# Spirometry avaluation in sitting-volleyball player: A pilot study

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**Abstract**

Sitting Volleyball is a recently introduced team sport suitable for people with lower limb disabilities, but can also be played by non-disabled people since it does not require any aid (e.g. wheelchair). This pilot study compares disabled with non-disabled athletes and aims to evaluate the effect of sitting volley practice on respiratory function, regardless of the presence of motor disability.

**Keywords**: Sitting volleyball, spirometry, smoking, disability.

**Riassunto**

Il Sitting Volleyball è uno sport di squadra di recente introduzione adatto a persone con disabilità degli arti inferiori, che può essere praticato anche da sportivi normodotati in quanto non necessita di ausili (Es. sedia a rotelle). Questo studio pilota confronta atleti disabili con atleti normodotati e si pone l'obbiettivo di valutare l'effetto della pratica del sitting-volley sulla funzione respiratoria, indipendentemente dalla presenza di disabilità motoria.

**Parole chiave:** Sitting volleyball, spirometria, fumo, disabilità.

## Introduction

Sitting volleyball is a team sports activity indicated for those with physical-motor limitations such as amputees, subjects affected by spinal cord injuries (paraplegia and poliomyelitis), brain injuries from birth and all invalidating diseases belonging to the "Les Autres" (paresis, ankylosis, dysmielias and other malformations). It can be practiced by non-disabled subjects without the use of specific aides, such as a wheelchair or other aides[1,2].
Sports practice is able to adapt respiratory mechanics in relation to the type of motor demand for each specific sport discipline: sitting volleyball respiratory adaptation is unknown.
Spirometry is a simple and non-invasive test that allows measurement of how much air an individual move out in a respiratory cycle and the time necessary to do so. Thus, measuring how effectively and quickly the lungs fill up and empty out. Spirometry is considered, according to DM 18.2.1982 of Italian Minister of Health and from the laws and decrees for the sanitary protection of competitive activity, a first level assessment[3].
Constant training determines that cardio-respiratory adaptations and high levels of physical activity could reduce the physiological age related decline of respiratory performance, and improves functional respiratory parameters. In fact, age and changes in body weight, determine changes in respiratory mechanics. If other factors are added for example, smoking habits and the presence of bronchial obstructive pathology, further spirometric alterations can be found[4]. The evaluation of exhaled volume in 1 second (FEV1) and forced vital capacity (FVC) constitutes an adequate screening test for the study of lung function. The study compares non-disabled athletes with athletes with motor disabilities and proposes to evaluate the validity of sitting volleyball as a sports activity equivalent to others in reducing the physiological decline of respiratory function, regardless of the presence of motor disability.

## Materials and methods

*Study population*

The study included 18 athletes participating in an international sitting volley tournament held in Aprilia (LT), Italy, in February 2014. All participants signed written informed consent. A self-administered questionnaire was then completed by each subject to obtain demographic information and data regarding sports activities and weekly training time.

*Spirometry*

The ventilatory parameters examined are: FVC, FEV1, inspiratory capacity (IC), slow inspiratory vital capacity (ICV), expiratory flow peak (PEF), average flow rate from 25 at 75% of FVC (FEF 25-75%) in accordance with the American Thoracic Society/European Respiratory Society (ATS/ERS) classification criteria. The device used is SPIROLAB II portable spirometer - Medical International Reserch (MIR). Respiratory function was assessed prior to the match. Measurement was taken in accordance with the expected theoretical values calculated on age, sex, height, weight, motor and sport activity practiced[5].

*Statistical analysis*

The data were analyzed in an Excel database and the analysis was performed using the statistical package for Social Sciences, version 15.0 (SPSS, Chicago, Illinois, USA). Descriptive statistics consist of standard deviation. The comparison between the groups was performed with the Student test for continuous parametric variables or the chi-square test. A $p$ value of $<0.05$ was considered statistically significant.

## Results

The original sample consisted of 18 athletes but two athletes chose not to undergo the test. Therefore the analysis was carried out on the remaining 16 players, mean age was 36 years (range: 17-68 years) All subjects have played sitting volleyball for at least three years, three times a week (Table 1). Of the above mentioned, 4 women and 5 men are carriers of various types of disabilities (poliomyelitis, amputation of the lower limbs at various levels, post-natal cerebral suffering). Among the women with disabilities, two are athletes of the Slovenian national team who participated in the Olympics and one of the disabled players was an Olympic athlete. The remaining tested subjects are non-disable subjects and are amateur Sitting Volley players; among the non-disable subjects there are volleyball athletes at provincial and regional level. Four athletes reported a smoking habit. A player with bilateral tibial transfemoral amputation had obesity of the thoraco-abdominal portion. All the spirometric values detected are within the expected range of values based on age, sex, height, weight, ethnic group. There is no significant difference in the ventilatory function of Olympic players compared to amateur players. Table 2 and Table 3 show all spirometry evaluations.

Graph 1 analyzes the values of FEV1, and does not show substantial differences between the examined groups (non-disabled subjects and disabled).

Graph 2, compares the FEV1 of Olympic athletes with those of amateurs.

Table 1

| N. | Age (years) | Weight (Kg) | Height (cm) | BMI (kg/m2) |
|---|---|---|---|---|
| 16 | 36±14 | 76,0±20 | 174±9,0 | 24,7±4,8 |

Table 2

| NON DISABLE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Men | | | | Woman | | |
| FEV1% | 102 | 96 | 124 | 94 | 88 | 106 | 119 |
| FVC% | 100 | 106 | 123 | 88 | 83 | 99 | 112 |
| PEF% | 92 | 84 | 124 | 113 | 103 | 116 | 112 |
| FEF 25-75% | 103 | 70 | 127 | 120 | 98 | 117 | 128 |
| CV% | 93 | 83 | 123 | 87 | 83 | 103 | 106 |
| CI% | 111 | 96 | 98 | 110 | 106 | 100 | 206 |

Table 3

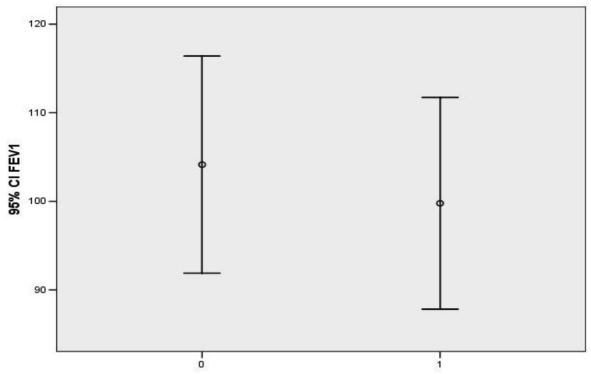
| DISABLE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | | | | | Woman | | | |
| FEV1% | 85 | 112 | 75 | 98 | 121 | 84 | 105 | 114 | 104 |
| FVC% | 84 | 108 | 77 | 91 | 115 | 96 | 111 | 117 | 99 |
| PEF% | 102 | 102 | 80 | 106 | 112 | 106 | 118 | 91 | 111 |
| FEF 25-75% | 142 | 111 | 65 | 101 | 134 | 49 | 81 | 101 | 131 |
| CV% | 89 | 105 | 67 | 53 | 114 | 90 | 112 | 119 | 92 |
| CI% | 124 | 56 | 83 | 62 | 130 | 121 | 148 | 119 | 123 |

## Discussion

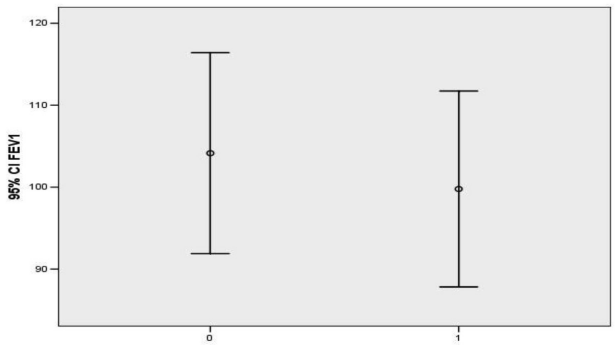
Sitting volleyball has only recently become popular, and to our knowledge, this is the first study on respiratory function in this sport.

In this small number of subjects, ventilatory parameter value show no statistically significant differences in the respiratory function of disabled athletes compared to non-disabled subjects.

Graph 1




Graph 2




A factor limiting the respiratory function of this sport is not strictly linked to physical disability but could be linked to the knowledge of the technical gesture and to smoking. Considering that sitting volleyball reflects many aspects of volleyball, especially from a technical point of view, both the able-bodied and the disabled have an expression of the respiratory function dependent on technical and motor skills. The latter are automated actions by repetition, freeing the consciousness and increasing the concentration on the tactical purpose of the action.

Respiratory centers injuries can cause suppression of spontaneous diaphragm respiratory activity (i.e. in the medullary lesions of the cervical tract higher than the IV cervical neuromere)[6, 7]. In our sample, there were no players with spine lesion up to IV cervical neuromere.

Although there are not many literature references regarding sitting volleyball that allows us to make direct comparisons with our study, our finding are in line with previous published articles concerning volleyball, and others that deal with the themes of people with motor disabilities and the metabolic effects of physical exercise and smoking[4, 8].

We should suppose why no significant differences were found between disabled and non-disabled athletes as we only tested subjects with amputation or polio cases. Degents et al.[4] affirm that the increase in age is characterized by a decrease in respiratory function and that subjects who have undergone amputations do not directly present respiratory problems if not due to age, which by nature leads to a decline in respiratory function.

Kobayashi et al.[9] state that the harmful effects of smoking on the cardiorespiratory system of apparently healthy subjects, occur during moderate exercise with a reduction in the efficiency of gas exchange in the lungs and muscles. In fact, sitting volley practice engages abdominal muscles as well as scapula levator muscle, rib levator muscle, pectoral large and small muscles, dorsal and trapezius muscles. These muscles act in forced inhalation and exhalation maneuvers, when exceptionally large and deep movements must be implemented.

Therefore, like other team sports, sitting volleyball promotes social aggregation and integration producing psychic benefits; in addition, its practice helps to preserve efficient respiratory performance.

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