

Acute Effects of Isometric Trunk Fatigue on Cervical, Scapular, and Lumbar Muscle Mechanical Properties: A Myotonometric Pilot Study Stratified by Nomophobia Level

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Introduction

Nomophobia, the fear of being without a mobile phone, has emerged as a behavioral phenomenon associated with altered psychological and physiological responses. Prolonged smartphone use may influence neuromuscular function and spinal loading; however, its potential impact on fatigue-related muscle mechanical responses remains unclear. This pilot study aimed to investigate the acute effects of isometric trunk fatigue on cervical, scapular, and lumbar muscle mechanical properties according to nomophobia severity.

Materials and Methods

Thirty-four healthy young adults were stratified into low and high nomophobia groups based on the Nomophobia Questionnaire. Participants performed a standardized plank-based isometric trunk fatigue protocol until volitional exhaustion. Mechanical properties of the upper trapezius, sternocleidomastoid, and lumbar erector spinae (L4 level) were assessed on the dominant side using myotonometry before and immediately after fatigue. Perceived exertion was assessed using the Borg CR-10 scale. Between-group differences were analyzed with Mann-Whitney U tests.

Results

At baseline, the high nomophobia group had significantly longer daily screen time, higher nomophobia and smartphone addiction scores, and shorter plank endurance time ($p < 0.05$), whereas sex distribution, BMI, dominance, and baseline exertion were similar between groups ($p > 0.05$). Significant between-group differences were observed in post-fatigue sternocleidomastoid parameters, including frequency ($p = 0.048$, $r = 0.34$), stiffness ($p = 0.040$, $r = 0.35$), and relaxation time ($p = 0.046$, $r = 0.34$). Specifically, the high nomophobia group demonstrated lower post-fatigue frequency, lower stiffness, and longer relaxation time compared with the low nomophobia group. Pre-fatigue decrement of the lumbar erector spinae was also significantly different between groups ($p = 0.030$, $r = 0.37$). Borg scores increased after fatigue in both groups without significant between-group differences ($p > 0.05$).

Conclusion

High levels of nomophobia were associated with altered myofascial mechanical responses following isometric trunk fatigue, most notably in the sternocleidomastoid muscle. These findings, together with shorter plank endurance and higher perceived exertion, suggest that smartphone-related behavioral patterns may influence cervical neuromuscular adaptations and fatigue tolerance. While trunk fatigue induced mechanical changes across spinal muscles in all participants, the distinct cervical and lumbar responses observed in the high-nomophobia group highlight a potential modulatory role of problematic smartphone use on spinal muscle mechanics. These preliminary findings underscore the need for larger-scale studies to replicate and extend these findings and clarify their long-term musculoskeletal implications.

Table 1: Baseline Demographic and Clinical Characteristics

Variables	Low Nomophobia (n=17)	High Nomophobia (n=17)	p-value
Age (years)	21.88±1.79	20.23±1.95	0.012^a
Gender (Female/Male)	11/6 (64.7/35.3)	12/5 (70.6/29.4)	0.714 ^b
Dominant Side	16/1 (94.1/5.9)	15/2 (88.2/11.8)	0.545 ^b
BMI (kg/m2)	21.50±2.36	22.36±2.18	0.408 ^a
Daily Screen Time (minute)	220.82±137.86	301.29±116.20	0.039^a
NMP-Q Total Score	43.52±10.67	107.88±9.55	0.001^a
SAS-SV Score	69.41±14.92	98.64±19.50	0.001^a
Plank Duration (sec)	85.47±36.56	60±31.48	0.030^a
Pre-Fatigue Borg (0-10)	1.70±1.26	2.47±1.46	0.190^a

BMI: Body Mass Index; NMP-Q: Nomophobia Questionnaire; SAS-SV: Smartphone Addiction Scale-Short Version; sec: seconds; min: minutes.

a) Mann-Whitney U test was used for between-group comparisons of continuous variables.

b) Chi-Square test was used for the comparison of categorical variables.

*Statistical significance was set at $p < 0.05$.

Table 1: Baseline Demographic and Clinical Characteristics

Table 2: Between-Group Comparison of Fatigue-Induced Mechanical Changes (Post-Pre Change. Primary Outcomes)

Outcome Measure	Low Nomophobia (Mean ± SD)	High Nomophobia (Mean ± SD)	Mean Diff. (95% CI)	p-value	Effect Size
Upper Trapezius					
Pre-Frequency (Hz)	17.79±3.27	16.16 ± 2.59	1.63 (-0.40; 3.66)	0.174	0.23
Post- Frequency (Hz)	16.62±3.34	16.42 ± 2.18	0.20 (-1.72; 2.12)	0.959	0.01
Pre-Stiffness (N/m)	366.84±105.70	329.81 ± 81.01	37.03 (-26.89; 100.95)	0.310	0.17
Post-Stiffness (N/m)	330.57±103.18	338.14 ± 59.57	-7.57 (-64.88; 49.74)	0.667	0.07
Pre-Decrement	1.03±0.14	1.03 ± 0.10	0.00 (-0.08; 0.08)	0.863	0.03
Post-Decrement	1.00±0.15	1.03 ± 0.10	-0.03 (-0.11; 0.05)	0.535	0.11
Pre-Relaxation (ms)	14.97±3.53	16.22 ± 3.16	-1.25 (-3.54; 1.04)	0.235	0.20
Post-Relaxation (ms)	16.16±3.75	15.72 ± 2.18	0.44 (-1.65; 2.53)	0.836	0.04
Pre-Creep	0.91±0.20	0.99 ± 0.17	-0.08 (-0.20; 0.04)	0.248	0.20
Post-Creep	0.97±0.20	0.96 ± 0.12	0.01 (-0.10; 0.12)	1.000	0.00
Sternocleidomastoid					
Pre-Frequency (Hz)	12.28±1.53	11.74 ± 0.88	0.54 (-0.31; 1.39)	0.399	0.14
Post- Frequency (Hz)	12.62±1.21	11.73 ± 1.20	0.89 (0.07; 1.71)	0.048	0.34
Pre-Stiffness (N/m)	200.27±49.92	177.41 ± 32.88	22.86 (-9.92; 51.64)	0.191	0.22
Post-Stiffness (N/m)	204.55±33.16	181.05 ± 46.60	23.50 (-4.14; 51.14)	0.040	0.35
Pre-Decrement	1.30±0.12	1.28 ± 0.10	0.02 (-0.05; 0.09)	0.593	0.09
Post-Decrement	1.26±0.20	1.30 ± 0.13	-0.04 (-0.15; 0.07)	0.326	0.17
Pre-Relaxation (ms)	22.38±3.37	23.65 ± 2.38	-1.27 (-3.25; 0.71)	0.221	0.21
Post-Relaxation (ms)	21.51±2.39	23.48 ± 2.98	-1.97 (-3.81; -0.13)	0.046	0.34
Pre-Creep	1.32±0.20	1.39 ± 0.14	-0.07 (-0.18; 0.04)	0.263	0.19
Post-Creep	1.27±0.15	1.38 ± 0.15	-0.11 (-0.21; -0.01)	0.091	0.29
Lumbar Erector Spinae (L4)					
Pre-Frequency (Hz)	11.85±1.35	12.13 ± 0.87	-0.28 (-1.06; 0.50)	0.174	0.23
Post- Frequency (Hz)	12.49±2.81	12.07 ± 0.88	0.42 (-1.01; 1.85)	0.617	0.09
Pre-Stiffness (N/m)	168.20±44.28	163.70 ± 35.24	4.50 (-22.96; 31.96)	0.973	0.01
Post-Stiffness (N/m)	194.95±103.09	158.50 ± 37.28	36.45 (-16.41; 89.31)	0.228	0.21
Pre-Decrement	0.95±0.19	0.87 ± 0.24	0.08 (-0.06; 0.22)	0.030	0.37
Post-Decrement	0.89±0.13	0.87 ± 0.20	0.02 (-0.09; 0.13)	0.301	0.18
Pre-Relaxation (ms)	23.02±3.37	23.09 ± 2.57	-0.07 (-2.12; 1.98)	0.931	0.02
Post-Relaxation (ms)	22.23±4.66	23.18 ± 2.59	-0.95 (-3.51; 1.61)	0.547	0.10
Pre-Creep	1.25±0.21	1.26 ± 0.17	-0.01 (-0.14; 0.12)	0.850	0.03
Post-Creep	1.22±0.27	1.24 ± 0.17	-0.02 (-0.17; 0.13)	0.918	0.02
Borg CR-10 Score					
Pre-Borg	1.70±1.26	2.47±1.46	-0.77 (-1.69; 0.15)	0.190	0.22
Post-Borg	7.76±1.09	8.05 ± 1.24	-0.29 (-1.08; 0.50)	0.523	0.11

Values are presented as mean ± SD unless otherwise stated.
n: number of participants (17 per group); CI: confidence interval; SCM: sternocleidomastoid muscle; L4: lumbar vertebra level 4; Borg CR-10: Borg Category-Ratio 10 Scale.
p < 0.05 indicates statistical significance based on the Mann–Whitney U test.
Effect size (r) was calculated as |Z|/√N (0.1 = small, 0.3 = medium, 0.5 = large).

Between-Group Comparison of Fatigue-Induced Mechanical Changes