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PosTer: A Smart Lumbar Posture Correction Vest Using a Fully Connected Neural Network Algorithm

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ABSTRACT

Maintaining proper lumbar posture is important for preventing musculoskeletal disorders among sedentary individuals, yet conventional interventions such as exercise and physical therapy are often impractical for sustained daily use, and existing wearable posture aids remain limited in sensor integration, adaptability, and real-time intelligence. This study developed and evaluated PosTer, a smart lumbar posture correction vest that combines Inertial Measurement Unit (IMU) and flex sensors with an ESP32-based web interface and a Fully Connected Neural Network (FCNN) for real-time posture classification, providing visual, auditory, and automatic corrective feedback. A quantitative developmental design was used; the system was tested by 126 purposively selected office-based employees of a Business Process Outsourcing (BPO) company in Calamba City, Philippines, representing individuals in low-intensity, sedentary work. Sensor readings and an ISO/IEC 25010-based survey were used to evaluate classification performance and system quality. The FCNN achieved 99.43% accuracy with precision, recall, and F1-score of 0.985, outperforming Logistic Regression (93.40% accuracy) and Support Vector Machine (99.33% accuracy). ISO/IEC 25010 evaluation showed strong mean ratings for functional suitability (3.84), performance efficiency (3.91), usability (3.83), reliability (3.68), and safety (3.80). Participants reported that the web interface was clear and that the vest responded promptly to posture deviations. These findings indicate that PosTer is an effective assistive tool for real-time lumbar posture monitoring and correction in short-term, non-clinical, sedentary settings, although its restricted vest sizing and dependence on correct sensor placement limit its suitability for long-term or clinical therapeutic use. The study provides a foundation for further work on sensor adaptability, extended-use evaluation, and mobile-based posture analytics.

Keywords: *Lumbar Posture Correction, Smart Vest, Wearable Sensors, Fully Connected Neural Network, ISO/IEC 25010, Ergonomics*

INTRODUCTION

Musculoskeletal disorders remain among the most common health burdens associated with modern sedentary lifestyles. Worldwide, an estimated 1.71 billion people live with a musculoskeletal condition, and low back pain alone accounts for approximately 570 million cases and 7.4% of all years lived with disability (World Health Organization, 2023). Prolonged use of digital devices and extended sitting, particularly under work-from-home and remote-learning arrangements, have been strongly associated with musculoskeletal discomfort in the neck, shoulders, and lower back, with corresponding effects on productivity and quality of life (Susilowati et al., 2022).

These concerns are especially relevant in Calamba City, Laguna, where a growing share of the workforce is engaged in office-based and Business Process Outsourcing (BPO) work that requires extended, desk-oriented sitting, supported by the region's rising rate of office-based employment (National Economic and Development Authority Regional Office IV-A, 2023). Conventional posture aids such as ergonomic chairs, lumbar supports, and wearable belts offer only passive assistance, while mobile posture applications typically rely on smartphone accelerometers that cannot reliably track lumbar-specific alignment. These gaps point to the need for a sensor-based system, supported by machine learning, that can monitor and correct lumbar posture in real time.

Prior work on wearable posture technologies indicates that such systems are promising but remain limited in sensor integration, adaptability, and comfort for everyday workplace use (Figueira et al., 2024). Studies on posture variability, sedentary risk, and single-sensor wearables have each been examined extensively, yet few have combined multi-sensor monitoring with deep-learning-based classification and real-time feedback specifically for the lumbar region in non-clinical, sedentary populations. This gap motivated the development of PosTer, a smart lumbar posture correction vest that integrates wearable sensors, embedded processing, and a Fully Connected Neural Network (FCNN) to detect and correct improper lumbar posture.

This paper presents the design, development, and evaluation of PosTer. It first reviews the literature on posture monitoring and correction technologies, then describes the system's theoretical basis, methodology, and implementation, followed by the results of sensor-based

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trials, algorithm comparison, and ISO/IEC 25010-based user evaluation, and closes with conclusions and recommendations for future development.

Statement of the Problem

This study examined whether a smart lumbar posture correction vest could serve as an effective preventive and assistive tool for posture monitoring and correction among sedentary individuals in low-intensity, office-based settings. Specifically, it sought to answer the following questions:

1. Can a smart lumbar posture corrector vest equipped with IMU, flex, and actuator components monitor and analyze lumbar posture in real time?

2. How effective and responsive is the vest in detecting and correcting improper lumbar posture during use?

3. Is the Fully Connected Neural Network the most suitable algorithm for classifying posture data when compared with Logistic Regression and Support Vector Machine models in terms of accuracy, precision, recall, and F1-score?

4. Does the developed system meet ISO/IEC 25010 standards for functional suitability, performance efficiency, usability, reliability, and safety?

Scope and Delimitations

This study focused on the design, development, and evaluation of a smart lumbar posture correction vest for low-intensity, sedentary environments, particularly office-based and BPO settings. The system's scope was confined to the lumbar region, and its performance depended on proper sensor placement and correct vest fitting; consistent with Department of Health and Food and Nutrition Research Institute guidance on healthy abdominal girth, the vest was sized for waist circumferences generally below 35 inches for women and 40 inches for men. Evaluation centered on algorithmic accuracy, precision, recall, and F1-score, and on ISO/IEC 25010 quality dimensions, namely functional suitability, performance efficiency, usability, reliability, and safety.

The vest integrated IMU, flex, and linear-actuator components; an electromyography (EMG) sensor was initially incorporated into the system design, but because surface EMG is known to be affected by motion artifacts, electrode displacement, and signal interference (Al-Ayyad et al., 2023), its readings were excluded from the final posture-classification model, which relied on IMU and flex-sensor data. The current prototype is not intended for long-term or clinical use, for pregnant users, for individuals recovering from recent back surgery, or for those with scoliosis or other orthopedic conditions, and a maximum session length of two hours was recommended to prevent user over-reliance on the device. PosTer is therefore best characterized as a preventive and assistive posture aid rather than a substitute for medical therapy.

REVIEW OF RELATED LITERATURE

Posture is increasingly understood as a dynamic, functional aspect of human movement rather than a fixed ideal, with postural variability associated with better spinal health, while prolonged static positions are more strongly linked to musculoskeletal discomfort than any single posture pattern (Swain et al., 2021). Sedentary behavior among office workers and students has been associated with a higher prevalence of back pain and musculoskeletal disorders, a trend that intensified during the shift to remote work and online learning brought on by the COVID-19 pandemic (Espinola et al., 2022; Gruman, 2020; Lazarus et al., 2022; Susilowati et al., 2022). Ergonomic studies of cashiers and high-risk industrial settings further show that workstation layout, repetitive movement, and sustained static postures elevate musculoskeletal risk, underscoring the need for both environmental and behavioral interventions (Aquino et al., 2022; IEOM Society Conference, 2021).

Targeted exercise programs and physical therapy, including proprioceptive neuromuscular facilitation, have been shown to improve spinal alignment and reduce discomfort (Han et al., 2021; Maher et al., 2020), and coaching-based mobile interventions have likewise supported posture awareness among older adults (Dino et al., 2024). However, these approaches require consistent supervision and adherence that are often impractical for sedentary working populations, which has driven interest in wearable alternatives capable of providing feedback during ordinary daily activity (Girgin et al., 2021; Van et al., 2022).

Wearable posture-monitoring technologies have emerged as practical, real-time alternatives to supervised interventions (Figueira et al., 2024; Lee & Park, 2020). Inertial Measurement Unit (IMU)-based systems have demonstrated the ability to track spinal orientation and detect deviations as they occur (Kirubakaran, 2020), and smart-vest prototypes using embedded sensors and actuators have shown the feasibility of real-time posture feedback, although most have been evaluated without control groups or across only limited user

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populations (Chen & Wu, 2022; Garcia & Lee, 2022; Smith et al., 2023). Multi-sensor systems that combine IMU with electromyography can improve detection robustness (Al-Ayyad et al., 2023; Prakash, 2023), but surface EMG in particular remains constrained by motion artifacts, electrode displacement, and signal interference that reduce its reliability outside clinical settings (Al-Ayyad et al., 2023). Related work on wearable postural-control systems for low-back-pain therapy (L. Wang et al., 2021) and camera-based posture notification systems (Johnson et al., 2020) further illustrates both the promise and the practical limitations—such as susceptibility to distortion and reduced privacy—of existing approaches.

Machine learning and deep learning have been widely applied to posture and movement classification. Camera-based approaches using pose-estimation frameworks such as OpenPose achieve strong accuracy but raise privacy, environmental, and computational concerns that limit their suitability for continuous, everyday wearable use (Gupta & Singh, 2023; S. Lee et al., 2022; Patel & Shah, 2021). In contrast, sensor-driven neural networks, including fully connected and convolutional architectures, can process complex, non-linear multidimensional sensor data while remaining portable and computationally efficient, and have been applied successfully to postural classification, medical image analysis, and related sensor-based recognition tasks (Chen & Zhou, 2023; Hajian & Morin, 2020; J. Lee & Kim, 2022; X. Wang & Chen, 2021; Zhang et al., 2019; Zhang et al., 2020). Baseline linear classifiers such as logistic regression and margin-based methods such as the support vector machine remain useful comparison points because of their interpretability and robustness in moderate-dimensional feature spaces (Hosmer et al., 2013; Vapnik, 2000), and comparative studies confirm that deep-learning approaches generally outperform these traditional classifiers in sensor-based human-activity and posture recognition (Luna-Perejón et al., 2021; Zhao et al., 2020).

Taken together, the literature shows that posture variability, sedentary risk, wearable sensing, and algorithmic classification have each been studied extensively in isolation, but few systems combine multi-sensor lumbar monitoring with deep-learning-based classification and real-time, non-intrusive feedback for non-clinical, sedentary users (Chen & Wu, 2022; Chen & Zhou, 2023; J. Lee & Kim, 2022; Smith et al., 2023; X. Wang & Chen, 2021). Existing solutions tend to be either clinical in scope, focused on upper-limb or gait motion, or lacking real-time corrective capability. This gap motivates the present study's development of PosTer, an integrated, lumbar-specific posture correction vest intended to provide immediate feedback and support ergonomic awareness among sedentary users.

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THEORETICAL FRAMEWORK

PosTer is grounded in biomechanics and Postural Control Theory. Biomechanics explains that proper lumbar alignment distributes mechanical stress evenly across the body, whereas poor posture—especially during prolonged sitting—places excessive strain on the spine, muscles, and ligaments and can lead to chronic discomfort and postural imbalance. Postural Control Theory further explains that the body maintains stability through sensory input from proprioceptors, vision, and the vestibular system; when posture becomes improper, the neuromuscular system attempts to compensate, but sustained misalignment gradually reduces the body's own capacity to self-correct. Together, these perspectives justify the use of an external, intelligent system that monitors posture continuously and delivers real-time corrective feedback, which is the design premise underlying PosTer.

CONCEPTUAL FRAMEWORK

The system follows an Input-Process-Output (IPO) model. Inputs consist of sensory data from the IMU and flex sensor, capturing body orientation, bending, and deviations from a neutral lumbar position. In the process stage, the ESP32 microcontroller relays this data to the Fully Connected Neural Network, which classifies the posture as correct or improper. Outputs consist of measurable postural outcomes—improved alignment and reduced deviation—achieved through visual feedback on a web dashboard, auditory alerts from a buzzer, and gentle mechanical correction from a linear actuator.

METHODOLOGY

Research Design

This study employed a quantitative developmental research design. The quantitative component supported the statistical analysis of sensor readings, algorithm performance metrics, and user-evaluation results, while the developmental component guided the iterative design, construction, and refinement of the wearable prototype and its embedded posture-classification model until target performance and software-quality benchmarks were achieved.

Research Steps

Development proceeded through an Agile process comprising preliminary preparation, expert consultation and instrument validation, prototype construction, system and user testing, and data analysis. During planning, requirements for sensor integration, the classification

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algorithm, and the user interface were defined; during development, the FCNN was implemented, sensor inputs were integrated, and the real-time feedback mechanism was established. During testing, the prototype was evaluated with selected employees of the partner BPO company, and feedback from users and consulted professionals—including a physical therapist and electrical engineers—was incorporated into successive refinements until the system met its targeted posture-detection and ISO/IEC 25010 quality benchmarks.

Data Collection and Sample Selection

The study population consisted of 385 office-based employees of a BPO company's Calamba branch, representative of sedentary, desk-oriented work. From this population, 126 participants were selected through purposive sampling because they were routinely exposed to prolonged sitting and therefore vulnerable to poor lumbar posture. Data were gathered through interviews with office workers and consulted professionals, prototype and sensor testing, and a structured, expert-validated survey questionnaire aligned with the ISO/IEC 25010 quality dimensions; post-testing interviews supplemented the closed-ended survey with qualitative user feedback.

Table 1
Hardware Components and Specifications

Component	Description	Specification
ESP32 Microcontroller	Central controller managing sensor data and system operations	Single/dual-core 32-bit LX6, up to 240 MHz
IMU Sensor Module	Detects body tilt, angular motion, and orientation	3.3 V, I²C; accelerometer, gyroscope, magnetometer
Flex Sensor	Detects lumbar bending to identify poor posture	Resistive sensor, 10– 30 kΩ range
Linear Actuator	Provides gentle corrective movement	12 V DC, adjustable stroke, low noise
OLED Display	Shows real-time posture status	128×64 px, I²C, 3.3 V
Buzzer	Provides audible alerts	Sound/haptic feedback on poor-posture detection
Web Dashboard	Remote monitoring and manual control via Wi-Fi	802.11 b/g/n, local IP access

Data Analysis Methods

Survey responses were interpreted using a four-point Likert scale (Strongly Agree = 3.26–4.00, Agree = 2.51–3.25, Disagree = 1.76–2.50, Strongly Disagree = 1.00–1.75), with the mean used as the primary measure of central tendency and the standard deviation used to assess consistency of responses. Classification performance of the trained models was evaluated using accuracy (the proportion of correct predictions among all cases), precision (the proportion of

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predicted bad-posture cases that were true bad-posture cases), recall (the proportion of actual bad-posture cases correctly identified), and the F1-score (the harmonic mean of precision and recall). Sensor data were derived from IMU angular readings and flex-sensor bending values, standardized using a StandardScaler prior to training.

Algorithm Application

Three machine-learning algorithms were trained and compared on the same posture dataset. Logistic Regression served as an interpretable linear baseline (Hosmer et al., 2013), and the Support Vector Machine (SVM) was included as a robust, margin-based classifier suited to moderate-dimensional sensor data (Vapnik, 2000). The Fully Connected Neural Network (FCNN), implemented under a deep neural network framework using TensorFlow Lite for Microcontrollers, was expected to better capture the non-linear relationships in the IMU and flex-sensor data and was ultimately deployed on the ESP32 for real-time classification.

Research Validation

In the absence of formal null hypotheses, the study's four objectives were treated as working propositions to be validated empirically: that the vest could monitor and analyze lumbar posture in real time; that it could effectively and responsively detect and correct improper posture; that the FCNN would outperform Logistic Regression and Support Vector Machine classifiers; and that the system would meet ISO/IEC 25010 quality benchmarks. These propositions were tested through sensor trials, comparative algorithm evaluation, and the ISO/IEC 25010 user survey.

Study Limitations and Ethical Considerations

The study was limited to lumbar posture monitoring in low-intensity, sedentary conditions and depended on correct vest fit and sensor placement; it was not designed for long-term, clinical, or high-intensity use, and excluded pregnant participants, individuals recovering from recent back surgery, and those with scoliosis or other orthopedic conditions. Surface EMG readings were found to be of limited value because of motion artifacts, electrode displacement, and signal interference, and IMU readings occasionally fluctuated during rapid micro-movements, indicating a need for stronger signal filtering in future versions. Ethical safeguards included informed consent, voluntary participation with the freedom to withdraw at any time,

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exclusion of at-risk individuals, anonymization of collected data, and the use of gentle, non-intrusive feedback mechanisms throughout testing.

RESULTS AND DISCUSSION

PosTer was successfully developed as a wearable system providing real-time visual, auditory, and automatic corrective feedback for lumbar posture. As shown in Table 2, users rated the clarity of posture display, the accuracy of posture readings, and the responsiveness of the beep alert and auto-adjustment features highly, with item means ranging from 3.77 to 3.90 (Strongly Agree), indicating strong acceptance of the device's monitoring and feedback functions.

Table 2
User Perception on Sensor Integration and Feedback Clarity

Statement	Mean	Interpretation
Web interface clearly shows whether posture is correct	3.80	Strongly Agree
Feedback displayed is clear and easy to understand	3.90	Strongly Agree
Posture readings match actual body position	3.87	Strongly Agree
Beep alert sounds immediately when slouching	3.77	Strongly Agree
Auto-adjustment helps align posture correctly	3.90	Strongly Agree

In a supplementary sensor trial, five participants of varying body sizes maintained a neutral sitting posture while IMU and flex-sensor readings were recorded (Table 3). Although IMU angular readings varied across participants because of differences in spinal curvature, pelvic tilt, and torso proportion, flex-sensor readings remained within a consistent moderate range (54–74), and all participants were correctly classified as maintaining good posture. This confirms that relying on IMU data alone could produce misleading classifications, whereas combining IMU and flex-sensor readings—requiring both angular deviation and actual lumbar bending before flagging poor posture—reduced the risk of false corrections and made the system more robust to natural postural variation.

Table 3
Posture Detection Trial for Five Participants

Participant	Size	IMU Range (°)	Flex Range	Classification
Person 1 (M)	Large	-8 to 8	60–73	Good Posture
Person 2 (M)	Large	-9 to 8.7	62–74	Good Posture
Person 3 (M)	XXL	-10 to -8.2	59–71	Good Posture
Person 4 (F)	Medium	-4.1 to 12.4	54–68	Good Posture
Person 5 (F)	Medium	-2.1 to 15.9	60–72	Good Posture

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The vest's effectiveness and responsiveness were evaluated through feedback from all 126 participants (Table 4). Respondents strongly agreed that the system responded quickly to posture changes and that the web interface loaded without delay, and rated the battery life and session stability favorably for regular daily use.

Table 4
System Responsiveness and Performance Ratings

Statement	Mean	Interpretation
System responds quickly to posture changes	3.91	Strongly Agree
Beep response speed is appropriate	3.88	Strongly Agree
Web server loads smoothly without delay	3.95	Strongly Agree
Battery is sufficient for regular daily use	3.87	Strongly Agree
System maintains performance during sessions	3.95	Strongly Agree

A controlled test in which participants intentionally slouched or leaned backward confirmed that the actuator engaged only when angular deviation was paired with confirmed lumbar bending, and that brief, incidental postural shifts did not trigger unnecessary correction—behavior consistent with the temporal and dual-sensor verification built into the system's feedback logic. Users additionally rated the interface itself as usable and easy to learn (Table 5), with the overall usability mean reaching 3.83.

Table 5
User Perceptions of System Usability and Interaction

Statement	Mean	Interpretation
Web server clearly indicates posture status	3.91	Strongly Agree
First-time users can easily learn the interface	3.84	Strongly Agree
Buttons and menus respond properly	3.89	Strongly Agree
User manual provides clear instructions	3.89	Strongly Agree
Beep alerts encourage correct posture	3.64	Agree

To identify the optimal classification algorithm, the FCNN, Logistic Regression, and SVM models were trained and evaluated on the same posture dataset using accuracy, precision, recall, and F1-score (Table 6). The FCNN achieved the highest and most balanced performance, with 99.43% accuracy and precision, recall, and F1-score of 0.985, correctly classifying 843 of 845 bad-posture samples and 198 of 200 good-posture samples—only four total misclassifications. The SVM achieved a comparable 99.33% accuracy but with a wider gap between precision (0.971) and recall (0.995), while Logistic Regression, a linear classifier, achieved the lowest accuracy (93.40%), reflecting the non-linear structure of the sensor data.

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Table 6
Comparison of Algorithm Performance Metrics

Algorithm	Accuracy	Precision	Recall	F1-Score
Fully Connected Neural Network (FCNN)	0.9943	0.985	0.985	0.985
Support Vector Machine (SVM)	0.9933	0.971	0.995	0.983
Logistic Regression	0.9340	0.862	0.780	0.819

These results support the use of deep-learning models over traditional linear classifiers for wearable posture classification (Zhang et al., 2019), and are consistent with related work: Luna-Perejón et al. reported 81% accuracy for an artificial-neural-network-based IoT posture-monitoring system (Luna-Perejón et al., 2021), while Zhao et al. found that deep-learning approaches generally outperform traditional machine-learning methods in sensor-based human-activity recognition (Zhao et al., 2020)—both consistent with the FCNN's superior performance in this study.

The system's software quality was assessed against the five ISO/IEC 25010 characteristics evaluated in this study (Table 7). PosTer received strong mean ratings for performance efficiency (3.91) and functional suitability (3.84), favorable ratings for safety (3.80) and usability (3.83), and a comparatively lower—though still positive—rating for reliability (3.68). These results indicate that respondents generally perceived the system as effective, efficient, usable, and safe for short-term use, while reliability, though still favorable, was the attribute most affected by occasional IMU fluctuation during rapid micro-movements.

Table 7
ISO/IEC 25010 System Quality Ratings

Attribute	Mean	SD	Interpretation
Functional Suitability	3.84	0.40	Strongly Agree
Performance Efficiency	3.91	0.35	Strongly Agree
Usability	3.83	0.35	Strongly Agree
Reliability	3.68	0.37	Agree
Safety	3.80	0.37	Strongly Agree

Several factors qualify these findings. The vest's restricted sizing and dependence on correct sensor placement limit its applicability beyond the tested BPO population, and its evaluation window did not extend to long-term or clinical use. Surface EMG readings, though part of the original hardware design, were excluded from the final classification model because of persistent motion artifacts and signal interference, and IMU readings occasionally produced abrupt, short-lived shifts in classification during rapid torso micro-movements, suggesting that future versions would benefit from additional signal filtering or temporal smoothing.

SUMMARY

This study developed and evaluated PosTer, a smart lumbar posture correction vest for sedentary users. The system was found capable of monitoring lumbar posture in real time and communicating clear, accurate feedback, with user-perception means ranging from 3.77 to 3.90. It was also found effective and responsive in detecting and correcting improper posture, combining IMU and flex-sensor verification with a temporal correction logic that avoided unnecessary alerts. Among the three algorithms compared, the Fully Connected Neural Network achieved the best and most balanced performance (99.43% accuracy; 0.985 precision, recall, and F1-score), outperforming Logistic Regression and Support Vector Machine. Finally, the system met ISO/IEC 25010 quality benchmarks across functional suitability, performance efficiency, usability, reliability, and safety, with mean ratings ranging from 3.68 to 3.91.

CONCLUSION

Based on the study's four objectives, several conclusions can be drawn. First, the development of a sensor-integrated smart lumbar posture correction vest was achieved: the combination of IMU and flex sensors with an ESP32-based web interface enabled real-time posture monitoring that users found clear and accurate. Second, the vest was effective and responsive in detecting and correcting improper posture through auditory alerts and automatic adjustment, while its dual-sensor and temporal verification logic avoided unnecessary or intrusive correction. Third, the Fully Connected Neural Network was established as the most suitable algorithm for posture classification, outperforming Logistic Regression and Support Vector Machine across all evaluation metrics. Fourth, the system met key ISO/IEC 25010 quality benchmarks for functional suitability, performance efficiency, usability, reliability, and safety.

These conclusions should be read in light of the study's scope: PosTer is intended as a preventive and assistive tool for short-term, non-clinical use among sedentary individuals, and its restricted sizing, reliance on correct sensor placement, and limited surface-EMG reliability constrain its applicability to long-term or clinical therapeutic contexts. Within these bounds, the study demonstrates that an integrated, multi-sensor, deep-learning-based vest can provide a practical foundation for wearable lumbar posture correction technology.

RECOMMENDATIONS

Building on these findings, several directions are recommended for future work. The system's scope may be extended to other spinal regions, such as the thoracic and cervical areas, and its sensor placement made more adjustable to accommodate a wider range of body sizes beyond the tested abdominal-girth range. Because PosTer is intended for short-term, preventive use, future versions could incorporate adaptive session timers that notify users when a recommended usage limit—two hours in this study—has been reached, alongside broader field testing across other sedentary environments such as classrooms and remote workspaces.

On the algorithmic and sensor side, temporal models such as Long Short-Term Memory (LSTM) networks may better capture gradual posture transitions than the current frame-by-frame classification, and stronger sensor-fusion and filtering strategies—prioritizing IMU and flex-sensor data over unreliable surface EMG—could reduce false activations from rapid micro-movements. To strengthen ISO/IEC 25010 compliance, particularly reliability and safety, future iterations may add automated self-diagnostic checks for sensor misalignment or improper fit, alongside continued reassessment as the system is adapted for longer use or broader populations.

Finally, because PosTer is a preventive rather than clinical device, future development should maintain a clear distinction from medical or rehabilitative systems, incorporating explicit in-interface warnings for users who are pregnant, post-surgical, or diagnosed with spinal disorders, and involving healthcare professionals should the system be extended toward therapeutic use. Companion features such as posture-history logging, trend visualization, and integration with a mobile application may further support user awareness and long-term ergonomic habit-building without encouraging dependency on the device.

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AI DECLARATION

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language editing, grammar correction, sentence restructuring, academic writing refinement, formatting guidance, and improvement of the overall clarity and organization of the manuscript. The AI tool was used solely as a writing and editing aid and was not employed to generate, fabricate, or interpret research data, results, analyses, or conclusions. All AI-generated content and suggestions were critically evaluated, verified, revised, and approved by the authors before incorporation into the manuscript. The authors accept full responsibility for the accuracy, integrity, originality, and final content of this publication.

REFERENCES

Al-Ayyad, M., et al. (2023). Electromyography monitoring systems in rehabilitation: A review of clinical applications, wearable devices and signal acquisition methodologies. *Electronics*, *12*(7), 1520.

Aquino, J., et al. (2022). Ergonomic analysis of supermarket cashier workstations. *Occupational Safety Journal, 45*(3), 134–142.

Chen, M., & Wu, Y. (2022). Inclusivity in smart posture monitoring devices. *IEEE Access, 10*, 55467–55478.

Chen, W., & Zhou, Y. (2023). Bone tumor examination based on enhanced FCNN. *IEEE Access*, *11*, 32415–32426.

Espinola, M., et al. (2022). Postural habits of college students in online classes. *Ergonomics in Education, 12*(2), 88–97.

Figueira, V., et al. (2024). Wearables for monitoring and postural feedback in the work context: A scoping review. *Sensors*, *24*(4), 1341.

Garcia, R., & Lee, S. (2022). Comparative study on smart vest and traditional posture correction. *Journal of Medical Devices*, *16*(4), 45–52.

Girgin, A., et al. (2021). Work-related musculoskeletal disorders and posture awareness. *Ergonomics International*, *34*(4), 175–183.

Gruman, D. (2020). The new normal in education and work during COVID-19. *Global Health Perspectives*.

Gupta, A., & Singh, R. (2023). Deep learning-based posture correction using OpenPose. *IEEE Transactions on Neural Networks and Learning Systems, 34*(2), 678–689.

Hajian, M., & Morin, P. (2020). Deep learning method for forearm velocity estimation with HD-EMG. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *28*(5), 1136–1145.

Han, K., et al. (2021). Effects of PNF on spinal alignment in AIS patients. *Journal of Orthopedic Rehabilitation, 37*(1), 45–52.

Hosmer, R., Lemeshow, S., & Sturdivant, R. (2013). *Applied logistic regression* (3rd ed.). Wiley.

IEOM Society Conference. (2021). Ergonomic risk assessment in high-risk industries. Rome, Italy.

Johnson, T., et al. (2020). Sitting posture notification and monitoring system. In *Proceedings of the IEEE International Conference on Computer Vision* (pp. 1182–1190). IEEE.

Kirubakaran, K. (2020). Detection of postural abnormalities with IMU based sensor. *IEEE Sensors Journal, 20*(8), 4084–4091.

Lazarus, R., et al. (2022). Ergonomic risk factors in Filipino mobile gamers. *Journal of Musculoskeletal Pain, 15*(4), 223–231.

Lee, S., & Park, J. (2020). Advances in smart posture correction technologies. *Technology in Healthcare, 25*(6), 133–143.

Lee, S., et al. (2022). Ergonomic posture correction through camera live feed. *IEEE Transactions on Cybernetics, 52*(6), 6123–6135.

Luna-Perejón, F., Montes-Sánchez, J. M., Durán-López, L., Vazquez-Baeza, A., Beasley-Bohórquez, I., & Sevillano-Ramos, J. L. (2021). IoT device for sitting posture classification using artificial neural networks. *Sensors, 21*(7), 2313.

Maher, M., et al. (2020). Effectiveness of exercise in managing lower back pain. PubMed.

National Economic and Development Authority Regional Office IV-A (CALABARZON). (2023, April). *Annual Regional Economic Situationer (ARES) 2022*. https://calabarzon.depdev.gov.ph/wp-content/uploads/2023/05/2022-ARES_jpj_ao-April-28.pdf

Patel, N., & Shah, P. (2021). Posture correction techniques: A comprehensive review. *IEEE Journal of Biomedical and Health Informatics, 25*(12), 4658–4668.

Prakash, N. (2023). Comprehensive analysis of an EMG-based human-robot interface. *IEEE Robotics and Automation Letters, 8*(3), 1233–1240.

Smith, J., et al. (2023). Development of a smart vest for lumbar posture monitoring. *IEEE Transactions on Biomedical Engineering, 70*(1), 23–31.

Susilowati, I. H., et al. (2022). The prevalence of bad posture and musculoskeletal symptoms originating from the use of gadgets as an impact of the work from home program of the university community. *Heliyon, 8*(10), e11059.

Swain, C., et al. (2021). Posture variability and spinal health. *Journal of Physiotherapy, 67*(2), 110–119.

Van, V., et al. (2022). Posture, flexibility, and back pain relationships. *Back Pain Research, 18*(1), 21–29.

Vapnik, V. (2000). *The nature of statistical learning theory* (2nd ed.). Springer.

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Wang, L., et al. (2021). Wearable postural control system for low back pain therapy. *Clinical Rehabilitation, 35*(5), 652–661.

Wang, X., & Chen, Z. (2021). Wearable IMU and machine learning for gait analysis. *Frontiers in Bioengineering and Biotechnology, 9*, Article 683494.

World Health Organization. (2023, February). *Musculoskeletal conditions*. https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions

Zhang, H., et al. (2020). Deep neural network correlation learning mechanism for CT brain tumor detection. *IEEE Transactions on Medical Imaging, 39*(3), 820–831.

Zhang, H., Huang, Y., & Li, Q. (2019). Postural classification using sensor data and deep learning models. *IEEE Sensors Journal, 19*(24), 11801–11810.

Zhao, Z., Zheng, H., Hu, J., & Yang, G. (2020). A comparative study of deep learning and traditional machine learning for sensor-based human activity recognition. *IEEE Access, 8*, 123000–123010.