



Effects of 12 Weeks of Regular Exercise with Vitamin C Supplementation in winter on the Rate of Respiratory Tract Infections in Male High School Students

Safdar Mohammadnia¹, Masoud Hajirasouli*¹, Laleh Behbudi¹

1. Department of Physical Education and Sport Science, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran.

ARTICLE INFO	ABSTRACT
<p><i>Article type:</i> Research Paper</p>	<p>Introduction: Respiratory tract infections are health issues across the world, which impose high economic costs on families. Studies have shown that regular exercise and vitamin C supplementation positively influence health. The present study aimed to investigate the effects of 12 weeks of regular exercise and vitamin C supplementation on respiratory tract infections in male students.</p>
<p><i>Article History:</i> Received: 26 Apr 2020 Accepted: 21 Jul 2020 Published: 30 Jan 2021</p>	<p>Methods: This clinical trial was conducted on 120 high school students, who were randomly assigned to four groups of 30, including placebo, exercise, exercise with vitamin C supplementation, and vitamin C supplementation. Groups two and three performed the selected exercises three sessions per week for 12 weeks. Groups three and four consumed three vitamin C tablets (250 mg) per week. Data were recorded on the duration of infection (day), frequency of the cases, and week of the first respiratory infection during the research period. Data analysis was performed in SPSS version 22 using one-way ANOVA and Tukey's post-hoc at the significance level of $P \leq 0.05$.</p>
<p><i>Keywords:</i> Exercise Vitamin C Respiratory infections Male high school students</p>	<p>Results: The duration of respiratory infections in the exercise group was significantly shorter compared to the placebo group ($P=0.001$) and vitamin C group ($P=0.02$), also it was significantly shorter in the exercise group ($P=0.007$) and vitamin C group ($P=0.007$) compared to the exercise with vitamin C group. In the exercise with vitamin C group, the first week of pulmonary infection was longer than the vitamin C group ($P=0.04$).</p> <p>Conclusion: According to the results, regular exercise could effectively prevent respiratory infections in the male high school students, while the effectiveness of vitamin C was dose-dependent; therefore, more investigations should be focused on vitamin C supplementation.</p>
<p>► Please cite this paper as: Mohammadnia S, Hajirasouli M, Behbudi L. Effects of 12 Weeks of Regular Exercise with Vitamin C Supplementation in Winter on the Rate of Respiratory Tract Infections in Male High School Students. <i>J Nutr Fast Health</i>. 2021; 9(1): 70-74. DOI: 10.22038/jnfh.2020.48265.1263.</p>	

Introduction

Lower respiratory tract infections are prevalent in children; they are commonly caused by viruses and lead to numerous health risks (1). The pathogenic causes of respiratory infections are not utterly clear as a variety of factors such as viruses, bacteria, and fungal-dependent pathogenic infections contribute to these infections (2). Acute respiratory infections encompass several disorders (e.g., bronchiolitis, colds, and sore throats) and have been reported in various developed countries, such as Switzerland, Italy, and the United States. The patients must refer to a physician multiple times, which imposes high economic costs and causes other issues for children and their families (3). Due to the insidious and progressive nature of these diseases, they are likely to impair 50% of the respiratory function before diagnosis, which

in turn increases the risk of chronic pulmonary diseases, such as respiratory failure, pneumonia, right-side heart failure (delivering blood to the lungs), reduced quality of life, and depression (4).

The consequences of respiratory infections adversely affect the educational quality of students. Due to the low effectiveness of drug therapy associated with diagnostic problems, respiratory rehabilitation seems to be a viable option to alleviate and improve patients. In addition, exercise has been recommended by researchers in this regard (4, 5). Previous findings have indicated that 12 weeks of exercise combined with respiratory exercises could improve the pulmonary function and maximum oxygen consumption (VO_{2max}), while reducing depression in women with mild-to-moderate asthma (6). Furthermore, eight weeks of

* Corresponding author: Masoud Hajirasouli, Department of Physical Education and Sport Science, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran. Tel: +982155745617, E-mail: hajirasouli@yahoo.com.

© 2021 mums.ac.ir All rights reserved.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

modified Pilates training has been shown to enhance the pulmonary function and quality of life of older adults with pulmonary diseases (7). On the other hand, a study in this regard showed that respiratory exercises have no significant effects on some pulmonary function markers in patients with chronic obstructive pulmonary disease (8).

Given the discrepancy in the results of sports science studies, it seems that nutrition plays a pivotal role in the quantity and quality of respiratory diseases and the improvement of the pulmonary function. As such, the World Health Organization (WHO) affirms the role of nutrition in reducing the risk of acute respiratory infectious diseases. Moreover, vitamin D consumption has been reported to effectively prevent acute pulmonary infections and reduce the risk factors of the acute respiratory distress syndrome (ARDS) (9). Studies have also confirmed the antioxidant properties of intravenous vitamin C to specifically address the cytokine storm features of ARDS, which occur in the later cycle of the COVID-19 infectious disease (9). Accordingly, one gram of vitamin C per day could reduce the risk of catching colds (10), while 2-4 grams of vitamin C significantly decrease the risk of catching colds (11).

Evidence suggests that vitamin C could decrease the risk of coronavirus infection (2019-nCoV) by improving the immune function. With the outbreak of the global disease 2019-nCoV and other respiratory disorders, which have become major global health concerns, extensive research has become essential for the prevention and treatment of pulmonary diseases, especially in children and adolescents (12). To date, limited studies have investigated the interactive effects of exercise and vitamin C on the incidence of pulmonary diseases, and no research has been focused on the simultaneous effects of exercise and vitamin C on the clinical causes of these disorders.

The present study aimed to investigate the effects of 12 weeks of regular exercise with vitamin C supplementation in winter on the rate of respiratory tract infections in male high school students in the 17th district of Tehran, Iran.

Materials and Methods

This clinical trial was conducted with a pretest-posttest design and a control group. Initially, the authors announced the conduction of the study to all the high schools of the second period in the

17th district of Tehran, and two high schools were selected via cluster sampling. At the next stage, the research objectives and the potential benefits and limitations were explained to the participants. In total, 120 students aged 15-18 years, with the height of 160-175 centimeters, weight of 62-70 kilograms, and no history of cardiovascular diseases, cancer, acute pulmonary diseases, and other certain diseases to affect the research process were randomly selected as the sample population. Written informed consent was obtained from the participants prior to enrollment.

In the pretest phase, data were collected using a researcher-made checklist to assess the rate of respiratory tract infections, which contained data on viral and bacterial infections. The subjects were randomly divided into four groups of 30, including placebo, exercise, exercise with vitamin C supplementation, and vitamin C supplementation.

Exercise Training Protocol

The exercise groups performed the selected exercises for 12 weeks three sessions per week (total: 36 sessions, 90 minutes each). The exercises consisted of general aerobic and stretching warm-ups and special combination exercises (10 minutes), skill training or review of the techniques and tactics (20 minutes), handball and futsal sports on the field of exercise (50 minutes), and aerobic and stretching exercises for cool-down (10 minutes) (13). The vitamin C supplementation groups received three vitamin C tablets (250 mg each) weekly during the study period (14).

The experimental protocol of the study was approved by the Ethics Committee of Tehran Islamic Azad University of Medical Sciences (code: IR.IAU.TMU.REC.1399.109).

Measurement Variables

The rate of upper respiratory tract infection was measured by comparing several variables in the four groups of students during the 12-week intervention. The variables were applied to the groups, and the obtained results were controlled and recorded by the researcher based on the degree of viral (mild) or bacterial infection (severe), disease duration, disease severity, and disease symptoms during the study.

Statistical Analysis

Data analysis was performed in SPSS version 22 using the Shapiro-Wilk test to assess the normal

distribution of the data. In addition, the differences between the groups were evaluated using one-way analysis of variance (ANOVA) with Tukey's post-hoc test at the significance level of $P \leq 0.05$.

Results

The demographic characteristics of the subjects are presented in Table 1, and Table 2 shows the mean duration of the respiratory infections (day), frequency of the respiratory infections, and week of respiratory infections in the research groups. The results of one-way ANOVA indicated significant differences in the duration of pulmonary infections ($P=0.001$) and frequency of pulmonary infections ($P=0.051$) between the groups, while no significant difference was observed in terms of the week of pulmonary infections ($P=0.048$).

The results of the Tukey's post-hoc test indicated no significant difference in the duration of the respiratory infections (day) in the placebo group compared to the vitamin C ($P=0.56$) and exercise with vitamin C groups ($P=0.19$). However, the number of the days of respiratory infections was significantly smaller in the exercise group compared to the placebo group ($P=0.001$). In addition, the number of days of respiratory infections in the exercise group was significantly smaller compared to the vitamin C group ($P=0.02$), while it was smaller in the vitamin C

group compared to the exercise with vitamin C group ($P=0.007$). The duration of the respiratory infections in the exercise group was significantly shorter compared to the exercise with vitamin C group ($P=0.001$).

Our findings demonstrated no significant difference in the frequency of pulmonary infections in the vitamin C ($P=0.15$), exercise ($P=0.072$), and exercise with vitamin C groups ($P=0.99$) compared to the placebo group. Furthermore, no significant difference was observed between the exercise group ($P=0.98$) and exercise with vitamin C group ($P=0.15$) compared to the vitamin C group in this regard, and no significant difference was denoted between the exercise group and exercise with vitamin C group ($P=0.072$).

The obtained results showed no significant difference in the first week of the pulmonary infections in the vitamin C ($P=0.51$) and exercise groups ($P=0.88$) compared to the placebo group, while in the exercise with vitamin C group, the first week of pulmonary infections was longer than the vitamin C group ($P=0.04$). However, no significant difference was observed between the exercise group ($P=0.91$) and exercise with vitamin C group ($P=0.059$) compared to the vitamin C group in this regard, and no significant difference was observed between the exercise group and exercise with vitamin C group ($P=0.23$).

Table 1. Demographic characteristics of research subjects in the four groups

Groups	Age	Height	Weight
Placebo	16.00 ± 1.71	168.83 ± 8.89	68.50 ± 3.11
Vitamin C	16.80 ± 1.10	170.02 ± 5.17	67.80 ± 3.71
Exercise training	17.00 ± 1.24	173.25 ± 4.28	68.90 ± 4.50
Exercise training + Vitamin C	16.11 ± 1.90	171.48 ± 5.35	66.80 ± 5.71

Table 2. Mean ± standard deviation of variable's in the research groups

Groups	Number of days of respiratory infections	Frequency of respiratory infections	Week of respiratory infections
Placebo	4.70 ± 2.96	1.23 ± 0.56	5.13 ± 2.88
Vitamin C	3.83 ± 2.29 ¥¥	1.03 ± 0.18	6.20 ± 3.23
Exercise training	1.93 ± 1.96 ***, €	1.0 ± 0.01	5.70 ± 2.71
Exercise training + Vitamin C	6.03 ± 2.97	1.23 ± 0.43	7.16 ± 3.11 €

Discussion

The results of the present study indicated that regular exercise could reduce the number of the days and frequency of respiratory infections in the male high school students. Previous studies have shown that the main cause of colds and pulmonary infections are microorganisms, and

these infections impose high economic costs on every community (15, 16).

Via the salivary immunoglobulin A modulation mechanism, exercise seems to enhance the immune function against environmental viruses, increase the differentiation of Th1-type immune cells to Th2, increase the immune function, improve anti-inflammatory factors (e.g., interleukin 10), and reduce pro-inflammatory

cytokines (e.g., interferon-gamma, interleukin-1 receptor, and tumor necrosis factor receptor alpha), thereby improving the expression of M ϕ antigen and leading to the development of phagocytosis-cytotoxic activity in the mucosa (13).

Previous findings have also demonstrated that low- and moderate-intensity exercise could maintain respiratory muscle strength, protect against airway obstruction by removing excess respiratory tract secretions, and improve the respiratory function or respiratory gas exchange in the alveoli (7). On the other hand, evidence suggests that depending on intensity and duration, exercise could improve general health and significantly reduce the incidence, duration, and frequency of pulmonary infections (15). For instance, Lee et al. reported that the duration (day) of colds in athletes was lower than non-athletes (17). Furthermore, high-intensity exercise has been shown to increase the number of the days of acute pulmonary infections, while moderate-intensity exercise has been reported to reduce the number of the days of acute pulmonary infections in athletes (13).

According to another research in this regard, eight weeks of modified Pilates training could improve pulmonary function (7). In the present study, vitamin C consumption had no significant effect on the duration, frequency, and week of pulmonary infections in the male high school students. The researchers believe that by participating in the structure of antioxidants as a cofactor, vitamin C could increase antioxidant activity and enhance anti-inflammatory activity. In addition, increased vitamin C levels could restore α -tocopherol from radical tocopherols, thereby improving the pulmonary and respiratory function and antioxidant activity against pulmonary infections (18).

According to the literature, consuming 100 milligrams of vitamin C per day improves the immune function, and the consumption of up to two grams per day has been recommended for adults by the US Food and Drug Administration (FDA). The only side-effect of high doses of vitamin C has been reported to be diarrhea, and no other complications have been confirmed for vitamin C supplementation. In addition, consuming 1000 milligrams of vitamin C per day could be beneficial and uncomplicated for pneumonia patients (19). According to previous findings, vitamins C, E, and D could effectively prevent acute pulmonary infections (18, 19). In

line with the results of the present study, receiving 10-15 milligrams and 0.3 gram of vitamin C per day has been reported to be insufficient for the prevention of acute pulmonary diseases and pulmonary obstruction in males (20), while 2-4 grams of vitamin C could decrease the risk of catching a cold more significantly (19).

In the current research, the non-significant effects of vitamin C consumption on the duration, frequency, and week of pulmonary infections were dose-dependent. In our study, age was another influential factor in determining the effectiveness of vitamin C in the prevention or improvement of pulmonary infections. The common dose of vitamin C was observed to reduce the risk of colds and shorten their periods, while also improving pulmonary function (21).

According to the results of the present study, exercise combined with vitamin C consumption had no significant effects on the duration, frequency, and week of pulmonary infections in the male high school students. However, exercise compared to vitamin C consumption and exercise with vitamin C consumption decreased the duration and frequency of respiratory infections. According to the literature, regular and long-term moderate-intensity exercise could prevent pulmonary infections via immune-boosting mechanisms, the differentiation of Th1 to cell-to-Th2 defenses, increasing anti-inflammatory factors, decreasing anti-inflammatory cytokines, improving the expression of M ϕ antigen, development of phagocytosis cytotoxicity in the mucosa, prevention of pulmonary infections (13), maintenance of respiratory muscle strength, protection of airway pressure by eliminating the excessive secretions of the respiratory tract, and improvement of respiratory efficiency (7). By participating in the structure of antioxidants, vitamin C also increases antioxidant and anti-inflammatory activities and regenerates α -tocopherols from tocopherol radicals, thereby enhancing the pulmonary and respiratory function and preventing pulmonary infections (18). Notably, factors such as dosage, age, and geographical area have also been reported to be effective in the prevention of pulmonary infections and improving disease symptoms (19-21). In addition to vitamin C, other structural vitamins such as vitamins E and D have also proven

effective in building antioxidants and protection against pulmonary diseases (18,19).

One of the limitations of the present study was failure to measure salivary immunoglobulin levels, and it is recommended that the levels of these physiological variables be evaluated in the further investigations in this regard. Moreover, we were not able to examine various doses of vitamin C, and it is suggested that these limitations be addressed in similar studies as well.

Conclusion

According to the results, regular exercise could effectively prevent respiratory infections in the male high school students. However, the effectiveness of vitamin C depended on the dosage and age of the individuals, and further investigations in this regard should be focused on vitamin C.

Acknowledgments

This article was extracted from a doctoral dissertation approved by the Islamic Azad University of Islamshahr Branch, Iran. Hereby, we extend our gratitude to the Research Deputy of the university for the support of this research project.

Conflicts of Interest

None declared.

References

- Pham HT, Nguyen PTT, Tran ST, Phung TTB. Clinical and Pathogenic Characteristics of Lower Respiratory Tract Infection Treated at the Vietnam National Children's Hospital. *Can J Infect Dis Med Microbiol*. 2020; 2020: 7931950.
- Li C-X, Li W, Zhou J, Zhang B, Feng Y, Xu C-P, et al. High-resolution metagenomic characterization of complex infectomes in paediatric acute respiratory infection. *Sci Rep*. 2020;10(1):1-11.
- Schaad UB, Esposito S, Razi CH. Diagnosis and management of recurrent respiratory tract infections in children: a practical guide. *Arch Pediatr Infect Dis*. 2016;4(1):e31039.
- Matthay MA, Zemans RL, Zimmerman GA, Arabi YM, Beitler JR, Mercat A, et al. Acute respiratory distress syndrome. *Nat Rev Dis Prim*. 2019;5(1):1-22.
- Jafar Saffar M. Acute Lower Respiratory Tract Infections Including Pneumonia; Clinical Approach to Diagnosis and Treatment: A Narrative Review. *J Clin Exc*, 2014; 3(1): 29-45.
- Zarneshan A. The Efficacy of Aerobic and Breathing Exercise Training on Asthma Control and Physical-Psychological Health Promotion in Women with Asthma. *Iran J Heal Educ Heal Promot*. 2018;6(2):179-88.
- Rakati B. The Effect of Eight Weeks of Modified Pilates Training on Pulmonary Function and Quality of Life of Chemical Veterans. *Iran J War Public Heal*. 2019;11(4):183-8.
- Ubolnuar N, Tantisuwat A, Thaveeratitham P, Lertmaharit S, Kruapanich C, Mathiyakom W. Effects of Breathing Exercises in Patients With Chronic Obstructive Pulmonary Disease: Systematic Review and Meta-Analysis. *Ann Rehabil Med*. 2019;43(4): 509-23.
- Boretti A, Banik BK. Intravenous vitamin C for reduction of cytokines storm in acute respiratory distress syndrome. *PharmaNutrition*. 2020;12: 100190.
- Rondanelli M, Miccono A, Lamburghini S, Avanzato I, Riva A, Allegrini P, et al. Self-care for common colds: the pivotal role of vitamin D, vitamin C, zinc, and echinacea in three main immune interactive clusters (physical barriers, innate and adaptive immunity) involved during an episode of common colds—practical advice on dosages and on the time to take these nutrients/botanicals in order to prevent or treat common colds. *Evidence-Based Complement Altern Med*. 2018;1-36. Article ID 5813095.
- Harri H. Vitamin C Supplementation and Common Cold Symptoms: problems with inaccurate reviews. 2009; 12: 804-9.
- Cheng RZ, Shi H, Yanagisawa A, Levy T, Saul A. Early Large Dose Intravenous Vitamin C is the Treatment of Choice for 2019-nCov Pneumonia. *Orthomol Med News Serv*. 2020; 16: 1-3.
- Martin SA, Pence BD, Woods JA. Exercise and respiratory tract viral infections. *Exerc Sport Sci Rev*. 2009;37(4): 157-64.
- (DGE) GNS. New reference values for vitamin C intake. 2015; 67(1):13-20.
- Grande AJ, Keogh J, Silva V, Scott AM. Exercise versus no exercise for the occurrence, severity, and duration of acute respiratory infections. *Cochrane Database Syst Rev*. 2020;(4).CD010596.
- Bayat M, Asemani Y, Asemani S. Effect of exercise on upper respiratory tract infection in elite runners. *J Sports Med Phys Fitness*. 2020; 11. DOI: 10.23736/S0022-4707.20.10646-7.
- Lee HK, Hwang IH, Kim SY, Pyo SY. The effect of exercise on prevention of the common cold: a meta-analysis of randomized controlled trial studies. *Korean J Fam Med*. 2014;35(3): 119-26.
- Yavary M, Mousavi SAJ, Janani L, Feizi Z, Vafa MR. Effect of supplementation of vitamin D, C and E on the lung spirometry and plethysmography in Idiopathic Pulmonary Fibrosis patients. *Razi Journal of Medical Sciences*. 2018; 25(170): 65-72.
- Hemilä H, Louhiala P. Vitamin C may affect lung infections. *J R Soc Med*. 2007;100(11):495-98.
- Gombart AF, Pierre A, Maggini S. A review of micronutrients and the immune System—Working in harmony to reduce the risk of infection. *Nutrients*. 2020;12(1): 236-46.
- Ran L, Zhao W, Wang J, Wang H, Zhao Y, Tseng Y, et al. Extra dose of vitamin C based on a daily supplementation shortens the common cold: A meta-analysis of 9 randomized controlled trials. *Biomed Res Int*. 2018;1-12. Article ID 1837634.