INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

Evaluating the Rest Function of a Smart Pressure Reducing Mattress in Promoting Comfortable Rest Among Bedridden Individuals: An Initial Experiment in Healthy Adults

Ni Putu Wulan Purnama Sari,[1*] Lanny Agustine,[2] Hartono Pranjoto[2]

[1]Department of Palliative Nursing, Faculty of Nursing, Widya Mandala Surabaya Catholic University, Indonesia

[2]Department of Electrical Engineering, Faculty of Engineering, Widya Mandala Surabaya Catholic University, Indonesia

DOI: https://doi.org/10.51583/IJLTEMAS.2026.150600130

Received: 28 June 2026; Accepted: 03 July 2026; Published: 17 July 2026

ABSTRACT

A bedridden condition with long-term bed rest often results in a pressure ulcer or decubitus, primarily in protruding body parts. Aiming at minimizing the risk and preventing the development of an advanced grade decubitus, an innovative smart pressure-reducing mattress was developed and tested in healthy adults to evaluate the rest function, basically. Back to the basic function of a mattress, this study aimed at evaluating the rest function of a smart mattress by analyzing the indicators of relaxation, rest facilitation, and sleep inducement, and their correlation with comfort after 40 minutes of utilization in the supine position. This was an experimental study employing the one-group post-test only design. The sample was 29 female nursing students (n=29). Instruments included a smart pressure-reducing mattress and the rest function questionnaire. Descriptive statistics and the Spearman Rank correlation test were employed in data analysis ($\alpha<0.05$). The majority gave maximum scores for indicators of relaxed feeling (69%), rest facilitation (69%), sleep inducement (65.5%), and comfort (79.3%). Comfort ($M \pm SD = 81.03 \pm 6.38; 2.79 \pm 0.41$) was strongly correlated with relax feeling ($M \pm SD = 3.69 \pm 0.47$) and rest facilitation ($M \pm SD = 3.66 \pm 0.55$) [$p<0.05$; $\rho=0.523$ and $\rho=0.662$, respectively]. Although most respondents fell asleep after 40 minutes lying down on the smart mattress, comfort was not correlated with sleep inducement ($M \pm SD = 3,52 \pm 0,78$; $p=0.290$). The rest function of the smart mattress is working very well. Utilizing a smart mattress for 40 minutes in supine position can promote comfortable rest by improving relax feeling and facilitating rest in healthy adults. There is a need for a future randomized controlled trial (RCT), testing this smart mattress directly against a regular mattress.

Keywords: air mattress, decubitus, pressure reduction, pressure ulcer, smart mattress.

"However, the age of technology has arrived, and Kingfisher has decided

it's time for something new: Technological Innovation."

In 'Innovation,' Wild Wise Weird (Vuong, 2024)

INTRODUCTION

Decubitus, widely known as pressure ulcers or bed sores, is injuries of the skin and soft tissue due to constant and prolonged pressure. It is an undesired condition frequently found in patients with difficulties in physical mobility making postural changes difficult, such as patients with total bed rest requirement: stroke, advanced cancer, spinal trauma, or heart disease (Zaidi & Sharma, 2021). Immobilization causes a constant decrease in blood and Oxygen supply to skin areas under pressure, raises poor blood circulation to the skin area that contact the bed, results in skin tissue experiencing hypoxia then necrosis which cause decubitus (Eberlein-Gonska et al., 2013; Ahmalia et al., 2024). Individually, the impacts of decubitus are pain, distress, hindering the natural

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

healing process, prolonged recovery process, individual burden, conformity, and exacerbating the prognosis (Ahmalia et al., 2024; Moore et al., 2020; Kim et al., 2019). Organizationally in the healthcare facilities, decubitus impacts include long-term bed occupancy, prolonged patient care, high care cost, and a substantial burden on the organization (Padula et al., 2019; Seyhan, 2018). Therefore, it is necessary to develop a mean to reduce decubitus risks and development globally.

Decubitus mainly occurs on areas of skin over prominent bones, such as: ischium, greater trochanter, sacrum, heel, malleolus, and occiput. The peak body pressure concentration rate is an indicator to determine uncomfortably pressured body parts (Min et al., 2015). Based on a trial of 10 matrix electrical sensors in the laying down position, it was found that there were four areas with the highest pressure on the sensors, namely: the back of the head (occipital), the shoulder area (scapula), the buttocks area (sacrum), and the heel area (Pranjoto et al., 2022).

Decubitus prevalence worldwide reaches 12.8%, and hospital-acquired decubitus prevalence reaches 16% in the ICU (Isfahani et al., 2024). Generally, there were 83% of patients treated in hospital have decubitus wounds in various grades and can be in more than one location (Zaidi & Sharma, 2021). Decubitus incidence on-hospital was 0.78%, with significant differences across ward or care units (the range was between 0-12.7%). Predictors of on-hospital decubitus incidence were older age, longer treatment period, being treated in the ICU, and being referred from an inadequate healthcare facilities, e.g. residential care facility (Eberlein-Gonska et al., 2013). Patient gender and disease severity were not significantly related to the incidence of decubitus in the hospital (Ladan et al., 2014; Eberlein-Gonska et al., 2013). A systematic analysis showed that the global burden of decubitus is significant. A decrease in the global indicators of disease burden, disability-adjusted life years and mortality, for decubitus both indicators were observed across most regions between 1990 and 2019 (Ding et al., 2024).

Even if hospital-acquired decubitus is an important indicator of patient safety determining quality nursing care, decubitus does not only occur in hospitals. Decubitus is also often experienced in patients treated at home with a prevalence of 12.9-19% (National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance, 2014). The development of decubitus at home is affected by malnutrition, number of comorbid disease, and status of used health equipment due to decreased mobility, while psychological problems may increase the risk of decubitus (Seyhan, 2018). It is recommended to use a mean of pressure reduction as homey bedding system to reduce the risk of decubitus and its development to a higher grade.

The Indonesian government implements universal coverage policy as a social security system under the coordination of the Social Security Administering Agency (BPJS) with an emphasis on promotive and preventive aspects. Treatment of decubitus in hospitals has more emphasis on curative and rehabilitative aspects to prevent disability, in which these two areas are no longer being the focus of Indonesian government in the era of universal coverage nowadays. Therefore, the implementation of clinical-based and community-based pressure reduction methods are potential to help developing a national program aiming at preventing decubitus to reduce the disease burden and economic loss. One solution is the development of a smart pressure reducing mattress which has a potency to reduce the risk and the grade advancement of decubitus which may applicable for on-hospital and home use.

So far, decubitus prevention by using various methods is still not satisfactory. Based on a narrative review, we found that information and communication technology (ICT) adoption in decubitus prevention methods was dominated by the implementation of artificial intelligence (AI) and internet of things (IoT) to periodically send the patient's data related to decubitus and to provide information for healthcare professionals useful for formulating preventive interventions (Ahmalia et al., 2024). Therefore, a smart pressure reducing mattress was developed by electrical engineers to fill the gaps (Pranjoto et al., 2021). This smart mattress is basically an air mattress with technological infusion of automated feature, useful for changing the pressure on the patient's skin by inflating and deflating the airbags inside the mattress automatically. Inflating or deflating the airbag is regulated based on inputs from recorded images which are connected to a computer with AI capabilities (Pranjoto et al., 2021). The basis of the work algorithm is to reduce the pressure at one point by moving it to another point

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

slowly while taking the period of pressure changes into account. Reducing and increasing pressure on the skin are carried out by inflating and deflating the airbags in that location by control of an AI computer with consideration of the pressure duration on the skin (Gaddam, 2011). The patient's condition laying down on the smart mattress, supine position, is monitored and recorded by the AI computer continuously. The monitoring results are represented as graphs for analysis of decubitus prevention or treatment. The AI computer is connected to the internet as part of IoT so that doctors or physiotherapists can monitor the graphs to provide maximum results in reducing the risk or the grade advancement of decubitus (Suriadi & Kitagawa, 2003).

The design of this smart mattress is continuously refined to obtain the best results before being produced in collaboration with the industry. In this study, an evaluation of the basic function of a mattress, the rest function, was carried out among healthy adults as initial experiment before further utilization among bedridden individuals. This study aimed at evaluating the rest function of a smart pressure reducing mattress by analyzing the indicators of relax feeling, rest facilitation, and sleep inducement, and their correlation with comfort after 40 minutes utilization in supine position. By collaboration between nurses and electrical engineers, it is possible to conduct an experimental study on human beings to evaluate the effectiveness of smart mattress utilization in promoting comfortable rest among healthy adults.

MATERIALS AND METHODS

This experimental study employed the one group post-test only design. The population was healthy adults of productive age. The targetted population was female nursing students. Samples were taken using a quota sampling technique. The targeted sample size was 30 individuals. The sample was 29 nursing students who were active in the odd semester of 2023/2024 academic year. One respondent who had participated in the initial stage of data collection but did not complete the questionnaire on time was excluded, so n=29 finally.

In this study, the respondents were asked to lie down on a smart mattress that had been installed with a pressure sensor. Thus, the independent variable was the use of a smart pressure reducing mattress. In implementation, the smart mattress was placed on a standard hospital bed during utilization to acommodate the needed requirement of thickness to promote physical relaxation. This smart mattress was developed by electrical engineers (Pranjoto et al., 2021). The dimension of this smart mattress is 2 x 1 x 0.1 metres in size. It has an automated feature of changing the strength of the air pressure based on supine position as shown by the inflating-deflating function of 22 airbags inside the mattress. This smart mattress was developed using an air pressure sensor, Raspberry Pi, solenoid valve, and AC air pump. The smart mattress inflation process was controlled based on air pressure from 0.7 to 2.1 PSI within 3.5 minutes for each group of airbags, when 11 airbags inflated then another 11 airbags deflated. The airbags were controlled to form a wave-like contour with feedback from an air pressure sensor. A long period of time to reach maximum pressure indicates an air leak. Initial test results showed that the control system could maintain airbag pressure from 0.7 to 2.1 PSI accurately during the inflation process, with or without weight on the smart mattress. The accuracy of the inflation duration for each group of airbags was 96.31% of the target of 3.5 minutes, and did not have any significant effect on the skin pressure (Pranjoto et al., 2021).

There were four areas susceptible to decubitus which being the targets for this rest function evaluation, namely: the back of the head (occipital), the shoulder area (scapula), the buttocks area (sacrum), and the heel area (Pranjoto et al., 2022). Under these four locations, pressure measurements were carried out using an electrical sensor for 10 minutes per location, so that the total duration of use of a smart mattress was 40 minutes per respondent. This electrical sensor consists of a 44x52 matrix of rows and columns with a total of 2,288 highly sensitive pressure detection points (Miyata et al., 2020). This pressure detection sensor was connected to a special tool capable of displaying body mass pressure imaging on the smart mattress. This process was recorded by a special application which was suitable with the electrical sensor, BPMS Research 7.60, on a computer connected to the sensor. After the recording process in these four locations was completed, respondents were asked to fill out a rest function questionnaire via Google form.

The dependent variable in this study was the indicators of rest function, namely: relax feeling, rest facilitation, sleep inducement, and comfort. The rest function of smart mattress was evaluated by a self-developed questionnaire. There are four items in the rest function questionnaire used in data collection of individual

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

responses related to 40 minutes laying down on the smart mattress, as follows: 1) “My body gets relax when laying down on the smart mattress”, 2) “I can get rest well after laying down on the smart mattress”, 3) “Laying down on a smart mattress makes me sleepy”, and 4) “Laying down for 40 minutes on a smart mattress is comfortable.” Each item was measured by Likert scale as follows: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. The data scale was interval. After testing the data distribution, the data of all indicators were not normally distributed. Descriptive statistic and the Spearman Rank correlation test were employed in data analysis.

This study protocol has been reviewed by the Ethical Commission of Health Study, Faculty of Nursing, Universitas Airlangga, Indonesia, with ethical clearance registered certificate of 2630-KEPK. Other ethical principles were also applied during the data collection process, such as: anonymity, confidentiality, justice, beneficence, non-maleficence, fidelity, and veracity.

RESULTS

There were 29 respondents who participated in this study, 100% were females in productive age (20-22 years old). In term of posture, all respondents have the average posture of Indonesian female adults. Table 1 explains the results of rest function evaluation of the smart pressure reducing mattress based on indicators of relax feeling, rest facilitation, sleep inducement, and comfort, while Table 2 explains the results of inferential test. Both tables are presented below.

Table 1 is here

Table 2 is here

Results showed that the majority gave maximum score or strongly agree to indicators of relax feeling (69%), rest facilitation (69%), sleep inducement (65.5%), and comfort (79.3%) after 40 minutes laying down on the smart mattress. Comfort (M ± SD = 81.03 ± 6.38; 2.79 ± 0.41) was strongly correlated with relax feeling (M ± SD = 3.69 ± 0.47) and rest facilitation (M ± SD = 3.66 ± 0.55) [$p<0.05$; $\rho=0.523$ and $\rho=0.662$, respectively]. Although most respondents fell asleep after 40 minutes laying down on the mattress, comfort was not correlated significantly with sleep inducement (M ± SD = 3,52 ± 0,78; $p=0.290$) in study respondents.

DISCUSSION

Findings showed that by 40 minutes laying down on a smart pressure reducing mattress can promote comfortable rest in healthy adults by facilitating rest and improving relax feeling. Most respondents of this study were strongly agree that utilizing smart mattress could facilitate good rest activity. A good mattress is essential for comfort and support while sleeping. A comfortable mattress, aided by a supportive pillow and incorporated by a soft blanket, is essential for promoting restful sleep (Lewis, 2024). There are some reasons why this smart mattress can promote comfort in study respondents. First, the technological infusion built inside the smart mattress, the inflating and deflating of airbags periodically, was not proved to significantly disturb the rest activity among respondents which was indicated by the majority gave maximum score to all rest function indicators. The number of airbags is 22, when 11 airbags are inflating then another 11 airbags are deflating at the same time to facilitate weight adjustment on the mattress based on position changes. A smart mattress or bedding system can enhance comfortable rest by considering variegated body shapes in laying position and controlling the body pressure (Ito & Usuki, 2024). A low pressure inflatable mattress overlay (air rotation overlay) is more comfortable because it does not trigger pain sensation on the back and skin pressure (Myers et al., 2015). This smart mattress employs a control system which could maintain the airbag pressure from 0.7 to 2.1 PSI accurately during the inflation process, with or without weight on it (Pranjoto et al., 2021). Thus making this smart mattress a low pressure inflatable mattress which is considered more comfortable.

Second, this smart mattress has a low interface pressure. Compared to a standard hospital mattress with an interface pressure of 100 mmHg inducing decubitus (Sikka & Garg, 2020), this smart mattress, which is basically an air mattress, can decrease the interface pressure of 20-30% (Defloor, 2000). Alternating-

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

pressure air mattresses can reduce interface pressure (Sasaki et al., 2012). Implementing the automated feature of inflating-deflating airbags inside the smart mattress supports the interface pressure reduction. It is recommended to increase the internal air pressure when the bedridden individuals lay down on a lateral position (Kawabata & Sugama, 2022). Thus, this smart mattress' automated feature can adjust the internal pressure to facilitate the variegated body shape and position changes while preventing decubitus and promoting comfortable rest.

Third, this smart mattress outer layer uses a suitable and recommended textile material. Textile material is an important aspect to be paid attention when developing a well-designed comfortable mattress for bedridden individuals. A mattress material should be soft, safe, comfortable, stretchable, durable, and affordable to be comfortly functional, especially for bedridden individuals who spend most of their time on the bed (Li et al., 2024). In this case, textile utility has various purposes, starting from aesthetic appearance until prevention of life threatening condition, as moisture accumulation on the skin becomes one of the predisposing factors of decubitus (Sikka & Garg, 2020). The feeling of comfort is also supported by the mattress material which directly touch the skin, the outer layer. Comfort is not just the moisture content or hydrophilicity of the outer layer material, but also water vapor resistance and increasing wellbeing (Marti et al., 2021). This smart mattress outer layer was made from polyester fabrics which does not induce skin irritation (Sparks et al., 2015; Takahashi et al., 2017). The nanoporous polyester can promote human body cooling important for not only increasing slow-wave sleep and calms the heart, but also promoting comfortable rest due to body heat loss (Herberger et al., 2024; Liu et al., 2018). By paying attention to the outer layer material, this smart mattres supports the micro-environment circulation on the pressured skin useful for not only reducing decubitus risk and development, but also promoting comfort on the skin and facilitating comfortable rest.

Comfort associates with the immediate sensation of relaxation (Hitka et al., 2024). In this study, most respondents were strongly agree that utilizing a smart mattress for 40 minutes could promote relax feeling during rest activity, and comfort was significantly correlated with relax feeling. Relaxed mood induced by physical relaxation was inlined with comfortable rest in this population. The design of smart mattress was contributed to the promotion of relax feeling during rest activity. The initial development of this smart mattress followed bio-mechanical principle important for promoting physical relaxation and the suitability of mattress strength (Min et al., 2015). Back at that time, the ideation process of this smart mattress involved the idea that physical and psychological relaxation would be a significant determining factor of comfort (Kim et al., 2011). Finally, this smart mattress's dimension is 2 x 1 x 0.1 metres in size considered as ergonomic for Asian adults. Previous research showed that a thick mattress can support the back of the thigh to relax the biceps femoris, while a thin mattress topper may cause significantly lower body pressure and temperature distribution (Yu-Chi et al., 2020). Therefore, this smart mattress was placed on a standard hospital bed during utilization to acommodate the needed requirement of thickness to promote physical relaxation. Further, the level of physical relaxation related to smart mattress utilization for 40 minutes in laying down position is recommended to be monitored by psychophysiological biofeedback, i.e. personal factors, subjective satisfaction, heart rates, Oxygen saturations, and Electromyography (EMG) [(Min et al., 2015].

This study also found that the utilization of smart mattress was not correlated significantly with sleep inducement, so that although most respondents slept after 40 minutes laying down on the smart mattress but this sleep activity was catalyzed by physical and psychological factors internally, such as the absence of disease and minimum stress. Other than smart mattress or bedding system, there are many external factors influencing sleep inducement, especially in healthy adults. Negatively, vape use (e-ciggarete smoking), gaming habits, and alcohol consumption may cause insufficient sleep due to evening activities and addiction contributing to unhealthy lifestyle. Vape use in healthy adults was proved to induce lower sleep quality and mental health symptoms (Evans & Alkan, 2024). Gaming habits may induce disruption in sleep pattern among young healthy adults (Firdos et al., 2024). Alcohol consumption among young healthy adults may intervene the circadian rhythms (Hasler et al., 2024). Environment (physical and social) is also an external factor majorly contributing to sleep among adults. Homeless environment may induce poor sleep quality among adults, even it was continued after re-entering housing facilities (Garcia et al., 2024). Socially, domestic violence may induce sleep disorders (Ghosh et al., 2024). Even if the matress or bedding system is greatly appropriate/favorable, or even luxurious, the rest and sleep activity may be negatively influenced by internal and external factors as mentioned above, so in the end a mattress may not perform a good rest function as intended when it was initially developed.

This study is not without limitations. We report the limitations here for transparency and further study. The sample size was small, possibly contributing to the insignificant correlation between comfort and sleep inducement during smart mattress utilization. Respondent's relatively homogenous characteristics (females only), even with sufficient health science background, possibly influenced the response rate on rest function indicators due to a better understanding of the scientific reasons behind the smart mattress development compared to the general population. Thus, it is important to do the testing in a broader group of samples/users next time.

The limited duration of utilizing the smart mattress on supine position, 40 minutes only, possibly contributed to the individual judgment on comfort aspect regarding this smart mattress rest function evaluation. Finally, the generalization of this study findings to the bigger healthy adults population needs to be cautious due to the heterogeneity of personal preferences on bedding system during personal rest/sleep. Further experiment in healthy adults population with more sophisticated/representative sample size is needed to accurately evaluate the rest function of this smart mattress, especially in the general population with none or very limited health science background to ensure a more objective judgment on comfort aspect regarding the smart mattress utilization.

CONCLUSION

The rest function of smart pressure reducing mattress is very well. Its utilization for 40 minutes in supine position can promote relax feeling, rest facilitation, and comfort during rest activity among healthy adults. Comfort is strongly correlated with relax feeling and rest facilitation in this population. Although most respondents fell asleep after 40 minutes laying down on the smart mattress, comfort is not correlated significantly with sleep inducement. Utilizing a smart mattres for 40 minutes in supine position can promote comfortable rest by improving relax feeling and facilitating rest in healthy adults.

ACKNOWLEDGMENTS

This study was funded by the Directorate of Research and Community Service, Deputy for Strengthening Research and Development; Ministry of Education and Culture, Research and Technology, with registered grant number of 260L/WM01.5/N/2023. We would like to thank all study respondents for their kind participation which make this study possible.

Declaration of Interest Statement

Hereby, we declare that we have no known competing interest regarding this study and publication.

Data Availability Statement

The dataset used in this study can be shared by the corresponding author on a reasonable request.

REFERENCES

1. Ahmalia, R., Aljaberi, M., & Said, M. (2024). Adoption of Information and Technology Communication in Ulcer Pressure Prevention: A Narrative Review. *International Journal of Advancement in Life Sciences Research*, *7*(1), 15-23. https://doi.org/https://doi.org/10.31632/ijalsr.2024.v07i01.002
2. Defloor, T. (2000). The effect of position and mattress on interface pressure. Applied Nursing Research, 13(1), 2–11. https://doi.org/10.1016/s0897-1897(00)80013-0
3. Ding, H., Yu, Z., Yao, H., Xu, X., Liu, Y., & Chen, M. (2024). Global burden and trends of disability-adjusted life years and mortality for decubitus ulcer: A systematic analysis. International Wound Journal, 21(2). Portico. https://doi.org/10.1111/iwj.14604

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

4. Eberlein-Gonska, M., Petzold, T., Helaß, G., Albrecht, D. M., & Schmitt, J. (2013). The Incidence and Determinants of Decubitus Ulcers in Hospital Care. Deutsches Ärzteblatt International. https://doi.org/10.3238/arztebl.2013.0550
5. Evans, S. L., & Alkan, E. (2024). Personality Risk Factors for Vape Use amongst Young Adults and Its Consequences for Sleep and Mental Health. Healthcare, 12(4), 423. https://doi.org/10.3390/healthcare12040423
6. Firdos, S., Al-Omar, S., Aldossary, F., Alshamrani, T., Alhussain, M., Al-Otaibi, T., & Alhusain, I. (2024). Exploring the Impact of Gaming Habits on Sleep Patterns Among Young Adults in Saudi Arabia: A Cross-Sectional Study. Cureus. https://doi.org/10.7759/cureus.56224
7. Gaddam, A. (2011). Master Thesis: Wireless Sensor Network Based Smart Home for Elder Care. Available at: http://mro.massey.ac.nz/handle/10179/3183
8. Garcia, C. M., Schrier, E. F., Carey, C., Valle, K. A., Evans, J. L., & Kushel, M. (2023). Sleep Quality among Homeless-Experienced Older Adults: Exploratory Results from the HOPE HOME Study. Journal of General Internal Medicine, 39(3), 460–469. https://doi.org/10.1007/s11606-023-08429-4
9. Ghosh, S., Sharma, H., Singhal, M., Gupta, S., & Sinha, J. K. (2023). Sleep Disorders and Domestic Violence. Encyclopedia of Domestic Violence, 1–7. https://doi.org/10.1007/978-3-030-85493-5_1559-1
10. Hasler, B. (2024). Sleep-Related Predictors of Risk for Alcohol Use and Related Problems in Adolescents and Young Adults. Alcohol Research: Current Reviews, 44(1). https://doi.org/10.35946/arcr.v44.1.02
11. Herberger, S., Penzel, T., Fietze, I., Glos, M., Cicolin, A., Fattori, E., Grimaldi, D., Reid, K., Zee, P., Mason, M., & Kräuchi, K. (2024). Enhanced conductive body heat loss during sleep increases slow-wave sleep and calms the heart. Scientific Reports, 14(1). https://doi.org/10.1038/s41598-024-53839-x
12. Hitka, M., Miklošík, A., Gejdoš, M., & Štarchoň, P. (2024). Insights into consumer preferences and purchasing behaviour for wooden bed furniture in Slovakia. Journal of Retailing and Consumer Services, 76, 103613. https://doi.org/10.1016/j.jretconser.2023.103613
13. Isfahani, P., Alirezaei, S., Samani, S., Bolagh, F., Heydari, A., Sarani, M., & Afshari, M. (2024). Prevalence of hospital-acquired pressure injuries in intensive care units of the Eastern Mediterranean region: a systematic review and meta-analysis. Patient Safety in Surgery, 18(1). https://doi.org/10.1186/s13037-023-00384-7
14. Ito, J., & Usuki, S. (2024). Measurement and Control of Body Pressure Towards Smart Bed System. International Journal of Automation Technology, 18(1), 104–111. https://doi.org/10.20965/ijat.2024.p0104
15. Kawabata, T., & Sugama, J. (2022). Relationship between mattress internal air pressure and interface pressure distribution in the lateral position. International Wound Journal, 19(8), 2115–2123. Portico. https://doi.org/10.1111/iwj.13817
16. Kim, J.-Y., Min, S.-N., Lee, M.-H., Jeong, J.-H., An, J.-H., & Shin, Y.-S. (2011). Measurement of User Experience to Select a Comfortable Mattress. Design, User Experience, and Usability. Theory, Methods, Tools and Practice, 449–458. https://doi.org/10.1007/978-3-642-21708-1_51
17. Kim, J., Lyon, D., Weaver, M. T., Keenan, G., & Stechmiller, J. (2019). Demographics, Psychological Distress, and Pain From Pressure Injury. Nursing Research, 68(5), 339–347. https://doi.org/10.1097/nnr.0000000000000357
18. Ladan, A.M., Garba, S.N., Sani, D.K., Sani, M.H., & Muhammad, A. F. (2014). Pressure ulcer stages among bed-ridden patients in Ahmadu Bello University Teaching Hospital (ABUTH), Zaria-Nigeria. IOSR Journal of Nursing and Health Science, 3(1), 61–68.
19. Lewis, L.E. (2024). Rest Assured: A Comprehensive Guide to Better Sleep, 2nd Edition. United Kingdom: Leon E. Lewis

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

20. Li, L., Yang, C., Wang, Z., Xiao, K., & Min, R. (2024). Stretchable polymer optical fiber embedded in the mattress for respiratory and heart rate monitoring. Optics & Laser Technology, 171, 110356. https://doi.org/10.1016/j.optlastec.2023.110356

21. Liu, R., Wang, X., Yu, J., Wang, Y., Zhu, J., & Hu, Z. (2018). A Novel Approach to Design Nanoporous Polyethylene/Polyester Composite Fabric via TIPS for Human Body Cooling. Macromolecular Materials and Engineering, 303(3). Portico. https://doi.org/10.1002/mame.201700456

22. Martí, M., Gisbert-Paya, J., Bonet-Aracil, M. Á., Jovančić, P., Lis, M. J., & Coderch, L. (2021). Increased Comfort of Polyester Fabrics. Polymers, 13(17), 3010. https://doi.org/10.3390/polym13173010

23. Min, S. N., Kim, J. Y., Kim, D. J., Park, Y. D., Kim, S. E., & Lee, H. S. (2015). Analysis of Human Body Suitability for Mattresses by Using the Level of PsychoPhysiological Relaxation and Development of Regression Model. Journal of the Ergonomics Society of Korea, 34(3), 199–215. https://doi.org/10.5143/jesk.2015.34.3.199

24. Miyata, A. F., Agustine, L., Yuliati, Sitepu, R., Joewono, A., & Pranjoto, H. (2020). Graphical Pressure Mapping of a 2288 Sensing-Point Matrix Pressure Sensor Using Raspberry Pi. Proceeding of 2020 2nd International Conference on Broadband Communications, Wireless Sensors and Powering (BCWSP). https://doi.org/10.1109/bcwsp50066.2020.9249473. Available at: https://ieeexplore.ieee.org/document/9249473
25. Moore, Z., Patton, D., Avsar, P., McEvoy, N. L., Curley, G., Budri, A., Nugent, L., Walsh, S., & O'Connor, T. (2020). Prevention of pressure ulcers among individuals cared for in the prone position: lessons for the COVID-19 emergency. Journal of Wound Care, 29(6), 312–320. https://doi.org/10.12968/jowc.2020.29.6.312

26. MYERS, J., JAMES, D., MURPHY, J., ROONEY, M., TAYLOR, J., ET AL. (2015). EFFECT OF MATTRESSES AND PILLOW DESIGNS ON PROMOTING SLEEP QUALITY, SPINAL ALIGNMENT AND PAIN REDUCTION IN ADULTS: SYSTEMATIC REVIEWS OF CONTROLLED TRIALS. UTICA COLLEGE PROQUEST DISSERTATIONS PUBLISHING, 3701312.

27. National Pressure Ulcers Advisory Panel (NPUAP), European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. (2014). Prevention and Treatment of Pressure Ulcer: Quick Reference Guide, 1st Edition. Available at: https://www.nzwcs.org.nz/images/International_PUG/Quick_Reference_Guide_DIGITAL-PPPIA-Jan2016.pdf

28. Sasaki, N., Nakagami, G., Sakai, K., Yamamoto, Y., Kato, H., Nanjo, Y., & Sanada, H. (2012). Determining the optimal inner air cell pressure for the effective reduction of interface pressure. Journal of Tissue Viability, 21(2), 47–53. https://doi.org/10.1016/j.jtv.2012.03.002

29. Seyhan, S. (2018). Decubitus ulcer development: An investigation on its effect and evidence in home care patients. Indian Journal of Palliative Care, 24(4), 505. https://doi.org/10.4103/ijpc.ijpc_85_18
30. Sikka, M. P., & Garg, S. (2020). Functional textiles for prevention of pressure ulcers – a review. Research Journal of Textile and Apparel, 24(3), 185–198. https://doi.org/10.1108/rjta-10-2019-0047
31. Sparks, J.L., Nicholas, A., Vavalle, K.E., Kasting, B. L., Martin, L., Tanaka, P.A., Sanger, K.S., & Teresa, A.C-K. (2015). Use of silicone materials to simulate tissue biomechanics as related to deep tissue injury. Advances in Skin and Wound Care, 28(2), 59–68. https://doi.org/10.1097/01.ASW.0000460127.47415.6e.
32. Suriadi, S.H., & Kitagawa, A. (2003). Master Thesis: Study of Reliability and Validity of The Braden Scale Translated into Indonesia. Japan: Kanazawa University.
33. Padula, W. V., Pronovost, P. J., Makic, M. B. F., Wald, H. L., Moran, D., Mishra, M. K., & Meltzer, D. O. (2018). Value of hospital resources for effective pressure injury prevention: a cost-effectiveness analysis. BMJ Quality & Safety, 28(2), 132–141. https://doi.org/10.1136/bmjqs-2017-007505

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VI, June 2026

34. Pranjoto, H., Sarwono, W.C., Miyata, A.F., & Agustine, L. (2021). Raspberry Pi-based decubitus reducing mattress with air pressure monitoring system and air leaks detector. Proceeding of 2021 4th International Conference of Computer and In-formatics Engineering (IC2IE). https://doi.org/10.1109/ic2ie53219.2021.9649373. Available at: https://ieeexplore.ieee.org/document/9649373/authors#authors

35. Pranjoto, H., Miyata, A.F., & Agustine, L. (2022). Combining 10 matrix pressure sensor to read human body's pressure in sleeping position in relation with decubitus patients. Journal of Sensor and Actuator Networks, 11(1), 16. https://doi.org/10.3390/jsan11010016
36. Takahashi, J., Nakae, K., Miyagawa, M., Yokota, O., Fujiki, Y., Ide, M., Nishida, S., Aoki, H., & Aoki, T. (2017). Plastic wrap as a dressing material to treat stage iii/iv pressure ulcers in the inflammatory phase: A randomized controlled trial. International Journal of Clinical and Experimental Medicine, 10(3), 5586–5594.
37. Yu-Chi, L., Chih-Yun, L., & Mao-Jiun, W. (2020). Better combination of thickness and hardness of mattress topper for supine sleeping posture: A physiological measurements evaluation. International Journal of Industrial Ergonomics, 78, 102979. https://doi.org/10.1016/j.ergon.2020.102979
38. Zaidi, S.R.H., & Sharma, S. (2021). Decubitus Ulcer. Treasure Island (FL): StatPearls Publishing. PMID: 31971747.