



# Mechanical Neck Pain Effect on Pulmonary Functions in Smartphone-Addicted Population

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## Abstract:

**Background:** Using smartphones has become part and parcel of daily life routine. The number of individuals using smartphones on a daily basis is rapidly growing. Many persons have complained of mechanical neck pain, especially after using smartphones for extended periods without intervals, which could affect pulmonary functions in a negative, noticeable way.

**Purpose:** to evaluate two parameters of pulmonary functions; PtcCO<sub>2</sub> and PEF.

**Methods:** 100 smartphone addicts with mechanical neck medical complications of both sexes were enrolled in this study. Delta University students were the participants in the current study. Subsequently, the range of age is 18 to 25.

**Results:** The results of this investigation showed that the mean PEF and PtcCO<sub>2</sub> values within the study group and the anticipated normal value differed statistically and in a crystal-clear way.

**Conclusions:** Mechanical neck pain was found to have a considerable deleterious influence on pulmonary functions in a smartphone-addicted spectrum of people.

**Keywords:** Smartphone, Pulmonary functions, Mechanical neck pain.

## 1. Introduction:

Smartphones have become a necessary pillar of daily life, and their usage is steadily increasing. Smartphones are thought of as the mobile versions of computers since they have an internet connectivity advantage over older versions and generations of cellphones (1).

People were urged to work from home when businesses and educational institutions were closed. Students had access to online educational resources. Nations implemented restrictions on social mobility and travel when the World Health Organization (WHO) deemed COVID-19 a public health emergency of international concern (2).

Proprioception and posture of the cervical spine may change as a result of prolonged smartphone use (3).

The cervical spine may experience significant strain from prolonged smartphone use, changing the curve (4). Most users of smartphones keep their heads flexed between (33° and 45°) from the vertical (5).

There are between 1% and 67.8% of smartphone users who experience musculoskeletal issues. Smartphone users report experiencing neck pain the most frequently, with a frequency ranging from 17.3 percent to 67.8 percent (6). According to research, people who use their phones frequently tend to have neck pain more frequent (7). Neck pain is correlated with the amount of time spent using a smartphone, particularly the length of time and multitasking activity (8).

Mechanical neck pain (MNP) is a general term for chronic pain that gets worse when the neck is move (9). When neck pain was caused or exacerbated by

repetitive neck movements or postures, it was labeled as “non-specific” or mechanical, and there was no underlying issue that could be found (10).

Localized and/or transmitted pain, joint soreness, and limited cervical range of motion are characteristics of mechanical neck discomfort (CROM). Less mobility in the upper cervical spine may lead to excessive movement in the lower cervical spine. The lower range of motion and altered neck posture result from increased fatigue in the sternocleidomastoid, anterior scalenus, and upper trapezius muscles (ROM) (11).

Functional complications in patients with persistent neck pain include weakened deep bending neck muscles brought on by stimulation of neck surface muscles, increased forward head posture deformity, impaired proprioception, and unsteady balance. Additionally, decreased cervical spine mobility limits the spine's range of motion and impairs pulmonary function (12).

A physiological examination called spirometry measures how much air a person can maximally inhale and expel. Spirometry evaluates volume or flow as a function of time as the primary indicator (13).

Cases with chronic neck pain may experience pulmonary dysfunction as a result of the weakening of the deep neck flexor and extensor muscles, which also decreased the stability of the cervical and thoracic spine and alters chest wall mechanics. Due to muscular hyperactivity and limited cervical spine motion, these mechanical changes cause anomalies in the force-length curves of the sternocleidomastoid muscles.

Although neck pain is typically considered to be a neuromusculoskeletal condition and is treated as such in medical care, some researchers think that due to the cervical region's close anatomical relationship with the thoracic spine, as well as their musculoskeletal and neural interconnection, there may also be changes in pulmonary function (14).

Blood chemistry variations are related to respiratory problems and acid/base balance, and blood gases are crucial indications of pulmonary function. There is proof that changes in blood gas can be used to identify discomfort and cardiorespiratory issues (15).

Nishino et al. (16) found that experimental pain caused by tourniquet inflation causes breathing to increase and end-tidal carbon dioxide tension to decrease. McLaughlin et al. (17) used capnography and found hypocapnia in a mixed group of people with spinal pain using the same pain stimuli approach.

## 2. Materials and Methods:

Study design: Randomized controlled study.

Delta University students have conducted the current study, which was intended to determine whether there is any connection between mechanical

neck pain and ventilatory function in the population that is addicted to smartphones. The enrolment process took place from March 2021 to November 2021.

### 2.1. Participants:

In this study, 100 volunteers of both sexes with a mechanical neck ache and smartphone addiction were enlisted. Inclusion criteria included:

- Male and female smartphone addicts with mechanical neck pain.
- Not being enrolled in any pulmonary rehabilitation program.
- BMI Ranging from 18.5-24.9 kg/m<sup>2</sup>. (Normal BMI) (18).
- A score ranging from 10% to 48% in the Neck disability index in both male & female participants.
- Smartphone addiction scale-short version (Arabic version) scores of  $\geq 31$  and  $\geq 33$  for male and female participants respectively.

### 2.2. Evaluation tools:

#### 1. The Neck Disability Index (NDI):

The patient's perceived disability as a result of their neck pain was evaluated using the NDI questionnaire (with a score of 50). Each of the 10 questions in this survey is worth 0 to 5 points (19). The Smartphone addiction scale-short version (SAS- SV) (Arabic version).

A ten-item survey with different levels of smartphone addiction was created in South Korea. On a dimensional scale, participants are asked to rate the degree to which each statement pertains to them (1 "strongly disagree" to 6 "strongly agree"). For male and female individuals, the smartphone addiction cut-off values were 31 and 33, respectively (20). An Arabic version of SAS-SV was utilized in this study, translated and validated by Sfindla et al (21).

#### 2. Ventilatory function test device:

Spirometry (FVC, FEV1, FEV1/FVC, and PEF) Medisoft ergocart professional, power 230V AC 50Hz, Serial number: 161121-05-0018, Belgium.

#### 3. Weight and height scale:

BMI calculation using weight and height measurements; serial number: 2015B100; China; deviation: 0.2 lb; maximum load: 200 kg; maximum height: 210 cm were all adopted in the current study.

#### 4. PtcCO<sub>2</sub> measurement:

PtcCO<sub>2</sub> was recorded using the TCM40 (Radiometer, Copenhagen, Analisi, Belgium). A color touch screen transcutaneous blood gases measurement device with portability and a small weight is called the TCM40. On its monitor, the waveforms and values of the arterial blood gases are graphically presented. Additionally, the TCM40 incorporates an electrode for a PtcO<sub>2</sub> and PtcCO<sub>2</sub> combination measurement. Additionally, a second finger sensor calculates SpO<sub>2</sub>. These sensors

provide both continuous monitoring of blood gas readings and individual parameter evaluation.

### 2.3. Study procedures

#### Before initiating the study:

- The major objective of the current study was highlighted for each case.
- A written consent was signed by each case to declare his/her approval to be included in the study.
- Each case has submitted two questionnaires of neck disability index and smartphone addiction scale so as to record his/her score to find out if the case was eligible to be included in the study or not.
- Each subject was examined medically by a physician to exclude any medical complications.
- A detailed record of each case's medical history was summed up in order to consider the physical ability.
- Height, Weight, and BMI were recorded for each case as a crucial step before initiating the study.
- A clear explanation of ventilatory function test procedures and different maneuvers for each task was provided for each case.
- The cases were asked to avoid having heavy meals before initiating the test procedures

#### Testing methods:

##### *Spirometry:*

**Apparatus used:** Spirometry (FVC, FEV1, FEV1/FVC, and PEF) Medisoft ergocart professional, power 230V AC 50Hz. With a serial number of 161121-05-0018, Belgium.

Testing procedure according to **Obaya et al., 2021 (25):**

1. The test's objective and methodology should be provided and highlighted to the participants as part of their preparation. with the explanation being succinct and straightforward.
2. The patient was dressed comfortably and any tight clothing, such as ties or belts, had been undone.
3. The patient was shown the ideal chin-neck position; the chin should be somewhat lifted, and the neck should be slightly extended. The patient was not allowed to bow their chins toward their chests during the forced expiratory procedures.
4. For each patient, a disposable mouthpiece was attached to the valve at the end of the spirometer tubing.
5. Before the test began, the patient was shown how to unwind and breathe normally via the mouthpiece.
6. The case's nose was fitted with a nose clip.
7. The case's personal information, including age, sex, race, weight, and height, was entered when the device was turned on.

8. The mouthpiece was in the patient's mouth, and it was requested that they not bite down on it, keep their lips tightly together, and keep their tongues out of the mouthpiece.

9. The patient was instructed to take three tidal breaths, fully exhale, then take a deep inspiration to exhale as forcefully and quickly through the mouthpiece as possible. The operation was performed three times, and the best record was recorded.

10. To accurately assess the case's ventilatory function, it is necessary to compare the case's test result to the reference or expected value. To achieve this, the case's height (without shoes), age (on the test day), sex, and weight are required.

#### Blood Gases Recording:

To record blood gases, transcutaneous blood gas monitoring was utilized (TCM40; Radiometer, Copenhagen, Analisi, Belgium). According to the directions in the manual, the TCM40 was originally calibrated using a detachable calibration gas cylinder for each participant separately for roughly 5 minutes. A fixation ring was placed five centimeters below the middle of the left collarbone after the placement area had been sanitized with alcohol and shaved.

The PtcCO<sub>2</sub> electrode was next joined to the fixation ring using a particular electrolyte solution to increase conductivity. To increase cutaneous blood flow without causing heat harm, the electrode was set to 43°C. Participants were asked not to speak throughout the recording and to maintain a normal breathing pattern while sitting comfortably. The data were obtained after a 20-min stabilization period since PtcCO<sub>2</sub> first exhibits high values as a result of an early CO<sub>2</sub> overshoot.

The values were calculated using the mean PtcCO<sub>2</sub> for the previous five minutes. The transcutaneous examination was reported to be a practical and trustworthy noninvasive method for determining PtcCO<sub>2</sub>. Another effective and reliable transcutaneous PtcCO<sub>2</sub> assessment technique is TCM. The geometric values and TCM PtcCO<sub>2</sub> measurements had a strong correlation ( $r = 0.87$ ) and little bias (0.6 mm Hg).

#### Data analysis:

The statistical analysis was carried out using the SPSS Package program for Windows, version 20. (SPSS, Inc., Chicago, IL). The next statistical methods were performed through:

- Descriptive statistics encompassing the mean and standard deviation for both PEF and PtcCO<sub>2</sub>.
- Statistical level all statistical analyses were clearly noticed at a level of probability less than an equal 0.05 ( $P \leq 0.05$ ).

### 3. Results:

#### PEF

As shown in **Table (1)**, the mean values of PEF in the predicted and measurement groups were  $8.45 \pm 1.59$  and  $5.33 \pm 1.39$ , respectively. The adopted statistical analysis by the independent t-test has figured out that there was a clear decrease in the mean value of PEF within the study group ( $P=0.0001$ ;  $P<0.05$ ) in comparison to the predicted normal values with a change of 3.12 between the predicted and the study group.

**Table (1):** the variation in Peak Expiratory Flow (PEF)

Items	PEF (Mean $\pm$ SD)
Predicted group (n=100)	$8.45 \pm 1.59$
study group (n=100)	$5.33 \pm 1.39$
Mean difference (change)	3.12
t-value	13.201
P-value ( $P<0.05$ )	0.0001*
Significance	S

Data are expressed as mean  $\pm$ standard deviation

P-value: probability value

S: significant \* Significant ( $P<0.05$ )

#### The partial pressure of arterial carbon dioxide:

A paired t-test was adopted to analyze the variation in arterial carbon dioxide partial pressure (PtcCO<sub>2</sub>).

The study group's data were contrasted with typical values. The findings demonstrate that patients with chronic neck discomfort had lower PtcCO<sub>2</sub> levels than expected ( $p < 0.01$ ) **Table (2)**.

**Table (2):** the variation in arterial carbon dioxide partial pressure (PtcCO<sub>2</sub>).

Variable	Study group (SD)	Normal Range (SD)	Mean Difference (95% CI)	P
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PtcCO <sub>2</sub> (mmHg)	34.9 ( $\pm 2.9$ )	37.3 ( $\pm 3.5$ )	-2.4 (-3.9, -1)	0.002**
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SD: Standard

Deviation, 95% CI: 95% Confidence Intervals

p: probability \*\* $p < 0.01$ , M: Mean,

### 4. Discussion:

The major objective of the current study was to trace how mechanical neck pain affected cases who were addicted to their smartphones' ventilatory functionalities. Peak Expiratory Flow (PEF) and

Partial Pressure of Arterial Carbon Dioxide were the values of ventilatory functions that were measured (PtcCO<sub>2</sub>).

These results are by those of Yozbatiran et al. (2006) (22), who looked at the impact of physiotherapy programs on patients with neck and low back pain and their peak expiratory flow rate (PEFR) and chest expansion. The study discovered that patients with neck pain had significantly lower PEF levels before enrolling in physiotherapy sessions.

The outcomes of this study were accorded with those of Jung et al (2016) (23), who investigated the effects of prolonged smartphone use on posture and respiratory function. Long-term smartphone users were shown to have markedly decreased PEF values than those who used their phones less frequently because they exhibited weaker forward head posture and rounded shoulders.

These findings are in agreement with those of Dimitriadis et al. (2013) (12), who investigated the relationship between hypocapnia and pain, muscle function, and psychological status in patients with persistent neck pain who had low PtcCO<sub>2</sub> levels that might go as low as the threshold for hypocapnia. It appears that both the physical and psychological symptoms of neck discomfort are related to this imbalance.

However, these consequences are at odds with those of Dimitriadis et al. (2014) (24), who performed a spirometric study to examine the pulmonary functions in patients with chronic neck pain and reported that there was no significant decline in PEF value in the chronic neck pain group compared to the control group in the study.

Additionally, people who experience chronic neck pain seem to share a lot of traits with people who suffer from respiratory dysfunction and neuromuscular weakness. Though pain and kinesiophobia may potentially directly or indirectly contribute to the emergence of this dysfunction, the origins of this weakness are thought to be linked to cervical muscular dysfunction.

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