Physical Activity Correlates With The Aging Process in Seniors Broadly – A Review

Bhuneshwari Dewangan [1], Naina Bhoyar [1]

Abstract

Lack of physical activity among seniors (65 and older) leads to premature aging, illness, and weakness. Engaging in Physical Activity (PA) and maintaining life satisfaction are identified as crucial factors for active aging, positively impacting mental and physical well-being. Life Satisfaction (LS), inversely related to health and longevity in seniors, is a key measure. Assessing the current state of LS in the elderly population and identifying contributing variables are essential for understanding good aging. To combat the pervasive fear of aging, wearable accelerometers evaluate PA, with the Internet of Things (IoT) based Physical Activities (IoT-PA) model showing promise in assessing LS due to age-related energy differences. This review paper discusses the benefits and challenges of virtual assistants in reducing sedentary lifestyles among seniors and presents technical findings from the suggested system. Encouraging regular physical exercise in the senior age group poses challenges for local governments, especially in low-income communities where engagement in physical activity remains low.

Keywords: Premature aging, Physical Activity (PA), Life Satisfaction (LS), Wearable accelerometer, Internet of Things (IoT) based Physical Activities (IoT-PA) model

Significance | A review of a correlation between physical activity, life satisfaction, and aging in the senior age group with Internet of Things (IoT) based Physical Activities (IoT-PA) model

*Correspondence: Bhuneshwari Dewangan, Department of Pharmacy, Kalinga University, Naya Raipur, Chhattisgarh, India.
Email: ku.bhuneshwaidewangan@kalingauniversity.ac.in

Editor Md Shamsuddin Sultan Khan And accepted by the Editorial Board Dec 25, 2023 (received for review Nov 26, 2023)

1. Introduction

Aging is an inevitable aspect of life, marked by the gradual deterioration of vital bodily systems. By 2050, individuals aged 65 and above are expected to constitute 16% of the global population, highlighting the demographic shift reported by the Bureau of Statistics (Ciumărnean, 2021). However, defining aging solely by age is deemed narrow, as health ages vary based on genetics, environment, and lifestyle choices (Richardson, 2023).

Perspectives on aging differ among individuals, influenced by demographics, well-being, social networks, and attitudes toward aging. Emotional health, sense of purpose, and quality of life play crucial roles in shaping the aging process (Izquierdo, 2021; Zapata-Lamana, 2021). Life satisfaction, a multifaceted term encompassing contentment, joy, and the outcomes of life endeavors, gains significance in the context of the rising senior population. Happiness, when consistently exceeding expectations, contributes to a sense of fulfillment (Sutkowy, 2021; Dominguez, 2021).

People assess their life satisfaction in relation to prior health-related behaviors, such as diet, physical activity, and substance use. Active lifestyles correlate with higher happiness levels across various life domains (Nejadghaderi, 2023; Trabelsi, 2021). Maintaining high life satisfaction throughout later life is vital, as successful aging varies among individuals and age groups (Sasaki, 2021). The senior age group's health and longevity are intricately linked to their level of life satisfaction (Zhang, 2021).

Transitioning to technology, the Internet of Things (IoT) emerges as a vast system requiring extensive data analysis and processing from various sensors (Laddu, 2021). The article provides an overview of IoT and its relevance to physical fitness surveillance,

Author Affiliation:
[1] Department of Pharmacy, Kalinga University, Naya Raipur, Chhattisgarh, India.

Please cite this article:
Bhuneshwari Dewangan, Naina Bhoyar. (2023). Physical Activity Correlates With The Aging Process in Seniors Broadly – A Review, Journal of Angiotherapy, 7(2), 1-7, 9413

emphasizing three functional layers: the field sensing network, distant connection system, and bodily activity monitoring information center (Chaabene, 2021).

Accurate physical activity surveillance is crucial for older adults to meet evidence-based health guidelines, reducing health risks and realizing substantial benefits (Larson, 2021). Adjustable triggers like physical activity, socializing, and mental tasks show promise in averting or postponing memory loss. However, the aging process, hereditary factors, and non-modifiable variables contribute to lower mental function and cognitive decline in elders (Teixeira, 2021; Zhang, 2021). Monitoring cognitively stimulating activities becomes crucial in maintaining cognitive function and autonomy, potentially avoiding or delaying hospitalization (Jo, 2021).

This review explores the interconnected themes of aging, life satisfaction, and the integration of IoT in the pursuit of enhanced health and well-being, recognizing the multifaceted nature of these components and their impact on individuals and societies. The primary contribution of this review paper lies in its comprehensive analysis of the correlation between the happiness of older individuals and their engagement in various forms of entertainment, considering the influence of multiple associated factors. The findings indicate that attaining a specific level of physical activity significantly increases the likelihood of successful aging. The study underscores the importance of lifestyle variables, including diet and physical activity, in promoting healthy aging. Moreover, the review provides the understanding of the impact of physical activity on older individuals by describing the current state of information, utilizing the IoT-PA model. By doing so, this review aims to provide valuable insights to better inform health programs and contribute to the development of effective policies for the well-being of older populations.

2. Literature Review

In the realm of promoting lively and healthy aging, recent research has introduced innovative technological approaches. The introduction of a Recurrent Neural Network (RNN) for Physical Activity and Energy Expenditure (PAEE) was pioneered by Paraschiakos in 2022, with the potential to accelerate lively and healthy aging by inducing behavioral changes in the senior age group and linking them to personal health advantages (Paraschiakos, S., 2022). Consequently, it serves as a tool for studying the correlations between PAEE and indicators of metabolic, cognitive, and emotional well-being in the senior age group.

In 2021, Shi et al. recommended that seniors' physical activity tracking interface abilities could benefit from support by Ambient Assisted Monitoring (AAM) systems and incentives for wearable fitness equipment (Shi, B., 2021). To maximize the capabilities of wireless sensors in tracking fitness progress, it is advised to maintain a healthy routine encompassing various exercise intensities.

Valera Román et al. (2021) argued that virtual voice assistants and other Internet of Things (IoT) technology could assist seniors in leading more active lives, reducing the risk of sedentary behavior. Their proposed method to combat inactivity involves employing smart wristbands, IoT devices, and virtual voice assistants, monitoring daily movement levels using voice commands.

The suggestion by Bastos et al. (2021) highlighted The SmartWalk system's design to motivate seniors in engaging in physical activity, specifically walking around the city. This system is monitored and modified by medical professionals for optimal outcomes, with research confirming the effectiveness of SmartWalk's security services in protecting users' private information during transit and at rest (Bastos, D., 2021).

Chen et al. (2021) proposed that the senior age group can access methods for addressing health concerns through Intelligent Health Management Technology (IHMT). This study not only summarizes IHMT's various applications but also identifies elements impacting the senior age group's adaptation to using IHMT, providing a systematic analysis of those aspects (Chen, Z., 2021).

In 2023, Chan et al. developed a unique method using a hybrid Convolutional Neural Network (CNN) and RNN in footwear to detect falls and identify different kinds of Physical Activities (PAs) (Chan, H. L., 2023). Data from 32 participants demonstrated the success of deep learning technology in detecting falls, static, and dynamic PAs, particularly when foot pressures were combined with inertial assessments.

3. Regular Physical Activity for Healthy Aging

Despite the numerous benefits associated with regular physical exercise for seniors, a significant proportion of the older population remains inactive. Factors such as awareness of physical limitations, lack of confidence, and limited access to expert coaching contribute to sedentary behavior among older individuals. Social factors, including gender, age, education, and relationship status, also influence seniors' engagement in physical activity. Research indicates that regular physical exercise is linked to healthier aging, offering various health, social, and financial advantages. Senior centers and community organizations providing health activities have proven effective in promoting physical activity and overall well-being among older adults. Overcoming barriers such as anxiety, loneliness, and a lack of information is crucial to increasing physical activity among the elderly. The positive effects of exercise on cognitive function, prevention of falls, and improvement in muscle strength contribute to an enhanced quality of life for seniors. Physical

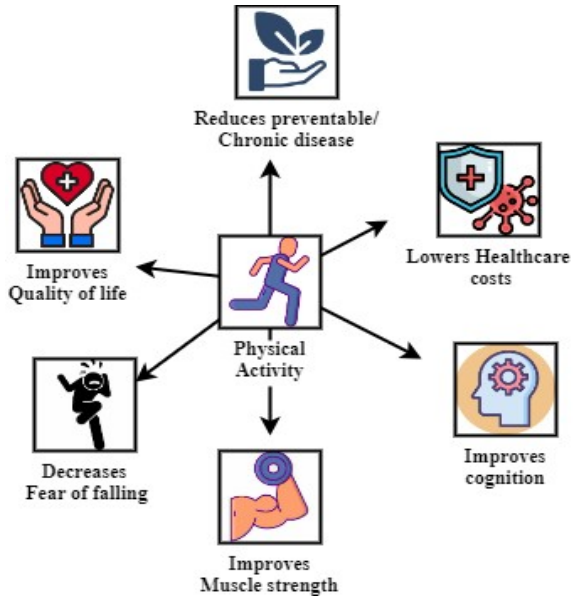

Figure 1. Physical activity and its components

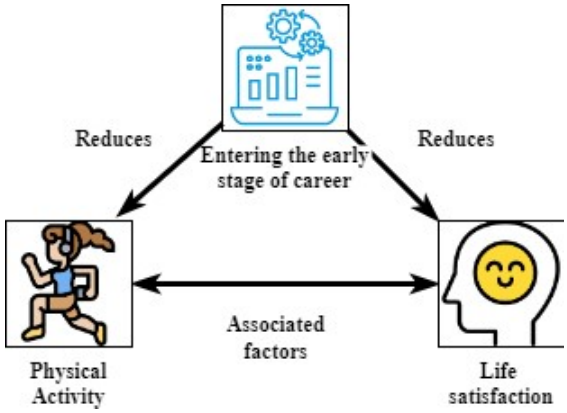

Figure 2. Associated factors for life satisfaction in aging

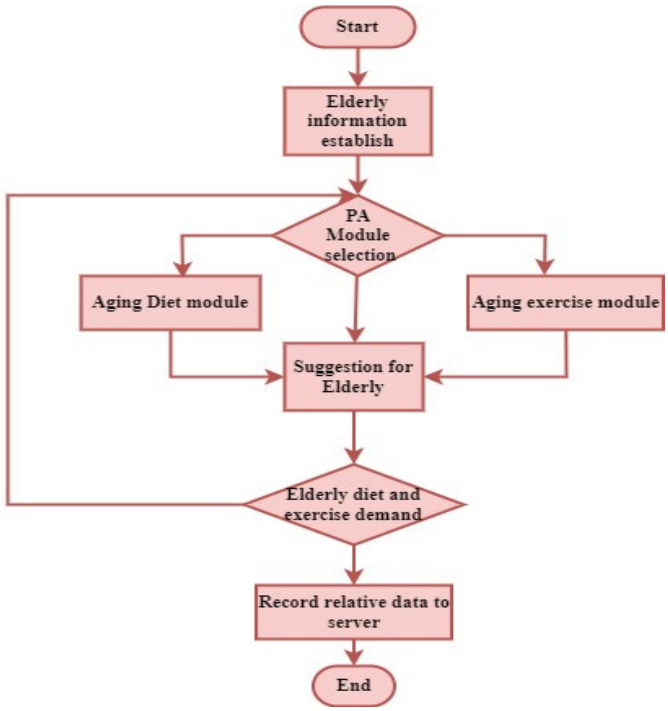

Figure 3. Flow diagram of IoT-PA for aging satisfaction in elders

Box 1

Using an index, the physical activity observing approach quantitatively measures the activity level given the constrained and genuine selection signals, giving meaningful data for the variance in the acquired strength.

$$A(n) = \sum_{x=1}^{na} \max d_s\left(m_n(x, y)\right) \quad (1)$$

Combine the action's variants based on several columns of x and y, as described by Equation (1). To illustrate the activity index (n), estimate the total standardized power in each column. In this expression, N is the total amount of time that was recorded, m_n is the standard health mapping power, and $\max d_s$ is the maximum number of columns.

$$INS = \int_{m=m_0}^{m_0+M} w_j(m)dt \quad (2)$$

Extensive trials validate students' ability to predict energy use using a monitoring device, improving the suggested system's accuracy, as Equation (2) defines. The estimate is based on the physical activity value obtained by solving Equation (2) for the time interval M beginning at m_0. IND, or the integral component of the device's output modulus, has a time-varying value that is proportional to the signal energy along all accelerometer axes w_j. Therefore, there is a good match between the amount of motion experienced by the sensor throughout the time dt. To exclude frequency components (mostly gravity) not associated with vigorous physical activity, the signal is narrowed to a bandwidth between 0.11 and 20 Hz before integration.

$$GA = \sum_{a=0}^{M} w_y d_{a+y} + \mu_m \quad (3)$$

As Equation (3) calculates, the fluctuating average GA function displays each activity signal as the characteristic vectors of the past instance plus the variance pattern. When the μ_m unique activity sequence is detected, these features will yield a real number that describes the sequence of events. Its definition, as utilized during removal, is given by Equation (3). Here, d_{a+y} is the $a + y$ attribute of the collected statistics, where w_y represents GA, and m is the most recent sampling from the detector's signal. The paper's chosen method of calculating moving averages yields the best possible outcomes for every given pattern of behavior.

This model aims to encourage fitness and physical well-being as people age. This module offers options for senior activities based on the following observations: Many seniors interested in sports also have physical limitations. Low- or non-weight-bearing, low-intensity, or moderate-intensity exercises may be prescribed depending on a person's health. Consider the risks, the fun factor, and the practicality of these activities. The key question is whether or not the elderly can find a sense of belonging and participation in the movement. The style of selected physical activity must be tailored to the specific needs and preferences of the aged person. It's important to consider not just workout requirements but also individual preferences. Modified physical activity, such as stretching and strengthening, should also be included in the physical activity prescription.

activity is associated with lower healthcare expenses, and its benefits extend to mental well-being, sleep quality, and overall life satisfaction. Research indicates that regular physical exercise is linked to healthier aging, offering various health, social, and financial advantages (Figure 1). Senior centers and community organizations providing health activities have proven effective in promoting physical activity and overall well-being among older adults. Overcoming barriers such as anxiety, loneliness, and a lack of information is crucial to increasing physical activity among the elderly.

The positive effects of exercise on cognitive function, prevention of falls, and improvement in muscle strength contribute to an enhanced quality of life for seniors. Physical activity is associated with lower healthcare expenses, and its benefits extend to mental well-being, sleep quality, and overall life satisfaction. The review also emphasizes the importance of lifelong exercise in reducing the risk of chronic illnesses and slowing age-related decline. Late-in-life exercisers can still enjoy health benefits, although starting physical activity earlier in life has a more significant impact (Figure 2). A connection between fitness levels and perceptions of health and happiness among seniors is highlighted. The review introduces an Aging Diet Module and an Aging Exercise Module within a health-promoting app designed for seniors. These modules provide personalized dietary recommendations and track physical activity, emphasizing simplicity and customization based on individual characteristics.

Additionally, the review discusses a model to encourage fitness and physical well-being as people age, offering options for senior activities tailored to individual needs and preferences (Box 1). Real-time feedback on physical activity levels for trainers is suggested, utilizing IoT apps to monitor biometric data, improve healthcare infrastructure, and enhance data security (Figure 3). This model introduces an approach for quantitatively measuring physical activity levels using constrained and genuine selection signals. The activity index is calculated by combining variants based on multiple columns, providing meaningful data on acquired strength variance. Equations (1), (2), and (3) outline the mathematical formulations for the approach, involving standardized power, integral components, and fluctuating averages. The model is validated through extensive trials, demonstrating its accuracy in predicting energy use using a monitoring device. It incorporates the physical activity value obtained by solving Equation (2) and utilizes the fluctuating average function defined in Equation (3) to characterize activity signals. The chosen method for calculating moving averages optimally captures behavior patterns. With a focus on promoting fitness and well-being in aging individuals, the model tailors physical activity options for seniors based on observed limitations and preferences. It emphasizes the importance of considering individual needs and preferences when prescribing modified physical activities like stretching and strengthening. Trainers can benefit from real-time feedback on seniors' physical activity levels, leading to shorter clinic visits, reduced healthcare expenses, and improved treatment quality. The model suggests using IoT apps to collect biometric data, create a web-based data management system, and facilitate real-time transmission and storage of sensed data. This approach aims to enhance uniformity in IoT software and address device compatibility issues, allowing healthcare professionals to assess data remotely and identify participants who would benefit most from physical activity tracking devices. Furthermore, the model proposes a secure data aggregation management strategy to enhance the quality and safety of data gathering, with proven resilience against passive scams and replication assaults based on security studies. This review advocates for the integration of regular physical exercise into the lives of older individuals, emphasizing the holistic benefits it brings to mental, physical, and emotional well-being for healthy aging.

4. Effectiveness of the model

Physical activity, characterized by voluntary muscular contractions increasing oxygen intake, is recognized for its crucial role in maintaining a healthy body, especially as individuals age. For seniors, regular exercise proves essential in promoting physical fitness, improving walking capabilities, reducing the risk of falls, and fostering autonomy. Studies indicate positive effects on self-awareness, life satisfaction, and overall well-being among senior populations engaged in regular physical activity.

a) Accuracy:

Employing various sensors and data integration enhances the accuracy of estimating and classifying physical activity, facilitating informed decision-making. Physical activity datasets utilize accelerometers in diverse locations, with the proposed method showing reliability in predicting life satisfaction in seniors. The suggested device fusion significantly improves the precision of physical state categorization.

b) Average Life Satisfaction in the Senior Age Group:

A comprehensive study measuring overall satisfaction at senior assistance centers across demographic variables reveals variations except for old age. Life satisfaction, linked to hedonic or eudaimonic well-being, suggests that motivation, alongside factors like physical exercise, plays a pivotal role. Regular physical exercise contributes to enhanced physical functionality, improved health, and pursuit of personal goals, positively impacting life satisfaction.

c) Rate of the Aging Process through PA:

Examining the rate of aging across age groups indicates a slowdown with increasing age, emphasizing the correlation between physical activity and the aging process. Targeted physical

activity serves as a sensible anti-aging technique, leveraging the body's physiological capacities. However, efforts to promote seniors' physical activity lack consistency in national or regional social policies. Studies highlight the positive impact of regular exercise in slowing aging and safeguarding against age-related functional issues.

5. Conclusion

In conclusion, maintaining a regular exercise routine emerges as a crucial factor in promoting health and well-being during the aging process. Regular physical activity proves instrumental in avoiding or delaying age-related health issues, ensuring independence by strengthening muscles for continued engagement in daily activities without relying on assistance.

Biological changes and external stressors contribute to the aging process, with certain environmental influences being modifiable to impact the trajectory of aging. Regular physical exercise plays a pivotal role in controlling noncommunicable diseases, such as heart disease, stroke, diabetes, and certain cancers. It not only provides protection against hypertension, aids in weight maintenance, and enhances emotional and physical well-being but also preserves mobility, preventing the onset of illnesses and reducing the likelihood of falls and accidents.

The key takeaway is that an active lifestyle significantly improves the prospects of maintaining good health as individuals age. Standardized measures of healthy aging and physical activity are essential for consistent comparison across studies, emphasizing the need for clinicians, family, and friends to encourage increased physical activity among older adults. Despite the overall low engagement in physical activity among the elderly, emphasizing low costs, heightened satisfaction, and fostering a sense of community can boost participation and enhance self-worth.

While the review acknowledges the need for a thorough evaluation of the ontology as a potential future avenue, its implications for policy decisions, especially in countries like India, are substantial. The findings highlight the most at-risk populations aged 70 and over, offering valuable insights that can inform policies aimed at improving the overall quality of life for the aging population.

Author contribition

B.D. comceptualized and reviewed on aging, emphasizing physical activity impact. N.B. reviwed the IoT-PA models for senior life satisfaction and exercise challenges. Both authors wrote and approved the paper.

Acknowledgment

None declared.

Competing financial interests

The authors have no conflict of interest.

References

Bastos, D., Ribeiro, J., Silva, F., Rodrigues, M., Rabadão, C., Fernández-Caballero, A., ... & Pereira, A. (2021). Security Mechanisms of a Mobile Health Application for Promoting Physical Activity among Older Adults. Sensors, 21(21), 7323.

Chaabene, H., Prieske, O., Herz, M., Moran, J., Höhne, J., Kliegl, R., ... & Granacher, U. (2021). Home-based exercise programmes improve physical fitness of healthy older adults: A PRISMA-compliant systematic review and meta-analysis with relevance for COVID-19. Ageing research reviews, 67, 101265.

Chan, H. L., Ouyang, Y., Chen, R. S., Lai, Y. H., Kuo, C. C., Liao, G. S., ... & Chang, Y. J. (2023). Deep neural network for the detections of fall and physical activities using foot pressures and inertial sensing. Sensors, 23(1), 495.

Chen, Z., Qi, H., & Wang, L. (2021, November). Study on the types of senior age group intelligent health management technology and the influencing factors of its adoption. In Healthcare, 9(11), 1494. MDPI.

Ciumărnean, L., Milaciu, M. V., Negrean, V., Orășan, O. H., Vesa, S. C., Sălăgean, O., ... & Vlaicu, S. I. (2021). Cardiovascular risk factors and physical activity for the prevention of cardiovascular diseases in the senior age group. International Journal of Environmental Research and Public Health, 19(1), 207.

Collado-Mateo, D., Lavín-Pérez, A. M., Peñacoba, C., Del Coso, J., Leyton-Román, M., Luque-Casado, A., ... & Amado-Alonso, D. (2021). Key factors associated with adherence to physical exercise in patients with chronic diseases and older adults: an umbrella review. International journal of environmental research and public health, 18(4), 2023.

Dominguez, L. J., Veronese, N., Vernuccio, L., Catanese, G., Inzerillo, F., Salemi, G., & Barbagallo, M. (2021). Nutrition, physical activity, and other lifestyle factors in the prevention of cognitive decline and dementia. Nutrients, 13(11), 4080.

https://www.kaggle.com/datasets/diegosilvadefrana/fisical-activity-dataset

Izquierdo, M., Duque, G., & Morley, J. E. (2021). Physical activity guidelines for older people: knowledge gaps and future directions. The Lancet Healthy Longevity, 2(6), e380-e383.

Jo, T. H., Ma, J. H., & Cha, S. H. (2021). Senior age group perception on the internet of things-based integrated smart-home system. Sensors, 21(4), 1284.

Laddu, D. R., Lavie, C. J., Phillips, S. A., & Arena, R. (2021). Physical activity for immunity protection: Inoculating populations with healthy living medicine in preparation for the next pandemic. Progress in cardiovascular diseases, 64, 102.

Larson, E. A., Bader-Larsen, K. S., & Magkos, F. (2021). The effect of COVID-19-related lockdowns on diet and physical activity in older adults: a systematic review. Aging and disease, 12(8), 1935.

Li, P. S., Hsieh, C. J., Shih, Y. L., Lin, Y. T., & Liu, C. Y. (2023). The effect of research on life satisfaction in middle-aged and older adults: physical disability and physical activity as a parallel and serial mediation analysis. BMC geriatrics, 23(1), 176.

Nejadghaderi, S. A., Ahmadi, N., Rashidi, M. M., Ghanbari, A., Noori, M., Abbasi-Kangevari, M., ... & Farzadfar, F. (2023). Physical activity pattern in Iran: Findings from STEPS 2021. Frontiers in Public Health, 10, 1036219.

Paraschiakos, S., de Sá, C. R., Okai, J., Slagboom, P. E., Beekman, M., & Knobbe, A. (2022). A recurrent neural network architecture to model physical activity energy expenditure in older people. Data Mining and Knowledge Discovery, 36(1), 477-512.

Richardson, D. L., Tallis, J., Duncan, M. J., Clarke, N. D., & Myers, T. D. (2022). The ongoing effects of the COVID-19 pandemic on perceived physical activity, physical function and mood of older adults in the UK: a follow-up study (March 2020–June 2021). Experimental gerontology, 165, 111838.

Rodrigues, F., Jacinto, M., Couto, N., Monteiro, D., Monteiro, A. M., Forte, P., & Antunes, R. (2023). Motivational Correlates, Satisfaction with Life, and Physical Activity in Older Adults: A Structural Equation Analysis. Medicina, 59(3), 599.

Sasaki, S., Sato, A., Tanabe, Y., Matsuoka, S., Adachi, A., Kayano, T., ... & Watanabe, T. (2021). Associations between socioeconomic status, social participation, and physical activity in older people during the COVID-19 pandemic: a cross-sectional study in a northern Japanese city. International Journal of Environmental Research and Public Health, 18(4), 1477.

Shi, B. (2021). Wearable exercise monitoring equipment for physical exercise teaching process based on wireless sensor. Microprocessors and Microsystems, 81, 103791.

Sutkowy, P., Woźniak, A., Mila-Kierzenkowska, C., Szewczyk-Golec, K., Wesołowski, R., Pawłowska, M., & Nuszkiewicz, J. (2021). Physical activity vs. redox balance in the brain: brain health, aging and diseases. Antioxidants, 11(1), 95.

Teixeira, E., Fonseca, H., Diniz-Sousa, F., Veras, L., Boppre, G., Oliveira, J., ... & Marques-Aleixo, I. (2021). Wearable devices for physical activity and healthcare monitoring in senior age group people: A critical review. Geriatrics, 6(2), 38.

Trabelsi, K., Ammar, A., Masmoudi, L., Boukhris, O., Chtourou, H., Bouaziz, B., ... & ECLB-COVID19 Consortium. (2021). Sleep quality and physical activity as predictors of mental wellbeing variance in older adults during COVID-19 lockdown: ECLB COVID-19 international online survey. International journal of environmental research and public health, 18(8), 4329.

Valera Román, A., Pato Martínez, D., Lozano Murciego, Á., Jiménez-Bravo, D. M., & de Paz, J. F. (2021). Voice assistant application for avoiding sedentarism in senior age group people based on IoT technologies. Electronics, 10(8), 980.

Wöbbeking Sánchez, M., Sánchez Cabaco, A., Bonete-López, B., Urchaga Litago, J. D., Loureiro, M. J., & Mejía, M. (2021). Physical activity and life satisfaction: an empirical study in a population of senior citizens. Frontiers in Psychology, 12, 636914.

Zapata-Lamana, R., Poblete-Valderrama, F., Cigarroa, I., & Parra-Rizo, M. A. (2021). The practice of vigorous physical activity is related to a higher educational level and income in older women. International Journal of Environmental Research and Public Health, 18(20), 10815.

Zhang, G., Guo, Z., Cheng, Q., Sanz, I., & Hamad, A. A. (2021). Multi-level integrated health management model for empty nest senior age group people's to strengthen their lives. Aggression and Violent Behavior, 101542.

Zhang, S., Xiang, K., Li, S., & Pan, H. F. (2021). Physical activity and depression in older adults: the knowns and unknowns. Psychiatry research, 297, 113738.

Zhao, Y., Song, J., Brytek-Matera, A., Zhang, H., & He, J. (2021). The relationships between sleep and mental and physical health of Chinese senior age group: exploring the mediating roles of diet and physical activity. Nutrients, 13(4), 1316.