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# Association between patients' knee posture and patient satisfaction in primary care consultations

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**Research Article**

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## Abstract

# Background

Nonverbal behaviour may provide information about patients' experiences during clinical encounters. Although facial expressions, gaze, and upper-body behaviours have been studied in relation to patient satisfaction, little is known about whether patients' lower-limb posture is associated with satisfaction. This study explored the association between patients' knee posture immediately before the end of an outpatient consultation and post-consultation patient satisfaction.

# Methods

This exploratory observational study included patients attending the Department of General Medicine at Tokyo Women's Medical University Hospital between April 2024 and December 2025. Consultations conducted by three physicians were video recorded. Two researchers visually classified the average posture of both knees during the final 30 seconds of each consultation as flexed, neutral, or extended relative to an approximately right-angled knee position. Joint angles were not instrumentally measured. Patient satisfaction was assessed after the consultation using the 12-item Patient Satisfaction Questionnaire developed by Takemura et al. Mean satisfaction scores were compared across the three knee-posture groups using one-way analysis of variance, with Bonferroni-adjusted pairwise comparisons.

# Results

Of 203 patients included in the analysis, 19 (9.4%) were classified as having a flexed knee posture, 119 (58.6%) as having a neutral posture, and 65 (32.0%) as having an extended posture. The overall mean patient satisfaction score was 49.4 (SD 6.4; range 31–60). Mean satisfaction scores differed significantly among the three knee-posture groups ($F[2, 200] = 3.32$, $P = 0.038$). In Bonferroni-adjusted pairwise comparisons, the neutral-posture group had a mean satisfaction score 2.50 points higher than the extended-posture group (95% CI 0.13 to 4.87; adjusted $P = 0.035$). No statistically significant differences were observed between the neutral and flexed groups or between the flexed and extended groups.

# Conclusions

Knee posture observed during the final 30 seconds of outpatient consultations was associated with post-consultation patient satisfaction, with higher satisfaction among patients with a neutral posture than among those with a relatively extended posture. These findings are exploratory and do not establish causality or indicate that knee posture alone can estimate an individual patient's satisfaction. Future

studies should evaluate the reproducibility of posture classification and determine whether the association persists after adjustment for potential confounding factors.

## Background

Patient satisfaction is an indicator of the quality of medical care from the patient's perspective. An association has been reported between hospital-wide satisfaction ratings and indicators of clinical quality [1]. Furthermore, satisfaction with treatment is associated with adherence and continuation of treatment [2]. In a previous study by the authors, a positive association was observed between "reflection" and "legitimation" in physicians' clinical interviews and patient satisfaction; the association with "reflection" remained significant even after adjusting for interview duration and other interview behaviours [3].

Human emotions are involuntarily expressed through facial expressions and posture [4]. It is therefore likely that patient satisfaction is expressed nonverbally. Previous studies have evaluated physicians' nonverbal behaviours—such as eye contact, nodding, leaning forward, body orientation, and the way arms and legs are crossed—and have examined their associations with clinical outcomes, including patient satisfaction [5]. In clinical settings where physicians and patients sit facing each other, the position of the lower limbs is also readily observable. Several studies have investigated whether knee angle is important as a form of nonverbal communication that conveys emotions [6]. However, in these studies, no significant relationship between knee angle and patient satisfaction was demonstrated. Other studies have distinguished between acute stress and relaxed states based on posture-related characteristics such as seated foot movements and plantar pressure [7]. These findings may suggest that lower-limb behavior may provide information about psychological states.

In clinical practice, it is conceivable that patients who appear to have low satisfaction might keep their knees bent so they can stand up at any time. To our knowledge, the association between patients' knee posture during primary care consultations and patient satisfaction has not been specifically examined. Accordingly, this exploratory study examined whether knee posture observed immediately before the end of an outpatient consultation was associated with post-consultation patient satisfaction.

## Methods

# Study design and setting

This study was an exploratory observational study conducted in the Department of General Medicine at Tokyo Women's Medical University Hospital, Tokyo, Japan, between April 2024 and December 2025.

## Participants

The study included 257 medical consultations with patients seen by three physicians in the Department of General Medicine. Consecutive adult patients attending consultations with the three participating physicians were invited to participate. Patients who gave informed consent and completed the post-consultation questionnaire were eligible for inclusion. This study received prior approval from the Ethics Review Committee of Tokyo Women's Medical University (Approval No. 2023 – 0116).

## Measurements

Patient consultations were recorded using a compact video camera with full high-definition (HD) resolution. Recordings were made from five different angles; for knee angle assessment, the patient was filmed from the front, from a distal angle, and from directly above the patient and physician. Two researchers observed the patient's knee posture during the 30-second video clip taken independently immediately before the end of the consultation and classified it into the three categories shown in Fig. 1. Disagreements were resolved by consensus. The internal angle formed by the thigh and lower leg—with full extension defined as 180 degrees—was used as the reference. A posture approaching a right angle was designated as 0 (neutral posture); a flexed posture with a smaller internal angle was designated as − 1 (flexed posture); and an extended posture with a larger internal angle was designated as + 1 (extended posture). Rather than measuring the angles, the average posture of both knees over the 30-second period was visually assessed.

Patient satisfaction was assessed immediately after the consultation using the 12-item Takemura Patient Satisfaction Questionnaire (TPSQ), which has demonstrated content validity, concurrent validity, internal consistency, and test–retest reliability. Total scores ranged from 12 to 60, with higher scores indicating greater satisfaction [8].

## Analysis

Continuous variables were summarised as means and standard deviations or as medians and interquartile ranges, as appropriate. Categorical variables were summarised as counts and percentages. Mean patient satisfaction scores were compared across the three knee-posture groups using one-way analysis of variance.

When the overall test was statistically significant, Bonferroni-adjusted pairwise comparisons were performed. Mean differences and 95% confidence intervals were reported. A two-sided P value below 0.05 was considered statistically significant.

## Use of generative artificial intelligence

During manuscript preparation, the authors used ChatGPT (GPT-5.6 Sol, OpenAI) for English-language editing and assistance with manuscript organisation. All generated content was critically reviewed,

revised, and verified by the authors, who take full responsibility for the final manuscript.

## Results

Of the 257 individuals invited to participate in the study, 244 (94.9%) consented and completed the questionnaire. Of these, 203 (83.2% of respondents) were included in the analysis because they provided the necessary data. Reasons for exclusion included an inability to assess posture (e.g., the knee was difficult to see) and missing questionnaire items.

The mean age among participants with available age data was 50.4 years (SD 18.4). Of the 175 participants with available sex data, 65 (37.1%) were male and 110 (62.9%) were female. The characteristics of the analytic sample are summarised in Table 1.

Of the 203 participants, 19 (9.4%) were classified as having a flexed knee posture, 119 (58.6%) as having a neutral posture, and 65 (32.0%) as having an extended posture. Characteristics by knee-posture category are shown in Table 2. Mean patient satisfaction scores were 48.8 (SD 7.8), 50.3 (SD 6.5), and 47.8 (SD 5.6) in the flexed, neutral, and extended groups, respectively.

Mean patient satisfaction scores differed significantly among the three knee-posture groups ($F[2, 200] = 3.32$, $P = 0.038$). Bonferroni-adjusted pairwise comparisons showed that the neutral-posture group had a significantly higher satisfaction score than the extended-posture group (mean difference, 2.50; 95% CI, 0.13 to 4.87; adjusted $P = 0.0352$), while the other pairwise comparisons were not statistically significant (Table 3).

Table 1
Characteristics of the analytic sample

| Characteristic | Overall (N = 203) |
|---|---|
| Age, years, mean (SD) | 50.4 (18.4) |
| Age available, n | 175 |
| Sex, n (%) | |
| Female (Sex = 0) | 110 (54.2) |
| Male (Sex = 1) | 65 (32.0) |
| Missing | 28 (13.8) |
| Knee posture, n (%) | |
| Flexed (-1) | 19 (9.4) |
| Neutral (0) | 119 (58.6) |
| Extended (+ 1) | 65 (32.0) |
| Patient satisfaction score, mean (SD) | 49.4 (6.4) |

Values are n (%) unless otherwise indicated. Percentages for sex use the full analytic sample (N = 203) as the denominator; patient satisfaction was available for all 203 participants.

Table 2
Characteristics according to knee-posture category

| Characteristic | Flexed (-1) (n = 19) | Neutral (0) (n = 119) | Extended (+ 1) (n = 65) |
|---|---|---|---|
| Age, years, mean (SD) | 56.7 (19.2) | 50.8 (17.7) | 47.1 (19.1) |
| Patient satisfaction score, mean (SD) | 48.8 (7.8) | 50.3 (6.5) | 47.8 (5.6) |
| Patient satisfaction score, median (IQR) | 49.0 (44.0–56.0) | 50.0 (47.0–56.0) | 48.0 (45.0–50.0) |

Knee posture was visually classified during the final 30 seconds of the consultation. Age was missing for 12 participants in the neutral group and 16 participants in the extended group. Group-specific sex distributions were not available in the current SAS output and are therefore not shown.

Table 3
Bonferroni-adjusted pairwise comparisons of patient satisfaction scores among knee-posture categories

| Comparison | Mean difference* | Simultaneous 95% CI | Adjusted P value |
|---|---|---|---|
| Neutral (0) vs Extended (+ 1) | 2.50 | 0.13 to 4.87 | 0.0352 |
| Neutral (0) vs Flexed (-1) | 1.50 | -2.30 to 5.30 | 1.0000 |
| Flexed (-1) vs Extended (+ 1) | 1.00 | -3.01 to 5.01 | 1.0000 |

*Mean difference = mean patient satisfaction score for the first posture minus that for the second posture. Pairwise comparisons were Bonferroni-adjusted. The overall one-way ANOVA across the three knee posture groups was significant: $F(2, 200) = 3.32$, $P = 0.0383$. CI, confidence interval.

# Discussion

In this exploratory observational study, patients with a neutral knee posture immediately before the end of the consultation had higher satisfaction scores than those with an extended posture. No significant differences were observed for the other pairwise comparisons.

The mechanisms underlying the associations observed in this study are unclear. Roether et al. analysed average joint angles and joint motion trajectories during emotion-expressive walking and identified postural and movement characteristics associated with emotional expression and perception [9]. Larsen and Smith reported that a physician's forward lean and body orientation toward the patient were associated with high patient satisfaction, while a backward lean was associated with low satisfaction [6]. These findings did not indicate that the patient's own knee posture serves as an expression of satisfaction. Elvitigala et al. demonstrated the potential to distinguish between acute stress and relaxation states while seated by combining foot movements, plantar pressure, and posture-related characteristics [7]. However, acute stress and satisfaction with a medical consultation are distinct concepts; therefore, specific meanings cannot be assigned—such as anxiety, discomfort, or reassurance—to particular knee postures based on these findings. It is possible that physical discomfort, range of joint motion, habitual sitting postures, the relationship between the chair and the patient's physique, and movements associated with the conclusion of the examination may have contributed to this association. However, this study did not evaluate the psychological and physiological factors underlying the association between knee posture and patient satisfaction, and the mechanism by which this association arises remains unclear.

One strength of this study is its relatively larger sample size compared with previous studies. Second, the inclusion of patients who attended the clinic for treatment is another strength. This suggests that this study has high external validity. Third, video was recorded in full HD resolution, allowing for precise measurement of 30 frames per second, and posture was evaluated using footage recorded from

multiple angles. Fourth, patient satisfaction was assessed using a questionnaire with established validity and reliability [8].

The study also has limitations. First, patient satisfaction was measured only after the consultation. In the future, we plan to conduct studies at various points during the clinical visit. Second, knee angle measurements rely on an observer's visual assessment of the average posture of both knees over a 30-second period. Observer misclassification of knee posture is possible, and verifying the validity and reproducibility of the classification remains a challenge.

In the future, we anticipate the use of AI for objective measurement of knee joint angles. We also plan to increase the sample size to enhance the statistical power of our analyses.

# Conclusions

Patients with a neutral knee posture during the final 30 seconds of an outpatient consultation had higher post-consultation satisfaction scores than those with a relatively extended posture. These findings suggest an exploratory association between knee posture and patient satisfaction but do not establish causality. Further studies are needed to confirm the association and evaluate potential confounding factors.

# Abbreviations

ANOVA: Analysis of variance

CI: Confidence interval

SD: Standard deviation

TPSQ: Takemura Patient Satisfaction Questionnaire

# Declarations

***Ethics approval and consent to participate***

This study was approved by the Research Ethics Review Committee of Tokyo Women's Medical University (approval No. 2023-0116) and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients before enrolment and video recording.

***Consent for publication***

Not applicable.

### *Availability of data and materials*

The datasets generated and/or analysed during the current study are not publicly available and cannot be shared because external data sharing is not permitted under the ethical approval for this study. The data include video recordings of clinical encounters containing potentially identifiable participant information.

### *Competing interests*

The authors declare that they have no competing interests. Yousuke C. Takemura received no personal financial compensation from NEC Corporation in relation to this study.


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### *Authors' contributions*

YT contributed to the conceptualisation and design of the study, project administration, ethics application, data collection, formal analysis, interpretation of the results, drafting the manuscript, funding acquisition, and provision of research resources. MI contributed to data collection, formal analysis, interpretation of the results, and drafting the manuscript. Both authors critically revised the manuscript, approved the final version, and agree to be accountable for all aspects of the work.


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# Figures

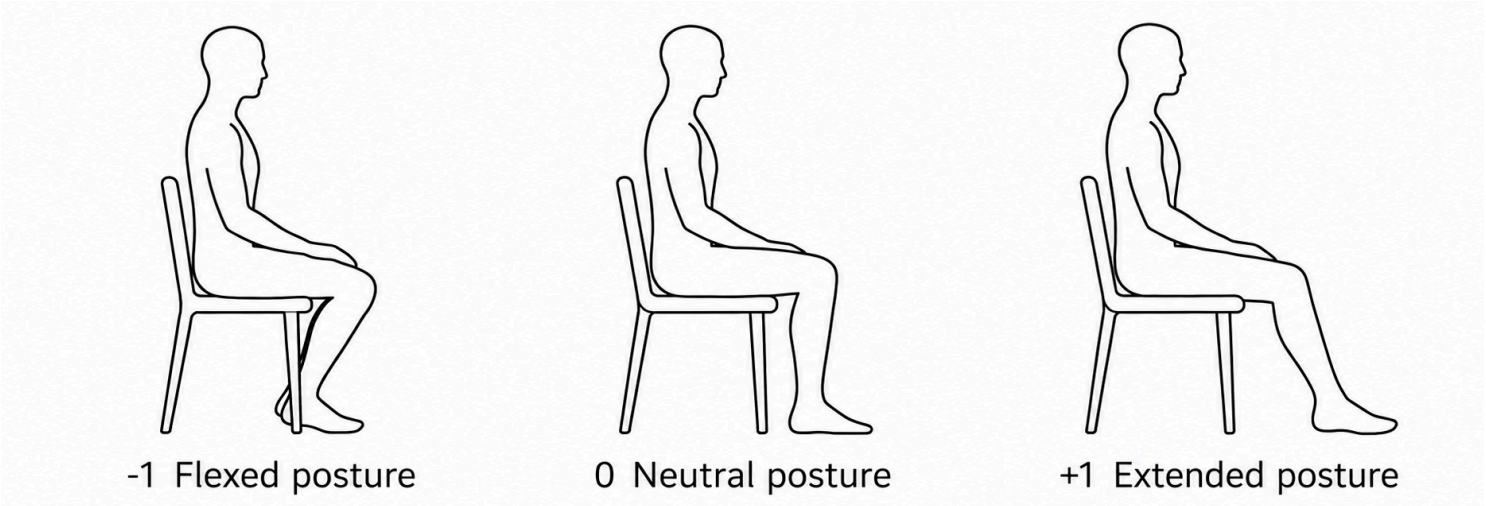



**Fig. 1 Knee posture categories used for visual assessment.**
Knee posture was classified as flexed (−1), neutral (0), or extended (+1) relative to an approximately right-angled knee position. The average posture of both knees during the final 30 seconds of the consultation was visually assessed by two researchers. Joint angles were not instrumentally measured.

**Figure 1**

See image above for figure legend.