Resveratrol and exercise: a review on the effects of resveratrol on physical and sport performance

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ABSTRACT. Phenolic compounds have been shown to be important molecules in human metabolism. Among these, resveratrol, found primarily in the skin of red grapes, has been touted as a promising adjuvant in the treatment and prevention of disease. Recently, the ergogenic potential of resveratrol has been investigated, however, showing diverging results. The purpose of this review was to analyze and discuss studies that evaluated the effects of resveratrol supplementation on exercise performance. The search terms *resveratrol*, *physical exercise* and *exercise training* on the PubMed platform were used, resulting in 18 studies eligible for the selection criteria. The selected studies confirm that there is no consensus in the scientific literature about the ergogenic potential of resveratrol. The selected studies do not point to a common result, and even similar experimental interventions show divergent results.

Keywords: Aerobic exercise, Exercise, Resveratrol, Supplementation.

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INTRODUCTION

The search for a healthy diet is linked to the search for foods that, besides their nutritional value, play a potentially beneficial role in reducing the risk of chronic diseases. One of these foods is grapes, the raw material for juices and wines. Moderate consumption of red wine and grape juice may have protective effects, reducing the risk of developing cardiovascular disease, atherosclerosis, hypertension, certain types of cancer, type 2 diabetes, neurological disorders, and metabolic syndrome (Golan, Gepner, & Shai, 2019). The beneficial effects of consuming grape derivatives are related to the phenolic compounds found in the fruit, especially resveratrol (RESV). Because of its ability to neutralize free radicals, reducing/preventing oxidative stress, and because of its anti-inflammatory potential, resveratrol has been widely studied (Guerrero, Garcia-Parrilla, Puertas, & Cantos-Villar, 2009).

In a literature review, Hecker et al. (2022)set out to study the effects of RESV on skin aging. The authors inferred that this phenolic compound shows promise in protecting the skin against photoaging as a result of its antioxidant and anti-inflammatory potential. In addition, by stimulating the synthesis of elastin and collagen by fibroblasts, RESV also helps to promote skin elasticity and firmness, increase hydration, and reduce wrinkles.

In their study, Vatavuk-Serrati et al. (2019) discuss the action of RESV on cardiovascular disease, cancer, neurodegenerative diseases, diabetes, hyperglycemia, as well as its possible effects on longevity. The authors suggest that RESV supplementation is safe and beneficial, acting positively on endothelial function, the glycemic profile of patients with insulin resistance, and inflammation.

There is consensus in the literature about the positive effects of RESV on health parameters. However, recent studies suggest that this phenolic compound also has an ergogenic effect in individuals undergoing exercise training. Some research, both in humans and animals, has indicated positive effects of resveratrol supplementation on sports performance (Alway et al., 2017; Hart et al., 2014). On the other hand, other experiments with humans have shown that RESV does not affect or negatively affects performance in different physical valences (Olesen et al., 2014, Scribbans et al., 2014, Tsao et al., 2021). Thus, despite the growing number of studies, the findings on the subject remain scarce and discrepant.

As an antioxidant compound, RESV can aid recovery after exertion and reduce the wear and tear caused by exercise sessions, contributing to the adaptive process to training and improving physical performance. In addition, RESV supplementation can improve mitochondrial activity, enhancing bioenergetic capacity and substrate utilization, and consequently improving performance in a stress test. Thus, the purpose of this literature review was to analyze and discuss data from studies evaluating the effects of resveratrol supplementation on exercise performance.

MATERIALS AND METHODS

This literature review was based on the PRISMA (EQUATOR) protocol recommended for review studies. The searches were performed exclusively in the Medline PUBMED database. The strategies for searching this database involved selecting the descriptors (MeSH Terms) resveratrol, physical exercise, exercise training, in a combined way through the boolean operator "and" (resveratrol “and” physical exercise / resveratrol “and” exercise training).

Studies that addressed the topic "resveratrol supplementation and physical performance" were eligible, and only those published after 2010 and in English were included. Review studies, meta-analysis, commentaries, letter to the editor, and brief communications were excluded. Studies conducted with specific groups, such as individuals with declared diseases (cancer, heart disease, diabetes, obesity, and motor difficulties) and animals subjected or induced to special health/disease conditions, such as diabetes, hypertension, and obesity, were also excluded.

Other criteria used for selection of the manuscripts are that they specifically address the subject in question as the main theme of the study, that there is no association of the ESRB with another food supplement or drug, quality of experimental design and sampling, methodological rigor, and consistency of conclusion (subjective parameters evaluated by the authors).

First, repeated or duplicate published studies were excluded. Then the titles of the papers were evaluated according to the exclusion and inclusion criteria. The abstracts of the remaining studies were read in their entirety and filtered according to the established criteria and their relation to the object of study of the present review. Finally, the full texts were assembled for evaluation according to the criteria described above.

RESULTS

The initial search resulted in 399 scientific articles. Sixty-three duplicate or repeated studies were excluded, and the remaining filters eliminated 318 articles. Thus, only 18 studies were considered eligible according to the standards set for this literature review (Figure 1).
Ten of the selected studies evaluated the proposed intervention in animal models, mainly mice. Eleven studies have evaluated the effects of supplementation and training in animals or untrained individuals. Only two studies did not include training in their experimental intervention, and among the studies that did include training, cardiorespiratory endurance training predominated. Eight studies found the RESV to have some ergogenic and/or adjunctive effect to applied physical training, while five studies observed no effect on the variables tested. Blocking and inhibitory effects of RESV supplementation to the adaptations promoted by applied training were evidenced in five studies (Table 1).

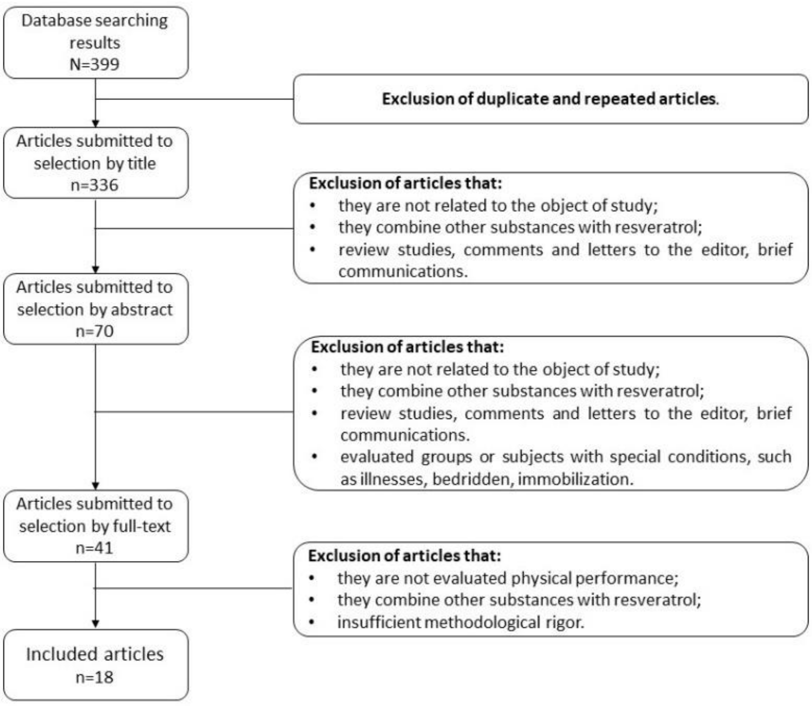

Figure 1: Article selection process.

Table 1: Studies on the effects of resveratrol on exercise performance.

Authors	Experimental model	n	Pre-intervention training level	Type of exercise	Training time	Dose of RESV	Supplementation Time	Effect on performance	Other effects
(Kan et al., 2018)	Mice	40	Untrained	Strength	4 weeks	25 mg/kg/day	4 weeks	Increased strength, climbing speed and aerobic endurance. Anti-fatigue effect.	Increased cross-sectional area of skeletal muscle.
(Muhammad & Allam, 2018)	Older mice	30	Untrained	Aerobic endurance	4 weeks	15 mg/kg/day	4 weeks	Anti-fatigue effect.	
(Olesen et al., 2014)	Older men	43	Untrained	High Intensity Interval Training	8 weeks	250 mg/day	8 weeks	No effect on aerobic endurance.	
(Ringholm et al., 2013)	Mice	30	Untrained	Aerobic endurance (ad libitum)	48 weeks	4 g/kg feed	48 weeks	No effect on aerobic endurance.	Resveratrol did not affect the expression of oxidative proteins in skeletal muscle.
(Huang et al., 2021)	Young men	36	Active	-	-	500 mg/day and 1000 mg/day	1 week	Small increase in maximal strength in anaerobic effort.	Reduction of muscle damage caused by exercise.
(Dolinsky et al., 2012)	Older mice	50	Untrained	Aerobic endurance (treadmill)	12 weeks	4 g/kg feed	12 weeks	Increased aerobic capacity and strength.	Improvement of fatty acid metabolism. Reduced insulin resistance and improved cardiac function.
(Alway et al., 2017)	Older men and women	30	Untrained	Aerobic endurance and strength exercise	12 weeks	500 mg/day	12 weeks	Increased aerobic capacity and type I muscle fiber hypertrophy.	
(Gliemann et al., 2013)	Older men	37	-	Aerobic endurance and strength exercise	8 weeks	250 mg/day	8 weeks	Blocking the increase in maximal oxygen consumption and no effect on functional capacity.	Resveratrol reduced positive effects of training on lipid profile.
(Scribbans et al., 2014)	Young adult humans	16	Active	High Intensity Interval Training	4 weeks	150 mg/day	4 weeks	Blocking the increase in maximal oxygen consumption and maximal anaerobic power.	
(Hart et al., 2013)	Adult mice (high running capacity)	24	Untrained	Aerobic endurance	12 weeks	150 mg/kg/day	16 weeks	Increased aerobic endurance and hind limb strength.	Resveratrol increased the relative amount of mitochondrial DNA in skeletal muscle.
(Hart et al., 2014)	Adult mice (low running capacity)	24	Untrained	Aerobic endurance	12 weeks	150 mg/kg/day	16 weeks	Blocking the increase in aerobic	.

								endurance and hind limb strength promoted by training.	
(Kan et al., 2016)	Adult mice	50	Untrained	Aerobic endurance	4 weeks	25 mg/kg/day	4 weeks	Increase in hind limb strength. No effect on aerobic endurance.	
(Xiao, 2015)	Adult mice	-	Untrained	Aerobic endurance	4 weeks	25, 50 or 100 mg/kg/day	4 weeks	Increase in aerobic endurance.	No antioxidant effect compared to isolated training.
(Tsao et al., 2021)	Young men	8	Physically active	-	-	480 mg/day	4 days	No effect on aerobic endurance.	
(Rodríguez-Bies, Tung, Navas, & López-Lluch, 2016)	Young, adult and old mice.	54	Untrained	Aerobic endurance	18 weeks	16-17 mg/kg/day	18 weeks	Increased aerobic endurance in adults and the elderly, and increased hind limb strength in the elderly.	Resveratrol reduced markers of oxidative damage.
(Voduc, La Porte, Tessier, Mallick, & Cameron, 2014)	Adult humans	12	Untrained	-	-	1000 mg/day	4 weeks	No effect on endurance and aerobic capacity.	
(Ryan et al., 2010)	Young and old mice	53	Untrained	-	-	5g/kg feed	10 days	No effect on former fatigue and isometric muscle contraction strength.	Resveratrol reduced oxidative stress in exercised muscle.

DISCUSSION

The results of the literature survey performed in the present study confirm the lack of a consensus in the scientific literature about the ergogenic potential of RESV supplementation. The selected studies do not point to common results, and even similar experimental interventions show discrepant or inconclusive results. Thus, the need to discuss and deepen the observation of the mechanisms that relate the RESV to the improvement of sports performance is reinforced.

Of the 18 articles selected in the present review, five did not observe any effect of the RESV on the physical valence tested (Olesen et al., 2014, Ringholm et al., 2013, Ryan et al., 2010, Tsao et al., 2021, Voduc et al., 2014). Of these, four evaluated aerobic endurance, which is the physical valence indicated as the main beneficiary of RESV supplementation.

The studies that applied the experimental protocols in humans and observed no ergogenic effect offered different doses of the supplement (250, 480 and 1000 mg/day) (Olesen et al., 2014, Tsao et al., 2021, Voduc et al., 2014). This suggests that the lack of effect may not be related to the amount of supplement ingested. However, the period under supplementation was different, ranging from 4 days to 8 weeks.

In evaluating the RESV intake of mice undergoing training for 48 weeks, Ringholm et al. (2013) found no significant effect of supplementation on the aerobic endurance of the animals tested. The biomolecular findings did not point to any interference of RESV on the expression of enzymes of oxidative metabolism(Ringholm et al., 2013). These data suggest that RESV supplementation, even if daily, over a lifetime, is not sufficient to improve performance in endurance effort.

While some papers suggest that RESV supplementation is not effective in improving endurance performance, seven of the selected studies showed favorable results for supplementation with the phytochemical (Alway et al., 2017, Dolinsky et al., 2012, Hart et al., 2013. Kan et al., 2018, Muhammad & Allam, 2018, Rodríguez-Bies et al., 2016, Xiao, 2015), where only one of these evaluated the effects of supplementation in humans(Alway et al., 2017). According to the study by Alway et al.(2017), daily intake of 500 mg of RESV enhances the effect of concurrent training (endurance and strength) on aerobic endurance in elderly subjects of both sexes. Furthermore, the study pointed to an association between supplementation and hypertrophy of type I muscle fibers, the muscle fibers specialized in aerobic metabolism.

Animal model studies have also verified the positive effect of RESV on aerobic endurance in elderly guinea pigs (Rodríguez-Bies et al., 2016, Muhammad and Allam (2018), and Dolinsky et al., (2012). According to the authors, the effects of RESV are related to a reduction of oxidative stress in the muscle of the supplemented animals. Since elderly individuals have impaired antioxidant function, RESV contributes to the enhancement of defenses against oxidative damage caused by reactive species. Ryan et al. (2010) also found an antioxidant effect of the RESV in exercised muscle of aged animals, but did not identify any ergogenic effect of the supplement.

Kan et al. (2018) obtained a positive result of RESV supplementation with potentiation of the effects of strength training in adult mice. After 4 weeks of stair climbing training, the supplemented mice showed improved strength, speed, and resistance to fatigue compared to the unsupplemented mice. The authors also showed that the RESV is able to contribute to the increase in the cross-sectional area of the muscle, agreeing with the findings of Alway et al. (2017). Other studies have also shown increased strength in response to RESV supplementation, even without the insertion of strength training during the experiment (Dolinsky et al., 2012, Hart et al., 2013, Huang et al., 2021, Kan et al., 2016, 2018, Rodríguez-Bies et al., 2016).

Three studies have shown a negative effect of RESV supplementation, two of them in humans (Gliemann et al., 2013, Hart et al., 2014, Scribbans et al., 2014). These studies point out that supplementation blocks or inhibits the positive effects of training on aerobic capacity and potency. One of these studies found that supplementation reduces strength gains(Hart et al., 2014), while another manuscript points out that RESV even impairs the effects of training on the lipid profile in the elderly(Gliemann et al., 2013). The negative effects of antioxidant supplementation on training adaptations are known in the literature. Gomez-Cabrera et al. (2008)have shown that antioxidant vitamin supplementation blocks the transcription of genes related to the enhancement of aerobic metabolism, impairing performance in both humans and animals.

Two studies by the same group of authors showed absolutely opposite results (Hart et al., 2014, 2013). One of the studies showed that RESV supplementation is positive for endurance performance in animals with high running ability(Hart et al., 2013). However, the second study highlights that RESV impairs training adaptation in animals with low running ability(Hart et al., 2014). While resveratrol collaborated in increasing mitochondrial DNA in the running animals, the opposite was observed in the animals of limited running ability. In their discussion, the authors suggest that the response to RESV appears to be selective with respect to the metabolic characteristics of individuals.

Although the ergogenic effects of RESV are discussed and publicized, the selected studies do not show favorable results for supplementation with this phytochemical in humans. Only two studies have shown positive effects in humans, while six studies point to no effect or a negative effect. It should be considered that the studies used different dosages of RESV, with varying protocol duration, and different training programs. These variations expand the possibilities for supplementation and training protocols, yet few favorable results have been noted.

In order to make the data more robust, this literature review listed only studies published in English language journals and indexed in the Medline PUBMED database. However, this search pattern limited the number of studies found, and did not cover quality studies published in other languages. Furthermore, the present study did not consider/evaluate the level of evidence of the eligible papers. Thus, a systematic review on the effects of resveratrol supplementation on sports performance, which considers the level of evidence of the studies as well as the experimental model applied, is needed.

FINAL CONSIDERATIONS

The findings of the present review suggest that RESV supplementation has not established itself as an ergogenic resource. However, this cannot be completely ruled out, as several studies have found some positive effect of supplementation on physical performance. It can be defined that the effects of ingesting RESV do not equate to exercise training, nor does it replace it. Thus, the hypotheses must be based on the coadjuvant effect of physical training.

The small number of studies selected reveals the need for more experimental trials on the topic, especially clinical trials, since few manuscripts have been dedicated to studying the effects of RESV on physical performance in humans. There is still a need for studies in the scientific literature that investigate these effects under various conditions, considering dosage, protocol duration, and type of exercise. Therefore, the present study points to the lack of consensus in the literature about the ergogenic effect of RESV supplementation and the need for clinical studies on the subject.

DECLARATION OF CONFLICT OF INTEREST

The author(s) have not declared any potential conflict of interest regarding the research, authorship and/or publication of this article.

REFERENCES

Alway, S. E., McCrory, J. L., Kearcher, K., Vickers, A., Frear, B., Gilleland, D. L., … Lively, M. W. (2017). Resveratrol enhances exercise-induced cellular and functional adaptations of skeletal muscle in older men and women. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *72*(12), 1595–1606.

Dolinsky, V. W., Jones, K. E., Sidhu, R. S., Haykowsky, M., Czubryt, M. P., Gordon, T., & Dyck, J. R. (2012). Improvements in skeletal muscle strength and cardiac function induced by resveratrol during exercise training contribute to enhanced exercise performance in rats. *The Journal of Physiology*, *590*(11), 2783–2799.

Gliemann, L., Schmidt, J. F., Olesen, J., Biensø, R. S., Peronard, S. L., Grandjean, S. U., … Pilegaard, H. (2013). Resveratrol blunts the positive effects of exercise training on cardiovascular health in aged men. *The Journal of Physiology*, *591*(20), 5047–5059.

Golan, R., Gepner, Y., & Shai, I. (2019). Wine and health–new evidence. *European Journal of Clinical Nutrition*, *72*(1), 55–59.

Gomez-Cabrera, M.-C., Domenech, E., Romagnoli, M., Arduini, A., Borras, C., Pallardo, F. V., … Vina, J. (2008). Oral administration of vitamin C decreases muscle mitochondrial biogenesis and hampers training-induced adaptations in endurance performance–. *The American Journal of Clinical Nutrition*, *87*(1), 142–149.

Guerrero, R. F., Garcia-Parrilla, M. C., Puertas, B., & Cantos-Villar, E. (2009). Wine, resveratrol and health: A review. *Natural Product Communications*, *4*(5), 1934578X0900400503.

Hart, N., Sarga, L., Csende, Z., Koch, L. G., Britton, S. L., Davies, K. J., &Radak, Z. (2014). Resveratrol attenuates exercise-induced adaptive responses in rats selectively bred for low running performance. *Dose-Response*, *12*(1), dose-response.

Hart, N., Sarga, L., Csende, Z., Koltai, E., Koch, L. G., Britton, S. L., … Radak, Z. (2013). Resveratrol enhances exercise training responses in rats selectively bred for high running performance. *Food and Chemical Toxicology*, *61*, 53–59.

Hecker, A., Schellnegger, M., Hofmann, E., Luze, H., Nischwitz, S. P., Kamolz, L., &Kotzbeck, P. (2022). The impact of resveratrol on skin wound healing, scarring, and aging. *International Wound Journal*, *19*(1), 9–28.

Huang, C.-C., Lee, M.-C., Ho, C.-S., Hsu, Y.-J., Ho, C.-C., & Kan, N.-W. (2021). Protective and recovery effects of resveratrol supplementation on exercise performance and muscle damage following acute plyometric exercise. *Nutrients*, *13*(9), 3217.

Kan, N.-W., Ho, C.-S., Chiu, Y.-S., Huang, W.-C., Chen, P.-Y., Tung, Y.-T., & Huang, C.-C. (2016). Effects of resveratrol supplementation and exercise training on exercise performance in middle-aged mice. *Molecules*, *21*(5), 661.

Kan, N.-W., Lee, M.-C., Tung, Y.-T., Chiu, C.-C., Huang, C.-C., & Huang, W.-C. (2018). The synergistic effects of resveratrol combined with resistant training on exercise performance and physiological adaption. *Nutrients*, *10*(10), 1360.

Muhammad, M. H., & Allam, M. M. (2018). Resveratrol and/or exercise training counteract aging-associated decline of physical endurance in aged mice; targeting mitochondrial biogenesis and function. *The Journal of Physiological Sciences*, *68*(5), 681–688.

Olesen, J., Gliemann, L., Biensø, R., Schmidt, J., Hellsten, Y., &Pilegaard, H. (2014). Exercise training, but not resveratrol, improves metabolic and inflammatory status in skeletal muscle of aged men. *The Journal of Physiology*, *592*(8), 1873–1886.

Ringholm, S., Olesen, J., Pedersen, J. T., Brandt, C. T., Halling, J. F., Hellsten, Y., … Pilegaard, H. (2013). Effect of lifelong resveratrol supplementation and exercise training on skeletal muscle oxidative capacity in aging mice; impact of PGC-1α. *Experimental Gerontology*, *48*(11), 1311–1318.

Rodríguez-Bies, E., Tung, B. T., Navas, P., & López-Lluch, G. (2016). Resveratrol primes the effects of physical activity in old mice. *British Journal of Nutrition*, *116*(6), 979–988.

Ryan, M. J., Jackson, J. R., Hao, Y., Williamson, C. L., Dabkowski, E. R., Hollander, J. M., &Alway, S. E. (2010). Suppression of oxidative stress by resveratrol after isometric contractions in gastrocnemius muscles of aged mice. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *65*(8), 815–831.

Scribbans, T. D., Ma, J. K., Edgett, B. A., Vorobej, K. A., Mitchell, A. S., Zelt, J. G., … Gurd, B. J. (2014). Resveratrol supplementation does not augment performance adaptations or fibre-type–specific responses to high-intensity interval training in humans. *Applied Physiology, Nutrition, and Metabolism*, *39*(11), 1305–1313.

Tsao, J.-P., Liu, C.-C., Wang, H.-F., Bernard, J. R., Huang, C.-C., & Cheng, I.-S. (2021). Oral Resveratrol supplementation attenuates exercise-induced Interleukin-6 but not Oxidative Stress after a high intensity cycling challenge in adults. *International Journal of Medical Sciences*, *18*(10), 2137.

Vatavuk-Serrati, G., Alves, R. T., Costa, E. S., Castro, A. G. P. de, & Machado, V. A. (2019). Efeitos da suplementação de resveratrol sobre fatores de risco cardiovascular. *Rev. Soc. Cardiol. Estado de São Paulo*, 88–93.

Voduc, N., La Porte, C., Tessier, C., Mallick, R., & Cameron, D. W. (2014). Effect of resveratrol on exercise capacity: A randomized placebo-controlled crossover pilot study. *Applied Physiology, Nutrition, and Metabolism*, *39*(10), 1183–1187.

Xiao, N.-N. (2015). Effects of resveratrol supplementation on oxidative damage and lipid peroxidation induced by strenuous exercise in rats. *Biomolecules&Therapeutics*, *23*(4), 374.

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