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Effect of vitamin c supplementation on aerobic capacity, blood pressure and pulmonary functions in young male subjects

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ABSTRACT

Aerobic capacity of a subject depends on proper functioning of both cardiovascular and respiratory system to deliver adequate amount of oxygen to exercising muscles. It is effected by oxidative stress and can be benefited by prolong supplementation with dietary antioxidants. In the present study, we evaluated the effect of supplementation with two different doses (500mg/day and 1000mg/day) of vitamin C (ascorbic acid) for 21 days on young healthy nonathletic male subject . Various anthropometric parameters, body composition, blood pressure, FEV 1 , FVC and VO2 max were recorded before and after supplementation and were compared with a parallel run placebo group. The results indicated that there was no significant differences in any of the parameters studied before and after supplementation in all the three groups. Therefore, we concluded that daily consumption of either 500mg or 1000mg of vitamin C for 21 days have no beneficial effect on aerobic capacity, blood pressure and pulmonary functions of the subjects.

Key words *:* Vitamin C , Aerobic capacity, Blood pressure, FEV 1 , FVC.

INTRODUCTION

Vitamin C is a major antioxidant vitamin that protect the cell against the negative influence of free radicals and their associated reactions.

It reacts directly with super oxide, hydroxyl radicals, and singlet oxygen [1]. It is involved in various biochemical reactions that is important both during health and during situation of oxidative stress , like exercise [2]. A large number of studies have reported a positive association between various functions of the body and intake of vitamin C. It plays a vital role in creatine synthesis, collagen formation and in synthesis of various neurotransmitters [3]. It exerts positive effects on lipid and iron metabolism and also promotes immune function of the body [4].

Over the years, vitamin C has been advocated as a dietary supplement for athletes [5]. It is well documented that exercise results in oxidative stress increasing generation of free radicals, which can cause decreased functional ability of the exercising muscles [6]. Several investigators have reported that ingestation of vitamin C can ameliorate the effect of free radicals generated during different grades of exercise . Maxwell et. al. observed 3 weeks of supplementation with vitamin C reduces markers of oxidative stress during bench stepping exercise [7]. Jakeman and Maxwell also found similar beneficial effects with vitamin supplementation during exercise [8]. Bryer and Goldfarb investigated effect of vitamin C supplementation before and after exercise. Their data suggested that vitamin C pre-treatment can reduce muscle soreness, delay creatine kinase increase, and prevent blood glutathione oxidation with little influence on muscle function loss [9]. Teekleaburge et.al.from their study on ascorbic acid in broncho constrictor response to exercise in asthmatic subjects, reported that ascorbic acid supplementation provides a protective effect against exercise induced airway narrowing in asthmatic subjects [10]. Ciocoiu et.al.reported that antioxidant supplementation in form of vitamin C and E are needed to counteract oxidative stress produced by physical exercise [11]. Gomez Cabrera et.al.reported oral administration of vitamin C decreases mitochondrial biogenesis and hampers training induced adaptation in endurance performance [12]. Recently, Jourkesh, et.al.reported that consumption of vitamin C at high dose does not have any effect on the basis of improvement of anaerobic and aerobic power in male college students [13]. Based on current literature, it can be concluded that antioxidant supplementation may partially protect against exercise induced oxidative stress. The results is inconsistent regarding the beneficial effect of vitamin C supplementation on aerobic capacity and performance of an individual.

Epidemiological studies over the years have documented an inverse relation between antioxidant vitamin supplementation and the risk factors associated with coronary heart disease [14]. There are suggestions from several studies that dietary intake of vitamin C reduces blood pressure [15]. However, clinical trials with vitamin C supplementation on hypertension has yielded inconsistent results [16,17].

Rodrigo, et.al.investigated effect of vitamin C and E on blood pressure of patients with essential hypertension. Their study supported the view that oxidative stress is involved in pathogenesis of essential hypertension, and the enhancement of antioxidant status by supplementation with vitamin C and E in patients with essential hypertension is associated with lower blood pressure. This suggested that intervention with antioxidants acts as an adjunct therapy for hypertension [18].

Antioxidants are found to influence pulmonary function positively [19]. Both vitamin C and vitamin E are found in lung where they protect against oxidative damage. Although, vitamin E is predominantly membrane bound, there is a close interaction between vitamin C and E, because vitamin C not only function directly as an antioxidant, but it recycles the antioxidant capacity of oxidized vitamin E [20]. There are several studies that analyzed the association between dietary intake of these antioxidant vitamins and respiratory function [21,22]. Still there is uncertainty about the extent and nature of such association because intake of food items rich in antioxidant vitamins is associated with other life style factors. Moreover, there are very few control epidemiological studies that evaluated the nature of such association [19].

Therefore, the main aim of the present study was to assess the effect of supplementation of vitamin C on aerobic capacity, blood pressure and pulmonary functions of young non athletic male subjects.

MATERIALS AND METHODS

Study design : The study employed a placebo control double blind random allocation technique. Ethical clearance of the study was obtained from institutional ethical committee. All the participants signed a informed consent before volunteering for the study.

Study subjects: The study included 53 male medical students (age 18 – 21 years) . All the subjects were healthy non-smokers, not suffering from any cardiovascular, respiratory or endocrine disorders and were not on any medication or nutritional supplementation. The subjects were randomly divided into three groups : Group I (n=18) consumed 1000 mg vitamin C daily, Group II (n=18) consumed 500 mg vitamin C daily and Group III (n=17) consumed a visually identical placebo for 21 days.

Experimental procedure : All data were collected during morning hours between 7am to 9 am to minimize possible diurnal variations. The details of procedures were explained to allay apprehension. All the parameters were recorded in proforma prepared for the purpose. The recordings were repeated once again after 21 days of respective supplementation.

Recording of Anthropometric parameters: All anthropometric measurements were taken according to standardized protocol : body weights was measured with participants wearing light cloths and no shoes, height was measured without shoes using standardized scales. Waist and hip circumference were measured according to standard established by McCarthy et.al. [23]. Bicep skin fold, triceps skin fold, subscapular skinfold, and upper arm circumference were recorded. The body mass index, waist-hip ratio, percent fat, fat mass and fat free mass were calculated.

Recording of cardiovascular and respiratory parameters: Systolic and diastolic blood pressure was recorded using mercury sphygmomanometer. The measurements were taken in recumbent position after a rest for 5-7 minutes. Spirometric measurements were taken according to American Thoracic Society (ATS) guidelines [24] by using a computerized spirometer (Helios 402, RMS, India.).

Recording of aerobic capacity : Aerobic capacity of the subject was recorded using Queen's College Step test [25]. The step test was performed on a stool of 16.25 inches (41.3 cm) height for a total duration of 3 minutes at the rate of 24 cycles per minute, which was set by a metronome. After completion of the exercise, the subject was asked to remain standing and the carotid pulse rate was measured from 5–20 seconds of the recovery period. This 15 second pulse rate was converted into beats per minute and the following equation was used to predict the maximum oxygen uptake capacity.

VO2 max (ml.kg.1 min1) = 111.33 – (0.42 X step test pulse rate).

Statistical analysis : The data were analysed by using statistical software SPSS version 17.0. Means and standard deviations were calculated for all the variables. Intragroup analysis was done by using 'one way ' ANOVA. The level of significance was set at $p < 0.05$.

RESULT

The descriptive characteristics of all the subjects divided in three different groups are presented in Table I. The subjects matched in almost all characteristics. The blood pressure record does not show any significant difference after 21 days of vitamin C supplementation within and between the groups (Table 2). There was no significant difference in FEV 1 and FVC recorded before and after supplementation in subjects of all the groups (Table3). Aerobic capacity of the subjects showed no significant change due to vitamin C supplementation (Table 4).

Table 1.Descriptive characteristics of study subjects.

(Values are in Mean ± SD)

Parameters	Group 1 (n = 18)	Group 2 (n = 18)	Group 3 (n = 17)
Age (yrs)	19.20 ± 0.12	19.41 ± 0.24	20.56 ± 1.36
Height (cm)	157.52 ± 5.09	153. 34 ± 3.82	156. 68 ± 4.92
Weight (kg)	56.87 ± 3.78	53.60 ± 2.85	55.78 ± 4.95
Waist circumference (cm)	70.65 ± 2.60	67.98 ± 4.32	72. 38 ± 3.96
Bicep skin fold (mm)	3.58 ± 1.76	2.98 ± 1.18	3. 26 ± 1.62
Triceps skin fold (mm)	4.70 ± 2.80	3. 86± 1.92	4.96 ± 2.34
Sub scapular skin fold (mm)	14.20 ± 4.72	12.93 ± 3.86	13 49 ± 3.79
Body mass index (kg.m2)	22.75 ± 3.24	22.15 ± 2.32	23.60 ± 2.38
Waist: Hip ratio	0.86 ± 0.08	0.92 ± 0.05	0.88 ± 0.04
Body Fat (%)	13.58 ± 1.10	12.70 ± 2.64	13.58 ± 1.02
Lean Body mass (kg)	46.49 ± 3.82	44.65± 2.86	44.75 ± 4.11

Table 2. Record of Blood pressure and Heart rate in different groups of subjects before and after supplementation with vitamin C.

(Values are in Mean ± SD)

Parameters	GROUP 1		GROUP 1		GROUP 1	
	PRE	POST	PRE	POST	PRE	POST
Heart rate (bpm)	73.16 ± 3.18	70.68 ± 4.95	71.54 ± 2..69	70.56 ± 3.94	73.18 ± 4.04	74.26 ± 3.98
Systolic Blood pressure (mmHg)	126.28 ± 6.541	122.13 ± 5.13	124.67 ± 4.83	124.12 ± 5.36	126.28 ± 3.78	124.87 ± 4.76
Diastolic Blood pressure (mmHg)	73.86 ± 5.21	71.74 ± 4.62.	75.78 ± 3.58	73.24 ± 5.79	72.75 ± 4.39	74.68± 3.48

Table 3. Record of Respiratory parameters (FEV 1 and FVC) in different Groups of subjects before and after supplementation with vitamin C.

(Values are in Mean ± SD)

Parameters	GROUP 1		GROUP 1		GROUP 1	
	PRE	POST	PRE	POST	PRE	POST
Respiratory rate (cpm)	17.91 ± 1.18	16.36 ± 1.21	17.76 ± 1.85	17.66 ± 1.35	17.54 ± 1.32	17.88± 1.90
FEV I (%)	87.0 ± 5.0	89.0 ± 6.0	91.0 ± 5.0	93.0 ± 3.0	89.0 ± 6.0	88.0 ± 4.0
FVC (ml)	3765.0 ± 340 .0	3890.0± 365.0	3850.0 ± 380.0	4150.0 ± 420.0	3810.0 ± 290.0	3760.0 ± 370.0

Table 4. Record of VO2 max (ml/min/kg) in subjects of different groups before

and after supplementation with vitamin C.
(Values are in Mean ±SD)

Variable	Group 1	Group 2	Group 3
Before supplementation	37.06 ± 2.18	35.44 ± 1.71	37.41 ± 2.66
After supplementation	39.38 ± 2.43	35.97 ± 1.54	36.96 ± 2.92

DISCUSSION

The present study is designed to determine whether antioxidant vitamin C supplementation influences cardio respiratory fitness of a young male subjects. Several early studies examined the effects of vitamin C on exercise performance of individual, on cardiovascular and respiratory parameters.

Aerobic capacity of an individual depends to a large extent on the effectiveness of the cardiovascular system and may be improved by physical training and supplementation [26]. The results regarding vitamin C supplementation on exercise performance are equivocal and most well controlled studies report no beneficial effect on either endurance or strength performance [27,28]. Subudhi, et.al.while testing the effect of antioxidant supplementation with 20,000 IU of beta-carotene, 400 IU alpha- tocopherol acetate, 500 mg ascorbic acid, 100 microgram selenium and 30 mg zinc found that supplementation did not significantly affect markers of oxidative stress associated with increased energy expenditure at high altitude [29]. Goldfrab, et.al. found that in response to a 30 minute run at 75% VO2 max exercise intensity markers like VO2, RER, REP, HR and lactate remained unaffected with either vitamin C (500 or 1000 mg/d for 2 weeks) or a placebo supplementation. Exercise decreased total blood glutathione (TGSH) and reduced glutathione (GSH) and increased oxidized glutathione (GSSG) independent of treatment [30]. Close, et.al. from their study concluded that ascorbic acid supplementation does not attenuate post exercise muscle soreness following muscle damaging exercise and may delay recovery process [31]. Mastaloudis, et.al.also studied the effect of antioxidant supplementation in muscle damage in response to an ultra marathon run. They concluded that antioxidants (1000mg vitamin C and 300mg alpha tocopherol acetate) had no effect on exercise induced increase in muscle damage or recovery [32]. Chawla et.al.evaluated fitness and correlated it with antioxidant level of 50 medical students in age group of 18 to 25 years and found that vitamin C level in blood did not correlate with the fitness value of the subject [33]. Result of the present study indicate that supplementation with 500mg and 1000mg vitamin C daily for 21 days have no significant effect on aerobic capacity of young male subjects. Recently, AzarKarimzadehMogaddam, et.al. have failed to record any beneficial effect of vitamin C supplementation on biogenic index in male college students [34]. Studies also showed vitamin C restriction in diet had no harmful effect on health and did not effect VO2 max of the subject [35]. Claudio, et.al.failed to find performance benefit in soccer players after vitamin C supplementation daily during the preoperative season. However, their study demonstrated that antioxidant vitamin C and E supplementation in soccer players may reduce lipid peroxidation and muscle damage during high intensity efforts.[36] Patil, et.al. demonstrated that there was no beneficial effect of vitamin E supplementation on cardiorespiratory efficiency of cyclist[37].

Experimental studies in animal models suggested that oxidative stress may be important in the pathogenesis of hypertension or in the underlying cause of arterial damage related to hypertension [38]. However, there are scarce data in regard to the relationship between oxidative stress, antioxidant and blood pressure in human population. In cross sectional studies, higher serum levels of dietary intake of vitamin C have consistently and significantly related to lower systolic and diastolic blood pressure among middle aged or elderly population [14,39]. In our study we could not find any significant difference in either systolic or diastolic pressure of the subjects after supplementation with vitamin C. Similar to our study, Fotherby, et.al. found that blood pressure was not reduced after supplementation with 500 mg vitamin C per day for 3 months in a double-blind, randomized, placebo- controlled crossover study[40]. However, Chen, et.al.identified an inverse association between serum vitamin C level and risk of hypertension and blood pressure in age, gender and race-adjusted analysis among United States population [14].

Reduced pulmonary function is an important predictor of mortality in general population [41]. Oxidant exposure has been suggested to be a potential mechanism linking reduced pulmonary function to mortality and antioxidant supplementation is thought to be acting against such oxidative damage to pulmonary function [42]. Hu, et.al.observed an increase of 143 ml in FEV1 and 94 ml in FVC per mg/dl increase in serum vitamin C after adjustment for several cofounders [43]. Schunemann, et.al.observed a 35 ml increase in FEV1 and 30 ml increase in FVC [19]. In our study, vitamin C supplementation for 21 days has been found to have no significant effect on either FEV1 or FVC . This might be due to the fact that effect of supplementation of vitamin on lung function depend on base line intake. Moreover, as lung tissue is found to contain both vitamin C and vitamin E, both the vitamins show close physiological interaction in pulmonary function [44]. It is observed that low levels of both vitamin C and E in serum are associated with lowest lung function but when overall effect of these two vitamins are examined, only vitamin E appeared to be related to pulmonary function independently [19].

CONCLUSION

In conclusion, it can be stated that supplementation with antioxidant vitamin C has not shown any positive effect on aerobic capacity, blood pressure and pulmonary function of young healthy male subject. The beneficial effects of antioxidants observed during various kinds of exercise test might not be applicable to healthy non athletic subjects. Therefore, the future research need to include a larger sample size and longer period of supplementation before deciding on health benefit of antioxidant supplementation in non athletic young subjects.

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