, and medicine ball exercises to last with 45 seconds rest between exercises
(Dewanti et al., 2020)	12 week	Resistance-based strength training: Leg Core Stability Arm
(M Terraza-Rebollo et al., 2017)	8 week 3 day/week	3 sets of each exercise were completed, with 1 minute rest between exercises and 3 minutes between sets With Fitness 3 sets of 6 repetitions were performed per exercise. Medicine ball weight: 2 kg with Medicine Ball and Elastic Band
(E. Baiget et al., 2022)	6 Week 2 days per week Week 1, 2, 3 60 to 80 s work Week 4, 5, 6 120 to 150 s work	isometric strength training (IST) Shoulder Internal Rotation (SHIR) or Shoulder Flexion (SHF) Intensity 100% Rep 3 -5 set 1 Rest between reps 15 s Rest between exercises for 60 s

DISCUSSION

The serve is a very complex tennis stroke and a significant tennis stroke, here are the service steps in tennis A) Start, (B) Release, (C) Loading, (D) Cocking, (E) Acceleration, (F) Contact, (G) Decelera-Tion,

And (H) Finish (Kovacs et al., 2011). Implementing an 8-week exercise program using excess weights, medicine balls, and elastic bands significantly improved service speed and one- and two-arm (2 Kg) drug ball throwing capacity. These results justify the introduction of strength training programs for young tennis players, as this seems to increase not only their general strength level but also their specific strength level (M Terraza-Rebollo et al., 2017). Tennis is very dependent on muscle strength in the upper extremities (Saleh & Saleh, 2023). Serve has been identified as one of the factors that will affect the performance of junior athletes in competition (Fitzpatrick et al., 2019), serve tennis is very difficult to do, especially for adolescent athletes (Ali & Supriono, 2021). Physical attributes strongly influence youth tennis performance, especially arm and wrist strength (Girard et al., 2009).

Plyometric training has been shown to have a significant positive impact on tennis serve performance in adolescent players. Studies have demonstrated that incorporating plyometric exercises into training routines can lead to improvements in various physical qualities essential for tennis, such as agility, speed, and power (Fernandez-Fernandez et al., 2016; Gelen et al., 2012; Lakshmikanth et al., 2018) Specifically, and research has highlighted that plyometric training, when combined with regular tennis training, results in enhanced physical qualities crucial for tennis players, including serve velocity, agility, and overall performance movements. The findings suggest that integrating plyometric exercises into the training regimen of adolescent tennis players can lead to notable improvements in serve performance, contributing to their overall athletic development and competitive edge on the court.

Resistance training and medicine ball training can be effective methods for improving ball velocity and accuracy in tennis serve performance for adolescent players. However, these training methods' acute and delayed effects on stroke velocity and accuracy have yet to be widely studied. While some studies suggest that strength training can enhance tennis performance, the specific effects on serve velocity and

accuracy in young competition tennis players still need to be well-established. The study mentioned in the search results aimed to investigate the acute and delayed effects of medicine ball throws and resistance training on ball velocity and accuracy in young competition tennis players. The study found no significant differences in ball velocity and accuracy after each method and each recovery time compared to the basal situation. This suggests that medicine ball throws and resistance training methods have no acute and delayed detrimental effects on stroke velocity and accuracy in young competition tennis players. In summary, while resistance training and medicine ball training can improve tennis serve performance, the specific acute and delayed effects on stroke velocity and accuracy in young competition tennis players must be well-established and require further research.

CONCLUSION

This review has contributed by providing a literature update on leadership in sports coaching, especially in technical tennis skills, from 2007-2024. Initially, many studies were found, but after applying the exclusion criteria, their number was reduced to 7 articles. The final result reflects that physical exercise can increase the speed of tennis serves. Physical exercises recommended to improve tennis services include Plyometric and Resistance Training for Leg Core Stability and Arm with a time of > 6 weeks. Plyometric Exercises and Core Stability Resistance of the Legs and Arms can improve tennis serve performance. Specific acute and delayed effects on stroke speed and accuracy in young competition tennis players need to be well established and require further research.

Some limitations inherent in reviews should be observed. First, despite a thorough literature search, some published studies may need attention due to the possibility of using keywords different from those currently used. Second, the database used in article search is only limited. As for future research, it will be interesting to discuss the topic of training with other technicalities in sports, especially tennis, and this review can also be continued by discussing appropriate topics other than techniques

on serve. Furthermore, researchers can also add other databases so that the data found is larger and has more interesting findings.

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