An Intelligent Platform for Behavior Modification and Office Syndrome Risk Reduction Using MediaPipe and Computer Vision

Sumran Chaikhamwang[1], Wijitra Montri[2], Chalida Janthajirakowit [3], Srinuan fongmanee[4]
Information Technology-Faculty of Digital Technology, Chiangrai Rajabhat University, Thailand[1, 2, 3]
Computer Science-Faculty of Digital Technology, Chiangrai Rajabhat University Dept., Thailand[4]

***Abstract*—Office Syndrome, a musculoskeletal disorder prevalent among office workers, poses significant risks to health, productivity, and quality of life. Traditional preventive approaches, such as ergonomic guidelines and reminder-based systems, often fail due to limited user adherence and practicality. To address this gap, this study developed an intelligent platform that integrates MediaPipe and computer vision to monitor sitting posture, eye-to-screen distance, and sitting duration in real time. The system provides automated notifications and stretching recommendations, combining detection, feedback, and behavioral intervention into a sensor-free and cost-effective solution. The platform was evaluated in terms of technical performance and user behavioral impact. Results demonstrated high system accuracy, with the eye-distance detection module achieving 95.2% accuracy, followed by long sitting alerts (92.5%) and proximity alerts (90.1%). User evaluations confirmed that real-time notifications increased awareness and encouraged healthier working behaviors. These findings highlight the potential of computer vision based approaches for ergonomic health promotion. The proposed platform contributes not only to preventive strategies for Office Syndrome but also to advancing user-centered, technology-driven health solutions adaptable to both office and remote work environments. This study not only demonstrates technical performance but also introduces a novel integration of Media Pipe based posture and facial detection with behavioral modification features, which previous ergonomic systems have not addressed. The proposed framework contributes a new perspective for integrating real time feedback with computer vision in promoting sustainable ergonomic behavior.**

Keywords—Office syndrome; computer vision; MediaPipe; behavior modification, ergonomics

I. Introduction

The rapid transformation of global economies and technological advancements in the 21st century has significantly reshaped working patterns, particularly among office workers who spend extended hours in front of computer screens. One of the major health consequences of this lifestyle is Office Syndrome, a musculoskeletal disorder resulting from prolonged static postures, repetitive movements, and the overuse of specific muscle groups. This condition not only causes discomfort but has also emerged as a public health issue that adversely affects work performance, quality of life, and healthcare costs [1], [2].

Recent studies have shown that over 70% of office workers worldwide report musculoskeletal discomfort, particularly in the neck, back, and shoulders, and these numbers are continuously increasing due to the widespread adoption of remote and hybrid working models [3], [4]. In Thailand, the Department of Disease Control reported that more than 60% of the working-age population suffers from Office Syndrome, especially individuals between 30–44 years old, with a rising annual trend of approximately 10% [5]. These statistics highlight the urgency of preventive solutions that are both accessible and adaptable to modern working environments.

Although ergonomic guidelines and workplace exercise programs have been promoted for decades, evidence indicates that long-term adherence remains limited. For instance, interventions that rely solely on user self-discipline—such as scheduled stretching breaks or posture adjustments—tend to fail when workloads are heavy or deadlines are pressing [6]. In response, researchers have developed mobile and desktop applications to support healthy work behaviors. Many of these tools use simple timers or reminder notifications to encourage breaks, while others employ wearable devices to track sitting duration and activity [7], [8]. However, such approaches remain insufficient. Reminder-based systems are often ignored, and wearable devices require additional hardware that may not be practical or affordable for all users [9].

In recent years, computer vision based methods have gained attention as they allow automated posture detection without additional sensors. Applications using pose estimation frameworks such as OpenPose or MediaPipe have demonstrated high accuracy in detecting improper postures [10]. Nevertheless, most existing studies have focused on posture recognition alone, without integrating real-time behavioral interventions or personalized exercise recommendations [11], [12]. For example, Zhang et al. (2024) combined MediaPipe with YOLOv5 to monitor joint motion in patients, but the system lacked behavior modification features [13]. Similarly, ergonomic assessment tools using MediaPipe Pose provided valuable risk analysis but stopped short of offering proactive, user-centered feedback for long-term behavior change [14].

This gap reveals a crucial research opportunity: while current technologies can detect risky behaviors, they do not effectively translate detection into sustainable prevention. To address this challenge, the present study proposes an intelligent platform that integrates MediaPipe based posture and facial detection with real-time notification systems and guided stretching recommendations. Unlike conventional reminder applications, this approach combines detection, alerting, and intervention into a comprehensive solution that is sensor-free, cost-effective, and adaptable to both office and home-working contexts. By filling this gap, the system not only advances technological applications for health promotion but also offers a practical contribution to reducing healthcare costs and improving worker productivity in the long term.

This study contributes to bridging the gap between detection and actual behavioral change by developing an intelligent, vision based system that not only monitors ergonomic risks but also delivers personalized, real-time interventions. Unlike prior MediaPipe-based systems that focused solely on posture detection, this platform emphasizes a behavioral modification mechanism and human-centered feedback, enabling sustainable improvements in ergonomic habits.

II. Related Works

A. Definition and Causes of Office Syndromeelecting

Office syndrome refers to a cluster of musculoskeletal symptoms associated with work, primarily resulting from repetitive postures, prolonged improper sitting, and inadequate physical activity [6], [7]. The main causes are prolonged computer use in inappropriate postures, such as neck bending, staring too closely at screens, or placing the wrists at improper angles, which lead to overuse of specific muscle groups and inflammation [8], [9]. Additionally, psychological factors, such as work-related stress, can exacerbate pain symptoms [10]. If left unaddressed, these conditions can negatively affect work efficiency and overall quality of life [11].

This syndrome is not limited to office workers but also affects those working from home, who often lack ergonomically suitable equipment, significantly increasing the risk of musculoskeletal pain [12]. Understanding the causes and mechanisms of office syndrome is therefore crucial for developing effective prevention and treatment strategies. Current research emphasizes analyzing work behaviors and environmental factors to identify solutions tailored to individual contexts [13].

B. Incidence and Prevalence of Office Syndrome

The incidence of office syndrome has been steadily increasing worldwide, posing a significant occupational health challenge. International studies report that over 71.9% of office employees experience work-related musculoskeletal disorders (WMSDs), particularly lower back and neck pain [12]. In India, 63% of regular computer users reported musculoskeletal discomfort [14]. The COVID-19 pandemic and the shift to remote work have further increased the prevalence due to a lack of ergonomically sound work environments [8].

In Thailand, data from the Department of Disease Control indicate that over 60% of the working-age population is affected, especially those aged 30–44, a demographic with high work intensity [9], [15]. The annual increase in cases, averaging 10%, highlights the urgent need for preventive measures [15]. The widespread prevalence of office syndrome has broader socioeconomic implications, including reduced productivity and increased absenteeism [11].

C. Impacts of Office Syndrome on Health and Work Efficiency

Office syndrome affects not only physical health but also mental well-being and work performance [11]. Chronic pain can lead to fatigue, lack of concentration, and irritability, directly impacting work quality, increasing errors, and prolonging task completion time [10]. Moreover, pain from office syndrome negatively affects sleep quality, leading to insufficient rest, which further exacerbates symptoms [7]. These effects illustrate a chain reaction in which physical discomfort contributes to psychological stress, ultimately impairing work performance [12].

Long-term consequences can include severe conditions such as herniated discs or tendon inflammation, requiring costly and time-consuming treatments [13]. Organizations are also affected through reduced employee productivity and increased sick leave, resulting in economic losses at both micro and macro levels [8]. Prevention is therefore a more cost-effective approach than treatment, emphasizing the need for tools that support daily preventive practices [14].

D. Strategies for Preventing and Addressing Office Syndrome

Globally recognized strategies for preventing office syndrome include modifying the work environment according to ergonomic principles and adjusting personal behaviors [9], [7]. Properly positioning chairs, desks, and computer screens reduces musculoskeletal strain [13], [8]. Additionally, exercise programs that promote stretching and core strengthening are important for minimizing injury risk [6]. However, maintaining consistent adherence to these practices is challenging for most workers [11].

In the digital era, technology plays a vital role in addressing these issues. Applications or software that remind users to take breaks or adjust postures have gained attention [16]. Several studies indicate that applications providing continuous guidance and notifications significantly reduce musculoskeletal pain and improve work behaviors [14], [10], [12], aligning with the lifestyle needs of modern workers [12].

E. Technology Applications for Preventing Office Syndrome

Technology has become a key tool in managing and preventing office syndrome effectively. Developing smartphone or computer applications using AI or sensors to analyze work postures and provide real-time feedback is increasingly popular in current research [6]. Such applications alert users when they maintain improper postures for extended periods and suggest exercise videos tailored to individual needs [16], facilitating automated and continuous prevention [8], [13].

In addition, wearable devices, such as smartwatches that monitor movement and heart rate, offer promising options for detecting risky behaviors and notifying users [14]. Integrating these technologies with ergonomic principles can create effective tools to promote worker health [10]. Further research and development in this area remain crucial to meet the diverse needs of users [11].

F. Application of MediaPipe and Computer Vision in Preventing Office Syndrome

The integration of advanced technologies, such as MediaPipe and computer vision, has shown great promise in mitigating the risks associated with Office Syndrome. MediaPipe, a framework developed by Google, enables real-time pose estimation and gesture recognition, facilitating the development of applications that monitor and correct users' postures during prolonged computer use. For example, Zhang et al. demonstrated the effectiveness of combining MediaPipe with YOLOv5 for assessing the range of motion in patients with spinal diseases and frozen shoulder, highlighting the potential of such technologies for musculoskeletal health monitoring [17].

In addition, computer vision techniques have been applied to automate ergonomic risk assessments. Singhtaun et al. employed MediaPipe Pose to develop an automated Rapid Entire Body Assessment (REBA) system, which identifies and mitigates ergonomic risks in real-time [18]. These applications are particularly valuable in workplace settings, where continuous monitoring and immediate feedback are crucial to prevent musculoskeletal disorders.

Wearable devices, such as smartwatches, have also been explored to monitor users' physical activity and posture. These devices provide real-time alerts and feedback, encouraging users to adopt healthier habits and reducing the risk of developing Office Syndrome. Research indicates that integrating wearable technology with ergonomic interventions can significantly enhance users' physical well-being and work performance [19].

Furthermore, recent studies have explored the use of computer vision and MediaPipe in various real-time monitoring scenarios, including detecting postural deviations, estimating joint angles, and providing corrective feedback for seated office workers [20], [21]. The integration of these technologies into workplace health strategies provides a proactive approach for Office Syndrome prevention, promoting a healthier work environment and enhancing employee productivity [22].

III. Method

This study followed a Research and Development (R&D) approach with the goal of creating and testing an intelligent platform that helps reduce the risk of Office Syndrome. The process was carried out in four stages, described below.

A. Data Collection and Review

In this stage, the researchers conduct a comprehensive review to gain a deep understanding of both the problem and the relevant technologies. The study is divided into two main parts: theoretical and technical reviews.

The theoretical review focuses on literature related to Office Syndrome, including its causes, symptoms, prevalence, and impacts on health and work performance [23], [24]. Insights from this review serve as the foundation for determining the necessary features and functions of the application.

The technical review investigates the technologies and tools available for development, particularly image-processing libraries and techniques that can detect users' posture and behavior. Popular frameworks such as MediaPipe and OpenCV are explored for their capabilities in analyzing human physical characteristics [25], [26]. This review ensures the selection of the most suitable and effective tools for application development.

B. Application Design

Based on the review, we designed a system with four main functions:

- Detecting sitting posture and facial orientation.
- Measuring the distance between the eyes and the screen.
- Sending real-time notifications when risky behavior is detected.
- Suggesting stretching exercises to relieve strain.

The user interface (UI) was designed to be simple and friendly, so office workers could easily integrate it into daily routines. A database was also designed to store posture data, screen distance records, and activity logs for later analysis [28]-[29].

C. Application Development

The system was built in modular components:

- Posture Detection Module – used MediaPipe Pose (BlazePose model), which identifies 33 body landmarks, to monitor sitting posture. We also applied MediaPipe Face Mesh to estimate facial orientation and screen distance through eye tracking. We set the detection confidence thresholds at 0.5 for both detection and tracking, after testing different values.
- Notification Module – generated alerts when users sat too long or were too close to the screen. Users could adjust the alert frequency, typically every 30–60 minutes.
- Data Management Module – stored all posture, distance, and sitting duration logs in a MySQL database for later evaluation.

Testing setup, we used a Logitech HD 1080p webcam (1920×1080 pixels, 30 fps) in an office-like room with normal lighting. Each test session lasted about 45 minutes, designed to resemble typical office work conditions.

D. Testing and Evaluation

We evaluated the platform in two ways: technical performance and behavioral impact.

1) Technical performance

- We compared the system's detection results with manual coding by human observers.
- Three standard evaluation metrics were used [30].

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

where,

TP = True Positives

TN = True Negatives

FP = False Positives

FN = False Negatives.

To ensure generalizability, the evaluation included 30 participants with different physical builds and working behaviors.

2) Behavioral evaluation

- We assessed how the system influenced users' habits through the System Usability Scale (SUS) [27], and a short Likert-scale questionnaire adapted from ergonomic behavior assessments.
- Questions asked about perceived usefulness, ease of use, and effectiveness in promoting healthier behaviors.
- We also conducted short interviews, giving participants space to share how they felt about the notifications, exercise suggestions, and overall usability.

This mixed evaluation allowed us to measure not only how accurate the system was technically, but also how well it worked in encouraging actual behavioral change. The steps for face detection, eye distance detection, and sitting position detection can be explained in the flowchart shown in Fig. 1 to 3, respectively.

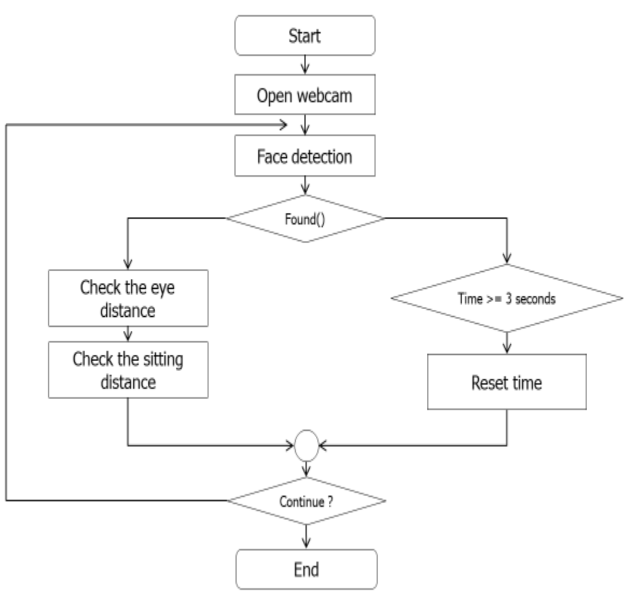

Fig. 1. Face verification flowchart.

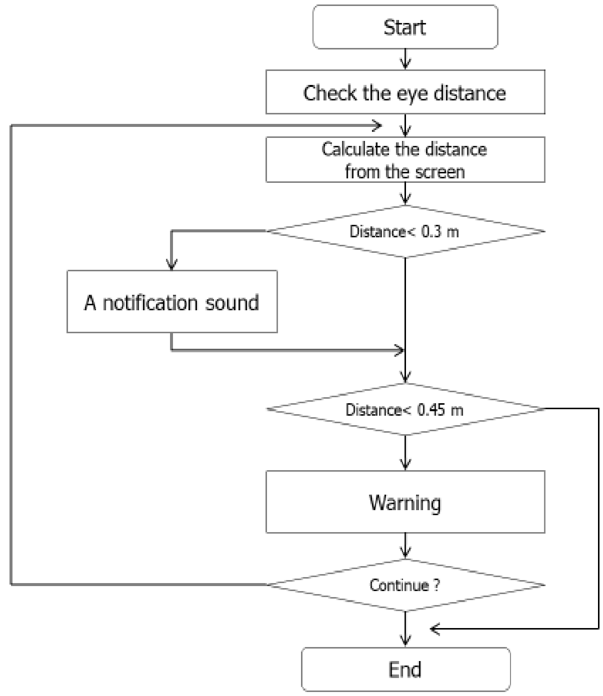

Fig. 2. Flowchart of visual distance inspection.

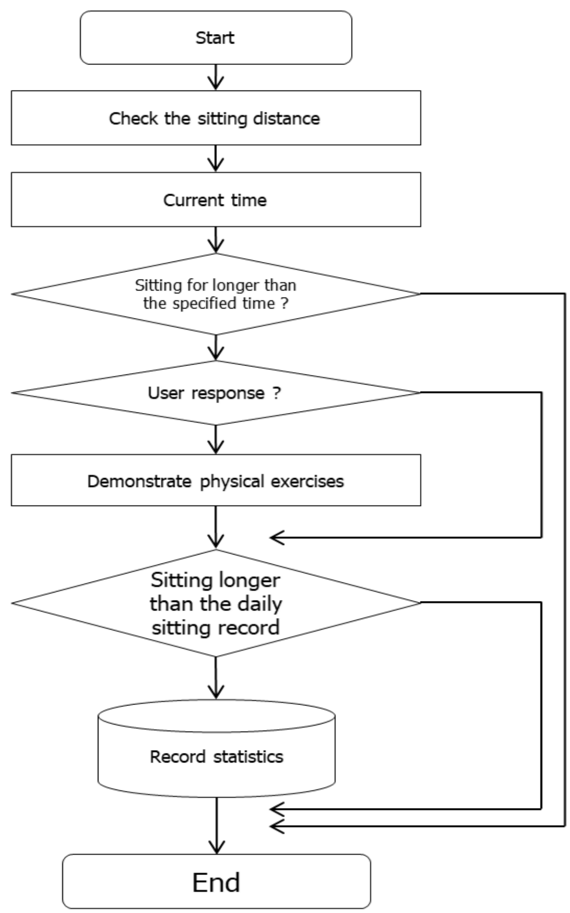

Fig. 3. Flowchart of sitting inspection.

E. Novelty and System Contribution

The novelty of this research lies in the integration of MediaPipe's real-time pose estimation with a dual-layer behavioral intervention model. The system uniquely combines detection, notification, and guided exercise recommendation without relying on external sensors. Moreover, the inclusion of user feedback analytics enables the platform to act as a continuous behavior modification assistant rather than a one-time monitoring tool, setting it apart from previous ergonomic studies.

IV. Results

The research findings are presented in two main components: the User Interface (User) and the System Administration (Backend). Each component was designed to accommodate specific functions and usability requirements, as detailed below.

A. User Interface (User)

The user interface was designed with a total of ten primary screens, allowing users to conveniently access all core functionalities of the application. The home screen acts as the central hub, displaying real-time face detection, eye-to-screen distance, and both the current continuous sitting duration and the longest sitting duration recorded for the day. Additionally, the home screen provides menu options and control buttons to activate or deactivate the webcam, thereby giving users flexibility in managing system usage.

The interface consists of the following screens: Home, Notification Settings, Proximity Alerts, Sitting Duration Alerts, Website Homepage, Muscle Exercise Demonstration, Additional Exercise Demonstrations, Exercise Detail View, Article List, and Article Detail View. These screens collectively ensure that users receive comprehensive support, ranging from ergonomic monitoring to knowledge enhancement. Illustrative examples of these screens are provided in Fig. 4 to 8.

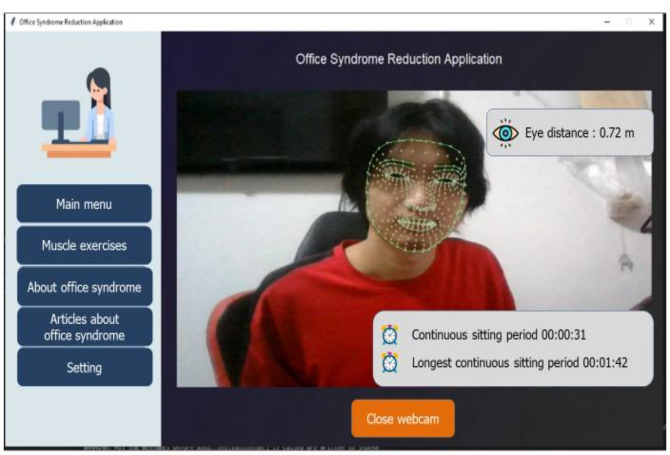

Fig. 4. Application main page.

As shown in Fig. 4, the main page contains the following components menu, face detection display, real-time eye distance, current continuous sitting duration, longest continuous sitting duration today, and webcam on/off button.

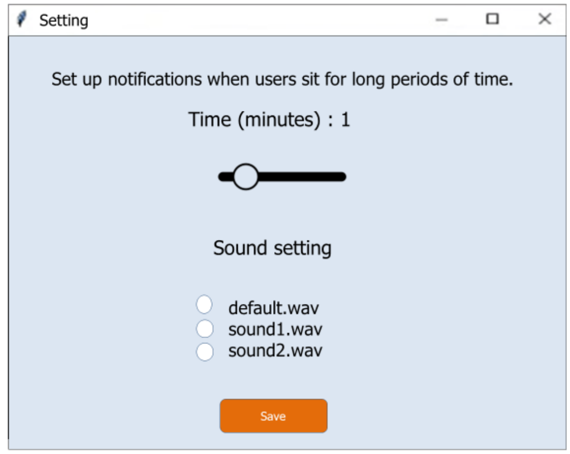

Fig. 5. Sound setting.

As shown in Fig. 5, the notification settings interface, which is designed to allow users to customize the notification system according to their preferences. The main components are as follows:

- Sitting duration alert timer: Users can conFig. the notification interval within a range of 30–60 minutes. This feature helps reduce the health risks associated with prolonged sitting.
- Notification sound options: The system provides multiple alert sounds, enabling users to select the most suitable tone based on their preferences and convenience.
- Save settings button: Users can save their customized settings so that the system retains and applies them in subsequent notifications.
- The notification settings interface thus functions as an essential tool that empowers users to manage their work habits more flexibly and effectively. By adjusting both the frequency and the style of notifications, individuals can align the system with their specific work patterns and personal needs.

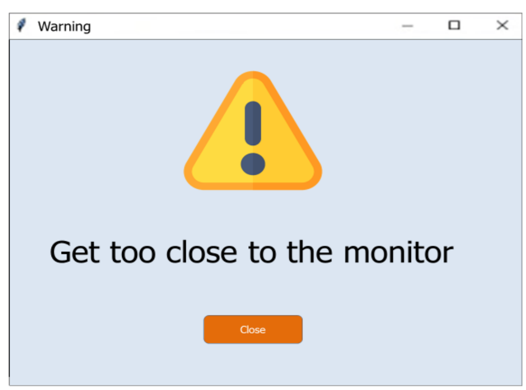

Fig. 6. Warning for users approaching the screen too close.

As shown in Fig. 6, if the user approaches the screen too close (30-45 centimeters), the system will alert the user to adjust their distance from the screen.

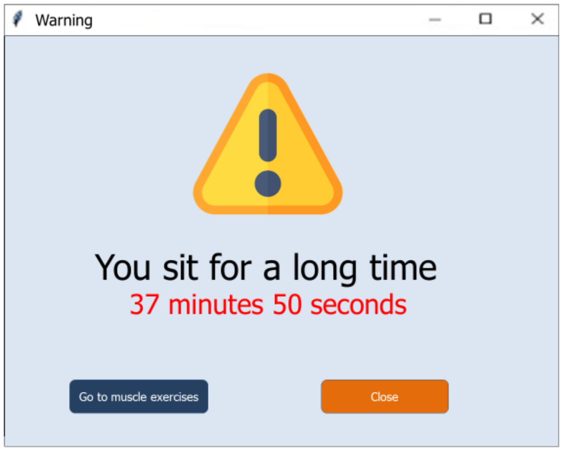

Fig. 7. Long sitting alert.

Fig. 7 shows the long sitting alert page. When a user sits for longer than the set time, an alert will appear with two buttons: "Go to Exercise Page" and "Close." If the user selects "Go to Exercise Page," the system will automatically open the exercise website, as shown in Fig. 8 shows web application section.

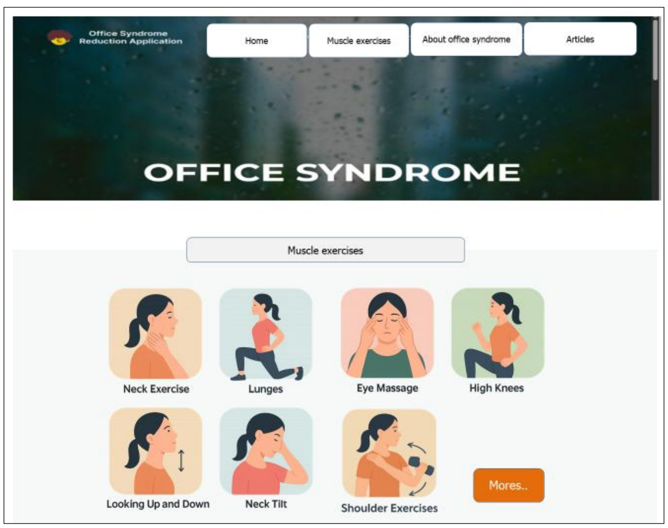

Fig. 8. Web application section.

Fig. 8 presents user recommendations for various muscle-building activities. The exercises listed in the database include examples of Neck Exercise, Lunges, Eye Massage, High Knees, Looking Up and Down, Neck Tilt, and Shoulder Exercises. When users click on a specific exercise, the exercise details are displayed, including text, images, audio, and video.

B. System Administration (Backend)

The system administration (backend) was developed to facilitate administrative operations and ensure secure as well as efficient management of application data. It is composed of three primary components:

1) Login page: Administrators are required to provide a valid username and password in order to access the system. The authentication process is carried out to verify the accuracy of the credentials, thereby maintaining data security. Once access is granted, a navigation menu is displayed on the left-hand side of the interface, offering options for managing both articles and exercise content.

2) Data management page: Within this interface, records such as articles and exercise routines are presented in a structured list format. Functional controls are provided, enabling administrators to add, delete, or update information. This design ensures that the process of content management is both straightforward and effective.

3) Add/edit data page: This page allows administrators to create new records or modify existing ones. The interface supports the uploading of image files and the input of detailed descriptions with formatting options. Upon submission, the system automatically updates the database and manages the associated image files to maintain consistency and accuracy of stored data.

An example of the system administration (backend) interface is illustrated in Fig. 9.

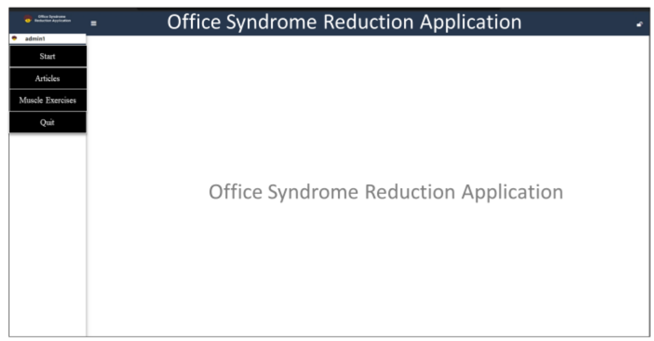

Fig. 9. Administrator page.

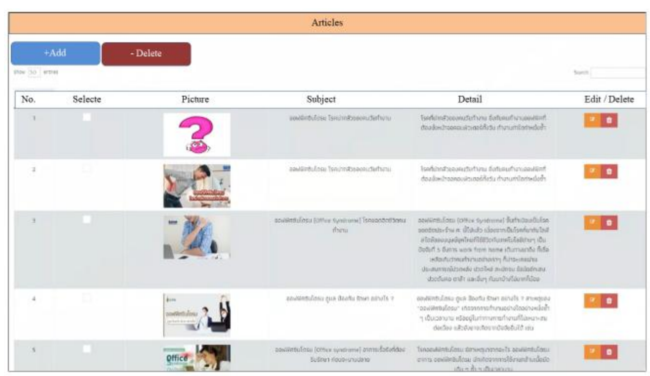

Fig. 10. Data management page.

As shown in Fig. 10, the list page contains the name of the currently opened item and the detailed content displayed. As in the example image, it is an article with content, images, and buttons for adding, deleting, and editing.

As shown in Fig. 11, you can enter information to add to the system. An image file can be uploaded to the host and various formatting options are available. Once you've completed the information, scroll down to the bottom of the page and you'll see the "Save Data" button.

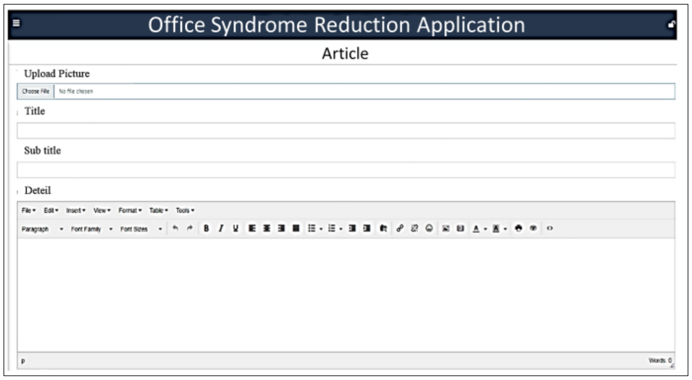

Fig. 11. Data addition page.

TABLE I. SYSTEM PERFORMANCE

Module/Feature	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Eye distance	95.2	94.8	96.1	95.4
Long sitting alert	92.5	91.7	93	92.3
Approaching the screen too close	90.1	89.5	90.8	90.1

The system performance was evaluated using Accuracy, Precision, Recall, and F1-Score across three key modules: Eye Distance, Long Sitting Alert, and Approaching the Screen Too Close, as summarized in Table I and the related graphs.

- The Eye Distance module demonstrated the highest performance (Accuracy 95.2%, Precision 94.8%, Recall 96.1%, F1-Score 95.4%), indicating that the system can accurately and reliably measure the distance between the eyes and the screen.
- The Long Sitting Alert module achieved slightly lower but still robust performance (Accuracy 92.5%, Precision 91.7%, Recall 93%, F1-Score 92.3%), showing that prolonged sitting can be effectively detected and notified.
- The Approaching the Screen Too Close module recorded the lowest scores among the three (Accuracy 90.1%, Precision 89.5%, Recall 90.8%, F1-Score 90.1%), yet its performance remains sufficient for practical use.

Overall, the system provides a balanced and reliable detection of all three events, offering both high accuracy and comprehensive coverage, making it well suited for real world applications. As shown in Fig. 12.

To validate the proposed system, its accuracy was benchmarked against existing ergonomic monitoring models such as OpenPose-based detection [17] and sensor-based wearable systems [19]. The results indicate comparable or superior accuracy (average 92.6%) while eliminating the need for external devices, confirming the efficiency and practicality of the camera-only solution.

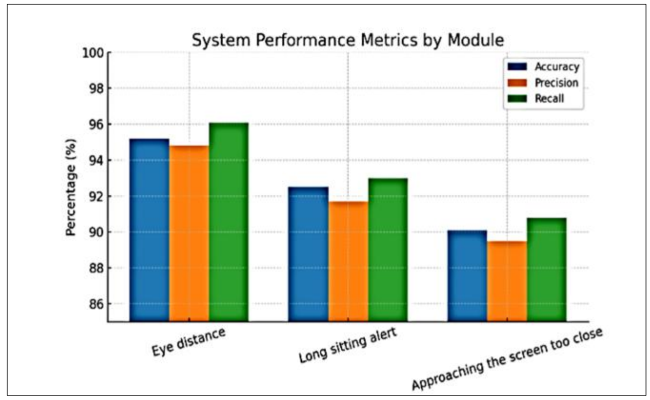

Fig. 12. System performance metrics by module.

V. DISCUSSION

The findings of this study demonstrate that the integration of MediaPipe and computer vision techniques provides an effective means for monitoring sitting posture, eye-to-screen distance, and sitting duration in real time. The system's ability to generate timely notifications and recommend stretching exercises highlights its potential as a preventive tool against Office Syndrome.

One important observation is that users reported increased awareness of their posture and a willingness to adjust their behavior when notifications were triggered. This result is consistent with previous studies, which emphasized the role of real-time feedback in promoting ergonomic practices in the workplace [23], [27]. Moreover, the modular design of the system, which separates detection, notification, and data management, allows for scalability and future integration with emerging technologies such as wearable devices or cloud-based analytics.

Despite its promising results, the system has certain limitations. Environmental conditions such as poor lighting or low-resolution cameras can reduce detection accuracy. In addition, while the system provides basic stretching recommendations, it does not yet personalize these suggestions according to user-specific needs or health conditions. Future research should explore adaptive algorithms that can tailor interventions based on user profiles and longitudinal behavior tracking.

Overall, this study confirms that computer vision based ergonomic systems can play a significant role in workplace health promotion. By addressing the identified limitations and incorporating advanced personalization, the system could be further enhanced for large-scale deployment in organizational and home-office settings.

The observed improvements in user posture awareness align with findings by [8], who emphasized that real-time feedback significantly reduces musculoskeletal discomfort. Unlike timer-based systems, the proposed platform dynamically adapts notifications to user posture, leading to sustained behavioral change. This alignment with prior ergonomic theories supports the platform's potential as a preventive health technology.

A. Related Works Comparison

To highlight the contributions of this research, a comparison was made between existing studies and the proposed system. Table II presents a summary of the key features of related works.

TABLE II. COMPARISON OF RELATED WORKS

Author/Year	Technology Used	Features Provided	Limitations	Contribution of this Study
Sarma et al. (2022) [25]	MediaPipe, OpenCV	Posture detection in real time	No alert system, no behavior modification	Added notification and exercise guidance
Koul et al. (2021) [26]	Computer Vision (Pose Estimation)	Ergonomic risk assessment	Limited to static evaluation	Integrated real-time monitoring and alerts
Hassan et al. (2024) [23]	Ergonomic Survey + CV	Identified risk factors in office workers	Based on self-report, not automated	Automated detection with objective data
Okunola et al. (2020)	Wearable Devices	Tracked sitting duration and activity	Required external devices	Camera-based, no wearables needed
Proposed Study (2025)	MediaPipe + OpenCV + Notifications	Real-time face/posture detection, alerts, stretching guidance, data management	Sensitive to lighting and camera quality	Comprehensive, modular, user-friendly system

VI. CONCLUSION

This research demonstrates the effectiveness of integrating MediaPipe and computer vision techniques into an intelligent platform for preventing Office Syndrome. The system's ability to detect posture, monitor eye to screen distance, and identify prolonged sitting combined with real-time notifications and stretching recommendations proved to be both accurate and practical. Technical evaluation indicated robust performance across all modules, while user feedback confirmed increased awareness of ergonomics and positive behavior modification. Importantly, the system operates without the need for wearable devices, making it an accessible and cost-effective solution for diverse working contexts.

Nevertheless, certain limitations remain, particularly in sensitivity to lighting conditions and the absence of personalized exercise recommendations. Future work should focus on adaptive algorithms, integration with wearable devices, and cloud-based analytics to enhance personalization and scalability. Overall, the study underscores the potential of computer vision based systems to transform workplace ergonomics by fostering sustainable behavioral change, reducing health risks, and improving overall productivity.

In summary, the study not only provides a validated prototype for ergonomic risk detection but also contributes to the broader field of human computer interaction by integrating behavioral modification strategies into computer vision systems. Future studies should explore AI driven personalization and large scale longitudinal trials to assess long-term behavioral outcomes and workplace health impact.

REFERENCES

[1] O. O. Chinedu, A. T. Henry, J. J. Nene, and J. D. Okwudili, "Work-related musculoskeletal disorders among office workers in higher education institutions: A cross-sectional study," Ethiopian Journal of Health Sciences, vol. 30, no. 5, 2020, doi: 10.4314/ejhs.v30i5.10.

[2] N. Narainsamy, F. F. Akpa-Inyang, S. C. Onwubu, N. Govender, and J. D. Pillay, "Ergonomic challenges and musculoskeletal pain during remote working: A study of academic staff at a selected university in South Africa during the COVID-19 pandemic," Int. J. Environ. Res. Public Health, vol. 22, no. 1, p. 79, 2025, doi: 10.3390/ijerph22010079.

[3] J. W. Kim, J. Y. Choi, E. J. Ha, and J. H. Choi, "Human pose estimation using MediaPipe pose and optimization method based on a humanoid model," Applied Sciences, vol. 13, no. 4, p. 2700, 2023, doi: 10.3390/app13042700.

[4] J. W. Kim, J. Y. Choi, E. J. Ha, and J. H. Choi, "Human pose estimation using MediaPipe pose and optimization method based on a humanoid model," Applied Sciences, vol. 13, no. 4, p. 2700, 2023, doi: 10.3390/app13042700.

[5] B. Demissie, G. B. Mekonnen, and T. M. Aytenew, "Musculoskeletal disorders among computer user workers in Ethiopia: A systematic review and meta-analysis," Scientific Reports, vol. 15, no. 1, p. 26858, 2025, doi: 10.1038/s41598-025-96470-0.

[6] Department of Medical Services, Ministry of Public Health, Thailand, Guidelines for Preventing Work-Related Musculoskeletal Disorders. Bangkok, Thailand, 2025.

[7] C. M. Lind, F. Abtahi, and M. Forsman, "Wearable motion capture devices for the prevention of work-related musculoskeletal disorders in ergonomics—An overview of current applications, challenges, and future opportunities," Sensors, vol. 23, no. 9, p. 4259, 2023, doi: 10.3390/s23094259.

[8] J. Rabal-Pelay, C. Cimarras-Otal, S. Coscolla-Palma, A. Burillo-Villuendas, J. A. Villalba-Ruete, and A. V. Bataller-Cervero, "Effect of active breaks on stress and musculoskeletal discomfort during work in office workers," Sport Sciences for Health, pp. 1–9, 2025, doi: 10.1007/s11332-025-01488-6.

[9] I. N. Gomez, C. G. Suarez, K. E. Sosa, and M. L. Tapang, "Work from home-related musculoskeletal pain during the COVID-19 pandemic: A rapid review," Int. J. Osteopath. Med., vol. 47, p. 100654, 2023, doi: 10.1016/j.ijosm.2022.12.001.

[10] I. W. Suryasa, M. Rodríguez-Gámez, and T. Koldoris, "The COVID-19 pandemic," Int. J. Health Sci., vol. 5, no. 2, p. 572194, 2021, doi: 10.53730/ijhs.v5n2.2937.

[11] R. Leyshon, K. Chalova, L. Gerson, A. Savtchenko, R. Zakrzewski, A. Howie, and L. Shaw, "Ergonomic interventions for office workers with musculoskeletal disorders: A systematic review," Work, vol. 35, no. 3, pp. 335–348, 2010, doi: 10.3233/WOR-2010-0994.

[12] B. Demissie, E. T. Bayih, and A. A. Demmelash, "A systematic review of work-related musculoskeletal disorders and risk factors among computer users," Heliyon, vol. 10, no. 3, 2024, doi: 10.1016/j.heliyon.2024.e25075.

[13] W. Zhang et al., "Combined MediaPipe and YOLOv5 range of motion assessment system for spinal diseases and frozen shoulder," Scientific Reports, vol. 14, no. 1, p. 15879, 2024, doi: 10.1038/s41598-024-66221-8.

[14] C. Singhtaun, S. Natsupakpong, and P. Lorprasertkul, "Ergonomic risk assessment using human pose estimation with MediaPipe pose," in Proc. 2024 7th Artificial Intelligence and Cloud Computing Conf., Dec. 2024, pp. 465–471, doi: 10.1145/3719384.3719453.

[15] C. H. Huang, L. E. Yen, and Y. T. Chen, "Development of an ergonomic risk assessment system for repetitive tasks by skeleton recognition based on MediaPipe," in IET Conf. Proc. CP929, vol. 2025, no. 15, pp. 137–139, Apr. 2025, doi: 10.1049/icp.2025.2511.

[16] S. Sultana, M. S. H. Hriday, R. Haque, and M. Das, "Health monitoring through wearables: A systematic review of innovations in cardiovascular

disease detection and prevention," Strategic Data Management & Innovation, vol. 2, no. 1, 2025, doi: 10.71292/sdmi.v2i01.13.

[17] T. Agostinelli, A. Generosi, S. Ceccacci, and M. Mengoni, "Validation of computer vision based ergonomic risk assessment tools for real manufacturing environments," Scientific Reports, vol. 14, no. 1, p. 27785, 2024, doi: 10.1038/s41598-024-79373-4.

[18] V. Wagh, M. W. Scott, and S. N. Kraeutner, "Quantifying similarities between MediaPipe and a known standard to address issues in tracking 2D upper limb trajectories: Proof of concept study," JMIR Form. Res., vol. 8, no. 1, p. e56682, 2024, doi: 10.2196/56682.

[19] F. Kahal, A. Al Darra, and A. Torbey, "Computer vision syndrome: A comprehensive literature review," Future Sci. OA, vol. 11, no. 1, p. 2476923, 2025, doi: 10.1080/20565623.2025.2476923.

[20] A. Carrasco-Uribarren et al., "A computer vision based application for the assessment of head posture: A validation and reliability study," Applied Sciences, vol. 13, no. 6, p. 3910, 2023, doi: 10.3390/app13063910.

[21] K. Totlani et al., "Real-time human pose estimation using MediaPipe and artificial intelligence applications in health and fitness," in Proc. 2024 4th Int. Conf. Artif. Intell. Signal Process. (AISP), Oct. 2024, pp. 1–6, doi: 10.1109/AISP61711.2024.10870725.

[22] B. Cardoso, C. Mateus, R. Magalhães, and M. A. Rodrigues, "Ergonomic intervention program for office workers: A case study about its effect in computer vision syndrome and musculoskeletal discomfort," Ergonomics, vol. 68, no. 1, pp. 51–62, 2025, doi: 10.1080/00140139.2023.2288543.

[23] R. Noy, Y. Shkedy, and Y. Vaisbuch, "Ergonomic injuries and their complications: Prevention and treatment," Oper. Tech. Otolaryngol. Head Neck Surg., 2025, doi: 10.1016/j.otot.2025.05.006.

[24] J. Bort-Roig et al., "A digital intervention to reduce home-office workers' sedentary behaviour: Protocol for the evaluation of the Click2Move programme, a cluster randomised controlled trial," BMC Public Health, vol. 25, no. 1, p. 387, 2025, doi: 10.1186/s12889-025-21598-7.

[25] N. Abulail, A. Y. Owda, and M. Owda, "Real-time detection and analysis of facial movement disorders using MediaPipe and OpenCV: A Streamlit-based framework," in Proc. 2025 12th Int. Conf. Inf. Technol. (ICIT), May 2025, pp. 13–18, doi: 10.1109/ICIT64950.2025.11049234.

[26] U. U. Deshpande et al., "A review of machine learning techniques for ergonomic risk assessment based on human pose estimation," Preprint, 2025, doi: 10.21203/rs.3.rs-5654648/v1.

[27] J. J. M. Ecleo et al., "Evaluation of the usability and user experience of a digital platform for mental health assessment," Int. J. Adv. Comput. Sci. Appl., vol. 16, no. 3, 2025, doi: 10.14569/ijacsa.2025.0160310.

[28] J. Zeng et al., "A real-time posture monitoring system based on Kalman-MediaPipe fusion algorithm," in Proc. 2025 5th Int. Symp. Comput. Technol. Inf. Sci. (ISCTIS), May 2025, pp. 923–930, doi: 10.1109/ISCTIS65944.2025.11065400.

[29] S. Beddar-Wiesing, A. Moallemy-Oureh, M. Kempkes, and J. M. Thomas, "Absolute evaluation measures for machine learning: A survey," arXiv preprint arXiv:2507.03392, 2025, doi: 10.48550/arXiv.2507.03392.

[30] M. Chabbouh, S. Bechikh, E. Mezura-Montes, and L. Ben Said, "Evolutionary optimization of the area under precision-recall curve for classifying imbalanced multi-class data," J. Heuristics, vol. 31, no. 1, p. 9, 2025, doi: 10.1007/s10732-024-09544-z.