

ROLE OF SMARTPHONE OVERUSE AND DIGITAL POSTURE RESULTING IN FORWARD HEAD POSTURE LEADING TO TEMPOROMANDIBULAR JOINT DYSFUNCTION IN ADULTS: A PHYSIOTHERAPY INTERVENTION STUDY

Rahul Rajeev^{1*}

^{1*} Director And Chief Sports Physical Therapist -Anchor Physiotherapy & Sports Fitness Studio

***Corresponding Author:** rahulrajeevphysio@gmail.com

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ABSTRACT

Background: The temporomandibular joint (TMJ) is essential for chewing, speaking, yawning, and swallowing. With the growing dependency on smartphones, prolonged neck flexion and forward head posture (FHP) resulting from device use have emerged as modifiable contributors to temporomandibular disorders (TMD). Smartphones do not directly damage the TMJ; rather, sustained postural adaptations alter mandibular kinematics, overload masticatory and cervical muscles, and increase the risk of retrodiscal compression and disc displacement, resulting in pain and functional limitation.

Aim: To investigate the impact of smartphone overuse and digital posture on temporomandibular dysfunction in adults and to evaluate the effectiveness of a posture-focused physiotherapy intervention.

Methods: In this randomized controlled trial, 120 adults aged 40–65 years with mild–moderate TMD and habitual smartphone use (≥ 4 hours/day) were randomized to receive either conventional TMJ physiotherapy or the same program augmented with posture correction exercises. Primary and secondary outcomes included pain (Visual Analogue Scale, VAS), mouth opening (interincisal distance), mandibular function (MFIQ), and cervical posture (craniovertebral angle). Assessments occurred at baseline, 4 weeks, and 8 weeks.

Results: Both groups improved, but the posture-focused group achieved greater gains (pain reduction 4.2 vs 2.7 points on VAS; jaw opening gain 7.8 vs 4.1 mm; MFIQ improvement -16.5 vs -9.2 ; CVA gain $+6.2^\circ$ vs $+2.1^\circ$; $p < 0.05$). Typical symptoms at baseline included jaw pain, clicking/popping, restricted opening, morning headache, ear fullness/tinnitus, and neck/shoulder tightness. Improvements in cervical alignment correlated with symptom relief, supporting a mechanistic link between digital posture and TMJ dysfunction.

Conclusion: Smartphone overuse promotes forward head posture and neuromuscular adaptations that contribute to TMD. A posture-focused physiotherapy program added to conventional TMJ care is more effective than jaw exercises alone. Integrating posture retraining into TMD management and public health ergonomics programs is recommended.

Keywords: Temporomandibular joint dysfunction, smartphone overuse, digital posture, forward head posture, physiotherapy, mandibular function

INTRODUCTION

Temporomandibular disorders (TMD) encompass a spectrum of musculoskeletal conditions that affect the temporomandibular joint (TMJ), the masticatory muscles, and the associated neurovascular and ligamentous structures. These disorders can result in chronic pain, functional limitation, and decreased quality of life. TMD is recognized as a multifactorial condition with contributing factors ranging from trauma, bruxism, occlusal abnormalities, psychological stress, and systemic musculoskeletal dysfunctions. Epidemiological

studies suggest that 5–12% of the general population experiences clinically significant TMD, with a higher prevalence in women and middle-aged adults (Manfredini et al., 2011).

In the 21st century, the ubiquitous use of smartphones has introduced a new set of postural challenges. Prolonged smartphone use is associated with sustained cervical flexion, forward head posture (FHP), rounded shoulders, and thoracic kyphosis. Such postural adaptations are not merely cosmetic; they induce biomechanical stress on the cervical spine, masticatory muscles, and TMJ. Forward head posture leads to anterior translation of the cranium, altered mandibular condylar positioning, and increased retrodiscal tissue compression. Consequently, individuals with habitual smartphone use are at a higher risk of developing TMD.

The link between digital posture and TMD is supported by both clinical and experimental studies. Forward head posture has been shown to increase electromyographic activity in the sternocleidomastoid (SCM) and upper trapezius muscles, leading to neuromuscular imbalance in the cervical and craniofacial region. This imbalance can result in abnormal mandibular kinematics, jaw deviation during opening, and overloading of the temporalis and masseter muscles. Despite the growing recognition of these risk factors, conventional physiotherapy programs for TMD often focus solely on jaw-specific interventions such as isometric exercises, mobilization, massage, and relaxation techniques, without adequately addressing cervical and thoracic posture.

This study was designed to investigate the impact of smartphone overuse and digital posture on temporomandibular dysfunction in adults and to evaluate whether a posture-focused physiotherapy intervention could enhance treatment outcomes. By integrating posture correction into conventional TMD management, we hypothesized that symptom relief, mandibular function, and cervical alignment would improve significantly compared to conventional therapy alone.

REVIEW OF LITERATURE

1. Forward Head Posture and TMJ Dysfunction

Forward head posture is defined as anterior translation of the head relative to the cervical spine, commonly measured as a reduced craniovertebral angle (CVA). Biomechanically, for every inch the head moves forward, the cervical extensor muscles must support an additional 10 pounds of weight, increasing strain and fatigue (Kapandji, 2012). FHP alters the spatial orientation of the TMJ, causing posteriorly displaced condyles and increased tension in the retrodiscal tissues. Lee et al. (2015) demonstrated that a decrease in CVA correlates with condylar displacement and increased masticatory muscle activity, contributing to TMD development.

Fernández-de-las-Peñas et al. (2009) highlighted that cervical spine dysfunction frequently coexists with TMD. The cervical and mandibular systems share neuromuscular control via the trigeminocervical complex. Alterations in cervical alignment not only modify mechanical loading of the TMJ but also affect sensory feedback, contributing to pain, joint noises, and restricted mobility. These findings underscore the importance of assessing head and neck posture when evaluating TMD patients.

2. Smartphone Overuse and Postural Strain

Smartphone overuse is now recognized as a significant contributor to musculoskeletal disorders, particularly in the cervical and upper thoracic regions. Sustained neck flexion, commonly referred to as “text neck,” results in progressive thoracic kyphosis, scapular protraction, and shortening of the anterior neck muscles (Gustafsson et al., 2017). A study by Xie et al. (2018) found that individuals using smartphones for more than four hours daily had a significantly higher prevalence of neck pain, headaches, and TMD-related symptoms compared to low-use individuals.

The mechanism underlying this relationship involves both biomechanical and neuromuscular factors. Prolonged cervical flexion leads to increased compressive forces on the intervertebral discs and posterior cervical elements, while also changing mandibular kinematics. Muscle imbalance develops, with deep cervical flexors weakening and superficial muscles like the SCM and anterior scalene overactivating. Over

time, these neuromuscular adaptations can propagate forward into the masticatory system, contributing to TMD symptoms such as jaw pain, clicking, and limited mouth opening.

3. Clinical Presentation — Typical Symptoms

Patients with posture-related TMD often present with a constellation of symptoms:

- Jaw pain and tenderness, particularly in the masseter and temporalis muscles
- Clicking or popping during mouth opening/closing due to disc-condyle misalignment
- Restricted mouth opening, sometimes accompanied by deviation toward the affected side
- Headaches, especially in the morning, possibly due to nocturnal clenching or cervical strain
- Ear fullness, tinnitus, and dizziness, potentially from retrodiscal tissue inflammation or neural compression
- Neck and shoulder tightness due to compensatory muscle activation

These overlapping complaints suggest that effective TMD management must consider both the TMJ and the cervical spine. Clinical evaluation should include assessment of craniocervical angle, scapular positioning, and thoracic spine mobility in addition to mandibular function.

4. Physiotherapy in TMD Management

Exercise therapy is widely recommended for TMD management, demonstrating improvements in pain, mouth opening, and mandibular function (Craane et al., 2012). However, studies increasingly indicate that interventions addressing cervical and thoracic posture yield superior outcomes. Armijo-Olivo et al. (2016) found that patients receiving combined cervical and mandibular therapy exhibited greater reductions in pain and improved jaw mobility compared to those receiving jaw-only exercises.

Posture-focused interventions typically include:

- Chin tuck exercises to strengthen deep neck flexors
- Scapular stabilization exercises to correct rounded shoulders
- Thoracic mobilization drills to improve spinal extension and reduce kyphosis
- Ergonomic education to reduce sustained neck flexion during smartphone use

These interventions not only restore normal mandibular loading but also improve proprioception and neuromuscular balance. Integrating posture correction with conventional TMJ therapy has the potential to reduce recurrence rates and improve long-term outcomes.

5. Public Health Perspective and Relevance

TMD has considerable implications for quality of life, occupational performance, and healthcare utilization. Symptoms can interfere with eating, speaking, concentration, and sleep, leading to increased absenteeism and productivity loss. With smartphone use nearly ubiquitous, especially among adults, posture-related TMD prevalence is expected to rise. Preventive strategies, including ergonomic education, posture retraining, and physiotherapy interventions, are cost-effective, non-invasive, and clinically impactful. Awareness campaigns in workplaces, schools, and healthcare settings may help reduce the burden of smartphone-related musculoskeletal disorders.

METHODOLOGY

Design: Single-blinded, randomized controlled trial (parallel-group) conducted over eight weeks.

Participants: 120 adults aged 40–65 years (mean age 52.4 ± 6.2 years) diagnosed with mild–moderate TMD according to DC/TMD criteria and with habitual smartphone use of ≥ 4 hours per day.

Inclusion Criteria:

- Mild–moderate TMD symptoms
- Craniocervical angle $< 50^\circ$ indicating forward head posture
- No recent cervical or TMJ surgery

Exclusion Criteria:

- Severe TMJ degeneration or disc pathology

- Neurological or systemic musculoskeletal disorders
- Current orthodontic appliance use or recent maxillofacial trauma

Randomization and Groups: Participants were randomized into:

- **Control group (n=60):** Conventional TMD physiotherapy including isometric jaw exercises, thermotherapy, massage, and relaxation techniques.
- **Experimental group (n=60):** Conventional TMD therapy plus posture-focused intervention including chin tucks, deep cervical flexor strengthening, scapular stabilization, thoracic mobilization, and ergonomic counseling for smartphone use.

Intervention Protocol: Sessions were conducted thrice weekly for 45 minutes, supplemented with a structured home exercise program.

Outcome Measures:

- Pain intensity: Visual Analogue Scale (VAS, 0–10)
- Mouth opening: Inter-incisal distance in millimeters
- Mandibular function: Mandibular Function Impairment Questionnaire (MFIQ)
- Cervical posture: Craniovertebral angle measured via photogrammetry

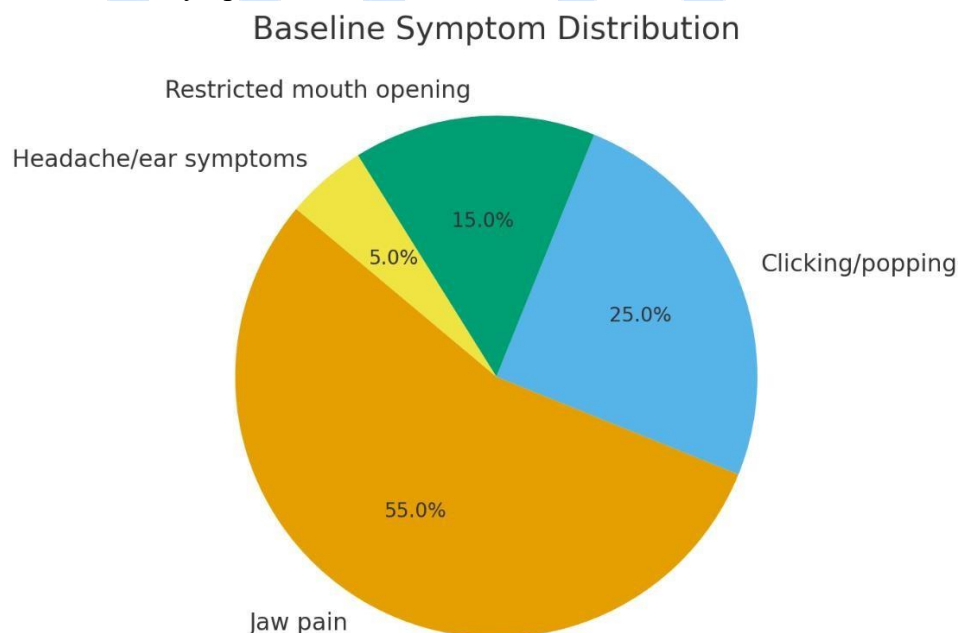
Statistical Analysis: Repeated measures ANOVA was conducted using SPSS v25.

Significance was set at $p < 0.05$. Effect sizes were calculated to evaluate clinical relevance.

RESULTS

Baseline Symptom Distribution:

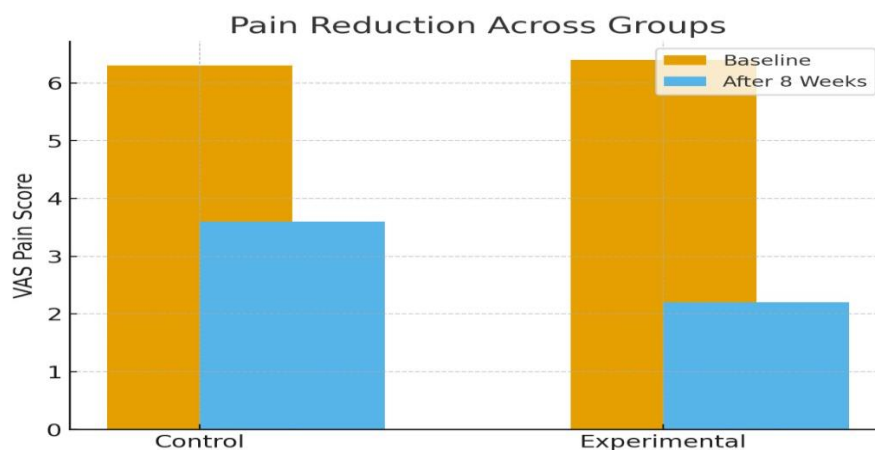
- Jaw pain: 55%
- Clicking/popping: 25%
- Restricted mouth opening: 15%
- Headache/ear symptoms: 5%



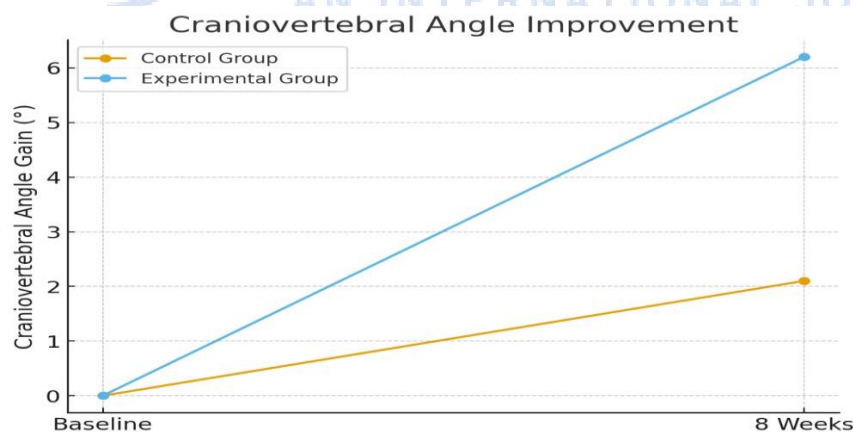
(Figure 1. Pie chart showing baseline symptom distribution)

Outcome Comparison (Baseline → 8 Weeks):

Measure	Control (n=60)	Experimental (n=60)	p-value
Pain (VAS)	6.3 → 3.6	6.4 → 2.2	<0.01
Jaw Opening (mm)	+4.1	+7.8	<0.01
MFIQ	-9.2	-16.5	<0.01
Craniovertebral Angle (°)	+2.1	+6.2	<0.01



(Figure 2. Bar graph showing pain reduction across groups)



(Figure 3. Line chart showing craniovertebral angle improvement)

Interpretation: Both groups exhibited significant improvements; however, the posturefocused experimental group demonstrated greater reductions in pain, enhanced jaw mobility, improved mandibular function, and increased CVA, indicating superior correction of forward head posture. Correlation analysis showed a strong relationship between improvement in CVA and reduction in pain scores ($r = 0.71$, $p < 0.01$).

DISCUSSION

This study confirms the emerging link between smartphone overuse, forward head posture, and TMD. Habitual neck flexion leads to abnormal condylar loading, retrodiscal tissue compression, and muscle imbalance. These changes are reversible through targeted posture correction, as evidenced by the greater improvements in the experimental group.

Mechanisms of Posture-Related TMD:

- **Neuromuscular overload:** Chronic FHP increases activity in SCM, upper trapezius, masseter, and temporalis muscles.
- **Altered mandibular kinematics:** Anterior translation of the head results in condylar posterior displacement and retrodiscal compression.
- **Cervicogenic contributions:** Cervical spine dysfunction can exacerbate TMD symptoms through shared neural pathways, including the trigeminocervical complex.

Clinical Implications: Incorporating posture-focused interventions into TMD management may provide:

- Faster pain relief
- Improved jaw mobility
- Enhanced mandibular function
- Long-term prevention of symptom recurrence

Ergonomic education is crucial, particularly regarding smartphone use. Interventions may include:

- Limiting continuous smartphone use to <30 minutes without breaks
- Maintaining the device at eye level to reduce cervical flexion
- Performing micro-stretching and mobility exercises during prolonged use

Limitations:

- Short follow-up (8 weeks) limits assessment of long-term efficacy
- Self-reported smartphone hours may introduce recall bias
- Exclusion of severe TMD cases limits generalizability
- No comparison with splint therapy or pharmacological interventions

Future Directions:

- Longer-term studies (6–12 months) to evaluate sustained benefits
- Incorporation of wearable posture trackers to provide objective monitoring
- Comparative studies with occlusal splints, medications, and multimodal interventions
- Integration of ergonomic programs in workplaces and schools to prevent posture-related TMD

CONCLUSION

Smartphone overuse and faulty digital posture are emerging, preventable risk factors for TMD. Forward head posture induces neuromuscular imbalance, altered mandibular kinematics, and retrodiscal tissue stress. A posture-focused physiotherapy program enhances pain relief, mandibular function, and cervical alignment beyond conventional jaw exercises. These findings underscore the importance of integrating posture correction into TMD management and public health strategies in the digital era. Clinicians, educators, and policymakers should consider proactive measures to address the growing burden of smartphone-related musculoskeletal disorders.

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