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ORIGINAL ARTICLE

Within-Session Reductions in Negative Mood During a 4-Week Upright Sitting Practice in Japanese Young Adults: An Exploratory Observational Study.

Takuma Usuda[1], Takuji Yamaguchi[2], Ailing Hu[2], Zenji Kawakami[2], Saori Karasawa[1], Munetaka Yamamoto[1], Hiroyuki Kobayashi[1]

1 Department of Hospital Administration, Juntendo University Graduate School of Medicine, Tokyo, Japan.
2 Department of Personalized Kampo Medicine, Juntendo University Graduate School of Medicine, Tokyo, Japan.

Correspondence to: Takuma Usuda, M. Med. Sc.
Department of Hospital Administration; Juntendo University Graduate School of Medicine; 2-1-1 Hongo, Bunkyo-ku, Tokyo 113-8421, Japan
TEL.: +81-3-3813-3111; FAX: +81-3-3813-3622; E-MAIL: t.usuda.kt@juntendo.ac.jp

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Key words: **upright sitting posture; stress-related indicators; mood states; autonomic nervous system; heart rate variability; salivary biomarkers; POMS2; healthy young adults**

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Abstract

OBJECTIVES: This exploratory study examined changes in stress-related indicators, including subjective mood states, autonomic nervous system activity, and salivary biomarkers, during a 4-week period in which healthy young adults performed an instructed upright sitting posture.

DESIGN: This study employed a single-arm, within-subject, repeated-measures observational design.

MATERIALS AND METHODS: Eighteen healthy university students (10 males and 8 females) completed a 4-week upright sitting posture practice. Assessments took place at baseline (Week 0), mid-practice (Week 2), and end-of-practice (Week 4). At each visit, participants underwent a 10-minute seated rest; pre-session assessments using the Profile of Mood States, Second Edition (POMS2), autonomic indices, and salivary biomarkers; a 5-minute upright sitting period; and post-session assessments. Autonomic activity was indexed by heart rate (HR) and heart rate variability (HRV), and salivary cortisol, chromogranin A, oxytocin, and α-amylase were measured.

RESULTS: Across assessment weeks, sessions that included the instructed upright sitting posture were accompanied by within-session pre–post improvements in most POMS2 mood indices, with large effects for several negative mood subscales and Total Mood Disturbance. Significant main effects of Week were observed for Confusion–Bewilderment, Tension–Anxiety, and Total Mood Disturbance, whereas other mood indices did not show consistent change. HR showed significant main effects of Measurement Timing and Week, while HRV indices and salivary biomarkers did not show consistent or statistically significant patterns. At Week 4, comfortable maintenance time—the self-reported maximum duration participants felt they could maintain the instructed posture—was positively associated with total practice time; this association was considered hypothesis-generating.

CONCLUSIONS: In this single-arm, exploratory study, sessions across a 4-week period that included an instructed upright sitting posture were accompanied by within-session reductions in self-reported negative mood. However, the fixed rest-to-task sequence and absence of a control condition preclude determination of whether observed mood changes were specifically attributable to posture.

Abbreviations:

POMS2	- Profile of Mood States, Second Edition
HR	- heart rate
HRV	- heart rate variability
LF	- low-frequency power
HF	- high-frequency power
LF/HF	- low-frequency/high-frequency ratio
CgA	- chromogranin A
SD	- standard deviation
SE	- standard error

INTRODUCTION

Bodily posture and emotional states are bidirectionally linked — a relationship documented since James (1890) connected somatic patterns to affective experience. Clinical descriptions of depressive symptomatology have frequently noted characteristic postural features, such as a bowed back or drooping shoulders (American Psychiatric Association, 2013).

Regarding psychological processes and stress-related physiology, several studies have examined these associations and reported differences in psychological and psychophysiological responses under experimentally manipulated postural conditions (Nair *et al.* 2015; Wilkes *et al.* 2017; Takayama & Sekiya, 2023; Tsai *et al.* 2016). Physiologically, posture manipulation and body position have been associated with variations in cardiovascular and autonomic indices, with evidence that heart rate variability (HRV) and related measures differ across seated, supine, or standing positions (Young & Leicht, 2011).

Salivary cortisol is widely used as an index of stress-related physiological activity in psychobiological research (Castro *et al.* 2000; Titman *et al.* 2020). However, its interpretation requires careful consideration of intra- and inter-individual variability, sampling conditions, and diurnal influences (Hellhammer *et al.* 2009). Moreover, laboratory research has suggested that adopting specific postures may be accompanied by changes in autonomic indices and stress-related salivary measures under controlled laboratory conditions (Goto *et al.* 2020). Despite these findings, previous studies have predominantly examined short-term posture manipulations conducted in laboratory settings, often within a single session and under constrained conditions. To our knowledge, few studies have investigated whether daily upright sitting posture practice over several weeks is associated with patterns of psychological and physiological outcomes in relatively naturalistic, observational, non-constrained settings. Specifically, few studies have examined whether daily practice of upright sitting posture is accompanied by changes in mood-related measures alongside exploratory autonomic and salivary indicators.

In the current study, healthy university students practiced an upright sitting posture daily for 4 weeks. Assessments were conducted at Weeks 0, 2, and 4, with pre- and post-session measurements obtained at each laboratory visit. This design allowed examination of both immediate within-session effects and cumulative changes over the practice period, addressing the limited evidence on longer-term posture practice. Psychological outcomes were assessed using the Profile of Mood States, Second Edition (POMS2), and exploratory physiological indices included autonomic measures and salivary biomarkers. End-of-practice postural maintenance capacity was operationalized as comfortable maintenance time, defined as the self-reported maximum duration for which participants could comfortably maintain the instructed posture at Week 4. This study examined patterns of change across the practice period and explored associations between postural maintenance capacity and stress-related indicators.

MATERIALS AND METHODS

Study Design and Participants

An a priori power analysis using G*Power 3.1 indicated that a sample size of 18 would provide 80% power to detect a medium effect ($d \approx 0.50$) at $\alpha = 0.05$. The inclusion criteria were: (1) age 18–25 years, (2) general good health without chronic conditions, (3) interest in improving sitting posture, and (4) ability to provide written informed consent. The exclusion criteria included: (1) history of cardiovascular, respiratory, neurological, or severe musculoskeletal disorders; (2) acute or chronic illness currently under treatment; (3) major injury or surgery involving the back, lower back, or neck within the past 6 months; (4) pregnancy; (5) severe psychiatric disorders; and (6) regular use of medications affecting posture or autonomic function. Based on these criteria, 18 healthy university students were recruited and enrolled in the study (10 males and 8 females; mean age 20.2 ± 1.4 years [SD]). All participants provided written informed consent before enrollment. The study protocol was approved by Waseda University Ethics Review Committee (Approval No. 2024-268).

This single-arm, observational, repeated-measures study assessed psychological and physiological indices during a 4-week upright sitting posture practice period. Laboratory assessments were conducted in Week 0 (baseline), Week 2, and Week 4. At each visit, participants completed a standardized sequence: (1) a pre-session assessment following 10 minutes of seated rest, including saliva sampling, psychological questionnaire,

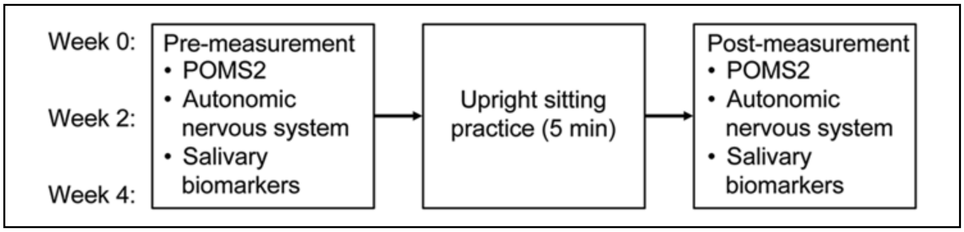

Fig. 1. Experimental design and assessment timeline.
Pre- and post-session assessments of psychological (POMS2), autonomic, and salivary indices were conducted at Week 0, Week 2, and Week 4. At each visit, a 10-min seated rest preceded the pre-session assessment; a 5-min upright sitting posture session was then performed, followed immediately by the post-session assessment. Note that pre-session measurements reflect a post-rest state and post-session measurements reflect a post-task state.

and autonomic assessment; (2) a 5-minute upright sitting posture maintenance period; and (3) a post-session assessment identical to the pre-session protocol. This design allowed for the evaluation of within-session pre–post differences at each assessment point, as well as changes across the practice period. The study timeline and assessment procedures are illustrated in Figure 1.

Upright Sitting Posture Practice

At Week 0, participants were seated on a height-adjustable chair, with the height adjusted so that both feet rested flat on the floor and the knees were flexed at approximately 90°. Participants were instructed to adopt an upright sitting posture without using the backrest or external restraints and to avoid excessive voluntary muscle contraction. They were asked to maintain a forward gaze, with their hands resting on their thighs. To facilitate self-monitoring, participants performed a brief palpation-based self-check to identify a comfortable trunk angle consistent with the instructed alignment (see Figure 2A–C).

Posture instruction was reinforced using standardized verbal guidance, reference images, and a posture checklist. Posture attainment was confirmed by the lead investigator, an experienced posture specialist. For visual confirmation of postural alignment, circular adhesive markers (approximately 1 cm in diameter) were placed on the acromion and greater trochanter. The 5-minute posture maintenance period was video-recorded for documentation purposes. During the

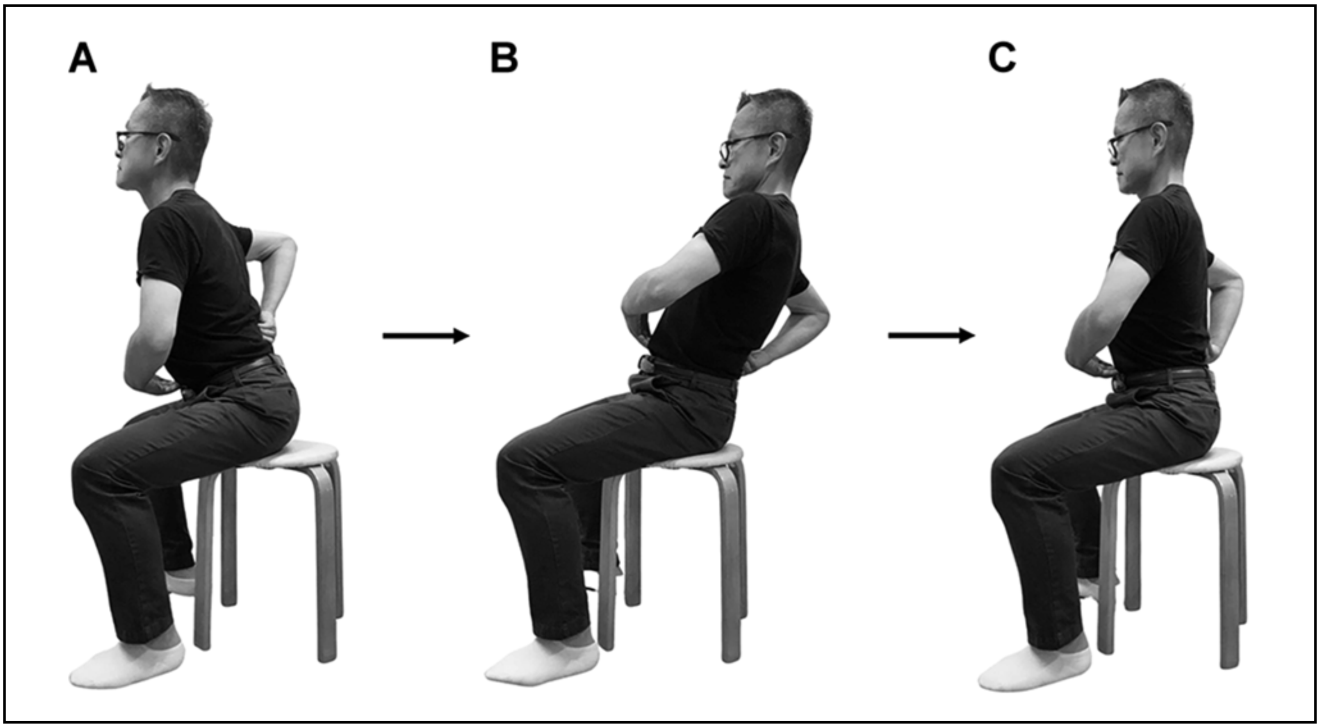

Fig. 2. Upright sitting posture instruction and palpation-based self-check.
At baseline (Week 0), participants were instructed to maintain physiological spinal curvatures with emphasis on preserving lumbar lordosis. While keeping spinal alignment, participants explored small anterior (A) and posterior (B) trunk tilts and used a brief palpation-based self-check to identify a comfortable trunk angle associated with minimal unnecessary muscle tension. Participants then adopted the intermediate trunk angle (C) at which unnecessary tension in both muscle groups felt minimal while spinal curvatures were preserved.

4-week practice period, participants practiced the instructed posture daily for at least 10 minutes and self-recorded their daily practice duration.

Evaluation of the Psychological Status

Psychological status was assessed using the 65-item full version of the POMS2® (Heuchert & McNair, 2012; Yokoyama & Watanabe, 2015). The POMS2® comprises five negative mood subscales, including Anger–Hostility (AH), Confusion–Bewilderment (CB), Depression–Dejection (DD), Fatigue–Inertia (FI), and Tension–Anxiety (TA), and two positive mood subscales, including Vigor–Activity (VA) and Friendliness (F). Participants rated their current mood states on a 5-point Likert scale ranging from 0 ("not at all") to 4 ("extremely"). Subscale scores were calculated by summing item responses. Total Mood Disturbance (TMD) was calculated as follows: TMD = (AH + CB + DD + FI + TA) − VA.

Measurement of Autonomic Nervous System Function

All physiological measurements were conducted in a quiet indoor environment under stable ambient temperature and humidity conditions. Autonomic nervous system (ANS) activity was assessed using HRV power spectra recorded with an acceleration pulse wave meter (Paras Analyzer Plus View TAS 9 VIEW, Tokyo, Japan). A sensor connected to the analyzer was placed on the left index finger, and all parameters were recorded for 2.5 minutes while the participant remained seated. Low-frequency power (LF; 0.04–0.15 Hz) and high-frequency power (HF; 0.15–0.40 Hz) were derived from the power spectra. HR (beats per minute) was also recorded, and the LF/HF ratio was calculated.

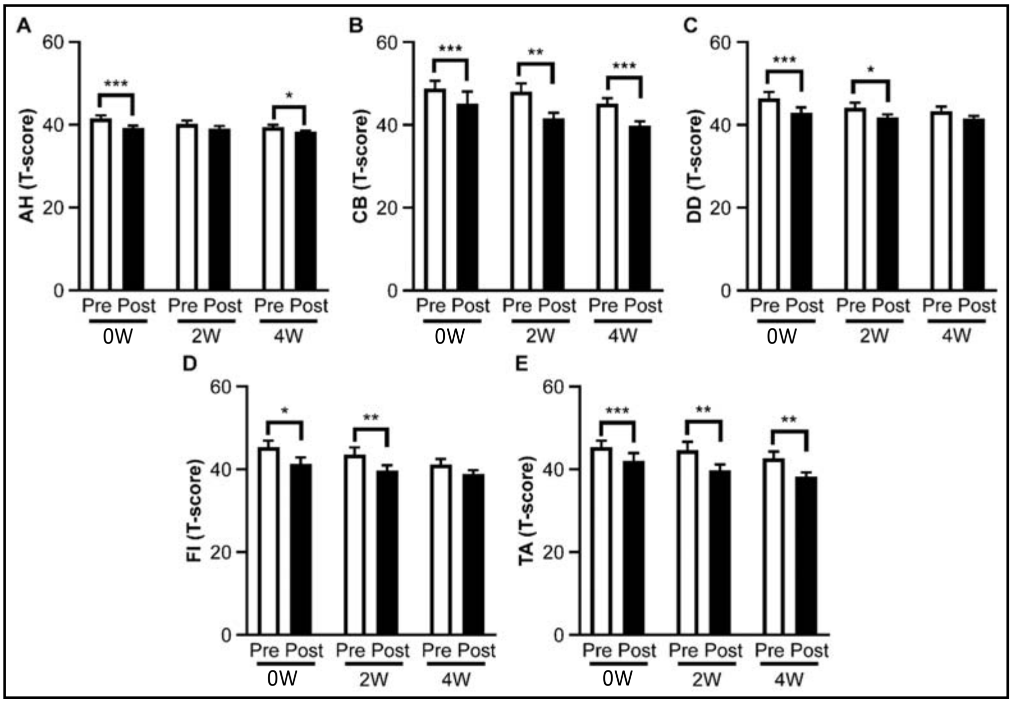

Fig. 3. Pre–post changes in negative mood subscales (POMS2).
Mean ± SE values (n = 18) of negative mood subscales of the Profile of Mood States 2nd Edition (POMS2) measured before (pre) and after (post) each session at Week 0, Week 2, and Week 4. Panels show Anger–Hostility (A), Confusion–Bewilderment (B), Depression–Dejection (C), Fatigue–Inertia (D), and Tension–Anxiety (E). *$p < .0167$, **$p < .01$, ***$p < .001$ indicate significant pre–post differences (Bonferroni-corrected threshold α = .0167). Bars without asterisks did not reach the corrected threshold; some show nominal $p < .05$ (see Table 1 for exact values).

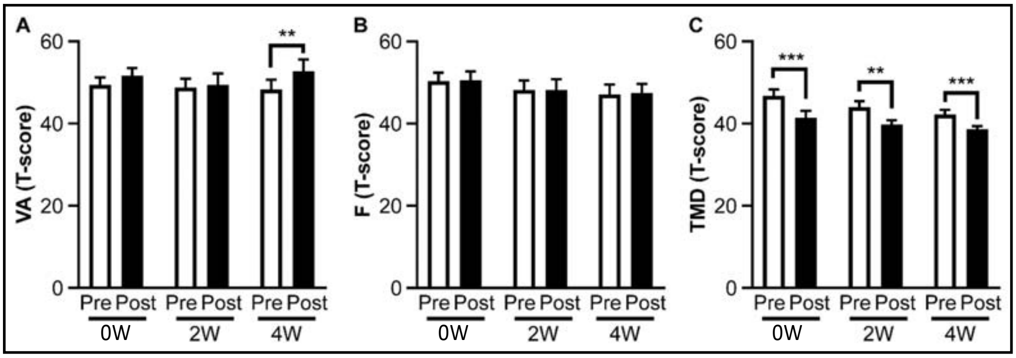

Fig. 4. Pre–post changes in positive mood subscales and Total Mood Disturbance (POMS2).
Mean ± SE values (n = 18) of POMS2 positive mood subscales and Total Mood Disturbance (TMD) measured pre and post each session at Week 0, Week 2, and Week 4. Panels show Vigor–Activity (A), Friendliness (B), and Total Mood Disturbance (C). *p < .0167, **p < .01, ***p < .001 indicate significant pre–post differences (Bonferroni-corrected threshold α = .0167). Bars without asterisks did not reach the corrected threshold; some show nominal p < .05 (see Table 1 for exact values).

Measurement of Salivary Stress Biomarker Levels

Saliva samples were collected using a Saliva Collection Aid (Salimetrics, USA) to obtain approximately 1 mL of saliva and were stored at −20°C until analysis. Salivary stress biomarkers included cortisol, chromogranin A, oxytocin, and α-amylase, which were measured using the Salivary Cortisol Enzyme Immunoassay Kit (Salimetrics, USA), the Human Chromogranin A EIA Kit (Yanaihara Institute Inc., Japan), the Oxytocin ELISA Kit (Enzo, USA), and the Salivary Amylase Monitor (Nipro, Japan), respectively.

Participants were instructed to refrain from alcohol consumption on the evening before each experimental session and to complete all food intake, beverages other than water, and oral hygiene at least one hour before testing. To reduce the effects of diurnal variation, saliva samples were collected between 10:00 and 17:00 following methodological recommendations for salivary hormone measurement (Hellhammer *et al.* 2009; Matsui *et al.* 2009). Each participant was assessed at approximately the same time of day (±1 hour) across all laboratory visits to minimize circadian influences.

Comfortable Maintenance Time

At Week 4, following the post-session assessment, participants self-reported their postural maintenance capacity by sending a message via LINE (a smartphone messaging application) to the research team. Reports included the maximum duration (in minutes) for which they could comfortably maintain the instructed upright sitting posture before feeling the need to change position. This self-reported measure, termed “comfortable maintenance time,” was used as an index of end-of-practice postural maintenance capacity.

Statistical Analysis

For each dependent variable, two-way repeated-measures analyses of variance (ANOVAs) were conducted with within-subject factors of Week (0, 2, 4) and Measurement Timing (Pre vs. Post). Sphericity was assessed using Mauchly’s test, and Greenhouse–Geisser–corrected degrees of freedom were applied when sphericity was violated ($p < 0.05$). Effect sizes for ANOVA were reported as partial eta squared (ηp^2).

Post-hoc paired t-tests examined pre–post differences within each assessment week. To control for multiple comparisons within each outcome variable across the 3 assessment weeks, Bonferroni correction was applied ($\alpha = 0.05/3 = 0.0167$). No family-wise correction was applied across the full set of outcome variables; all findings should therefore be interpreted as exploratory. Cohen’s d was calculated as the effect size for post-hoc comparisons. Pearson correlation and simple linear regression analyses examined associations between total practice time and comfortable maintenance time at Week 4. All statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Participant Flow and Adherence

All 18 participants completed the study protocol, with no dropouts or missing data. Adherence to daily posture practice was 92.3% (SD = 8.1%), with participants completing an average of 25.8 days (SD = 2.3) of the 28-day practice period.

Changes in Psychological Status Measured by POMS2

Figures 3A–E and 4A–C illustrate pre–post changes across the three assessment weeks for all POMS2 subscales. Two-way repeated-measures ANOVAs revealed significant main effects of Measurement Timing for six of seven POMS2 subscales and for TMD (all $p < .05$; Table 2). Friendliness was the sole subscale showing no significant main effect. Significant main effects of Week were identified for Confusion–Bewilderment, Tension–Anxiety, and Total Mood Disturbance. No significant Week × Measurement Timing interactions were observed for any POMS2 indices (all $p > .05$).

Post-hoc paired t-tests with Bonferroni correction ($\alpha = .0167$) revealed significant pre–post differences for several POMS2 subscales across assessment weeks. Confusion–Bewilderment, Tension–Anxiety, and Total Mood Disturbance showed significant pre–post differences at all three time points (Weeks 0, 2, and 4). Other subscales showed significant pre–post differences at specific assessment weeks. Anger–Hostility exhibited significant pre–post differences at Weeks 0 and 4, but not at Week 2. Depression–Dejection and Fatigue–Inertia showed significant pre–post differences at Weeks 0 and 2 only. Vigor–Activity demonstrated a significant pre–post difference at Week 4, whereas Friendliness showed no significant pre–post differences at any week.

Complete post-hoc results for all POMS2 subscales are presented in Table 1. Summary results of the two-way repeated-measures ANOVAs for psychological, autonomic, and salivary indices are provided in Table 2.

Changes in Autonomic Nervous System Measurements

For LF power, HF power, and the LF/HF ratio, no significant main effects of Measurement Timing or Week, and no significant interactions, were observed (all $p > .05$; Figures 5A–5C). For HR, two-way repeated-measures ANOVA revealed significant main effects of Measurement Timing and Week (Figure 5D). Post-hoc paired t-tests with Bonferroni correction indicated a significant pre–post difference at Week 2, whereas no significant pre–post differences were observed at Week 0 or Week 4.

Changes in Salivary Stress Biomarker Levels

For salivary cortisol, oxytocin, chromogranin A, and α-amylase, two-way repeated-measures ANOVAs revealed no significant main effects of Measurement

Tab. 1. Post-hoc paired t-test results for POMS2 subscales comparing pre- and post-session scores

Measure	Week	Mean Diff	95% CI	t	*p*		Cohen's d
Anger–Hostility	0	2.33	[1.14, 3.53]	4.12	<.001	***	0.78
	2	1.11	[0.12, 2.10]	2.36	.030		0.38
	4	1.00	[0.22, 1.78]	2.70	.015	*	0.54
Confusion–Bewilderment	0	7.28	[3.47, 11.09]	4.03	<.001	***	0.60
	2	6.44	[2.30, 10.59]	3.28	.004	**	0.88
	4	5.28	[3.15, 7.41]	5.23	<.001	***	1.07
Depression–Dejection	0	3.50	[1.58, 5.42]	3.84	.001	***	0.57
	2	2.33	[0.64, 4.02]	2.92	.010	*	0.52
	4	1.78	[0.12, 3.44]	2.26	.037		0.44
Fatigue–Inertia	0	4.06	[1.02, 7.09]	2.82	.012	*	0.60
	2	3.83	[1.15, 6.52]	3.01	.008	**	0.60
	4	2.22	[−0.08, 4.52]	2.04	.057		0.45
Tension–Anxiety	0	6.78	[4.40, 9.16]	6.01	<.001	***	0.84
	2	4.78	[1.88, 7.68]	3.48	.003	**	0.63
	4	4.50	[1.88, 7.12]	3.62	.002	**	0.76
Vigor–Activity	0	−2.28	[−6.78, 2.23]	−1.07	.301		−0.29
	2	−0.61	[−6.24, 5.01]	−0.23	.821		−0.06
	4	−4.44	[−7.46, −1.43]	−3.11	.006	**	−0.39
Friendliness	0	−0.22	[−2.49, 2.04]	−0.21	.839		−0.02
	2	0.00	[−2.52, 2.52]	0.00	1.00		0.00
	4	−0.33	[−3.24, 2.57]	−0.24	.812		−0.03
Total Mood Disturbance	0	5.33	[3.14, 7.52]	5.14	<.001	***	0.78
	2	4.17	[1.75, 6.59]	3.63	.002	**	0.78
	4	3.61	[2.04, 5.18]	4.84	<.001	***	0.87

Note. Mean Diff = pre–post; positive values indicate reduction in negative mood. For Vigor–Activity and Friendliness, negative values indicate improvement (increased scores). CI = confidence interval. Cells without an asterisk did not reach the Bonferroni-corrected significance threshold ($\alpha = .0167$), including p-values between .017 and .05 (e.g., AH Week 2, DD Week 4, FI Week 4). *$p < .0167$, **$p < .01$, ***$p < .001$.

Timing or Week, and no significant interactions (all $p > .05$). Results for salivary stress biomarkers are shown in Figures 6A–6D.

Changes in Comfortable Maintenance Duration and Association with Total Practice Time

At Week 4, the mean comfortable maintenance time was 29.83 minutes (SD = 15.37; range = 5–67 minutes). Pearson correlation analysis revealed a positive association between total practice time and comfortable maintenance time ($r = .50$, $p = .037$, $n = 18$), with a wide confidence interval. Simple linear regression indicated a significant model fit ($F(1,16) = 5.19$, $p = .037$, $R^2 = .25$), but given the small sample size and lack of adjustment for potential confounders, this association is best regarded as hypothesis-generating rather than evidential of a robust dose–response relationship. The regression equation was as follows: comfortable maintenance time = 0.0115 × total practice time + 16.66.

DISCUSSION

This study examined whether sessions conducted during a 4-week upright sitting posture practice period were associated with changes in self-reported mood, autonomic indices, and salivary biomarkers in healthy young adults. Unlike previous studies that primarily focused on acute postural manipulations (Nair *et al.* 2015; Wilkes *et al.* 2017), this study addressed associations between repeated upright sitting practice and psychological and physiological stress-related indicators over time. Earlier experimental studies typically employed brief, laboratory-based posture manipulations within a single session, often involving physical constraints such as taping, to examine immediate affective or stress responses. While these studies provided crucial insights into the short-term psychophysiological correlates of posture, they leave unexamined whether sustained engagement with — or increasing

Tab. 2. Main effects of Measurement Timing (Pre vs. Post) and Week (0, 2, 4) from two-way repeated-measures ANOVAs

Domain	Measure	Timing (Pre vs. Post)			Week (W0, W2, W4)		
		$F(1, 17)$	p	η_p^2	$F(2, 34)$	p	η_p^2
Psychological	Anger–Hostility	23.38	<.001	.579	2.771	.077	.140
	Confusion–Bewilderment	39.72	<.001	.700	5.150	.011	.232
	Depression–Dejection	20.47	<.001	.546	2.871	.070	.144
	Fatigue–Inertia	19.58	<.001	.535	3.400	.045	.167
(POMS2)	Tension–Anxiety	40.40	<.001	.704	6.087	.006	.264
	Vigor–Activity	7.70	.013	.312	0.024	.976	.001
	Friendliness	0.14	.709	.008	1.407	.259	.076
	Total Mood Disturbance	51.14	<.001	.751	4.367	.021	.204
Autonomic	Heart Rate	14.42	<.001	.459	4.316	.021	.202
	LF Power	4.07	.060	.193	2.279	.118	.118
	HF Power	2.81	.112	.142	1.364	.269	.074
	Ln(LF/HF) Ratio	0.037	.850	.002	0.047	.954	.003
Salivary	Cortisol	0.93	.349	.052	0.362	.699	.021
	Chromogranin A	0.87	.363	.049	0.895	.418	.050
	Oxytocin	0.09	.771	.005	1.644	.208	.088
	α-Amylase	0.04	.834	.003	0.163	.851	.009

Note. ηp^2 = partial eta squared. POMS2 = Profile of Mood States, Second Edition. LF = low-frequency power (0.04–0.15 Hz); HF = high-frequency power (0.15–0.40 Hz); Ln(LF/HF) = natural logarithm of the LF/HF ratio. All analyses conducted with n = 18. Week main effects were significant for Confusion–Bewilderment, Tension–Anxiety, and Total Mood Disturbance (see text). No significant Week × Measurement Timing interactions were observed for any variable (all $p > .05$).

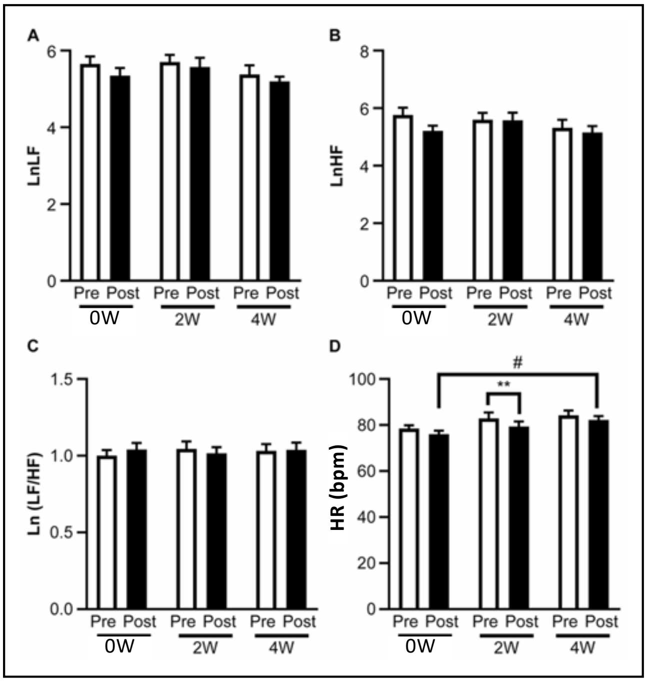

Fig. 5. Autonomic nervous system indices across assessment weeks. Mean ± SE values (n = 18) of autonomic indices measured pre and post each session at Week 0, Week 2, and Week 4. Panels show low-frequency power (LF; 0.04–0.15 Hz) (A), high-frequency power (HF; 0.15–0.40 Hz) (B), LF/HF ratio (C), and heart rate (beats/min) (D). # indicates a significant main effect of Week for heart rate (Panel D; two-way repeated-measures ANOVA). $^*p < .0167$, $^{**}p < .01$, $^{***}p < .001$ indicate significant Bonferroni-corrected pre–post differences. LF power, HF power, and the LF/HF ratio (Panels A–C) showed no significant main effects of Measurement Timing or Week, and no significant interactions (all $p > .05$).

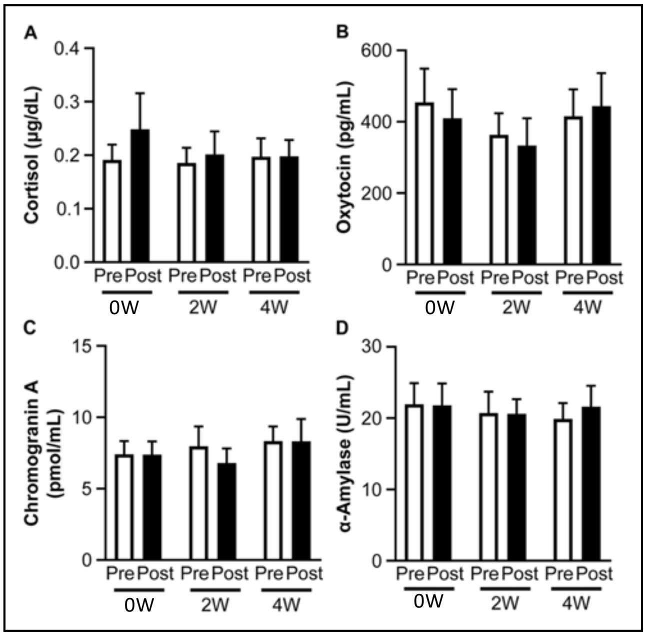

Fig. 6. Salivary stress biomarkers across assessment weeks. Mean ± SE values (n = 18) of salivary biomarkers measured pre and post each session at Week 0, Week 2, and Week 4. Panels show cortisol (μg/dL) (A), oxytocin (pg/mL) (B), chromogranin A (pmol/mL) (C), and α-amylase (U/mL) (D). No significant pre–post differences or main effects were observed for any salivary biomarker (all $p > .05$; see Table 2). Significance markers are not shown.

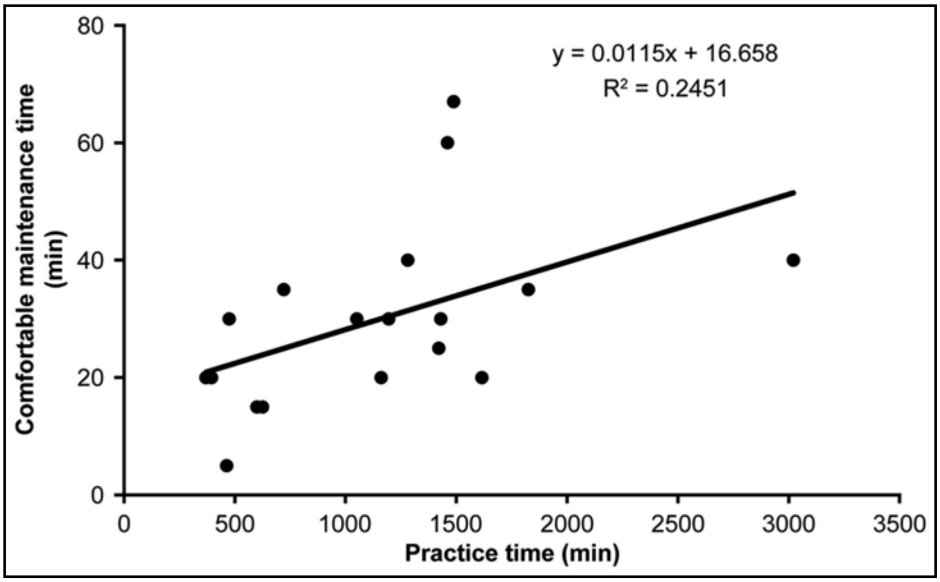

Fig. 7. Association between total practice time and comfortable maintenance time at Week 4. Scatter plot of the relationship between total accumulated practice time (min) during the 4-week period and comfortable maintenance time (min) self-reported at Week 4 (n = 18). The solid line represents the fitted linear regression line (r = .50, R^2 = .25, p = .037). The regression equation is: comfortable maintenance time = 0.0115 × practice time + 16.66. Note that the 95% CI for r is wide given the sample size (n = 18) and this finding should be interpreted as hypothesis-generating.

proficiency in — upright sitting posture is associated with stress-related outcomes across time.

In contrast, the current study adopted a repeated-practice framework over 4 weeks, allowing participants to gradually develop familiarity and proficiency with upright sitting in their daily lives. Within this context, changes observed in several mood-related indices within sessions indicate that sessions including upright sitting were accompanied by acute pre–post reductions in negative affect. However, in the absence of significant Week × Measurement Timing interactions and without a control condition, it remains unclear whether such within-session patterns reflect posture-specific processes, general session-related factors, or any accumulation into longer-term changes in resting mood. This interpretation does not imply causality but underscores a conceptual distinction between acute posture manipulation paradigms and approaches that conceptualize posture as a learned or habitual behavior. From this perspective, upright sitting posture may be considered not merely as an experimental manipulation but as a behavioral practice for which psychological correlates could emerge through repetition and adaptation; this possibility requires confirmation in controlled trials.

Self-reported mood indices demonstrated more consistent pre–post patterns than physiological or salivary measures. This observation aligns with prior posture-manipulation studies reporting associations between upright posture and affective appraisal under acute conditions (e.g., Nair *et al.* 2015; Wilkes *et al.* 2017). However, without a control group, attribution to posture practice cannot be established in this uncontrolled design.

A complementary interpretation is that repeated upright-sitting practice may facilitate attainment of a more stable postural set at specific time points, although this possibility was not directly tested in the present study. Salivary stress biomarkers did not show statistically significant or convergent patterns across assessment weeks, and all four biomarkers exhibited effect sizes near zero. Although descriptive variation was observed, the combination of small sample size, wide sampling window, and null effect sizes precludes a substantive interpretation of posture-related effects on salivary markers in this dataset. Descriptive variation should not be interpreted as directional trends. Future studies employing controlled designs, stricter sampling schedules, and larger samples must clarify whether repeated posture practice influences salivary stress-related biomarkers.

This study is novel in framing upright sitting posture as a practice-based capacity rather than solely as a transient experimental manipulation. The positive association between total practice time and comfortable maintenance time at the final assessment is consistent with, but does not prove, the interpretation that upright sitting posture may function as a learnable and maintainable behavior in some individuals. Although based on a single exploratory association, this finding suggests that sustained engagement in posture practice may relate to individual differences in posture maintenance capacity.

In summary, this study provides preliminary, uncontrolled observations indicating that sessions incorporating an instructed upright sitting posture were accompanied by within-session reductions in self-reported negative mood in healthy young adults, without establishing whether these changes were specifically attributable to posture, the task context, or other non-controlled factors. Physiological and salivary indices did not show consistent or interpretable patterns. These findings should be interpreted cautiously given the exploratory design and the absence of a control group.

Limitations and Future Research Directions

This study has several limitations. First, the single-arm design without a control group limits causal inferences. Second, the relatively small sample size (n = 18) may limit generalizability. Third, the wide saliva sampling window (10:00–17:00) may have introduced additional variability despite the participants being scheduled at consistent times. Fourth, the 4-week practice period may have been insufficient to detect changes in salivary biomarkers. Fifth, each session followed a fixed sequence: a 10-minute rest period preceding the pre-session assessment and a 5-minute active posture task preceding the post-session assessment. Pre–post reductions in negative mood indices may therefore reflect non-specific effects of transitioning from a passive rest period to a structured, attentive task, rather than — or in addition to — any posture-specific effect. Consequently, the present design does not permit isolation of the unique contribution of posture from general task engagement or time effects. Future designs should include a rest-only or alternative-task control condition to isolate posture-specific contributions. Future studies should investigate whether greater postural maintenance capacity is associated with larger changes in psychological or physiological outcomes. To clarify the mechanisms underlying posture-mood associations, future studies should employ randomized controlled designs with larger samples, more tightly controlled sampling protocols, and counterbalanced measurement sequences.

De-identified data supporting the study's findings are available from the corresponding author upon reasonable request.

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CONFLICTS OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

Takuma Usuda, Hiroyuki Kobayashi, Munetaka Yamamoto, Takuji Yamaguchi, Zenji Kawakami, Ailing Hu, and Saori Karasawa conceived and designed the study. Takuma Usuda, Ailing Hu, and Saori Karasawa collected the data. Ailing Hu, Saori Karasawa, and Hiroyuki Kobayashi contributed data and analysis tools. Takuma Usuda, Ailing Hu, Takuji Yamaguchi, Zenji Kawakami, and Saori Karasawa performed the data analysis. Takuma Usuda, Takuji Yamaguchi, Zenji Kawakami, and Ailing Hu drafted the manuscript. All authors reviewed, revised, and approved the final version of the manuscript.

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