



## EXPERIENCE SAMPLING METHOD (ESM) INTEGRATION IN A BALANCE ASSESSMENT DEVICE TO SUPPORT PREVENTIVE HEALTHCARE AND SDG 3: GOOD HEALTH AND WELL-BEING

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### Abstract

**Background:** Primary innovation health for everyone, anywhere, at any time, is an extreme need to provide primary care. Lack of assessment and public awareness, including healthcare knowledge in society, leads to the implementation of care primarily and equitable access to care guidelines for the prevention of quality of life equally and distribution. Many areas need a plan to help Medicare beneficiaries visit the community. A higher level of preventive care aligns with Sustainable Development Goal 3: Health and Well-Being, which emphasizes preventive measures.

**Objectives:** This innovation study aims to present an innovative healthcare solution that integrates with services, balances the utilization of an assessment device to support sustainable public health, and achieves Sustainable Development Goal (SDG 3): Good Health and Well-being outputs to propel Thailand toward global innovation.

**Methodology:** Experience-based research innovation on developing healthcare issues to prepare for planning preventive, innovative, and service care measures nationwide for the development of the country. Screening a balance assessment device supports preventive care services and sustainability statements. Universal screening employs indicators of health and well-being to identify individuals who may require early intervention.

**Result:** Primary innovation in care leads to improved preventive health guidelines, testing, and treatment services to better deliver care and monitor individuals. This early prevention in people's health is a preventive care model for care and response to Sustainable Development Goal Health and Well-being (SDG 3). Utilization of a Balance Assessment Device to Support Preventive Healthcare programs associated with SDG 3, towards converging health records, and the utilization of a balance assessment device.

**Discussion:** A body health assessment innovation device is expected to deliver innovative solutions to serve people and the community, involving novel approaches to healthcare services to balance device utilization, support prevention, and enhance the effectiveness of healthcare-association SDG 3. Step forward and implement public health care adaptation nationwide in Thailand.

**Keywords:** Balance Assessment Device, Preventive Care, Healthcare, Thailand, Sustainable Development Goal



## Introduction

The preventive innovation care is delivered to provide full-service care flexibly. The Balance Assessment Device involves confirming adherence to precautionary care guidelines. In the meantime, there is a lack of technologies, medical staff, and services to carry out local health standards. Prevention programs are offered to people to address prevention objectives, based on recommendations from a scientific statement. Implementing an observational design with integrated technology and innovation solutions, a harmonized practical balance test method that links to relative balance health. This innovation research highlights preventive care management through lifestyle changes and the effective organization of prevention programs across the continent. Natural therapy exercise is pure science, and physical coordination is encouraged with primary health care. Guidance care for people obviously relates to signs and the specific effectiveness of preventive care services.

Balancing innovation is a key strength in performance, with a significant impact on adults and older people, for preliminary testing and training. Each of the 17 Sustainable Development Goals (SDGs) is linked to expected improvements to test the potential impacts of measuring progress. For SDG 3 (Good Health and Well-being), there are quantitative publications. Few in the area can highlight the existence of SDG 3. Enhanced healthcare assessment is necessary in response to limited budgets and resources. Building and facilities depend on the framework. By implementing a balance assessment device, health mobility services and health-related quality of life for population health will be improved. In practical physical activity, help individuals and communities approach public health through the power of mobility assessment.

Moreover, implementing primary prevention requires integrating practical experience between centralization and localization. Manual communications may be difficult to interpret, as handwriting paper input to the system. Real-time technology measurement records will support assessment-confirmed experience signs and connect to a computer that can link to hospitality services. A balance assessment device for preventive services specifies the community-based services task guidelines to best fit the response considerations and personal evaluation. Health disciplinary mobile services support sustainable preventive healthcare with simple tools and are customized to localization to serve communities.

Although progress has been made in health assessment, preventive care needs investment in healthcare-associated adaptations, proactive screening, and vital signs monitoring. Screening tests, procedures, preventive health practices, and health care assessment: a balance assessment device monitors signs, performs real-time preventive measurements, conducts physical checks, reports balance results and relevant BMI, balance support area, sway, and data visualizations for effectiveness testing. Preventive guidelines of foot standing body balance in persons, with the effectiveness of treatment, signs of human benefit, real-time pre-screening signs, and appropriate training in the care of persons. Principles of preventive care involve identifying early signs through screening, balance assessment devices, and lifestyle modifications. Manuals sometimes cannot record sign results based on an approach. Often, manual labor lacks linkage to technology, and the transfer of technology has boundaries. This research applies a balance assessment device that integrates technologies, principles, and innovative solutions to provide effective care and supports a preventive care-based model for implementation in Thailand.



Preventive Services Task Force Recommendation Statement challenges to prevention, management, and clinical care. Approaches to solutions, AI, and personalized health care to prevent and treat individuals, and to update analyses, have been increasingly discussed to prepare future health care treatment services. Conversely, using a manual system, particularly for records analysis, management, evaluation, and updates, is time-consuming but less effective in a specific place. Preventive Services Task Balance Assessment Fulfillment contributes to advancing new technologies to balance mobility services in remote areas and to implement comprehensive prevention in Thailand.

Currently, managing health services personnel who sustain the use of preventive care, which is of high value, and services statements for individuals with signs and symptoms of care to meet health outcomes. Association of care alignment: screening with technologies and practical exercise guidelines for Primary Care. Along with reductions in, or better management of, factors that balance emphasis on physical features with screening design and technical support for timely, individualized care. Screening tests serve the needs of prevention, prior intervention, maintenance, and rehabilitation. Key challenges in preventive care involve digital transformation, which adapts local needs to improve effectiveness and deliver healthcare benefits within communities. Having smart solutions also enhances healthcare services; using a balance assessment device is considered to support primary preventive care and treatment.

This research innovation aims to link the use of a balance assessment device to SDG 3: Good Health and Well-being, to increase the quantity of publications on an innovative preventive care solution in healthcare services. This study explores the important health population in the community, which the health-related SDG 3 targets to screen, test, and provide practical solution recommendations for the care of people and long-term care facilities.

## **Literature Review**

Many patients have not received guideline-supported preventive care, consistent with a study on recommended primary care (Porter et al., 2023). Although most signs and symptoms are detected during screening, not everyone is aware of them. Most ignore their health until they become ill or injured and expect improvements in their health and well-being. Preventive screening services include advice on self-care signs, promoting public awareness, and links to healthcare and wellness for details, vital checks, and laboratory work for select patients. This integration will merge healthcare services to meet people's needs, thereby enabling the public to respond to Sustainable Development Goal SDG 3: Good Health and Well-being.

Interestingly, promoting physical activity is potentially linked to the area health-related Sustainable Development Goal (SDG) targets for population health. Similarly, physical activity brings solutions to operate the United Nations SDG, which possibly benefits supporting SDG 3 Good Health and Well Being (Salvo et al., 2021). Preventive services are tasks carried out by the task force, including an assessment of the balance in people screening to inform a recommendation statement on body balance.

People's good health has an extremely positive impact on the national economy. However, lack of exercise has a direct negative effect on physical health and people's overall health (Dhuli et al., 2022). Responding, there is outcomes-based support for population health, prevention, health promotion, and



wellness capabilities to position the organization to address social needs and reduce the global burden of public awareness (Magnusson et al., 2020). Implementing preventive health measurement needs to include physical activity, balancing performance and functional exercises with therapy to support activity.

Physical activity is linked to balance and cognitive function, enhancing motor function and balance performance by preventing symptom decline and prolonging the safe duration of treatment (Fan et al., 2020). Moreover, prioritize the prevention, treatment, and recommendations needs body computing. Likewise, physical exercise is a significant treatment for improving static and dynamic balance and reducing falls, especially among the elderly aged 65 or more (Papalia et al., 2020). Research specifically states that falls in older adults are mainly caused by balance disorders and require multiple treatments, and reviewing body-integrated motor signals is difficult (Xing et al., 2023).

Technologies applied to prevention are more effective and reduce risk factors for symptoms and complications through big data analytics (Razzak et al., 2020). Adoption of health sciences in preventive medicine involves identifying patterns, signs, and symptoms to clarify the effectiveness and origin of treatment needs, and the safety of prevention services (Elmore et al., 2020). Updated supplements and reports need to be managed systematically, as health science technologies will fill gaps in primary prevention results-based approaches, balancing high prevalence.

Screening primary treatment strategies increasingly consider the costs to economic scale and public implementation. Screening for the assessment and service balance is an interesting area for study, with the aim of summarizing descriptions to find a possibly practical way to deliver specific preventive care services. Specifically, preventive care services obviously consider body balance, as well as cognitive screening-related signs or symptoms. Later, educating on treatments and fall prevention involves integrating strategies to maintain balance, quick-win strategies to collaborate with the government, private, and other stakeholders, and applications. An illustration, cognitive impairment screening in elderly adults in the United States is a task force reference of the balance service and assessment statement (Owens, 2020).

More importantly, the significance of primary care, focusing on preventive care and management services especially for the community among Medicare beneficiaries, shifts toward value-based care (Berenbrok et al., 2020). Correspondingly, nursing fundamentals include work on case findings studies, practice communication, and physical examination skills in a lab or virtual setting, and caring for patients in various situations (Potter, 2022). The discussion of preventive care and physical activity services will examine how they are managed in practice to meet the required service quality standard. However, most research provides guidelines and recommendations for cardiovascular health; only a few studies focus on physical balance.

Particularly, physical aging refers to the physical signs of aging, which are often experienced as pain and are often treated; preventive care is of great importance (Saxon et al., 2021). Often, signs and checks are triggered almost immediately, which can miss treatment opportunities and delay recovery. Some checks, administration, and point-of-care can recover or rehabilitate the same, but some, such as falls, once they occur, cannot be recovered from, especially in older people.

Applying balanced physical assessment services care guidelines to the base care model publications assessment approach, health, and movement, the power of physical activity helps individuals and community health. Managing preventive care-related supports to telemedicine, which



includes a balance assessment device that can plug into a hybrid to connect a computer and collaboration telehealth and physical distancing. This research study examines how the use of technologies in balance assessment devices will support preventive healthcare, serve as an important link to the specific effectiveness of preventive care, and provide guidance for long-term care exercise, in line with Sustainable Development Goal (SDG) Health and Well-being.

### **Methodology**

This study uses an experience-based research innovation method with a descriptive design to examine how a balance assessment device supports preventive care and contributes to SDG 3: Health and Well-being. Physical activity and exercise recommendations for preventive services aim to enhance an innovative technology solution that balances health, well-being, and active lifestyles. Applied a contemporary sampling technique, convenience of experience-based integration, direct trend context engagement, lived experiences, and real-world observation.

As shown in Figure 1, users place their foot on the balance plate platform. Then, the software will analyze balance results and evaluate balance assessment criteria to predict the degree of risk of falling, leading to the provision of exercise guidelines. Moreover, the balance assessment device does not need to be worn or attached to body sensors. This method is efficient for recording real-time measurements and presenting results without bias by asking questions, interviewing, and recording patient details. This balance assessment device test upgrades the quality of service to evaluate performance, quality of care, and user experience to standardize care and assist in screening tests to increase healthcare access overall.



Figure 1: BALDES, the first stability analyzer in Thailand

Source: Thailand, 2024

The Experience Sampling Method (ESM) is implemented to observe the target sample, who are potential influential participants, as they report their thoughts, feelings, and moments in their natural setting, as shown in Figure 1. The balance innovative assessment device gets great honor from Shark as an innovative solution to increase public awareness of healthcare. This experience provides immediate feedback from participants, reflecting their signaling about the nature and new excellence of their experiences at that time. This applied method research is the ultimate recommendation and guidance for a practical, modern way to access sampling and engage in meaningful activity.

Moreover, ESM is a practical technique for leveraging knowledge and real-world observations within a typical balance assessment device, offering an innovative approach to engaging with daily life and lifestyle solutions. Moreover, the experience-sampling research method provides a comprehensive framework for exploration-intensive longitudinal body balance research and related applications, such as the health and sport sciences. This technique is a comprehensive guide to engage with new and innovative experiences, approaches, and mapped dimensions, and, over time, to develop, within ultimate applications, an integrated academic-practitioner approach on board of balance assessment and an innovative platform solution.

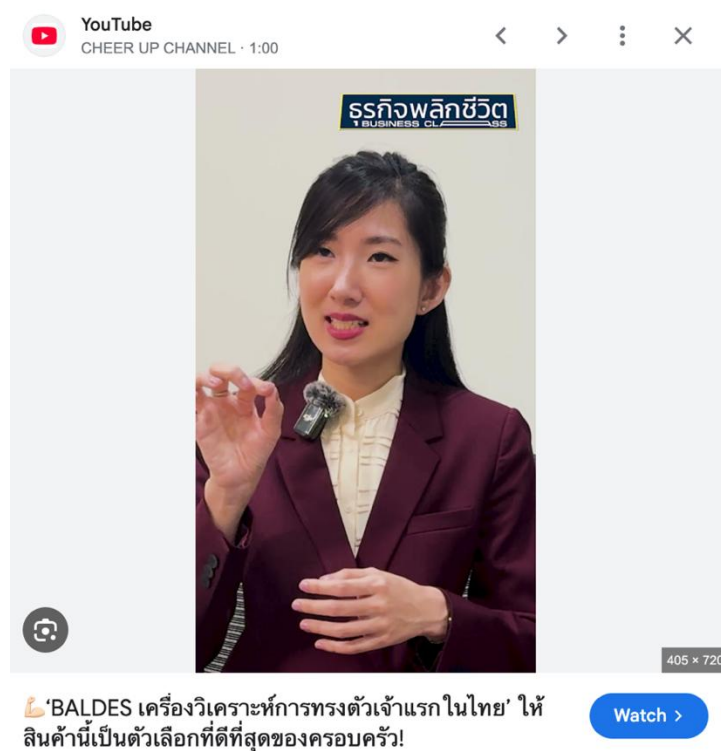
More importantly, the Experience Sampling Method (ESM), a Balance Assessment Device, is an innovative healthcare service beyond applying user experience (UX) design to capture value. The



“what” shows real-time measurement of individuals, and the “how” presents guidelines for primary prevention of body balance. The balance assessment device commonly used in healthcare identifies patterns, adds-on services, and educates and trains to deliver value to mobility services and expand in the community, as evaluated in the pitch and investment pitch in Shar Tank Thailand season 5, shown in Figure 1. This method, like applying user interviews, surveys, focus groups, and usability testing, reflects the existing user experience of their participants. This primary balance assessment test method is an early, regular physical screening test, therapy, and exercise for a prevention model of balance and motor signs in functional and autonomic balance of the autonomic nervous system, and the degree of physical activity.

This innovative balance assessment solution test experience-based research method is combined with quantitative and qualitative methods (mixed methods), results data visualization, and behavior real-time measurement, which will provide both in-depth natural test measurement, context body balance, and wider applications such as physical activity, and norm body balance patterns leading to the prediction of falls and prevent balance care.

To address the User-Experience Research Method, the digital experience is used to deliver a message to the target audience and raise public awareness within the focus channel group. The assessment balance device is broadcast as shown in Figure 2 to demonstrate its utilization for preventive care in healthcare and Sustainable Development Goal (SDG) 3: Health and Well-Being. Applying the experience sampling method to open the public to criticism and closer to insight to conduct research on a set of public opinions. This research method involves communicating with the public to address product value and increase social value, including ways of collecting and analyzing, to be implemented for the public and community. Also, the gap between innovative solutions and their practical use is more likely to help me understand a particular context or society, as presented in Figure 2. This experience method is a powerful approach that combines the development of concepts and theories to support the implementation of effort.



**Figure 2:** BALDES, the first stability analyzer in Thailand

Source: YouTube, n.d.

Utilizing an innovation balance assessment device, explore user experiences to examine the nature of context for research data to support preventive healthcare in the target community and mobile services to respond to Sustainable Development Goal 3: Health and Well-being, as shown in Figure 3. This exploration can only be observed to generate generalized findings and to consider perspectives and assessments in the character's natural environment for a larger population. This combination of practice-based research and people's influence in usability testing helps identify new user experience challenges and turn them into implementation research.

Figure 3 illustrates a guided, practice-based research method that raises public health awareness and helps people effectively use a balance assessment device to support Sustainable Development Goal 3 (Good Health and Well-being) in the community. Highlighting the unique core value, body check-ups include proactive health mobile checks to implement for the public population in Thailand. The research varies considerably in its balance, covering information that can provide indications for analysis and detailed insights into customer experiences, balance assessment test, and service. This customer experience demonstrates the use of rich insights, open-ended feedback, feelings, signs, and questions to inform approaches, procedures, methods, and techniques for scientific research, with real-world implementation and nationwide scalability.



**Figure 3:** Loss of balance can be detected using a "balance analyzer"

Source: Chivitchiva, 2024

This research innovation, grounded in specific experiences, is a form of market research that involves firm verification and learning procedures, leading to concrete experience and reflective observation and resulting in significant findings. Until the Experience Sampling Method (ESM) learns customer-centric styles and adapts to the product owner for experiential product development, it is well prepared to target larger populations. This person-centered experience approach balances assessment tools to reveal latent profiles of preventive care and healthcare services that sustain self-care awareness and balance good health and well-being, supporting exercise recommendations. This assessment device is based on personal experience and engagement, selecting an influencer, a situation balance, and a phenomenon under the platform. Organizing the balance assessment device is directly connected to and informed by people's situations. Improve health promotion in practice and pave the way for nationwide implementation within mobility services to support the Sustainable Development Goals.

To sum up, selecting a research innovation method is important for designing, developing, and implementing the nationwide stages. This research innovation is the application of research in real life, which requires a state-of-the-art balance between data collection and experience to yield results and draw practical conclusions. This exploration uses the Experience Sampling Method (ESM) to gather information from representative potential influencers through real-life experiences or observations. This research proposes an innovative solution, a balance assessment device, to improve quality of life, support preventive care in healthcare, and provide a practical solutions-based approach to health promotion in Sustainable Development Goal 3: Health and Well-being. This innovative, proactive healthcare promotion draws together data that is extremely useful when scaled nationwide.



## Results

This research innovation reports findings from an innovative balance assessment device to give information on body balance measurement, Body Mass Index (BMI), Balance Performance based on physical standing activity, predict the degree of fall risk assessment, exercise recommendations, and balance applications for the four primary quadrants of the body: left, right, front, and back. This novel, innovative solution is a balance assessment device. These findings are based on applying suggestions to improve balance, achieve equilibrium, maintain posture, enhance performance, improve the area, and exercise.

Also, this research can be applied to the functional aspects of health promotion, fitness, exercise, confidence, strength, and imbalance. Beyond that, the balance assessment device was validated using the Experience Sampling Method (ESM), a master class on balancing to develop practical approaches to implementing Support Preventive Healthcare and SDG 3: Good Health and Well-Being. The significant findings are as follows:

### 1. Signals an innovative balance assessment solution

The research found that the balanced Performance Criteria Assessment signals the integration of data innovation and enables real-time measurement of human behavior, which depends not only on hardware but also on the balanced integration of hardware and software. The mean during the physical activity, real-time monitor balance, innovative assessment device: The left balance demonstrates single -leg, two-leg, or movements, The right balance demonstrates single -leg, two-leg, or movements, The front balance demonstrates single -leg, two-leg, or movements, The back balance demonstrates single -leg, two-leg, or movements, The coordination left-right balance demonstrates single -leg, two-leg, or movements, The coordination front-back balance demonstrates single -leg, two-leg, or movements, and Core strength links to the core body to monitor the time response to the center of body balance

These results present the body composition of the lower and upper body over time, using time-series analysis. By doing so, this research employs an innovative balance assessment device that measures balance and coordination. Because results are unbiased by subjective opinion or visual observation, they are real-time measurements of users' altered muscle activity and body alignment, as shown in Figure 1. Assessing body balance, parameters, and body composition in a control context cannot be done without technology for tutorial purposes. Moreover, a balance assessment device, such as Body Balance, is frequently used to monitor progress, alongside strength and flexibility assessments, and is often used with a smart device for simple use.

### 2. Body Mass Index (BMI)

The experience research method found that BMI is included in a general health checklist. The research found that a balance assessment device uses BMI to conduct a body checkup. Incorporating body balance with BMI shifts in body shape to monitor balance performance, strength, and shape. The balance and BMI patterns can be interpreted as indicating a symmetric distribution of muscle mass, and a simulation experiment on stability and dynamic body balance. Reinforcement balance identifies BMI-related balance as a full-body simulation model in a balance assessment device, an innovative solution for presenting experimental physical activity, and applies it in healthcare preventive services.

### 3. Exercise recommendation

The research found that the unique value of the association between balance ability and standing



physical activity in exercise recommendations helps fill a gap in preventive care and can be applied to lifestyle solutions for modern daily life. The balance assessment device analyzes balance test results and provides individualized exercise recommendations, supporting health care and longevity. Full-body balance, exercise training, body sway, and workout recommendations. This innovative balance assessment device system may be used for balance training and is operative in both static and dynamic balance training.

#### **4. Degree of fall risk assessment**

This research emphasize balances the assessment device in global health, offering an innovative analysis of real-world insights that integrates innovations with cutting-edge research and development within the healthcare innovation system. Balance measurement increases self-awareness and preventive care, which are also related to fall risk prediction. The results of the fall risk assessment indicate that balance assessment and targeted balance exercises led to significant improvements in health. These findings may inform the adoption of standard balance-training tools and help reduce risk factors.

### **Discussion**

Balance is a part of movement in activities. An innovative balance assessment device system improves balance measurement records by using results to indicate balance performance, physical activity, and exercise recommendations, to predict fall risk, and to provide preventive care. To upstage health promotion, apply technology support, measure and utilize resources, and work efficiently. In particular, the innovation balance system matters at the large-scale level.

This research innovation is a balance assessment device that serves as a multi-tool: a simple tool for balance assessment, balance whole-body vibration, exercise guidelines recommendations, fall risk assessment, general health checklists, and balance applications, such as balance areas individually. These beneficial adaptive balance assessment measurement to the effectiveness of need-based health promotion to support preventive healthcare and Sustainable Development Goal, SDG 3: Good Health and Well-Being. The main balance assessment device uses a technique to evaluate the utilization of each node community in network technology to improve the quality of life in localization. Through movement and design, movement sequences maintain body balance.

Presently, lifestyle modifications are more important than ever, as a one-size-fits-all approach may not meet the needs of individualism. Utilizing a balance assessment device supports public preventive care in healthcare and the Sustainable Development Goal (SDG) Health and Well-being, providing screening guidance and practical recommendations to support individuals in personal monitoring. This evaluation is proactive preventive healthcare, focusing directly on prioritizing facilities such as nursing homes and healthcare centers, and specifying an analytics system to identify the position work as a new balance technology assessment device in the generation and device application. This balance assessment device is like a system that combines analytical research with digital health, smart health, the Internet of Things (IoT), Artificial Intelligence (AI), and new knowledge journals.

More interestingly, integrating body balance measurement, Body Mass Index (BMI), physical activity, exercise suggestions, and guidelines on balance function in healthy individuals, and fall risk assessment to enhance balance in programs for individuals. This research innovation also combines balance training with technology, stimulating techniques in individuals with innovative approaches to



the benefits of standing. This innovative system can deliver stronger, faster measurements, boost public health, and improve public health utilization. Balancing users and innovation is the connection between technological innovation and public implementation. Outcomes focus on reality-based balance assessment and experiences to promote effective physical balance and functional strength balance movement in healthy individuals.

This digital balance assessment device offers a variety of body balance and core training exercises to support a longer, healthier life, prime healthy signals, address other health issues, and promote public health sustainability. Body balance features on the balance assessment device, an innovative solution, is a scientific combination of balance facilities to address element muscle physical activity, alignment, balance coordination, and strength as a system, and upright to mobility services to serve the community nationwide. This device will integrate discipline health science and sport science to strengthen balance measurement, making it happen in the community by incorporating innovative methods.

Moreover, the Experience Sampling Method (ESM) was applied to identify potential influential participants and to publicize the approach to increase public awareness in the context of a nationwide work core body balance assessment device approach with proof. This science balance assessment device, scout, and shape implementation plan are more practical for delivering social value and lifelong societal results. These balance experience-sampling findings hand in hand with circle health promotion at the national level, shaping society-wide groups' sense of balance to push at the national level.

Science-led, innovation-driven primary screening test for public health implementation improves human balance and, in addition to mobility add-on services, enhances mobility. Moreover, advancing this public health involves both proactive screening and fall risk assessment tests to promote a range of balance dimensions and, specifically, improve individual ability. This study provides a balanced landscape of knowledge and practices across balance, functional balance task performance, falling assessment, and health-related core balance training.

This balance assessment device was early incorporated into balance sequences exercise, maintain, recovery, rehab, and instructions to use the body as resistance to help public health build strength, benefits, and welfare, training, after training, and treatment immersion. The advanced muscle moves beyond developing public health; it is parallel with research and development of innovations and their implementation. In this regard, the health of the public and well-being drive the nation forward. Body balance shifts and the key to efficient balance performance: balance training and assessment with the whole body on a platform in an upright position, and mobility services.

## **Conclusion**

An innovative balance assessment is a better balance challenge that involves body awareness and working together to lead body dedication to maintain balance and address balance issues as resistance. The body balance workout focuses on creating movement-relevant research and innovation in the use of balance between prior upper-body strength, science, and technology. A specific research methodology, the Experience Sampling Method (ESM), is integrated to maintain a proper balance among assessment system control, body movements, body balance, muscle strength, physical activity, and training exercise recommendations. This balance practice and body composition screening assessment test method is an instructional technology in health and physical dimensions, and a



responsive, innovative research approach that uses meta-analysis and ESM methodology to identify potential influencers and public awareness drive to drive public health in the nation.

The balance assessment evaluation device system test, workout, and balance improvement to load balance exercises and body balance training. Beyond that, the balance assessment device can be used for mobility services in any community or location with a standardized quality of service. Connecting public health to balance assessment devices and innovation research highlighted the prioritization of balance and innovation management, which are ready for public health implementation and adaptable to localization. The balance assessment device is not only a device application; it also involves how to position the body for balance and serves as a practical public implementation tool for preventive care in public health promotion.

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## SEASONAL VARIABILITY AND HUMAN HEALTH RISK OF NITRATE AND PHOSPHATE CONTAMINATION IN CANAL WATER

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### Abstract

Water quality degradation from nutrient pollution is a growing environmental and public health concern, especially in canal systems affected by intensive human activities. This study determined nitrate and phosphate concentrations in Bang Sue Canal (Nakhon Pathom Province, Thailand) and assessed associated human health risks during the dry and wet seasons. Water samples were collected at six sites representing residential, agricultural, and industrial land uses. Nitrate was measured by the brucine method (EPA Method 352.1) and phosphate by the ascorbic acid method (EPA Method 365.2). Seasonal differences were evaluated, and human health risks were estimated using Hazard Quotient (HQ) and Hazard Index (HI) approaches for oral and dermal exposures in adults and children. Nutrient concentrations were significantly higher in the dry season (nitrate: 15-22 mg/L; phosphate: 2.5-3.5 mg/L) than in the wet season (nitrate: 8-13 mg/L; phosphate: 1-2.8 mg/L). Higher dry-season concentrations were attributed to reduced dilution, increased evaporation, and continued inputs from agricultural runoff, industrial effluent, and domestic wastewater. Risk assessment indicated oral nitrate exposure poses potential health risks, especially for children (HQ = 2.37); dermal nitrate exposure was negligible. Phosphate showed extremely high oral HQs for adults (HQ = 3,135) and children (HQ = 7,315), indicating severe potential health risks. Combined oral HI values confirmed a significant cumulative risk. These results highlight an urgent need for nutrient-source controls, improved wastewater management, and community awareness to protect public health.

**Keywords:** Human Health Risk, Nitrate, Phosphate, Wet and Dry Season

### Introduction

Water is essential for life and socio-economic development, yet water quality is increasingly threatened by pollutants, notably nitrate ( $\text{NO}_3^-$ ) and phosphate ( $\text{PO}_4^{3-}$ ). These nutrients support plant and aquatic growth but become pollutants at elevated concentrations, causing eutrophication and harmful algal blooms (Akinawo, S. O. 2023).

Anthropogenic sources—excessive agricultural fertilizer use, inadequately treated municipal and industrial wastewater, and atmospheric nitrogen deposition—drive nutrient enrichment (Zahoor & Mushtaq, 2023). Eutrophication reduces dissolved oxygen when algal biomass decomposes, producing hypoxic “dead zones” and supporting harmful algal blooms that can release toxins dangerous to wildlife, livestock, and humans (Bailey et al., 2020).



Bang Sue Canal (Rai Khing Subdistrict, Sam Phran District, Nakhon Pathom Province) is a critical resource for local communities but faces severe pollution from agricultural runoff, industrial discharge, and domestic wastewater. Monitoring by TTW (June 2022–June 2023) showed low DO (1.00–1.75 mg/L) and a poor Water Quality Index (WQI = 49) for the canal, indicating significant organic and nutrient pollution. High ammonia-N and BOD suggest inputs from fertilizers, livestock waste, and untreated sewage.

Excess nitrate poses direct human health risks—conversion to nitrite can cause methemoglobinemia in infants and has been associated with certain cancers and thyroid dysfunction (Abdipour et al., 2025). High phosphate concentrations contribute to eutrophication and—at chronic, high exposures—may affect renal, cardiovascular, and bone health (Sharma et al., 2024). This study quantifies nitrate and phosphate in Bang Sue Canal across seasons and evaluates potential human health risks.

## Research Objectives

1. To determine the nitrate and phosphate concentration in Bang Sue Canal generated by agricultural, industrial, and household sources in the wet and dry seasons
2. To determine the nitrate and phosphate concentration in Bang Sue Canal generated by agricultural, industrial, and household sources in the wet and dry seasons

## Literature Review

Nitrate and phosphate enrichment of aquatic systems is driven by agricultural runoff, wastewater discharge, and atmospheric deposition, leading to eutrophication, oxygen depletion, and harmful algal blooms (Kapsalis, V. C., & Kalavrouziotis, I. K., 2021). Canals and small waterways are particularly vulnerable due to limited water exchange and strong land-use influence. Elevated BOD, low DO, and high ammonia often indicate chronic organic and nutrient pollution from domestic and agricultural sources (Gomes et al., 2019). In addition to ecological impacts, nitrate and phosphate contamination threaten public health through direct exposure and by complicating drinking water treatment (Nieder et al., 2018).

## Research Methodology

### 1. Materials and Methods

#### 1.1 Sampling Areas

Sampling was conducted in Bang Sue Canal (13°44'13.3 "N, 100°17'20.7" E), Rai Khing Subdistrict. Six sites were selected to represent residential (H1, H2), agricultural (A1, A2), and industrial (I1, I2) land uses. Samples were collected in both dry and wet seasons, with three replicates per site.

#### 1.2 The Determination of Nitrate and Phosphate

Nitrate was measured using the brucine method (EPA Method 352.1). Standards and reagents (brucine-sulfanilic acid and concentrated sulfuric acid) were prepared; samples and standards were reacted and incubated at 100°C for 25 minutes to develop color and read at 410 nm. Concentrations were determined from a calibration curve.

Orthophosphate was measured by the ascorbic acid method (EPA Method 365.2). Orthophosphate standards were prepared from  $\text{KH}_2\text{PO}_4$ . Samples were reacted with ammonium

molybdate, potassium antimony tartrate, sulfuric acid, and ascorbic acid to form molybdenum blue; absorbance was read at 880 nm after color development, and concentrations were determined via a calibration curve. All reagents were analytical grade, and glassware was acid-washed to avoid contamination.

### 1.3 Risk Characterization

Hazard Quotient (HQ) was calculated as:

$$HQ_{\text{oral,dermal}} = \frac{CDI_{\text{oral,dermal}}}{RfD_{\text{oral,dermal}}}$$

where CDI is the chronic daily intake (mg/kg/day) for oral or dermal exposure, and RfD is the reference dose. Reference values used: nitrate oral RfD = 0.36 mg/kg/day and dermal RfD = 0.18 mg/kg/day (USEPA 2000, 2003). For phosphate, an oral RfD of 0.00002 mg/kg/day was applied; a dermal RfD was not available. Hazard Index (HI) was computed as the sum of relevant HQs:

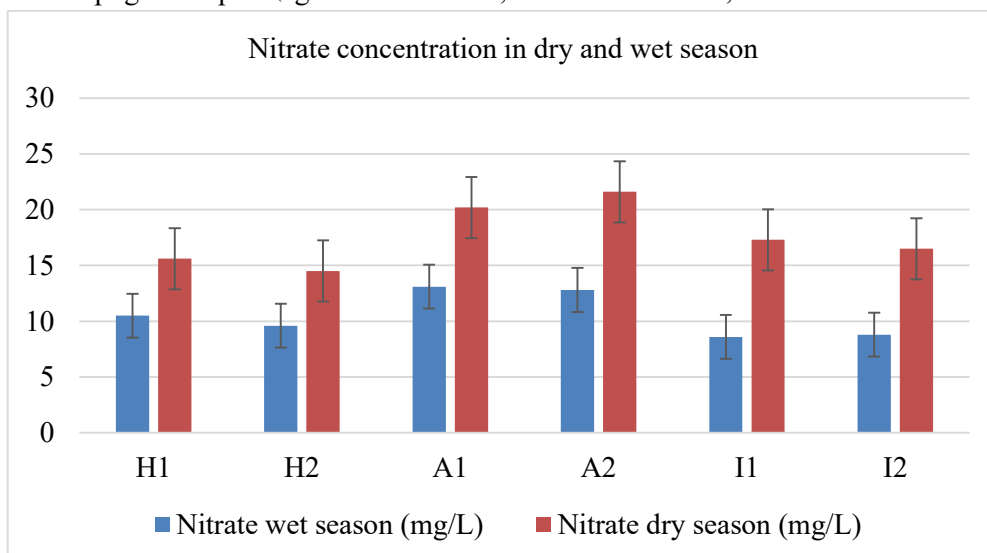
$$HI_{\text{oral,dermal}} = HQ_N + HQ_P$$

HI > 1 indicates potential for adverse health effects.

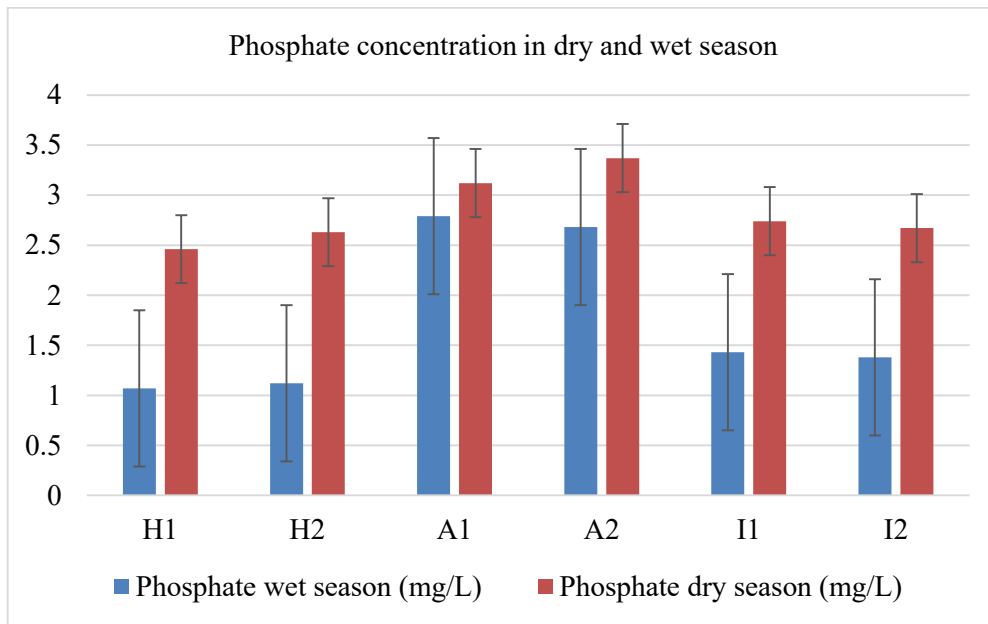
## Results

### 1. Nitrate and phosphate concentration in the dry and wet seasons

All sampling locations (H1, H2, A1, A2, I1, I2) exhibited clear seasonal variability. Nitrate concentrations were higher in the dry season (□ 15–22 mg/L) than in the wet season (□ 8–13 mg/L). Phosphate concentrations were also elevated in the dry season (□ 2.5–3.5 mg/L) relative to the wet season (□ 1–2.8 mg/L). Seasonal increases are attributed to lower dilution capacity, increased evaporation, and sustained anthropogenic inputs (agricultural runoff, industrial effluent, domestic wastewater).



**Picture 1:** Nitrate concentration in the dry and wet season



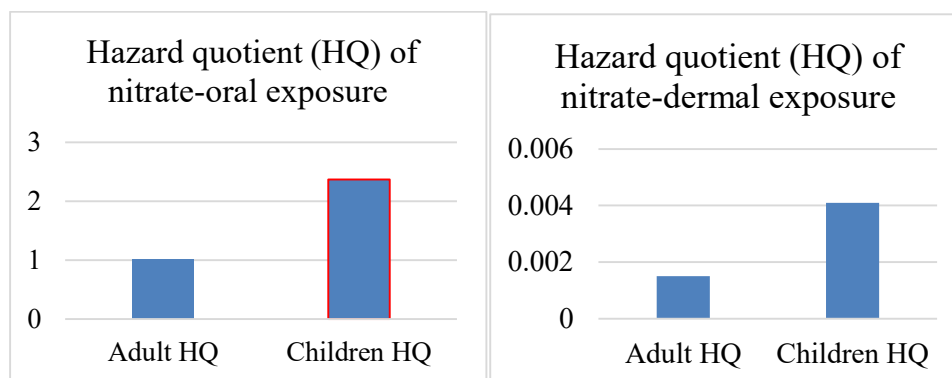
**Picture 2:** Phosphate concentration in the dry and wet seasons

## 2. Health Risk Assessment

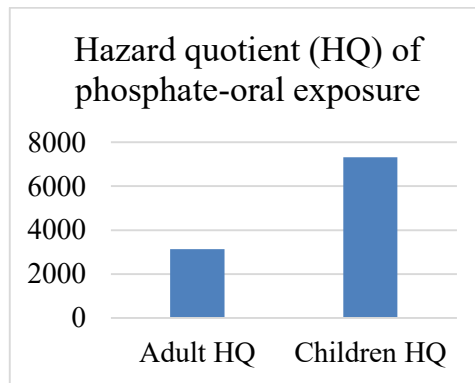
Using measured concentrations and standard exposure assumptions, oral HQs for nitrate were 1.01 for adults and 2.37 for children, indicating potential risk—especially for children. Dermal HQs for nitrate were negligible (0.0015 for adults, 0.0041 for children), indicating minimal risk by dermal contact.

Phosphate presented extremely high oral HQs: 3,135 for adults and 7,315 for children, far exceeding the threshold of 1 and indicating severe potential risk from oral exposure. Dermal HQs for phosphate could not be computed due to the absence of an established dermal RfD.

Combined oral HI values (nitrate + phosphate) were considerably  $>1$  for both adults and children, confirming significant cumulative risk from oral exposure.

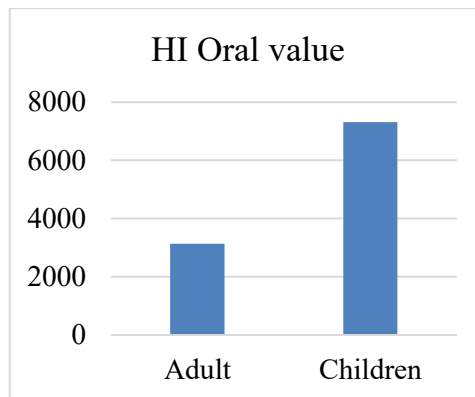


**Picture 3:** Hazard quotient (HQ) of oral and dermal exposure



**Picture 4:** Hazard quotient (HQ) of phosphate oral exposure

Picture 5 shows that the oral Hazard Index (HI) values demonstrate a very high health risk for both adults and children, as the calculated values are significantly greater than 1, which indicates potential adverse health effects. Conversely, the dermal HI values could not be fully computed due to the absence of dermal HQ data for phosphate.



**Picture 5:** Oral hazard index (HI) of adults and children

## Discussion

Nutrient concentrations were consistently higher in the dry season across land-use types, reflecting reduced dilution, greater evaporation, and constant anthropogenic nutrient inputs. Agricultural fertilizer runoff, domestic wastewater, and industrial discharges likely sustain elevated nutrient loads that become concentrated during low-flow periods. The canal shows signs of chronic nutrient pollution and ecological stress.

Risk assessment indicates ingestion is the primary exposure pathway of concern. Oral nitrate exposure poses a moderate to high risk—children are particularly vulnerable due to higher intake per body weight and physiological sensitivity. Phosphate's oral HQs are orders of magnitude above acceptable levels, indicating a critical and urgent public-health concern. The inability to evaluate dermal phosphate risk (no dermal RfD) is a limitation, though dermal uptake is generally less significant than ingestion for these ions.

## Conclusion

Bang Sue Canal exhibits significant seasonal variation in nutrient concentrations, with much higher nitrate and phosphate levels during the dry season. Elevated nutrient levels are driven by decreased dilution, evaporation, and ongoing anthropogenic inputs. Health-risk assessment shows oral



nitrate exposure poses notable risk—especially for children—and phosphate yields extraordinarily high oral HQs for both adults and children, indicating severe potential health hazards. These findings underscore an urgent need for targeted interventions: stricter regulation and control of nutrient discharges, enhanced wastewater treatment, land-management practices to reduce agricultural runoff, and public education on the risks of using contaminated canal water.

### Recommendations

Implement nutrient-source controls (best management practices for agriculture, stricter effluent standards for industry). Improve wastewater collection and treatment for domestic wastewater. Regular water-quality monitoring during dry and wet seasons with public reporting. Community outreach on water-use risks and promotion of safe drinking-water alternatives.

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# CONE-BEAM COMPUTED TOMOGRAPHIC ASSESSMENT OF MANDIBULAR LINGULA POSITION IN RELATION TO ANATOMICAL LANDMARKS

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## Abstract

**Background:** Accurate localization of the Mandibular Lingula (ML) is essential for successful Inferior Alveolar Nerve Block (IANB) and mandibular ramus surgery. Anatomical variability of the lingula may contribute to anesthetic failure and surgical complications. Cone-Beam Computed Tomography (CBCT) enables precise three-dimensional evaluation of lingula position relative to clinically relevant landmarks.

**Objective:** This study aimed to evaluate the spatial relationship between the mandibular lingula and selected anatomical landmarks using CBCT imaging.

**Methods:** A retrospective observational analysis was performed on 36 CBCT scans from individuals aged 20–70 years. Bilateral morphometric measurements included the vertical distance from the Occlusal Plane to the Lingula (OP–ML) and the horizontal distance from the Internal Oblique Ridge to the Lingula (IOR–ML). Statistical analyses were conducted using paired t-tests, independent t-tests, and one-way ANOVA with a significance level of  $p < 0.05$ .

**Results:** The mean OP–ML distance was  $7.97 \pm 3.19$  mm, and the mean IOR–ML distance was  $13.78 \pm 2.01$  mm. No significant differences were observed between the left and right sides. Males demonstrated greater mean values than females; however, statistically significant gender differences were limited to the right IOR–ML measurement ( $p = 0.012$ ). Age-related variation was minimal, with significant differences detected only for left IOR–ML among age groups.

**Conclusion:** The mandibular lingula exhibited relatively symmetrical bilateral positioning with measurements comparable to previous CBCT studies. These findings support the use of CBCT-based morphometric evaluation to enhance anatomical accuracy and improve clinical outcomes in IANB and mandibular ramus surgery.

**Keywords:** Mandibular Lingula, Cone-Beam Computed Tomography, Inferior Alveolar Nerve Block, Mandible Anatomy, Morphometric Analysis

## Introduction

Achieving a successful inferior alveolar nerve block is essential for a wide range of dental and surgical procedures involving the mandible. Despite being a routinely performed technique, it is associated with a relatively high failure rate, which has frequently been attributed to anatomical variability within the mandibular ramus. Among the anatomical structures influencing the accuracy of this procedure, the mandibular lingula plays a critical role. The lingula is a small bony prominence that overlies the mandibular foramen and marks the entry point of the inferior alveolar nerve into the mandible. Accurate localization of this structure is therefore essential, as its position serves as a key reference for determining the optimal needle insertion site and angulation during anesthetic administration.



Conventional methods for identifying the lingula commonly rely on external or palpable anatomical landmarks; however, these references may not reliably correspond to the underlying osseous anatomy, particularly in individuals with substantial anatomical variation. Cone-Beam Computed Tomography (CBCT) has emerged as an advanced imaging modality that enables detailed three-dimensional evaluation of craniofacial structures, providing greater spatial accuracy than traditional radiographic techniques. CBCT imaging allows clinicians and researchers to assess the positional relationships between the lingula and adjacent anatomical landmarks with improved precision, thereby supporting enhanced clinical decision-making and surgical planning.

Given the importance of anatomical accuracy in regional anesthesia and mandibular ramus surgery, further investigation into the spatial position of the mandibular lingula is warranted. A clearer understanding of these anatomical relationships may contribute to improved success rates of inferior alveolar nerve block and promote safer operative interventions within the mandibular ramus region.

## Research Objective

This study aims to evaluate the spatial relationship between the mandibular lingula and relevant anatomical landmarks using cone-beam computed tomography.

## Literature Review

The Mandibular Lingula (ML) is a bony prominence located on the medial surface of the mandibular ramus. It serves as the attachment site for the sphenomandibular ligament while forming the anterior boundary of the mandibular foramen (MF), the entry point of the inferior alveolar neurovascular bundle into the mandible (Chen et al., 2023). Accurate identification of the ML is essential for clinical procedures such as Inferior Alveolar Nerve Block (IANB) and sagittal split ramus osteotomy (SSRO). Variations in lingula morphology and position have been frequently associated with anesthetic failure, hemorrhage, and inferior alveolar nerve injury during surgical interventions (Jung et al., 2018; Sekerci et al., 2013). Consequently, numerous anatomical and radiological studies have investigated the morphology and spatial relationships of the lingula to improve clinical outcomes.

### 1. Dry-Skull Studies

Early anatomical knowledge of the ML was largely derived from direct measurements of dry human mandibles. These investigations established foundational classification systems but were limited by the absence of demographic data, soft-tissue context, and clinical history of the specimens. Lingula morphology was categorized into four types: triangular, truncated, nodular, and assimilated. The triangular type was reported as the most prevalent, followed by the truncated form (Tuli et al., 2000). However, more recent dry-skull research has demonstrated population-specific variability in the distribution of these morphological types (Samanta & Kharb, 2012).

Morphometric analyses in skeletal collections primarily focused on the relationship between the ML, the MF, and the borders of the mandibular ramus. Classic observations suggested that the ML is positioned near the midpoint of the ramus height, with vertical location increasing during growth, from a lower position in children to a more superior position in adults. Horizontally, the ML is typically located slightly posterior to the midpoint of the ramus width, with mean distances from the anterior border ranging from approximately 16.1 mm in Korean populations to 20.6 mm in Thai populations (Jansisyantont et al., 2009; Woo et al., 2002). The vertical distance between the ML and the sigmoid notch, commonly reported as 15–20 mm, has been described as a critical safety reference during vertical ramus osteotomies (Samanta & Kharb, 2012).



Despite their anatomical value, dry-skull studies present important limitations. The maceration process may damage delicate bony structures, particularly the thin apex of the triangular-shaped lingula, potentially leading to misclassification of morphology and biased prevalence data.

## **2. Two-Dimensional Imaging Studies Using Panoramic Radiography**

Panoramic radiography (Orthopantomography; OPG) has contributed significantly to the clinical understanding of ML position; however, the literature consistently highlights a balance between accessibility and measurement accuracy. Although widely used in clinical practice, panoramic images are subject to projection errors, ghost images, and non-uniform magnification, which may compromise the precise localization of the lingula compared with three-dimensional imaging modalities such as Cone-Beam Computed Tomography (CBCT).

The lingula is reportedly visible in approximately 80% of panoramic radiographs, whereas visualization in the remaining cases may be obscured by superimposition of contralateral structures or airway shadows (Jansisyant et al., 2009). Additionally, magnification errors ranging from 10% to 30% can affect horizontal measurements more substantially than vertical ones, reducing the reliability of linear morphometric analyses (Kositbowornchai et al., 2007).

Age-related positional changes of the ML have also been described in panoramic studies. In young children, the lingula is often positioned at or below the occlusal plane, necessitating lower injection sites for effective IANB. As mandibular growth progresses, the lingula migrates superiorly, stabilizing approximately 6–10 mm above the occlusal plane in adulthood (Sekerci et al., 2013). Furthermore, skeletal Class III malocclusion has been associated with a more superior lingula position relative to the coronoid notch (Jung et al., 2018).

## **3. Three-Dimensional Imaging Studies Using Cone-Beam Computed Tomography (CBCT)**

Cone-Beam Computed Tomography (CBCT) has emerged as an important imaging modality for evaluating mandibular lingula anatomy because it provides accurate three-dimensional visualization without the magnification and distortion commonly associated with two-dimensional radiographic techniques. CBCT enables detailed assessment of cortical bone morphology and the spatial relationships between anatomical landmarks, thereby improving preoperative planning for procedures such as Sagittal Split Ramus Osteotomy (SSRO), Intraoral Vertical Ramus Osteotomy (IVRO), and inferior alveolar nerve block (IANB) (Jang & Han, 2019; Sekerci & Sisman, 2014).

CBCT studies have demonstrated significant population-based variability in mandibular lingula morphology. In a Turkish population, the nodular type was reported as the most prevalent form, followed by truncated and triangular types (Sekerci & Sisman, 2014). In contrast, studies in Asian and Indian populations have more frequently reported triangular or truncated morphologies (Jung et al., 2018; Mutha et al., 2018). These findings suggest that lingula morphology varies across populations and craniofacial patterns, emphasizing the importance of population-specific anatomical assessment.

Dry-skull studies often report the triangular type as the most common mandibular lingula morphology, whereas CBCT studies frequently identify higher prevalence of nodular or truncated forms (Hsu et al., 2022; Samanta & Kharb, 2012; Tuli et al., 2000). This discrepancy may be partly explained by structural alterations during skeletal preparation and maceration. Because CBCT preserves native anatomical structures, it may provide a more accurate representation of lingula morphology in living populations (Chen et al., 2023). However, CBCT interpretation may still be influenced by factors such as image resolution, voxel size, and software reconstruction. Therefore, some studies have analyzed dry mandible and CBCT datasets separately to evaluate differences in lingula morphology and bilateral symmetry across populations (Hsu et al., 2022).



Three-dimensional measurements derived from CBCT have also clarified the spatial position of the lingula within the mandibular ramus. In adult populations, the mandibular lingula is generally located approximately 6–10 mm superior to the occlusal plane and 13–20 mm inferior to the sigmoid notch, measurements that are important when determining osteotomy levels during mandibular surgery (Chen et al., 2023; Sekerci & Sisman, 2014; Yu & Wong, 2008). Horizontally, the lingula is typically positioned slightly posterior to the midpoint of the ramus width, commonly reported at approximately 15–20 mm from the anterior border of the mandibular ramus (Chen et al., 2023). Furthermore, CBCT investigations have demonstrated that skeletal Class III malocclusion may be associated with a more superior lingula position relative to Class I skeletal patterns, which has important implications for surgical planning (Jung et al., 2018).

Developmental CBCT studies have also identified age-related variations in lingula position. In pediatric populations, the lingula may appear relatively higher in relation to the occlusal plane due to ongoing vertical growth of the mandibular ramus. Additionally, nodular morphology has been reported more frequently in younger individuals, emphasizing the importance of age-specific anatomical evaluation when planning anesthesia or surgical interventions (Sekerci et al., 2013). Collectively, these CBCT findings highlight the value of three-dimensional imaging in providing accurate morphometric data and improving the predictability and safety of mandibular anesthesia and surgical procedures.

#### **4. Clinical Implications of Mandibular Lingula Position Knowledge**

Accurate knowledge of the spatial position of the mandibular lingula has significant clinical implications in both anesthesia and mandibular ramus surgery. Because the lingula marks the entrance of the inferior alveolar neurovascular bundle, its anatomical variability directly influences the success of the inferior alveolar nerve block and the safety of osteotomy procedures. Several studies have demonstrated that inaccurate estimation of lingula height or anteroposterior location can lead to anesthetic failure or increase the risk of inferior alveolar nerve injury (Choi & Hur, 2021; Jung et al., 2018).

##### **4.1 Implications for Inferior Alveolar Nerve Block**

Successful IANB requires precise placement of the anesthetic solution near the mandibular foramen, which is closely associated with the lingula. Traditional landmark-based techniques rely on structures such as the occlusal plane and coronoid notch; however, individual anatomical variation can result in inconsistent outcomes. CBCT-based morphometric studies have demonstrated that lingula height commonly lies approximately 6–10 mm above the occlusal plane in adults, supporting the use of a higher injection level during anesthesia (Jang & Han, 2019; Sekerci & Sisman, 2014). Furthermore, investigations using internal oblique ridge-guided approaches have reported improved anesthesia success rates, suggesting that accurate knowledge of the horizontal relationship between the lingula and intraoral landmarks enhances clinical predictability (Jang & Han, 2019). These findings highlight the importance of population-specific morphometric data when planning anesthetic techniques.

##### **4.2 Implications for Mandibular Ramus Surgery**

The position of the lingula also plays a crucial role in surgical planning for procedures such as Sagittal Split Ramus Osteotomy (SSRO) and Intraoral Vertical Ramus Osteotomy (IVRO), as the lingula serves as an important anatomical landmark during medial osteotomy of the mandibular ramus (Jung et al., 2018; Zhou et al., 2017). Incorrect estimation of lingula height may result in unfavorable fracture patterns (“bad split”) during osteotomy and may increase the risk of injury to the inferior alveolar nerve (Yu & Wong, 2008). CBCT studies have shown that the vertical distance between the lingula and sigmoid notch provides an important surgical safety reference, enabling



clinicians to determine appropriate osteotomy levels and minimize complications (Sekerci & Sisman, 2014). Additionally, skeletal malocclusion patterns, particularly Class III deformities, have been associated with a more superior lingula position, suggesting that individualized preoperative evaluation is necessary (Jung et al., 2018).

### **4.3 Implications for Personalized and Image-Guided Dentistry**

Advances in CBCT imaging have shifted clinical practice toward patient-specific anatomical assessment. Three-dimensional evaluation allows clinicians to identify variations related to gender, age, and craniofacial morphology, thereby improving treatment planning and reducing procedural risks. Recent literature suggests that incorporating CBCT-based morphometric data into clinical decision-making can enhance anesthetic accuracy, reduce the risk of nerve injury, and improve surgical outcomes compared with relying on traditional two-dimensional imaging or generalized anatomical assumptions (Chen et al., 2023). Consequently, a comprehensive understanding of lingual position is increasingly recognized as an essential component of modern oral and maxillofacial practice.

## **Research Methodology**

### **1. Study design**

This retrospective observational study utilized cone-beam computed tomography (CBCT) scans to evaluate the positional relationship of the mandibular lingula (ML) relative to selected anatomical landmarks. Morphometric analyses were performed using previously acquired CBCT images.

### **2. Sample Selection**

A total of 36 CBCT scans from individuals aged 20 to 70 years were included in the study. Scans were collected from the existing radiographic database of patients who had undergone CBCT imaging for diagnostic purposes unrelated to the present research.

#### **2.1 Inclusion Criteria**

- Individuals aged 20-70 years
- High-quality CBCT scans without motion or metal artifacts
- Clear visualization of related anatomical structures

#### **2.2 Exclusion Criteria**

- Presence of mandibular deformities, pathological lesions, or fractures
- History of mandibular surgery or orthognathic procedures
- Incomplete or distorted CBCT data

### **3. Imaging and Data Acquisition**

All CBCT scans were obtained using a standardized imaging protocol and exported in Digital Imaging and Communications in Medicine (DICOM) format for analysis. The datasets were processed using dedicated CBCT viewing software capable of generating multiplanar reconstructions and performing linear measurements.

### **4. Morphometric Measurements**

Three primary anatomical reference structures were identified for morphometric analysis: the Mandibular Lingula (ML), the mandibular Occlusal Plane (OP), and the Internal Oblique Ridge (IOR). These landmarks were selected due to their clinical relevance in determining the spatial positioning of the lingula within the mandibular ramus and their consistent visualization on CBCT images.



Bilateral measurements were obtained from each scan. The vertical distance from the occlusal plane to the lingula (OP–ML) was measured perpendicular to the mandibular occlusal plane to assess the superior–inferior position of the lingula. The horizontal distance from the internal oblique ridge to the lingula (IOR–ML) represented the anteroposterior relationship between these structures, providing insight into the anteroposterior position of the lingula within the mandibular ramus.

All measurements were performed by a single calibrated observer to ensure measurement consistency and minimize inter-observer variability.

### 5. Statistical Analysis

Descriptive statistics, including mean values and standard deviations, were calculated for all morphometric variables. The Shapiro–Wilk test was used to assess data normality. Comparative analyses were conducted to evaluate potential differences between groups. Side-to-side comparisons were performed using the paired t-test, while gender-based differences were analyzed using the independent t-test. Variations among age groups were assessed using one-way analysis of variance (ANOVA). Statistical significance was defined as a p-value < 0.05.

### Results

A total of 36 CBCT scans were evaluated, consisting of 16 males (44.4%) and 20 females (55.6%). Participant ages ranged from 21 to 69 years, with a mean age of 44 years. All morphometric measurements demonstrated normal distribution according to the Shapiro–Wilk test.

Table 1 presents the comparison of distances from the mandibular lingula to selected anatomical landmarks between the left and right sides. The overall mean distance from the occlusal plane to the lingula (OP–ML) was  $7.97 \pm 3.19$  mm, with mean values of  $8.08 \pm 3.55$  mm on the left side and  $7.87 \pm 3.59$  mm on the right side. The mean distance from the internal oblique ridge to the lingula (IOR–ML) was  $13.78 \pm 2.01$  mm, including  $13.83 \pm 2.17$  mm on the left and  $13.73 \pm 2.09$  mm on the right. No statistically significant differences were identified between sides for OP–ML ( $p = 0.698$ ) or IOR–ML ( $p = 0.659$ ).

**Table 1:** Distances from the Mandibular Lingula to Anatomical Landmarks Comparing Sides

Distances	Side	Mean $\pm$ SD	Minimum	Maximum
OP-ML (mm.)	Left	$8.08 \pm 3.55$	0.9	14.1
	Right	$7.87 \pm 3.59$	1.5	14.7
	Both	$7.97 \pm 3.19$	2.4	14.1
IOR-ML (mm.)	Left	$13.83 \pm 2.17$	8.0	18.0
	Right	$13.73 \pm 2.09$	10.4	17.9
	Both	$13.78 \pm 2.01$	9.5	17.7

Table 2 shows the comparison of measurements between genders. Male groups demonstrated greater mean distances than females for both OP–ML and IOR–ML on both sides. For OP–ML, males exhibited mean values of  $9.20 \pm 3.75$  mm (left) and  $9.15 \pm 3.02$  mm (right), while females showed  $7.18 \pm 3.18$  mm (left) and  $6.85 \pm 3.76$  mm (right). These differences did not reach statistical significance ( $p = 0.090$  and  $p = 0.056$ , respectively). For IOR–ML, males presented mean values of  $14.58 \pm 2.77$  mm (left) and  $14.69 \pm 2.11$  mm (right), compared with  $13.24 \pm 1.34$  mm (left) and  $12.96 \pm 1.77$  mm (right) in females. A statistically significant difference was observed for the right IOR–ML measurement ( $p = 0.012$ ), while the left side approached but did not reach statistical significance ( $p = 0.089$ ).

**Table 2:** Distances from the Mandibular Lingula to Anatomical Landmarks Comparing Genders

Distances	Side	Male	Female	<i>p</i> -value
OP-ML (mm.)	Left	9.20 ± 3.75	7.18 ± 3.18	0.090
	Right	9.15 ± 3.02	6.85 ± 3.76	0.056
IOR-ML (mm.)	Left	14.58 ± 2.77	13.24 ± 1.34	0.089
	Right	14.69 ± 2.11	12.96 ± 1.77	0.012*

\**p* < 0.05

Table 3 presents the comparison of morphometric measurements across different age groups. One-way ANOVA demonstrated no statistically significant differences among age groups for OP–ML on either the left (*p* = 0.539) or right side (*p* = 0.948). Similarly, no significant variation was observed for right IOR–ML (*p* = 0.060). In contrast, left IOR–ML showed a statistically significant difference among age groups (*p* = 0.008), with the highest mean value identified in the 30–39-year age group.

**Table 3:** Distances from the Mandibular Lingula to Anatomical Landmarks Comparing Age groups

Distances	Side	Age group (years)					<i>p</i> -value
		20-29	30-39	40-49	50-59	60-69	
OP-ML (mm.)	Left	9.72 ± 2.91	8.88 ± 3.72	7.45 ± 2.42	7.37 ± 5.16	6.85 ± 3.08	0.539
	Right	8.01 ± 2.88	8.17 ± 5.55	8.31 ± 2.92	8.01 ± 3.55	6.81 ± 2.87	0.948
IOR-ML (mm.)	Left	11.94 ± 1.36	15.60 ± 1.49	14.35 ± 1.91	12.94 ± 2.67	14.10 ± 1.62	0.008*
	Right	12.78 ± 1.22	15.22 ± 1.85	14.40 ± 2.40	12.51 ± 1.75	13.52 ± 2.21	0.060

\**p* < 0.05

## Discussion

The present study evaluated the spatial relationship between the Mandibular Lingula (ML) and clinically relevant anatomical landmarks using Cone-Beam Computed Tomography (CBCT). The findings demonstrated that the ML was positioned approximately 7.97 mm above the occlusal plane and 13.78 mm posterior to the internal oblique ridge, with no statistically significant differences between the left and right sides. These results suggest a relatively symmetrical bilateral distribution of the lingula, consistent with previous CBCT investigations reporting minimal side-to-side variation in lingula position. Such anatomical consistency supports the predictability of lingula localization, which is beneficial for surgical planning and inferior alveolar nerve block procedures.

The mean vertical distance observed in the present study aligns with previous CBCT-based reports indicating that the lingula is typically located approximately 8-10 mm superior to the occlusal plane in adult populations (Chen et al., 2023). A CBCT study conducted in a Korean population reported a mean vertical distance of 8.85 ± 2.59 mm, which closely corresponds with the measurements obtained in this investigation (Jang & Han, 2019). The similarity of these findings reinforces the reliability of CBCT-derived morphometric analysis and supports clinical recommendations that anesthetic needle insertion for IANB should generally be directed superior to the occlusal plane. Furthermore, the absence of significant side differences in OP–ML measurements observed in the present study is consistent with previous CBCT literature demonstrating symmetrical vertical positioning of the lingula (Chen et al., 2023). From a clinical perspective, this symmetry suggests that bilateral anatomical landmarks may serve as dependable guides when direct visualization of the lingula is limited.

The mean horizontal distance from the internal oblique ridge to the lingula (IOR–ML) measured in this study (13.78 mm) is comparable to values reported in earlier CBCT analyses, which



typically range between 14 and 15 mm (Jang & Han, 2019). These findings further support the internal oblique ridge as a clinically relevant landmark for guiding needle placement during inferior alveolar nerve block.

Regarding gender differences, male participants demonstrated greater mean morphometric values than females for both OP–ML and IOR–ML measurements; however, statistically significant differences were limited to the right IOR–ML measurement. Similar trends have been described in previous CBCT studies, which often report larger mandibular dimensions in males, likely reflecting sexual dimorphism in craniofacial morphology (Jang & Han, 2019). Nevertheless, literature reviews have indicated that gender-related differences are not consistently significant across all populations and measurement parameters, suggesting that such variation may be influenced by ethnic background, sample composition, and methodological factors (Chen et al., 2023). The present findings therefore support the notion that although gender-related morphometric differences exist, they may not uniformly affect lingula positioning.

With respect to age-related variation, most measurements in this study did not demonstrate statistically significant differences among age groups, except for the left IOR–ML distance. Previous CBCT and anatomical investigations suggest that the lingula undergoes superior positional changes during growth and tends to stabilize after skeletal maturity (Sekerci et al., 2013). Because the study population consisted primarily of adults, substantial growth-related anatomical changes were unlikely, which may explain the limited age-related differences observed in the present analysis.

From a clinical standpoint, accurate localization of the mandibular lingula is essential for both regional anesthesia and mandibular ramus surgery. CBCT imaging provides precise three-dimensional visualization without the magnification and distortion associated with panoramic radiography, enabling clinicians to assess lingula position relative to surgical landmarks with improved accuracy. Previous literature has emphasized that a thorough understanding of lingula anatomy may reduce the risk of inferior alveolar nerve injury and improve the success rate of IANB (Choi & Hur, 2021). The findings of this study therefore support the continued application of CBCT-based morphometric evaluation to refine clinical guidelines for anesthesia and osteotomy procedures.

Several limitations should be acknowledged. First, the relatively small sample size may limit the generalizability of the findings. Second, the retrospective study design restricted access to detailed skeletal classification data, which could influence lingula positioning. Finally, all measurements were performed by a single observer, which may introduce measurement bias despite efforts to maintain consistency.

## **Conclusion**

Within the limitations of this CBCT-based retrospective study, the mandibular lingula demonstrated consistent bilateral positioning relative to the occlusal plane and internal oblique ridge, with no significant side differences. The mean vertical and horizontal distances identified were comparable to values reported in previous CBCT investigations, supporting the reliability of these anatomical landmarks for clinical reference. Although males tended to exhibit larger morphometric values than females, statistically significant gender differences were limited. Age-related variation was minimal among adult participants. These findings highlight the importance of three-dimensional CBCT evaluation in improving anatomical understanding and may contribute to enhanced accuracy and safety in inferior alveolar nerve block administration and mandibular ramus surgery.



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## LONGEVITY ENHANCEMENT: BY APPLYING HEALTH BEHAVIOR MODIFICATION

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### Abstract

**Background:** Longevity refers to living a longer and healthier life. Promoting longevity through effective health behavior modification is an important strategy for improving overall well-being and quality of life.

**Objectives:** This study aimed to examine the definition and significance of longevity and to explore approaches for enhancing longevity through behavioral modification.

**Methodology:** This research employed documentary analysis based on textbooks, academic books, journal articles, and related research studies.

**Results:** The findings indicate that: (1) longevity involves sustaining a longer and healthier lifespan, while behavioral modification refers to transforming unhealthy habits into healthier practices; (2) the significance of longevity extends beyond merely increasing lifespan to improving quality of life; and (3) strategies for enhancing longevity through behavioral modification include regular physical exercise, balanced nutrition, adequate sleep, effective stress management, positive social relationships, avoidance of harmful behaviors, and appropriate healthcare practices such as disease prevention and medical monitoring.

**Conclusion:** This documentary research and analysis are based on textbooks, academic books, journal articles, and related research studies. Enhancing longevity through behavioral modification include regular physical exercise, balanced nutrition, adequate sleep, effective stress management, positive social relationships, avoidance of harmful behaviors, and appropriate healthcare practices.

**Keywords:** Longevity Enhancement, Applying, Health Behavioral Modification

### Introduction

In the present population ageing is a major demographic transition both opportunities and challenges both in Thailand and global. From the year 2000 to 2050, the proportion of the world's population aged 60 years and older will double, whereas the proportion of those aged 80 years and older will almost quadruple. WHO advocates moving away from a disease-focused model of ageing and frailty, and towards a more positive model of healthy ageing that focuses on preserving functional ability and preventing loss of capacity. Healthy ageing is defined by WHO as "the process of developing and maintaining the functional ability that enables well-being in older age. (WHO, 2015). Including focus on health life span, longevity, and quality of life of the people also.

The average age of the global population is increasing rapidly, driven by multiple factors such as longer life expectancy and reduced birth rates in both developed and developing countries (United



Nations, 2019). Especially, the trend of longevity is very important in the world. Including medical factors and a healthy lifestyle are increasingly important trends.

As the demographic transition enters a new stage of a longevity transition, the focus needs to extend beyond an ageing society towards a longevity society. An ageing society focuses on changes in the age structure of the population, a longevity society seeks to exploit the advantages of longer lives through changes in how we age. Achieving a longevity society requires substantial changes in the life course and social norms, and involves an epidemiological transition towards a focus on delaying the negative effects of ageing. (Scotts, 2021)

Health Adjusted Life Expectancy, or Health Life Expectancy, is an important population health measure, as stated by the Director-General of WHO in the mid-1990s: "Increased longevity without quality of life is an empty prize." Health Life Expectancy is more essential than life expectancy. We should keep in mind that health expectancy numbers vary depending on the definition of health, the measures used, and the calculation method. The duration of both healthy and total life expectancy could rise, while the fraction of healthy life expectancy could fall. We need to understand what variables influence these changes and differences in order to recommend approaches to improve population health. (Saito, Yasuhiko; Robine, Jean-Marie; & Crimmins, Eileen M, 2014 : Chulaporn Sota et al (2024).

The broad changes required to achieve healthy longevity include an increased focus on healthy life expectancy, a shift from intervention towards preventive health, a major public health agenda to avoid increases in health inequality, the establishment of longevity councils to ensure coordinated policy across government departments, and intergenerational assessment of policies, to ensure that in adapting to longer lives, policies are not skewed towards older people. A longevity society represents a new stage for humanity and requires deep-seated notions about age and ageing to be challenged if society is to make the best use of the additional time that longevity brings. (AndrewJ. Scotts, 2021)

As a result, researchers would like to investigate the definition and importance of longevity Enhancement by applying health behavioral modification to better understand and develop appropriate interventions for longevity enhancement.

### **Research Objective (s)**

1. Study the definition of longevity-enhancing and behavioral modification.
2. Study the important of longevity enhancing and behavioral modification.
3. How to improve longevity enhancing by applying behavioral modification.

### **Literature Review**

**Longevity Enhancing:** The term “longevity” describes the length or duration of life, usually determined by comparing an individual's or species' lifespan to that of other species. But according to contemporary health sciences, longevity refers to both living longer (lifespan) and living better (health span), which means preserving social, mental, and physical well-being throughout life.

**Longevity Principles:** The guiding concepts that describe how to live a long and healthy life are known as the principles of longevity. They combine psychology, lifestyle, and biology to create a holistic approach to well-being. Principle 1: Comprehensive Harmony Maintaining homeostasis through appropriate sleep, diet, and emotional stability is essential for longevity. Principle 2: Maintaining Health Throughout Life Health is cumulative, meaning that our actions during childhood, adulthood, and old age all have an impact on our later years. The secret to healthy ageing is early prevention.

Principle 3: Adaptation to Stress. Stress isn't always bad. Exercise and mental challenges are examples of “eustress,” or positive stress, which fortifies biological systems and fosters resilience.



Principle 4: Connection and Purpose. Longevity and mental well-being depend on having social connections and a purpose in life. Individuals who have a strong sense of purpose tend to live longer and recover from illness more quickly. Principle 5: Prevention Is Better Than Treatment Longevity research focusses on early lifestyle modifications, exercise, mental health, and nutrition in order to prevent disease rather than just treat it.

**Health Behavioral Modification or Life style medicine is very important for increasing longevity** (American College of Lifestyle Medicine, 2025).

**Health Behavioral Modification** or Lifestyle medicine.

Lifestyle medicine is an evidence-based medical specialty designed to treat the whole person by empowering patients and clinicians to make lasting, healthy choices together. The goal of lifestyle medicine, an evidence-based medical specialty, is to treat the full person by enabling patients and doctors to jointly make long-lasting, healthful decisions. Lifestyle medicine, which treats, reverses, and prevents chronic illnesses including type 2 diabetes and cardiovascular disease, is based on six major interrelated pillars.

1. Nutrition: Increase your intake of whole foods and concentrate on nutrient-dense, plant-based, minimally processed meals and snacks.
2. Exercise: Include aerobic, strength, and flexibility exercises in your daily regimen.
3. Stress to face the constantly shifting demands of life and increase resilience, cultivate good coping mechanisms.
4. Sleep: Establish the ideal environment for getting seven to nine hours of good sleep each night so that the body can recharge and heal.
5. Relationships. Interconnectedness. Create connections and supportive relationships that give life meaning and purpose.
6. Avoiding dangerous substances: Steer clear of actions that include using or being around dangerous chemicals. Redefining care and restoring health

## **Research Methodology**

This was documentary research, which was conducted by reviewing documents and literature related to longevity enhancing by applying behavioral modification from textbooks and documents, as well as searching for information from journals, various databases, websites, and related research. The data was then analyzed into categories (content analysis), summarizing methods, definition, importance, how to improve longevity enhancing by applying behavioral modification, and guidelines for improving longevity enhancing by applying behavioral modification

## **Results**

### **Definition of Longevity and Health Behavior modification.**

Longevity and Health Behavior modification.

**Longevity** longevity is living a longer and healthier life. It means how long a person is going to live, and how healthy his later life will be, or Longevity refers to the ability to live a long life or the lifespan of an organism

### **Health Behavior modification.**

Health behavior modification is a therapeutic approach that uses learning principles like conditioning to change unhealthy habits into healthier ones. This involves using techniques such as reinforcement (positive or negative) and other strategies to make desired behaviors more likely and undesired behaviors less likely. The goal is to improve health outcomes by altering specific actions through environmental adjustments, self-monitoring, goal setting, and other motivational techniques.



### **Study the important of longevity enhancing and behavioral modification.**

The importance of longevity goes beyond simply living longer — it includes living healthier, more productive, and meaningful lives.

The Importance of Longevity

#### **Promoting Health and Quality of Life**

Longevity emphasizes not only lifespan but also **healthspan** the number of years lived in good health without major disease or disability. A longer healthspan allows individuals to maintain physical independence, mental clarity, and emotional well-being. Research shows that healthy longevity reduces the burden of chronic diseases such as cardiovascular disease, diabetes, and dementia, improving both individual and community health outcomes (World Health Organization, 2022).

#### **Advancing Scientific and Medical Knowledge**

Studying longevity helps scientists understand the **mechanisms of aging** at genetic, molecular, and cellular levels. Discoveries in longevity science — such as the role of telomeres, caloric restriction, or sirtuin activation — have led to potential interventions to delay aging and prevent age-related diseases (López-Otín et al., 2013). These advances benefit medicine, biotechnology, and personalized health.

#### **Social and Economic Benefits**

An increase in longevity contributes to **economic productivity** by allowing people to work longer, share experience, and support younger generations. Healthy older adults can continue to contribute socially and economically. However, if longevity is not accompanied by good health, it can create challenges for healthcare systems and pension structures — highlighting the importance of *healthy* longevity rather than just longer life expectancy (Bloom et al., 2020).

#### **Strengthening Intergenerational Relationships**

Longer lives provide more time for **intergenerational learning and family stability**. Elders can pass on cultural knowledge, wisdom, and values, enriching communities. Societies that promote longevity also tend to value social connection, empathy, and cooperation — qualities that strengthen social capital.

#### **Guiding Public Policy and Sustainable Development**

Longevity research informs **public health and policy planning**. Nations with aging populations need strategies to maintain workforce participation, ensure healthcare access, and design age-friendly environments. The United Nations' Decade of Healthy Ageing (2021–2030) recognizes longevity as essential to achieving sustainable development and human well-being.

#### **How to improve longevity enhancing by applying behavioral modification.**

To improve longevity through behavioral modification, use techniques like positive and negative reinforcement to adopt healthy habits, such as exercising, eating well, and getting enough sleep. These techniques can help create a strong foundation for a longer, healthier life by reinforcing positive choices and discouraging unhealthy ones

**Apply behavioral modification for longevity. The important approach both positive and negative are very important such as.**

Positive approach by reward yourself for completing healthy actions to make them more likely to occur again. Rewards can be small, like praise, a small treat, or extra leisure time after a workout or on a healthy eating day.

Negative approach by remove an unpleasant stimulus once you complete a desired behavior. For example, the annoying beeping of a car's seatbelt reminder stops only when you buckle up, making you more likely to use it in the future. Another example is to remove a tempting snack from your vicinity after a healthy meal.

**Apply behavioral modification for longevity. Focus on key behaviors for longevity, namely.**

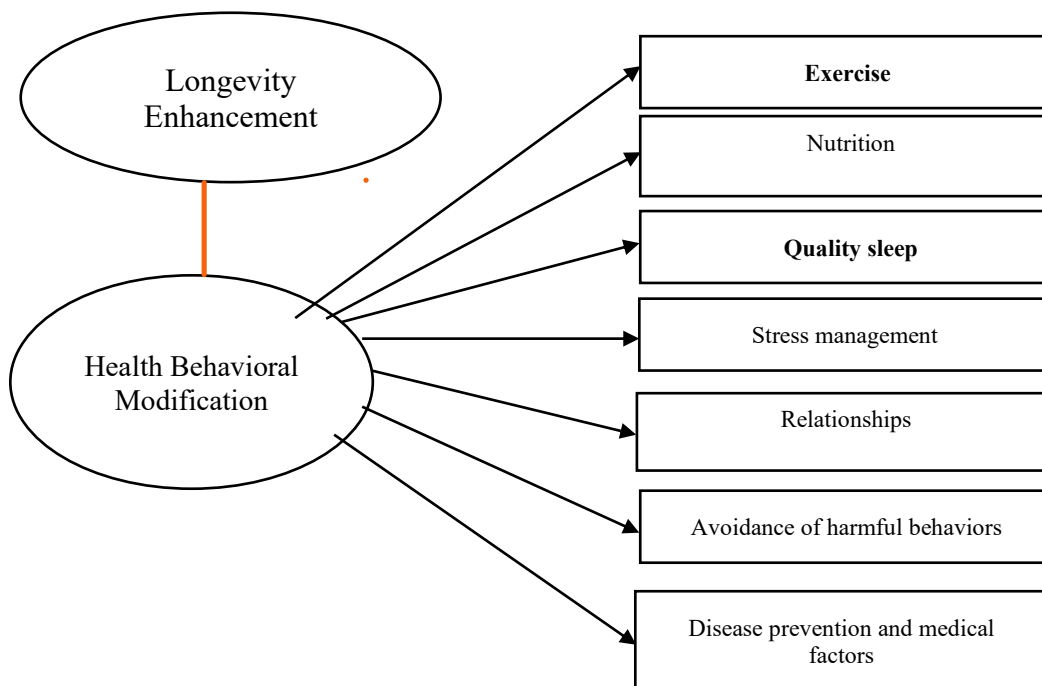
**Healthy eating:**

Develop new habits around eating by using positive reinforcement for healthy meal choices and avoiding environments that trigger unhealthy eating patterns., Diet: Patterns such as higher fruit/vegetable intake, more plant-based foods, lower processed food intake, and a healthy macronutrient balance are associated with longer/healthier lives.

**Regular Exercise:**

Reward yourself after completing workouts to build the habit. You can also use negative reinforcement by setting a goal to walk a certain number of steps, and you can remove the self-imposed "restriction" of fewer steps once you hit your goal .Physical activity: Regular exercise (aerobic + strength), maintaining mobility, avoiding sedentary behaviour. Lifestyle reviews show strong links with longevity.

1. Quality sleep. Create a routine and reward yourself for sticking to it. If you have trouble sleeping, try techniques to make your bedroom less stimulating at night.
2. Stress management. Practice techniques like meditation, deep breathing, or hobbies to manage stress instead of resorting to unhealthy coping mechanisms like excessive drinking or smoking. Psychological/mental health, stress resilience, purpose in life, social connectedness: These may not get as much public attention as diet/exercise, but research supports their relevance
3. Avoidance of harmful behaviors: Not smoking, moderate alcohol (or none), avoiding obesity/metabolic disease
4. Good relationship in family, social, avoid conflict, and can manage conflict smoothly
5. Health care, disease prevention, and medical factors. Preventive health care, early diagnosis & treatment of chronic diseases (cardiovascular disease, cancer, diabetes) obviously impact lifespan. In populations with good medical care, chronic diseases become predominant determinants. The management of risk factors (hypertension, hyperlipidemia, etc) shifts the trajectory of aging and increases “health span” (years lived without major disability) as Picture 1



**Picture 1:** Model of Longevity Enhancement by Applying Health Behavior Modification



## Discussion

Longevity is promote living a longer and healthier life mean while behavioral modification is a therapeutic approach that uses learning principles like conditioning to change unhealthy habits into healthier ones or life style medicine. These is high valuable for save cost from treatment, drug and hospital admission. Relevance Dawn Mussallem (2025) said that “Lifestyle medicine is integral to delivering successful world-class care and is a fundamental part of Mayo’s integrated clinical practice, education, and research.” Jon Bonnet (2025) said that “We all went into medicine to be healers, and lifestyle medicine is arguably the safest, cheapest, and most evidence-based set of interventions that exist to do just that.” Wayne Dysinger (2025) said that “This isn’t just about individual lives, it’s about a healthier society, a lighter burden on healthcare systems, and a world where improved well-being is the norm.”

Behavioral behaviors modification are goes beyond simply living longer it includes living **healthier, more productive, and meaningful lives including good quality of life. Various of health** behaviors modification have to focus such as health literacy improvement, life style modification basically knowledge, attitude , perception, value on health practice including applying behavioral science modification. “We are committed to supporting access to high-quality care and improve longevity enhancement by applying behavioral modification, have to focus on improve longevity through behavioral modification, use techniques like positive and negative reinforcement to adopt healthy habits, such as exercising, eating well, and quality sleep, stress management, good relationship, avoidance of harmful behaviours including health care, disease prevention and medical factors. These techniques can help create a strong foundation for a longer, healthier life by reinforcing positive choices and discouraging unhealthy as well as longevity enhancement. Strengthen for improve health behaviors continuously are very important for all people , set the goal in daily life and improving plan are essential. Including Kate Goodrich. (2025). Said that We are committed to supporting access to high-quality care and improving the health for all of our members and patients. Motivating lifestyle change is critical in preventing and treating chronic diseases, like diabetes. This partnership will ensure our clinicians receive evidence-based lifestyle change and behavioral motivation training to treat chronic disease more effectively.”

## Conclusion

This documentary research was based on textbooks, books, articles, research studies, theses and electronic documents that have content related to Longevity Enhancement and Health Behavioral Modification. Content analysis was used. The results of the study found that ). The definition of longevity is promote living a longer and healthier life mean while behavioral modification is a therapeutic approach that uses learning principles like conditioning to change unhealthy habits into healthier ones.

Improve longevity enhancement by applying behavioral modification, have to focus on improve longevity through behavioral modification, use techniques like positive and negative reinforcement to adopt healthy habits, such as exercising, eating well, and quality sleep, stress management, good relationship, avoidance of harmful behaviours including health care, disease prevention and medical factors. These techniques can help create a strong foundation for a longer, healthier life by reinforcing positive choices and discouraging unhealthy as well as longevity enhancement.



## Recommendations

### Recommendations For Applying

1. Encouragement academic personnel focus on how to improve longevity enhancing by applying behavioral modification.
2. Stimulate health personnel to close the gap of Health Life Expectancy and Life Expectancy.
3. Available resource for increase how to improve longevity enhancing by applying behavioral modification.

### Recommendations For Further Research

1. Study factor effecting how to improve longevity enhancing by applying behavioral modification.
2. Conduct the effectiveness of the program for increasing how to improve longevity enhancing by applying behavioral modification.
3. Expand and Study the effectiveness of improving longevity enhancing by applying behavioral modification.

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