Research Square

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Poor Postures in Nursing Students' Care Operations: A Field Study

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Abstract

Objective

To assess the occurrence of poor working postures in nursing students across five fundamental nursing procedures — urinary catheterization, oral care, bed bathing, cardiopulmonary resuscitation (CPR), and bed making — in order to provide evidence for mitigating ergonomic risks in clinical training.

Methods

A field observational study was conducted using the Ovako Working Posture Analysis System (OWAS) to classify and analyze the postures of 219 nursing students while they performed the five aforementioned nursing procedures.

Results

A total of 54658 valid images were extracted, of which 81.1% represented poor working postures. Bed making had the highest rate of poor postures (89.2%). The higher posture hazard scores were observed during the removal of the bedside table and chair and sweeping the bed (2.5 ± 0.1), airway opening (2.4 ± 0.2), and bed unit arrangement (2.4 ± 0.1).

Conclusions

Poor working postures are widely prevalent among nursing students during practical training. To reduce ergonomic risks, optimization of equipment height, introduction of ergonomic intervention tools, and reinforcement of posture safety education should be prioritized.

Introduction

Nursing work is characterized by high physical demands, repetitive tasks, and considerable occupational risks[1]. Nurses often spend long hours standing, bending, exposuring to non-neutral working postures and lifting within confined workspaces, which predisposes them to chronic musculoskeletal injuries [2]. Poor postures such as repeated deep bending, trunk twisting, and prolonged static postures have been identified as key contributors to muscle fatigue and pain [3, 4]. In particular, basic bedside nursing tasks such as catheterization, bed-making, and cardiopulmonary resuscitation often require nurses to adopt asymmetrical or dynamic weight-bearing postures[5].

A meta-analysis has reported that the prevalence of work-related musculoskeletal disorders (WMSDs) among nurses is as high as 77.2%, with low back pain (LBP) being the most common symptom [6]. However, due to limited experience, inadequate posture control, and low awareness of harmful postures,

nursing students are exposed to more severe ergonomic risks during skills training and clinical placements[7]. The prevalence of LBP among nursing students is notably high and shows a progressive increase with clinical training exposure, peaking in prevalence among new graduate nurses[7]. Evidence suggests that more than 70% of nursing students experience low back pain during practical training[8]. Work-related discomfort contributes to occupational fatigue, and together these factors can undermine the quality of nursing care and potentially jeopardize patient safety. Unlike clinical nurses with rich operational experience and standardized training, nursing students are in the initial stage of forming operational habits, with insufficient proficiency in standard postures and weak awareness of occupational health protection, making them more prone to developing persistent poor posture habits[9]. These not only affect the quality of skill acquisition but may also increase the risk of future occupational health problems[10]. Although numerous studies have evaluated the awkward postures of clinical nurses[11], research specifically focusing on nursing students' poor postures during care operations remains scarce. Therefore, this study employed field observation combined with a standardized work posture analysis system to systematically assess nursing students' postures across five common procedures. The aim was to identify suboptimal postures and quantify their frequency during different procedural steps, thereby providing evidence for ergonomic interventions and improvements in nursing practice.

Methods

Study design

This investigation employed a single-center field observational design.

Study setting and sample

Field observation was conducted at a private comprehensive vocational university in Hainan Province, China. The School of Nursing offers undergraduate and diploma programs in nursing and midwifery, and all students undergo standardized skills training in a dedicated clinical skills laboratory. The laboratory is equipped with hospital-standard beds, mannequins, and medical devices, providing a simulated ward environment for practice. Classes were selected using a random sampling method, and on-site observations were conducted at the class level. A total of five classes were included in the study.

Participants were second-year, full-time undergraduate nursing students enrolled in the "Basic Nursing Practice" course between September and December 2024. These students had completed theoretical instruction and were engaged in concentrated practical training, making their operational postures representative of nursing students in the practice phase. Inclusion criteria :1Full-time second-year undergraduate nursing students enrolled at the university and receiving standardized basic nursing training. 2Voluntary participation with signed informed consent for video recording; privacy protection measures (e.g., data anonymization, coded storage) were applied. 3Availability of continuous posture data during observation with no prolonged absence for personal reasons. Exclusion criteria: 1Students who had not passed the relevant skill assessments (to avoid observing postures attributable to

insufficient skill mastery). 2Students with major medical or motor impairments affecting posture (e.g., severe lumbar disc herniation, lower-limb motor disability) that could produce unrepresentative postures.

Previous studies have suggested that a minimum of 100 action images are required to achieve 95% reliability in OWAS analysis results[12]. Accordingly, at least 100 action images were collected for each procedure. In total, video recordings from 219 nursing students were analyzed.

Approval was obtained from the university academic administration and course instructors before data collection commenced. Prior to commencing on-site observations, researchers informed participants of the study's objectives, significance, observation procedures, and the respective rights and obligations of participants, ensuring voluntary and informed participation.

Data collection methods and instruments

Data were collected from September 2024 to January 2025, trained researchers entered classes to observe students' posture. Each student was observed multiple times. During this study the teaching schedule and equipment configuration remained stable, thereby minimizing potential confounding from equipment replacement or site relocation. High-definition video recordings of students' care procedures were captured using smartphone cameras with a lateral field of view. The recordings were processed into static frames using KINOVEA v0.8.24 at a sampling rate of one image per five seconds. These static images were subsequently analyzed using the Ovako Working Posture Analysis System (OWAS) to classify posture risk categories[13].

Based on findings from the preliminary interview component of the present study, students reported experiencing relatively higher levels of physical fatigue when performing five basic nursing procedures: urinary catheterization, oral care, bed bathing, cardiopulmonary resuscitation (CPR), and bed making. Although these interview results have not been formally published, they were used as an exploratory basis for selecting observation targets in the current field study. To facilitate data analysis, procedural steps for each operation were standardized according to "Fundamentals of Nursing (7th ed.)"[14] and are summarized in Table 1. With students' consent and safeguards for privacy, smartphone cameras recorded the procedures from fixed positions that captured lateral views to ensure unobstructed visualization of postures. During observation the fixed recording angles preserved visibility of the back, arms and legs to reduce measurement error.

Video recordings were processed into still images using the video screenshot function of KINOVEA (version 0.8.24), with frames extracted at 5-second intervals. This sampling frequency aligns with commonly accepted practices in ergonomic observational research, allowing an appropriate balance between representativeness and operational feasibility. All extracted images were securely stored on the lead researcher's password-protected computer.

Ovako Working Posture Analysis System (OWAS)[13]: An internationally recognized observational tool that classifies working postures by analyzing back, arm, leg positions and load status to generate a five-

digit code and one of four action-category grades (AC1–AC4). The action category classification criteria were defined as follows: action-category1 (AC1) – Normal posture requiring no corrective action; action-category2 (AC2) – Slight posture hazard warranting near-term ergonomic improvement; action-category3 (AC3) – Significant posture hazard requiring prompt corrective measures. action-category4 (AC4) – Severe posture hazard necessitating immediate ergonomic intervention.

Each student's recordings for a given procedure were organized in a dedicated folder. Two trained researchers independently applied OWAS to each static image, scoring back, arm, leg and load status to derive the five-digit OWAS code and corresponding AC grad. Discrepancies were resolved by joint review and discussion; when consensus could not be reached a third researcher adjudicated.

Two posture indicators were calculated from the final AC grades: the Rate of poor posture and the Posture hazard score.

Rate of poor postures (%)= (AC2 + AC3 + AC4 posture images / Total valid images) × 100%.

Posture hazard score=Sum of numeric AC values for all images / Total valid images. Mean numerical OWAS grade, where AC1=1, AC2=2, AC3=3 and AC4=4: . These indicators were calculated per procedure and per procedural time point to quantify the distribution and severity of suboptimal postures during students' practical training.

Quality control

Two analysts completed standardized OWAS training. In order to ensure the consistency of the score, two people will jointly watch and discuss the conflicting images and reach an agreement on the final result. If necessary, a third party can be invited to participate in the discussion to ensure the objectivity of the judgment. A two-stage quality check removed images with blur, missing body parts, or exposure problems. Remaining images were cross-checked against original video segments to confirm temporal and situational accuracy.

Statistical analysis

Statistical analyses were conducted using SPSS 26.0 and R. The Shapiro–Wilk test was applied to assess data normality. Normally distributed variables were expressed as mean ± SD, and categorical variables as frequencies (%). The chi-square test was used to compare the incidence of non-ergonomic working postures across different nursing tasks. To evaluate the temporal changes in posture hazard scores, a multivariate Hotelling's T^2 test based on a general linear model was employed. Hotelling's T^2 and corresponding F statistics were calculated, followed by univariate within-subject tests to confirm time effects. Trends in score changes were further analyzed to identify the curve pattern. Statistical significance was set at $P < 0.05$.

Results

Researchers conducted four months of field observations, involving 219 nursing students performing clinical procedures. A total of 74 hours of video recordings were collected.

The training room (113.6 m²) was designed to simulate a clinical ward and to provide a realistic environment for students to practice basic nursing procedures. The facility contained 12 hand-cranked hospital beds spaced 1.2–1.5 m apart; each bed occupied approximately 1.84 m². Supporting equipment dimensions were fixed and representative of clinical settings: bed height 56 cm; bedside cabinet height 72.5 cm; infusion stand adjustable between 147.5 and 185.5 cm; treatment cart 80.5 cm high and 75–86 cm in both length and width; chair height 41 cm. These standardized parameters ensured that students' working postures during training were comparable to those in routine clinical practice(Fig. 1a-b).

Prevalence of adverse working postures

A total of 54,658 postures were observed, among which 81.1% were classified as adverse working postures. Specifically, 98 posture images (0.2%) were identified as AC4, 8638 posture images (15.8%) as AC3, and 35594 posture images (65.1%) as AC2. Among the five nursing tasks, the highest proportion of adverse postures occurred during bed making (89.2%), followed by CPR (89.1%) and urinary catheterization (83.7%). The difference among tasks was statistically significant ($\chi^2 = 1{,}233.8973$, $P < 0.005$). Details are presented in Table 2 and Fig. 3.

Field observations indicated that nursing students frequently assumed high physical load postures—such as forward bending, trunk twisting, and squatting—while performing basic nursing tasks. During checking patient information (e.g., verifying wristbands and bed numbers), students maintained a posture characterized by flexed knees and an approximately 50° forward trunk inclination for about 6 seconds (Fig. 2a). When communicating with patients, such as conducting condition assessments, students frequently adopted a combined posture involving approximately 15° of left trunk rotation and 30° of forward trunk inclination; the duration of this posture varied, with the longest continuous maintenance reaching 1 minute and 2 seconds (Fig. 2b). During bed bathing, students sustained a forward trunk inclination of around 25° throughout the procedure, which lasted 25 minutes and 23 seconds (Fig. 2c). Notably, when cleaning patients' backs, this posture intensified to an estimated 45° forward trunk inclination, often accompanied by unilateral knee flexion and load bearing (Fig. 2f). In handling the urinary catheter drainage bag, including fixation and volume checking, posture patterns differed between individuals, with one student adopting a squatting posture (Fig. 2d) and another bending forward at approximately 60° (Fig. 2e). Clinical posture of subjects during nursing operation. Photographed by the authors. Written informed consent for publication of this image was obtained from the subjects.

Posture hazard scores

Analysis of posture hazard scores showed that the highest mean score was observed during bed making at Time Point 2, corresponding to the removal of the bedside table and chair and sweeping the bed (2.5 ± 0.1). This was followed by Time Point 3 during CPR, particularly during airway opening (2.4 ± 0.2), and

Time Point 6 during bed making, when arranging the bed unit (2.4 ± 0.1). Detailed posture hazard scores across procedures and time points are presented in Table 2.

Comparison of Working Posture Hazard Scores Across Sequential Operational Stages

Multivariate analysis using Hotelling's T^2 test demonstrated statistically significant overall differences in posture hazard scores across time points for each nursing procedure ($P < 0.05$), and the temporal trends are illustrated in Fig. 4.

Discussion

Through a four-month field observation, this study identified that among five routine nursing procedures —urinary catheterization, oral care, bed bathing, CPR, and bed making—the proportion of images showing adverse postures reached 81.1%. Specifically, 15.8% of postures were classified as AC3, requiring prompt correction, and 0.2% were AC4, demanding immediate improvement. These findings highlight that poor postures are widespread in current nursing education and represent a potential threat to the physical health and learning efficiency of nursing students.

Further analysis revealed that bed making exhibited the highest proportion of poor postures (89.2%), followed closely by CPR, (89.1%) and urinary catheterization (83.7%). From an ergonomic perspective, these tasks share several critical risk characteristics, including prolonged forward trunk flexion, frequent trunk rotation, weight-bearing demands, and asymmetric postures. Together, these factors expose nursing students to combined static, repetitive, and asymmetric mechanical loads. In forward-bent postures, trunk flexion increases the external moment arm acting on the lumbar spine, thereby requiring substantially greater force generation by the erector spinae muscles to maintain postural equilibrium. Biomechanical studies have demonstrated that both intradiscal pressure and paraspinal muscle activation increase progressively with greater forward bending angles, indicating elevated lumbar loading even in the absence of external weight[15]. Such cumulative loading contributes to fatigue of the lumbar extensor muscles and may accelerate tissue creep and passive structure deformation if sustained over time[16]. The emergency nature of CPR further compounds these biomechanical demands. High-frequency chest compressions (100–120 compressions per minute for durations exceeding five minutes) require repetitive force application under time pressure, often accompanied by sustained trunk flexion and static contraction of the upper limb and trunk muscles. Similarly, urinary catheterization involved notable postural hazards during disinfection and fixation steps. Video-based observation revealed that mismatches between bed height and operator stature frequently resulted in trunk flexion angles exceeding 45° while securing the catheter and urine collection bag. During the second disinfection step, the non-dominant hand often remained in a fixed position to prevent recontamination and prepare for catheter insertion; this prolonged static holding further increased localized muscular load. In the present study, the fixed bed height (56 cm) combined with limited bedside workspace compelled students to maintain awkward postures for extended periods, thereby exacerbating trunk strain and cumulative fatigue.

Consistent with these findings, previous research using posture analysis systems has shown that nurses spend significantly more time in forward-bent postures when beds are set below optimal working height, whereas height-adjustable beds facilitate a more upright trunk posture and shift exposure away from hazardous spinal positions toward neutral alignment[17, 18]. Moreover, adjustable patient beds have been demonstrated to reduce time-integrated spinal compression and shear forces during patient handling, even under dynamic conditions, compared with fixed-height beds[19]. Collectively, these findings underscore the critical role of ergonomic bed design—particularly height adjustability—in mitigating excessive forward flexion and lumbar loading, and highlight the necessity of implementing adjustable hospital beds to reduce musculoskeletal risk in clinical nursing practice.

Hospitalised patients, particularly those who are bedridden and unable to maintain personal hygiene independently, often require nursing assistance with bed bathing to meet basic hygiene needs and preserve personal dignity[20, 21]. Bed bathing is among the most time-consuming nursing care activities and typically requires caregivers to maintain prolonged static, forward-inclined trunk postures while supporting, washing, and repositioning patients[22]. During these tasks, trunk flexion is frequently sustained beyond 20–30° for several minutes, substantially increasing compressive and shear forces acting on the lumbar spine and necessitating continuous activation of the erector spinae and abdominal stabilising muscles, thereby accelerating the onset of muscular fatigue. Moreover, static postures maintained without dynamic movement—such as holding a patient's limb in position, stabilising the patient's trunk to prevent slipping, or leaning over the bed to provide assistance—have been widely recognised as significant ergonomic risk factors for work-related musculoskeletal disorders in nursing practice. Ergonomic exposure assessments consistently indicate that healthcare workers experience high levels of physical load during patient handling and movement tasks, including activities comparable to bed bathing, underscoring the necessity for ergonomic interventions and assistive equipment to mitigate cumulative musculoskeletal loading[23].

Bed making involves repeated deep trunk flexion, torso rotation, and frequent elevation and extension of the upper limbs to reach, lift, and spread bed linens, collectively generating substantial mechanical loads on the lumbar spine and shoulder girdle[4]. Key subtasks—including lifting the mattress to insert sheets, tossing and shaking bulky duvets, and smoothing heavy bedding layers—require sustained activation of trunk and upper-limb musculature to control large, resistant loads, particularly when bed height and workspace are not adjusted to the caregiver's anthropometry. The combination of repetitive, forceful upper-body exertions with prolonged trunk flexion and asymmetric postures markedly increases spinal loading and shoulder demand, thereby predisposing caregivers to muscular fatigue, cumulative tissue loading, and long-term musculoskeletal strain[24]. Previous postural analyses have identified bed making and other basic nursing care tasks as among the most ergonomically hazardous activities, with a high percentage of observations involving pronounced trunk inclinations (> 60°), which are strong predictors of low back discomfort and cumulative load exposure[4].

Limitations and Future Directions

This field observational study offers several strengths. First, it adopts a direct observational approach in real clinical practice rather than relying solely on self-reported data, which helps to minimize recall bias and provides objective insights into actual working postures among nursing students. Second, the use of validated ergonomic assessment tools such as OWAS enables systematic and quantifiable evaluation of postural risks across multiple basic nursing tasks. Additionally, the random selection of classroom groups as sampling units enhances internal validity and reduces selection bias, while field data collection in authentic care settings increases ecological validity and the relevance of findings to real-world nursing workflows. The study also contributes to a relatively under-researched area—postural hazards in nursing students during routine care operations—which has implications for both occupational health and nursing education curriculum design.

However, several limitations should be acknowledged. The single-center design limits the generalizability of results to broader educational and clinical contexts; multicenter studies across diverse colleges and levels would be beneficial in future research. The cross-sectional nature of the observations precludes causal inferences about the development of musculoskeletal symptoms over time. Although ergonomic tools like OWAS provide robust postural classification, they do not directly measure muscle activity or spinal load, which could be further elucidated using electromyography or motion capture technologies in future work. Moreover, while observer training and standardized procedures were employed, field observations are still subject to inter-observer variability. Finally, the study did not incorporate participants' subjective perceptions of discomfort or fatigue, which may complement objective posture assessments and provide richer insights into the relationship between observed postures and musculoskeletal symptomatology. These limitations should be considered when interpreting the findings and designing follow-up studies.

Conclusions

This field-based study demonstrated that adverse working postures are highly prevalent among nursing students during fundamental clinical care activities and identified specific high-risk ergonomic exposures within five common nursing procedures. Notably, bed making, cardiopulmonary resuscitation, and urinary catheterization exhibited particularly elevated postural hazard scores, with the removal of the bedside table and chair, airway opening during CPR, and bed unit arrangement during bed making registering the highest posture hazard scores. These findings suggest that integrating ergonomic principles into nursing training — including optimizing equipment height, incorporating wearable posture-monitoring and assistive devices, refining procedural techniques, and enhancing team-based approaches — should be prioritized to mitigate biomechanical stress. In addition, nurse educators should strengthen students' competencies in posture assessment and ergonomic risk recognition during clinical training to reduce the likelihood of occupational injury at its source.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of The Fourth People's Hospital of Haikou City (Approval No.202415, Date:2024-10-10). Written informed consent was obtained from all participants prior to the observations. All video data were anonymized and stored on a password-protected server accessible only to the research team.

Consent for publication

All participants were informed about the purpose and procedures of the study prior to participation. The authors confirm that all identifiable individuals have provided consent for publication of anonymized data and figures, in accordance with institutional ethical requirements.

Availability of data and materials

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

Competing interests

The authors declare no competing interests.

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Authors' contributions

Tianqiao ZHANG: Conceptualized and designed the study; supervised field observation and data acquisition; contributed substantially to data interpretation and manuscript revision.

Ning WEI: Assisted in data visualization and validation; contributed to manuscript editing and language polishing; approved the final version.

Yahui ZOU: Collected and organized observation data; performed statistical analysis; drafted the first version of the manuscript.

Xiuying GUO: Contributed to the design of the observation framework; participated in OWAS posture classification and data verification; provided critical revisions for intellectual content.

Zhaoxia CHENG*: Provided overall project supervision and methodological guidance; critically revised and approved the final version; responsible for the integrity and accuracy of the study as the corresponding author.

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Tables

Tables 1 and 2 are available in the Supplementary Files section.

Figures



（a）　　（b）

Figure 1

Operating Environments of Nursing Students

Two representative operating environments for nursing students during clinical practice, as shown in panels (a) and (b).

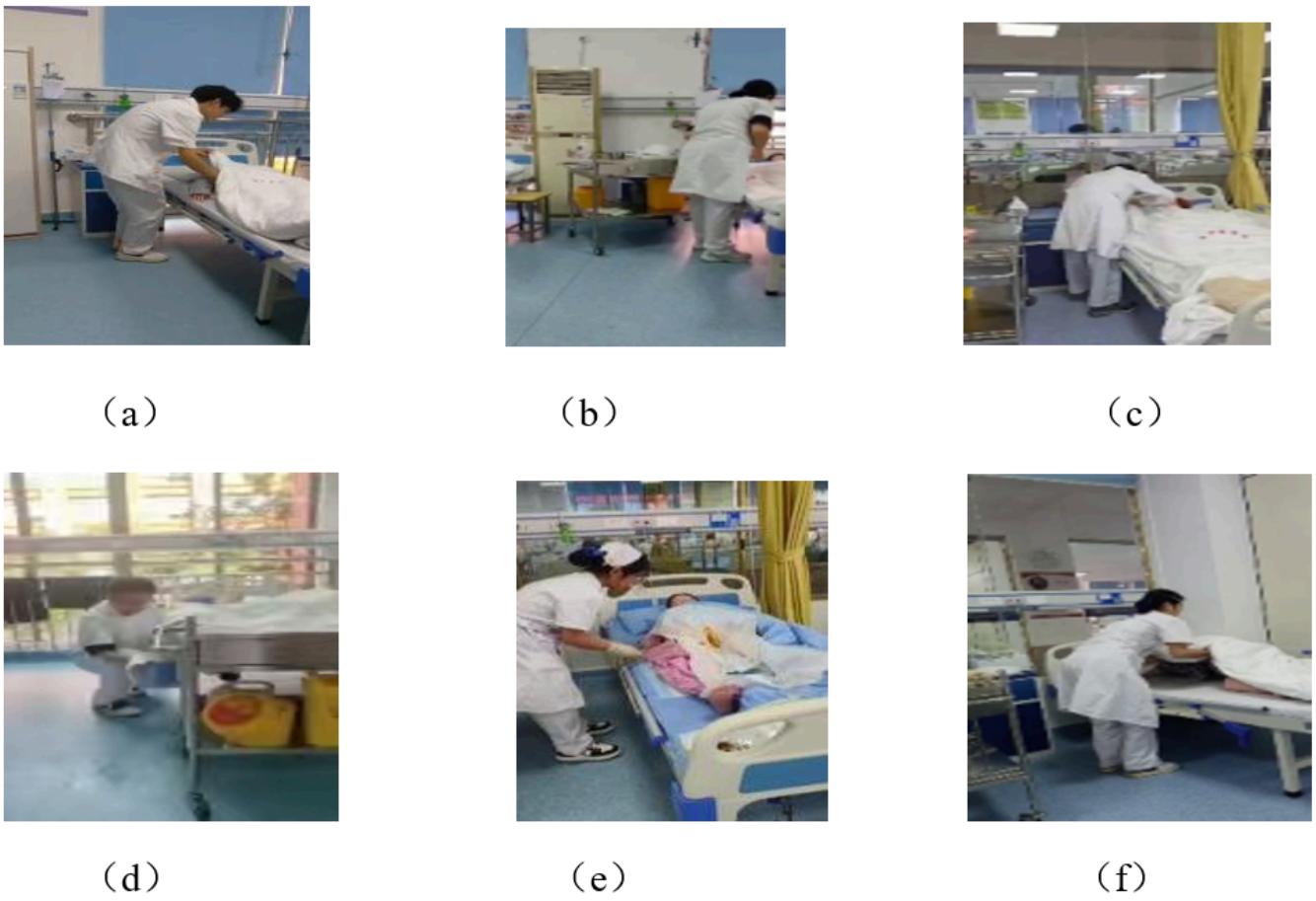


Figure 2

On-site Observation Examples of Nursing Students' Operating Postures

Six typical examples of nursing students' operational postures captured during on-site observation, corresponding to panels (a) to (f), covering common practice scenarios.

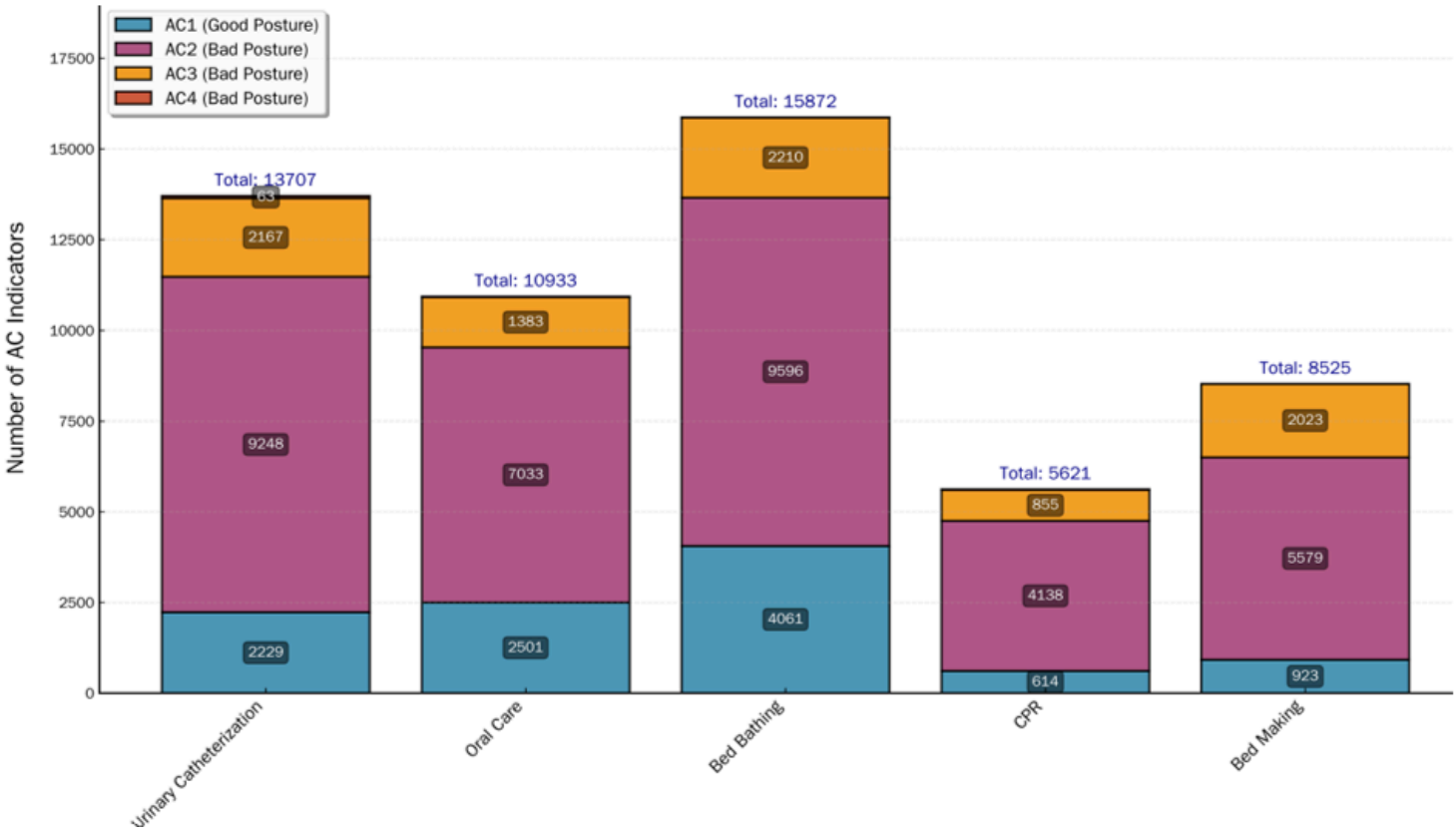


Figure 3

Composition of Poor Postures Across Different Nursing Operations

Distribution of posture indicators (AC1 to AC4) across five nursing operations (Oral Care, Bed Bathing, CPR, Bed Making, and Urinary Catheterization). AC1 represents good posture, while AC2, AC3, and AC4 represent poor postures; the total number of observations for each operation is labeled respectively.

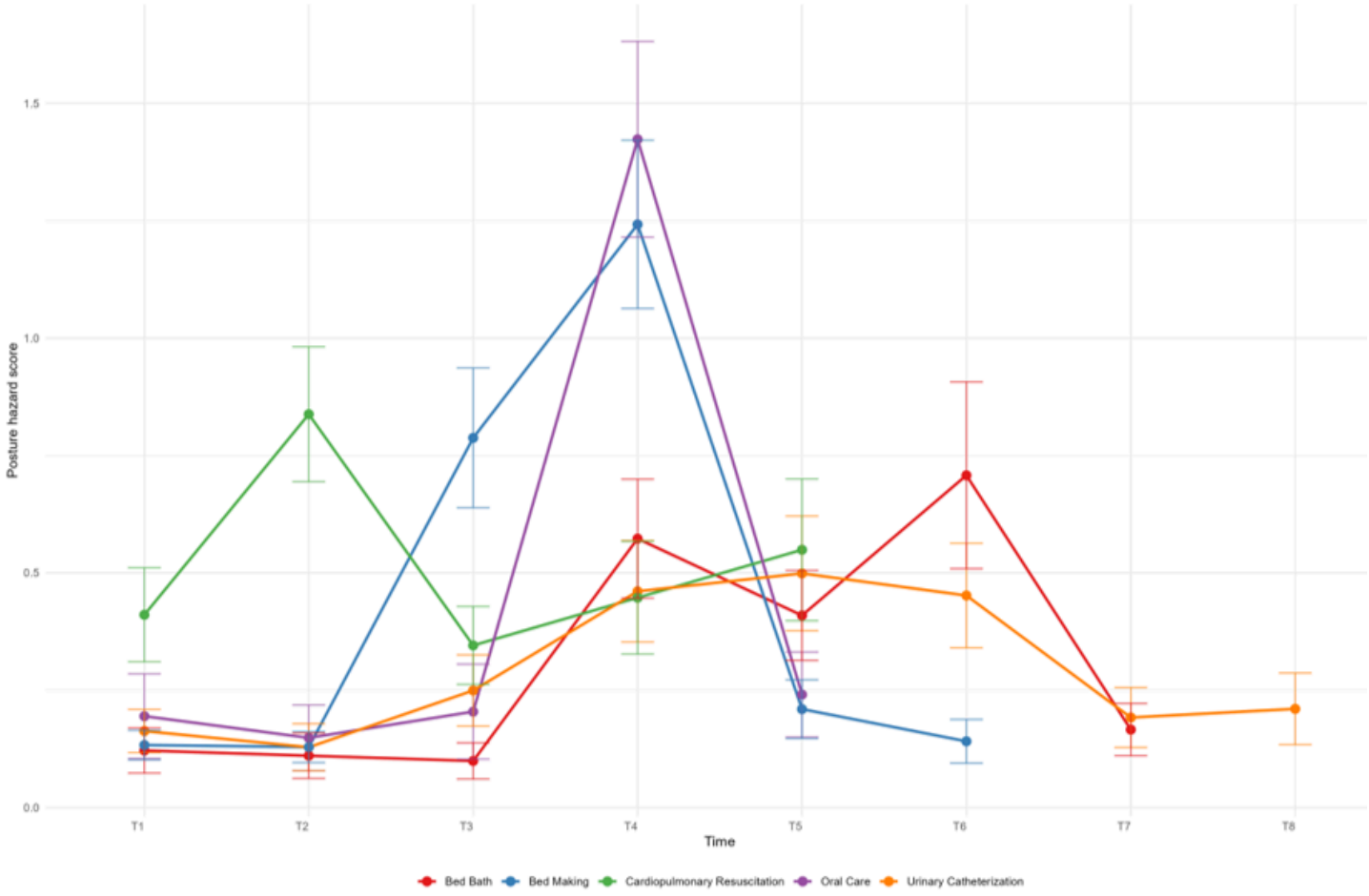


Figure 4

Temporal Trends and Comparison of Working Posture Hazard Scores Across Operational Time Points

Temporal variation trends of working posture hazard scores and comparative analysis among different operational time points, reflecting the dynamic changes in posture-related risks during nursing practice.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1NursingOperationTimePointsDivision.docx
- Table2PostureRiskAnalysisofNursingProcedures.docx