



## Short communication

Received: 2023/12/15, Revised: 2024/02/29,  
Accepted: 2024/03/04, Published: 2024/03/31

©2024 Aditi Upmanyu et al.; Licence Physical Activity and Nutrition. This is an open access article distributed under the terms of the creative commons attribution license (<https://creativecommons.org/licenses/by-nc/2.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

\*Corresponding author : Varun Kalia, Dr

Jalandhar-Delhi G.T. Road, Phagwara, Punjab 144411, India.

E-mail: [Varun.26576@jpu.co.in](mailto:Varun.26576@jpu.co.in)

©2024 The Korean Society for Exercise Nutrition

## Influence of sitting time on pulmonary function in computer-using office workers

Aditi Upmanyu / Amit Kumar / Varun Kalia\*

Department of Physiotherapy, School of Allied Medical Sciences, Lovely Professional University, Punjab, India

### INTRODUCTION

Modern workplaces have transitioned from active to sedentary, resulting in prolonged periods of sitting. One reason for this shift is the change from paper-based to electronic and paperless work<sup>1</sup>. The nature of work in developing countries has changed drastically, and the focus has shifted to a more sedentary nature rather than being mobile<sup>2</sup>. Current occupations require the heavy use of computers (due to prolonged sitting), which may contribute to poor health function<sup>3</sup>. Professionals currently spend a substantial portion of their working hours seated in front of computers, leading to restricted mobility and potential systemic health issues<sup>4</sup>. Most of an individual's work hours are invested in immobility, resulting in dysfunction of the cardiovascular and musculoskeletal systems<sup>3,5</sup>.

Epidemiological investigations involving over 200,000 individuals have revealed prolonged sitting as a major concern for all-cause mortality, contributing to 7% of premature deaths. In 2018, approximately 25% of all jobs in the United States involved prolonged sitting, a significant increase from 15% in 1960<sup>1</sup>. Forty-two percentage male and forty-seven percentage of females spend an average of 6.3 hours in sedentary and seated roles during their 8-hour shifts<sup>6</sup>.

Prolonged sitting can alter the normal curvature of the spine, exerting increased pressure on intervertebral discs and resulting in anterior compression and posterior stretching. This can cause rearward movement of the nucleus pulposus, potentially leading to disc herniation. Changes in thoracic compliance induce a three-dimensional alteration in the form and movement of the thoracic wall during respiration, impacted by the foremost and back enunciations of the thoracic spine and rib cage<sup>7</sup>. Biomechanical changes in postural arrangement influence the scopes of movement, area, and coupling pattern of enunciations between thoracic spinal vertebrae and the rib confine, affecting lung compliance by altering articular development during respiration<sup>8</sup>.

Body position significantly influences respiratory function, with changes affecting the length and tension generation of respiratory muscles, specifically the diaphragm. Compared to a typical upright posture, a slump, poor posture significantly impacts pulmonary functions, expiratory flow, and lumbar lordosis<sup>9</sup>. Evidence indicates that even minor changes in posture can alter respiration, with slump sitting reducing tidal vol-

**[Purpose]** We aimed to identify the changes in pulmonary function after prolonged sitting. Pulmonary function tests (PFTs) allow physicians to assess the respiratory capability of patients under numerous clinical circumstances and when there are risk factors for lung sickness, occupational exposure, and pulmonary toxicity. PFTs are routinely performed in the standing or high sitting position because of the devices and patient comfort.

**[Methods]** A total of 180 asymptomatic office workers were recruited as eligibility criteria and divided into three groups according to their daily sitting duration (group 1: 2–4 h, group 2: 4–6 h, and group 3: > 6 h). PFTs were performed twice consecutively to determine the mean of the readings. A Helios 401 spirometer was used to quantify lung function. The parameters were "forced expiratory volume in 1 s (FEV1)", "forced vital capacity (FVC)", "peak expiratory flow rate (PEFR)", and the "ratio of FEV1 to FVC (FEV1/FVC)".

**[Results]** Our results suggest that noteworthy changes were present in the lung function of all the participants. For individuals with > 6 h of sitting; FVC, FEV1, and PEFR were higher compared to those of the participants with 2–4 h and 4–6 h of sitting. The FEV1/FVC ratio was also reduced in individuals with prolonged hours of sitting.

**[Conclusion]** Body position impacts the result of PFTs; however, that as it may, the ideal position and extent of advantage changed between the review populaces. These results suggested that noteworthy changes occur in the lung function of healthy individuals exposed to sitting time.

**[Keywords]** prolonged sitting, body composition, pulmonary function, lung health, spirometer, office worker

ume, forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and peak expiratory flow rate (PEFR) compared with that during upright postures<sup>10</sup>.

Additionally, pulmonary function is influenced by factors such as age, weight, height, and race, with lung capacity and elasticity decreasing with age. This leads to decreased lung function, making respiration more challenging and increasing the risk of getting pulmonary conditions such as “chronic obstructive pulmonary disease (COPD)”. Aging can also change the structure of airways and lung tissues, narrowing airways and reducing flexibility, further impeding airflow. The walls of the air sacs in the lungs may also become thicker and less efficient at exchanging oxygen and carbon dioxide. These age-related changes in lung structure and function contribute to symptoms such as shortness of breath, decreased exercise tolerance, and increased susceptibility to respiratory infections. Therefore, keeping a healthy lifestyle, including customary activity and abstaining from smoking, is crucial to mitigate the effects of aging on lung health<sup>11</sup>.

## MATERIALS AND METHODS

### Ethics approval

Morals endorsement and agree to partake in this study were obtained from the Gene Bandhu Independent Ethics Committee Protocol Number ECG004/2023.

### Study participants

One hundred and eighty healthy volunteers from the Lovely Professional University (122 men and 68 women) participated in the study. Participants characteristics described as (mean  $\pm$  SD) : 32.94  $\pm$  4.70 years old, 167.81  $\pm$  11.84 cm tall, and 69.15  $\pm$  12.64 kg weight. A written consent was taken from all volunteers before participating in the study. Healthy, asymptomatic, non-obese, moderately built individuals aged 25 – 40 years with sitting jobs and computer use were included in this study. Individuals were excluded if they had any cardiovascular or neurological impairment, orthopedic spinal disease, or respiratory dysfunction and were current smokers who had stopped smoking cigarettes within the past five years. Participants with a history of back pain or suffering from back pain were also excluded. The exclusion criteria were based on closed-ended questions. (Example: Have you previously experienced cardiovascular or neurological impairments? Yes/No)

Calculated by using this formula

$$n=2\{(Z\alpha+Z\beta) s\div d\}^2$$

**Table 2.** Inferential analysis.

Variable/Time	2-4 hours	4-6 hours	>6 hours	Sig.
FVC	2.91 $\pm$ 0.82	3.19 $\pm$ 1.09	4.11 $\pm$ 0.95	<0.001
FEV1	2.30 $\pm$ 0.69	2.44 $\pm$ 0.88	3.28 $\pm$ 0.92	0.000
FEV1/FVC	79.56 $\pm$ 12.43	77.17 $\pm$ 13.15	78.36 $\pm$ 7.65	0.488
PEFR	5.18 $\pm$ 3.07	5.90 $\pm$ 2.79	7.50 $\pm$ 2.61	<0.001

A significant difference in FVC, FEV1, and PEFR between 2-4 hours 4-6 hours, and >6 hours

FEV1 = forced expiratory volume in 1 second; FEV1/FVC = ratio of forced expiratory volume in 1 second to forced vital capacity; FVC = forced vital capacity; PEFR = peak expiratory flow rate.

**Table 1.** Subject characteristics.

Variables	Mean $\pm$ SD
Age (years)	32.94 $\pm$ 4.70
Weight (kgs)	69.15 $\pm$ 12.64
Height (cm)	167.81 $\pm$ 11.84
BMI (kg/m <sup>2</sup> )	23.47 $\pm$ 2.76

KG =kilogram; cm = centimetre; BMI= Body Mass Index; kg/m<sup>2</sup> = kilogram/meter<sup>2</sup>

The total sample size is 165 + 13% dropout

The total sample is 180

### Procedure

The participants were further split into three groups: group 1 (2–4 h of sitting), group 2 (4–6 h of sitting), and group 3 ( $\geq$ 6 h of sitting). The spirometry was performed on all participants. Adjustable stools without armrests and back support were used by the participants, which could be modified according to their heights. The individuals were asked to sit on the stool with their backs serenely laid on the seat and their feet in contact with the ground. The participants were requested to sit with their feet at hip width. The monitor was positioned at the eye level of the participants.

### Spirometer measurement

A “Helio 401 spirometer” was used to measure lung function. FVC, FEV1, FEV1/FVC ratio, and PEFR were measured using the spirometer. These parameters have been used to assess the degree of lung disease and can also be used to test the pulmonary function of healthy individuals<sup>10</sup>. Each time an estimate was made, the individuals blew into a mouthpiece associated with the apparatus. They were advised to look straight when performing spirometry. The individuals were instructed to inhale and exhale normally thrice and then to inhale and exhale deeply.

### Data analysis

IBM SPSS Insights 20 (for Windows) was utilized for measurable investigations. “One-way repeated measures analysis” of difference was used to look at the progressions in lung function over time. Bonferroni’s test was utilized as the “post-hoc test”.

## RESULTS

Our findings revealed significant changes in the lung function of the participants. Post-hoc testing revealed signif-

icant differences in FVC, FEV1, FEV1/FVC, and PEFr for 2–4 h, 4–6 h, and > 6 h of sitting (Table 2).

## DISCUSSION

We evaluated changes in lung function during prolonged sitting. The finding of this study indicated a noteworthy change in pulmonary function when an individual was seated for a longer period. These results revealed that changes in lung function occur during sitting.

Our findings revealed a decrease in lung function during inspiration among participants seated for extended periods, consistent with those of various literature reports biomechanical changes, such as muscle stiffness and change in torso ROM, due to prolonged sitting<sup>12,13</sup>. The adoption of a posture that flexes the spine, for example, when one sits on a PC and accomplishes work area work, has become undeniable in many workspaces. During slumping, the lumbar region and pelvic spinal portions are subject to inactive designs to keep up with the situation against gravity<sup>14,15</sup>. Consequently, flexed spine posture can cause stiffness & decrease muscle versatility. Similarly, Beach et al. revealed that lumbar spine constraint increases with prolonged sitting. A diminished range of lumbar movement after prolonged sitting has been previously reported<sup>12,15</sup>. Callaghan and McGill revealed a diminished range of motion in the lumbar region which is incited by structures like lumbar flexors that provide passive resistance.

Moreover, weakness in the deep flexor and extensor muscles of the neck may destabilize the cervical and thoracic spine, affecting rib cage biomechanics and altering inspiratory muscle function by modifying curves of force length and capabilities of force-production<sup>16,17</sup>.

Additionally, respiratory dysfunction may result from changes in force-length bends, muscle imbalances, and segmental unsteadiness of the cervical spine. Segmental unsteadiness in the cervical spine might reach out to the thoracic spine on account of specific muscles, for example, the longus colli, which append to regions impacted by neck proprioceptor impedance, in this manner confounding ideal spinal arrangement<sup>18</sup>. Moreover, sagittal stances of the thoracic spine were seen to be related to forward head pose, cervical versatility, and neck torment<sup>19</sup>. Concerning respiratory capability, thoracic kyphosis was demonstrated to be joined by dyspnea and ventilator brokenness<sup>20</sup>. In healthy young individuals with normally positioned diaphragms, a slumped sitting posture increases intra-abdominal pressure by bringing the ribs closer to the pelvis, hindering diaphragmatic descent during inspiration<sup>21</sup>.

Our study highlights a decline in lung function during prolonged sitting. Despite its limitation of a small sample size, we anticipate that our findings will serve as a reference for future studies investigating the effects of prolonged sitting.

## REFERENCES

1. Church TS, Thomas DM, Tudor-Locke C, Katzmarzyk PT, Earnest CP, Rodarte RQ, Martin CK, Blair SN, Bouchard C. Trends over 5 decades in US occupation-related physical activity and their associations with obesity. *PLoS One*. 2011;6:e19657.
2. Huysmans MA, Srinivasan D, Mathiassen SE. Consistency of sedentary behavior patterns among office workers with long-term access to sit-stand workstations. *Ann Work Expo Health*. 2019;63:583-91.
3. Thorp AA, Healy GN, Winkler E, Clark BK, Gardiner PA, Owen N, Dunstan DW. Prolonged sedentary time and physical activity in the workplace and non-work contexts: a cross-sectional study of office, customer service and call center employees. *Int J Behav Nutr Phys Act*. 2012;9:128.
4. Desai S, Joshi O. The paradox of declining female work participation in an era of economic growth. *Indian J Labour Econ*. 2019;62:55-71.
5. Evans RE, Fawole HO, Sheriff SA, Dall PM, Grant PM, Ryan CG. Point-of-choice prompts to reduce sitting time at work: a randomized trial. *Am J Prev Med*. 2012;43:293-7.
6. Driscoll P. Gray's Anatomy, 39th Edition. *EMJ*. 2006;23:492.
7. Ackermann BJ, O'Dwyer N, Halaki M. The difference between standing and sitting in 3 different seat inclinations on abdominal muscle activity and chest and abdominal expansion in woodwind and brass musicians. *Front Psychol*. 2014;5:913.
8. Kang KW, Jung SI, Lee DY, Kim K, Lee NK. Effect of sitting posture on respiratory function while using a smartphone. *J Phys Ther Sci*. 2016;28:1496-8.
9. Lin F, Parthasarathy S, Taylor SJ, Pucci D, Hendrix RW, Makhsous M. Effect of different sitting postures on lung capacity, expiratory flow, and lumbar lordosis. *Arch Phys Med Rehabil*. 2006;87:504-9.
10. Miller MR, Hankinson J, Brusasaco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CPM, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J. Standardization of spirometry. *Eur Respir J*. 2005;26:319-38.
11. Skloot GS. The effects of aging on lung structure and function. *Clin Geriatr Med*. 2017;33:447-57.
12. Beach TAC, Parkinson RJ, Stohart JP, Callaghan JP. Effects of prolonged sitting on the passive flexion stiffness of the in vivo lumbar spine. *Spine J*. 2005;5:145-54.
13. Dunk NM, Callaghan JP. Gender-based differences in postural responses to seated exposures. *Clin Biomech (Bristol, Avon)*. 2005;20:1101-10.
14. Callaghan JP, Dunk NM. Examination of the flexion relaxation phenomenon in erector spinal muscles during short-duration slumped sitting. *Clin Biomech (Bristol, Avon)*. 2002;17:353-60.
15. Callaghan JP, McGill SM. Low back joint loading and kinematics during standing and unsupported sitting. *Ergonomics*. 2001;44:280-94.
16. Wirth B, Amstalden M, Perk M, Boutellier U, Humphreys BK. Respiratory dysfunction in patients with chronic neck pain—influence of thoracic spine and chest mobility. *Man Ther*. 2014;19:440-4.
17. Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J. Respiratory weakness in patients with chronic neck pain. *Man Ther*. 2013;18:248-53.

18. Boyd-Clark LC, Briggs CA, Galea MP. Muscle spindle distribution, morphology, and density in longus colli and multifidus muscles of the cervical spine. *Spine*. 2002;27:694-701.
19. Lau KT, Cheung KY, Chan KB, Chan MH, Lo KY, Chiu TTW. Relationships between sagittal postures of thoracic and cervical spine, presence of neck pain, neck pain severity and disability. *Man Ther*. 2010;15:457-62.
20. Di Bari M, Chiarlone M, Matteuzzi D, Zacchei S, Pozzi C, Bellia V, Tarantini F, Pini R, Masotti G, Marchionni N. Thoracic kyphosis and ventilatory dysfunction in unselected older persons: an epidemiological study in Dicomano, Italy. *J Am Geriatr Soc*. 2004;52:909-15.
21. Lin F, Parthasarathy S, Taylor SJ, Pucci D, Hendrix RW, Makhsous M. Effect of different sitting postures on lung capacity, expiratory flow, and lumbar lordosis. *Arch Phys Med Rehabil*. 2006;87:504-9.