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BEYOND INJURY PREVENTION: AN ITERATIVE CYCLE ARCHITECTURE FOR MUSCULOSKELETAL HEALTH AND QUALITY OF LIFE IN SEDENTARY ADULTS

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INTRODUCTION

The contemporary lifestyle, shaped by digitalization, automation, and urbanization, has contributed to unprecedented levels of physical inactivity and sedentary behavior. According to World Health Organization (WHO), more than 31% of adults worldwide fail to meet recommended physical activity levels, while occupational sitting commonly reaches 6–8 hours per day[1,2]. These trends represent major modifiable risk factors for musculoskeletal disorders (MSDs), which not only increase clinical burden but also reduce health-related quality of life (HRQoL) through pain, impaired physical functioning, reduced vitality, and restricted social participation[3,4,5,6]. HRQoL serves in this article as an interpretive framework rather than a directly measured outcome; the functional findings are discussed in relation to established Short Form-36 (SF-36) and EuroQol Five-Dimension (EQ-5D), with formal HRQoL assessment reserved for future research.

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[1] Strain T., Flaxman S., Guthold R., Mathers C., Temmerman M., Bull F. C. et al. National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: A pooled analysis of 507 population-based surveys with 1.9 million participants. The Lancet Global Health. 2024. Vol. 12, No. 8. P. e1312–e1323. DOI: 10.1016/S2214-109X(24)00150-5.

[2] Park S., Lee S., Kim Y., Lee Y., Jee S. H., Kim Y. Sedentary behaviour and physical activity among adult workers: A systematic review and meta-analysis. BMC Public Health. 2024. Vol. 24. Article 19449. DOI: 10.1186/s12889-024-19449-y.

[3] Lee J. H., Yun I., Nam C. M., Jang S. Y., Park E. C. Association between physical activity and health-related quality of life in middle-aged and elderly individuals with musculoskeletal disorders: Findings from a national cross-sectional study in Korea. PLOS ONE. 2023. Vol. 18, No. 11. Article e0294602. DOI: 10.1371/journal.pone.0294602.

[4] Moreira S., Criado M. B., Santos P. C., Ferreira M. S., Gonçalves C., Machado J. Physical activity, musculoskeletal symptoms and quality of life in computer workers: A narrative review. Healthcare. 2022. Vol. 10, No. 12. Article 2457. DOI: 10.3390/healthcare10122457.

[5] Alhashim A. A., Alyousof A. A., Aldawsari M. R., Alghannam A. A., Alsayed M. A., Alawadh R. A., Almulhim S. A. Work-related musculoskeletal disorders and their impact on quality of life: A comprehensive review. Saudi Journal of Medicine & Pharmaceutical Sciences. 2025. Vol. 11, No. 5. P. 360–377.

[6] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

MSDs associated with sedentary lifestyles – including degenerative spinal disorders, postural dysfunctions, muscular syndromes, and osteoarthritis – have become a significant public health and socioeconomic challenge[7]. Although physical activity is widely recognized as protective, conventional fitness approaches are often unsuitable for sedentary adults because they rarely account for low baseline fitness, existing functional deficits, or the pathophysiological consequences of inactivity[8,9].

Evidence-based programs specifically adapted for this population and explicitly targeting HRQoL improvement remain limited[10]. Addressing this gap constitutes the central problem of the present study.

For the purposes of this article, sedentary behavior refers to waking activities performed while sitting, reclining, or lying with energy expenditure $\leq$1.5 metabolic equivalents of task (METs), whereas physical inactivity denotes failure to achieve recommended levels of moderate-to-vigorous physical activity – a distinction formally established by the Sedentary Behaviour Research Network (SBRN) in 2017[11]. An individual may satisfy weekly activity guidelines yet remain highly sedentary throughout the day, making this differentiation directly relevant for both assessment and intervention design[12].

The aim of this study is to develop and substantiate a conceptual framework for physical activity programming in sedentary adults – the iterative cycle architecture, integrating the PDCA model, Just-in-Time Adaptive Interventions (JITAI), and Self-Determination Theory (SDT) – and to evaluate its practical feasibility through a 12-week intervention with a

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[7] Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. Physiological Reviews. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

[8] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[9] Prince S. A., Saunders T. J., Gresty K., Reid R. D. A comparison of the effectiveness of physical activity and sedentary behaviour interventions in reducing sedentary time in adults: A systematic review and meta-analysis of controlled trials. Obesity Reviews. 2014. Vol. 15, No. 11. P. 905–919. DOI: 10.1111/obr.12215.

[10] Dempsey P. C., Friedenreich C. M., Leitzmann M. F., Buman M. P., Lambert E., Willumsen J., Bull F. Global public health guidelines on physical activity and sedentary behavior for people living with chronic conditions: A call to action. *Journal of Physical Activity and Health*. 2021. Vol. 18, No. 1. P. 76–85. DOI: 10.1123/jpah.2020-0525.

[11] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[12] Owen N., Healy G. N., Matthews C. E., Dunstan D. W. Too much sitting: The population-health science of sedentary behavior. Exercise and Sport Sciences Reviews. 2010. Vol. 38, No. 3. P. 105–113. DOI: 10.1097/JES.0b013e3181e373a2.

3-month follow-up, using functional capacity outcomes as proxy indicators of health-related quality of life (HRQoL) pending formal HRQoL assessment in future research. For the purposes of this article, the iterative cycle is defined as a repeatable sequence of four interconnected stages – initial assessment, individualized program design, implementation with concurrent monitoring, and data-driven adjustment – in which each completed cycle generates new information about the participant's physiological responses and behavioral patterns, enabling progressive convergence of program parameters toward individual needs. This architecture is distinguished from classical periodization by its explicit responsiveness to real-world variability and from JITAI by its macro-level structural scope. The framework is grounded in the pathophysiological consequences of sedentary behavior and informed by the empirical assessment of functional capacity and injury-risk factors, enabling personalized intervention and longitudinal follow-up beyond the traditional injury-prevention paradigm.

To achieve this aim, the study pursued three objectives: (1) to examine existing physical activity programming models – classical periodization, FITT-based prescription (FITT – Frequency, Intensity, Time, and Type), and JITAI – and to identify the structural gap that limits their applicability to sedentary adults with high motivational variability and low functional baseline; (2) to develop and empirically substantiate an iterative cycle architecture for physical activity programming that integrates classical periodization, the PDCA model, and adaptive intervention principles (JITAI) alongside motivational constructs from SDT; and (3) to report 3-month follow-up outcomes extending the 12-week intervention data, and to evaluate both the maintenance and continued trajectory of functional gains in sedentary adults, including domains in which improvement persisted beyond the immediate post-intervention assessment.

This article reports an original empirical study comprising a 12-week exercise intervention in sedentary adults (n = 27)[13] and a 3-month follow-up assessment (n = 23). The intervention data were originally collected as part of the first author's thesis (Shanin, 2025); the present article constitutes an independent scholarly contribution by subjecting those data to new theoretical analysis and adding three original elements absent from the thesis: an HRQoL outcomes framework, an iterative cycle architecture integrating PDCA, JITAI, and SDT, and the follow-up assessment itself.

[13] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

1. Defining Sedentary Behavior and Physical Inactivity

Paradoxically, the same technological advances that have made recreational and leisure-time movement more accessible have also restructured work, transport, and domestic life in ways that systematically remove incidental physical activity from daily routines. The result is a population-level erosion of habitual movement that now ranks among the leading modifiable contributors to chronic non-communicable disease burden and musculoskeletal disorder incidence worldwide (MSDs)[14]. For a rigorous theoretical analysis, it is essential to clearly differentiate the baseline concepts: sedentary behavior and physical inactivity. Despite their semantic proximity, these terms possess distinct methodological foundations and biomedical consequences, which directly affect health-related quality of life (HRQoL). These constructs form a hierarchical continuum: sedentary behavior operates at the observable behavioral tier, physical inactivity reflects a quantitative shortfall against public health benchmarks, and the chronic physiological deconditioning that emerges from their prolonged interaction constitutes a qualitatively distinct pathophysiological state[15,16,17].

From a behavioral epidemiology standpoint, sedentary behavior encompasses waking activities where energy demand remains at or below 1.5 METs – a threshold that captures postures ranging from seated work to supine rest [18,19]. It is important to note, however, that reliance on the 1.5-MET threshold alone has certain limitations. Empirical studies have shown that some standing activities may fall below this threshold, whereas certain seated activities may exceed it, suggesting that energy expenditure criteria should be interpreted alongside postural and behavioral

[14] Katzmarzyk P. T., Friedenreich C., Shiroma E. J., Lee I.-M. Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. British Journal of Sports Medicine. 2022. Vol. 56, No. 2. P. 101–106. DOI: 10.1136/bjsports-2020-103640.

[15] Owen N., Healy G. N., Matthews C. E., Dunstan D. W. Too much sitting: The population-health science of sedentary behavior. Exercise and Sport Sciences Reviews. 2010. Vol. 38, No. 3. P. 105–113. DOI: 10.1097/JES.0b013e3181e373a2.

[16] Park S., Lee S., Kim Y., Lee Y., Jee S. H., Kim Y. Sedentary behaviour and physical activity among adult workers: A systematic review and meta-analysis. BMC Public Health. 2024. Vol. 24. Article 19449. DOI: 10.1186/s12889-024-19449-y.

[17] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[18] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[19] Ainsworth B. E., Haskell W. L., Herrmann S. D., Meckes N., Bassett D. R., Tudor-Locke C. et al. 2011 compendium of physical activities: A second update of codes and MET values. Medicine & Science in Sports & Exercise. 2011. Vol. 43, No. 8. P. 1575–1581. DOI: 10.1249/MSS.0b013e31821ece12.

characteristics when classifying sedentary behavior[20,21,22,23]. This behavioral category, while often conflated with physical inactivity in lay discourse, operates through distinct mechanistic pathways that are particularly relevant to musculoskeletal health outcomes[24]. In occupational and leisure contexts alike, this behavioral pattern surfaces as prolonged desk-based computing, passive screen time, reading in a fixed posture, and vehicle-based commuting – activities whose common denominator is sustained low postural demand rather than any specific setting or device[25,26]. Within the context of this study, the term «inactive behavior» is used only as a behavioral descriptor referring to prolonged low-energy activities characteristic of sedentary behavior. It should not be interpreted as synonymous with physical inactivity, which remains a distinct construct defined by insufficient achievement of recommended physical activity levels. It is critical to emphasize that sedentary behavior should not be equated with physical inactivity. An individual can meet the recommendations for moderate-to-vigorous physical activity yet still spend a substantial portion of the day in a low energy expenditure state.

Under WHO guidelines, adults aged 18–64 are considered physically inactive when they accumulate fewer than 150 minutes of moderate-intensity effort – or fewer than 75 minutes of vigorous effort – per week; activities in

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[20] Mansoubi M., Pearson N., Clemes S. A., Biddle S. J. H., Bodicoat D. H., Tolfrey K. et al. Energy expenditure during common sitting and standing tasks: Examining the 1.5 MET definition of sedentary behaviour. BMC Public Health. 2015. Vol. 15. Article 516. DOI: 10.1186/s12889-015-1851-x.

[21] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[22] Dzakpasu F. Q. S., Carver A., Brakenridge C. J., Cicuttini F., Urquhart D. M., Owen N., Dunstan D. W. Musculoskeletal pain and sedentary behaviour in occupational and non-occupational settings: A systematic review with meta-analysis. International Journal of Behavioral Nutrition and Physical Activity. 2021. Vol. 18. Article 159. DOI: 10.1186/s12966-021-01233-8.

[23] Owen N., Healy G. N., Matthews C. E., Dunstan D. W. Too much sitting: The population-health science of sedentary behavior. Exercise and Sport Sciences Reviews. 2010. Vol. 38, No. 3. P. 105–113. DOI: 10.1097/JES.0b013e3181e373a2.

[24] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[25] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[26] Thosar S. S., Bielko S. L., Mather K. J., Johnston J. D., Wallace J. P. Effect of prolonged sitting and breaks in sitting time on endothelial function. Medicine & Science in Sports & Exercise. 2015. Vol. 47, No. 4. P. 843–849. DOI: 10.1249/MSS.0000000000000479.

this threshold range demand 3–6 METs and above[27,28]. The definitional boundary between this construct and sedentary behavior was formally clarified in 2017, when the Sedentary Behaviour Research Network (SBRN) published a terminology consensus[29]. That consensus established physical activity as skeletal-muscle-driven bodily movement that elevates energy expenditure above resting metabolic rate – a definition that deliberately excludes the low-demand postural behaviors captured by the sedentary behavior category.

The musculoskeletal consequences of prolonged sitting unfold through interconnected biological systems, each exerting measurable effects on daily functioning[30,31]. Prolonged sedentary behavior translates into clinically relevant dysfunction through seven interconnected pathophysiological mechanisms. Chronic underrecruitment of high-threshold type II myofibers drives selective fast-twitch atrophy, reducing explosive force capacity and prolonging recovery from exertion[32]. Uninterrupted postural immobility impairs venous return and endothelial shear signaling, promoting lower-limb edema and nocturnal cramping that fragment sleep[33]. Attenuated mechanoreceptor discharge degrades proprioceptive reflex fidelity, elevating fall risk and constraining participation in daily physical activities[34]. Suppressed lipoprotein lipase activity and impaired GLUT4 translocation

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[27] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

[28] Dempsey P. C., Friedenreich C. M., Leitzmann M. F., Buman M. P., Lambert E., Willumsen J., Bull F. Global public health guidelines on physical activity and sedentary behavior for people living with chronic conditions: A call to action. *Journal of Physical Activity and Health*. 2021. Vol. 18, No. 1. P. 76–85. DOI: 10.1123/jpah.2020-0525.

[29] Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

[30] Thosar S. S., Bielko S. L., Mather K. J., Johnston J. D., Wallace J. P. Effect of prolonged sitting and breaks in sitting time on endothelial function. Medicine & Science in Sports & Exercise. 2015. Vol. 47, No. 4. P. 843–849. DOI: 10.1249/MSS.0000000000000479.

[31] Bruyère O., Scott D., Papaioannou A., Buehring B., Camargos B. M., Chapurlat R. et al. The impact of sedentary behavior and physical activity on bone health: A narrative review from the Rehabilitation Working Group of the International Osteoporosis Foundation. Calcified Tissue International. 2025. Vol. 116, No. 1. P. 109. DOI: 10.1007/s00223-025-01421-6.

[32] Gordon T. Neuromuscular activity determines, at least in part, the motoneuron, nerve and muscle properties under normal conditions and after nerve injury. International Journal of Molecular Sciences. 2025. Vol. 26, No. 14. Article 6891. DOI: 10.3390/ijms26146891.

[33] Hamilton M. T., Hamilton D. G., Zderic T. W. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. Diabetes. 2007. Vol. 56, No. 11. P. 2655–2667. DOI: 10.2337/db07-0882.

[34] Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. Physiological Reviews. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

sustain low-grade systemic inflammation and amplify perceived fatigue[35]. Sustained postural loading simultaneously shortens hip flexors and posterior chain structures while promoting maladaptive collagen remodeling in fasciae and tendons, reducing joint mobility and elevating injury risk upon sudden mechanical demand[36]. Skeletal unloading further suppresses osteoblastic activity and accelerates resorption, progressively compromising structural bone integrity and increasing fracture susceptibility[37]. Finally, prolonged inactivity attenuates heart rate variability and elevates resting sympathetic tone, amplifying cardiometabolic risk independently of the other sedentary-behavior pathways described above[38]. At the structural level, reduced osteoblast stimulation and altered cartilage nutrition accelerate degenerative changes that present as morning stiffness and activity-limiting pain. When low mechanical demand persists over months and years, converging processes undermine musculoskeletal integrity: proprioceptive throughput from joint mechanoreceptors diminishes, local microvascular perfusion declines, articular cartilage degrades through disuse, and the passive stabilizing structures of the spine and peripheral joints gradually lose tensile capacity. The cumulative result is not simply weakness – it is a reduction in the organism's functional reserve across multiple systems simultaneously, which manifests clinically as reduced pain tolerance, impaired postural control, and a progressive narrowing of the activities a person can perform without discomfort.

Each of these seven mechanisms imposes a distinct demand on the exercise program designed to reverse it. Fast-twitch atrophy requires resistance stimuli capable of recruiting high-threshold motor units – not merely sustaining low-intensity movement. Proprioceptive degradation requires dedicated balance and coordination training as a distinct program component, not a by-product of strength work. Metabolic dysregulation produces highly variable session-to-session tolerance, which fixed-load programming cannot accommodate without ongoing monitoring and

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[35] Hamilton M. T., Hamilton D. G., Zderic T. W. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. Diabetes. 2007. Vol. 56, No. 11. P. 2655–2667. DOI: 10.2337/db07-0882.

[36] Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. Physiological Reviews. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

[37] Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. Physiological Reviews. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

[38] Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. Physiological Reviews. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

adjustment. Connective tissue shortening requires individually calibrated mobility work, not a uniform stretching routine. Taken together, these demands define a programming profile that no single existing model fully addresses – and that the iterative cycle architecture introduced in Chapter 3 is specifically designed to meet.

The key emphasis: health-related quality of life (HRQoL) as an integrative outcome. In individuals with a sedentary lifestyle, the deterioration of quality of life occurs across several domains that are directly measurable and clinically relevant. Rather than treating HRQoL as a post-hoc outcome, we frame it as a mechanistically informative lens[39,40]. For instance, limitations in the physical functioning domain – difficulty carrying groceries, prolonged standing tolerance – directly reflect the cumulative burden of type II fiber atrophy and stabilizer deconditioning. Bodily pain scores capture the subjective correlate of altered nociceptive processing from degenerating intervertebral discs and facet joints. Vitality ratings, often dismissed as non-specific, track the inflammatory and metabolic dysregulation characteristic of prolonged sitting. This mechanistic specificity allows targeted exercise prescription to address both biological dysfunction and its experiential consequences. The mental well-being domain includes anxiety, low mood, and reduced social participation due to activity limitations and, in some cases, social isolation.

This mechanistic mapping between pathophysiology and HRQoL domains has a direct practical implication: it specifies what a program for this population must measure, not only what it must prescribe. A program that reduces acute pain but fails to address metabolic dysregulation will improve bodily pain scores without improving vitality. A program that increases weekly step count without interrupting prolonged sitting will reduce physical inactivity without resolving the specific musculoskeletal burden of sedentary behavior. Outcome monitoring that does not track both dimensions will therefore systematically misread the program's actual effect. Recent studies consistently demonstrate that excessive sedentary behavior is an independent risk factor for reduced quality of life, even after controlling for the volume of moderate-to-vigorous physical activity. Individuals with prolonged daily sitting time tend to demonstrate a substantially higher likelihood of reporting moderate to severe musculoskeletal pain compared to those with lower sedentary exposure, even when levels of weekly physical

[39] EuroQol Group. EuroQol – a new facility for the measurement of health-related quality of life. Health Policy. 1990. Vol. 16, No. 3. P. 199–208. DOI: 10.1016/0168-8510(90)90421-9.

[40] Ware J. E., Sherbourne C. D. The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. Medical Care. 1992. Vol. 30, No. 6. P. 473–483.

activity are comparable[41,42]. The relationship between sedentary time and health-related quality of life appears to be nonlinear, with adverse effects becoming more pronounced beyond a moderate threshold of daily sitting. Moreover, the combination of prolonged sedentary behavior and very low engagement in moderate-to-vigorous physical activity is associated with a marked deterioration in quality of life, exceeding the impact observed when either risk factor is present in isolation.

Maintaining the distinction between these two constructs carries concrete clinical utility across three domains. In assessment, it determines whether the primary target is interrupting prolonged low-energy postures – a behavioral problem addressed through scheduled movement breaks and postural variation – or closing a shortfall in structured moderate-to-vigorous activity, which calls for progressive volume prescription. In preventive design, the two profiles call for different near-term strategies: sedentary behavior interventions can achieve meaningful reductions in musculoskeletal pain through brief work-hour activity bouts, whereas physical inactivity correction requires systematic load progression toward guideline thresholds. In therapeutic programming, mechanistic understanding of each construct guides exercise selection – metabolic normalization, myotonus restoration, and articular protection depend on accurately identifying which deficit is primary[43,44]. This distinction is not merely taxonomic. It determines the primary unit of intervention: a program targeting sedentary behavior must be structured around the distribution of movement across the day, whereas a program targeting physical inactivity must be structured around the progressive accumulation of exercise volume. When both deficits are present simultaneously – as they are in the majority of desk-based workers – a programming architecture that addresses only one will systematically

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[41] Ekelund U., Tarp J., Steene-Johannessen J., Hansen B. H., Jefferis B., Fagerland M. W. et al. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: Systematic review and harmonised meta-analysis. BMJ. 2019. Vol. 366. Article l4570. DOI: 10.1136/bmj.l4570.

[42] Biswas A., Oh P. I., Faulkner G. E., Bajaj R. R., Silver M. A., Mitchell M. S., Alter D. A. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: A systematic review and meta-analysis. Annals of Internal Medicine. 2015. Vol. 162, No. 2. P. 123–132. DOI: 10.7326/M14-1651.

[43] Dzakpasu F. Q. S., Carver A., Brakenridge C. J., Cicuttini F., Urquhart D. M., Owen N., Dunstan D. W. Musculoskeletal pain and sedentary behaviour in occupational and non-occupational settings: A systematic review with meta-analysis. International Journal of Behavioral Nutrition and Physical Activity. 2021. Vol. 18. Article 159. DOI: 10.1186/s12966-021-01233-8.

[44] Ekelund U., Tarp J., Steene-Johannessen J., Hansen B. H., Jefferis B., Fagerland M. W. et al. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: Systematic review and harmonised meta-analysis. BMJ. 2019. Vol. 366. Article l4570. DOI: 10.1136/bmj.l4570.

underserve the other. This is the first structural requirement that any framework for this population must satisfy.

Although sedentary behavior and physical inactivity are frequently treated as interchangeable in public discourse, they occupy different positions on the causal chain leading to musculoskeletal deterioration. The former is a pattern of daily time use; the latter is a quantitative shortfall in structured exertion. Their combined and sustained presence, however, produces a qualitatively distinct outcome: progressive morphofunctional remodeling whose downstream effects – pain, fatigue, restricted mobility, and social withdrawal – constitute the lived experience of poor HRQoL. It is this downstream convergence that makes precise upstream differentiation clinically necessary.

The population defined by this profile – simultaneously sedentary and physically inactive, presenting with multiple interacting functional deficits and high variability in day-to-day capacity – constitutes a programming problem that existing models were not designed to solve. Classical periodization assumes stable adaptation trajectories. FITT-based prescription assumes that initial calibration holds across the program duration. Just-in-time adaptive interventions address the moment but not the macrostructure. The gap between what this population requires and what current models provide is the problem that the following chapters address directly.

2. Physical Activity Programming for Sedentary Adults: Models, Gaps, and an Iterative Framework

Building on the conceptual distinctions established in Chapter 1, this chapter maps the landscape of existing physical activity programming models, identifies the structural gap that limits their applicability to sedentary adults, establishes the evidence base for the tailored exercise approach developed in this study, and traces the pathophysiological mechanisms of sedentary deconditioning to specific deficits in health-related quality of life. The epidemiological scale of the problem is substantial. WHO surveillance data indicate that more than one in four adults globally fails to meet minimum physical activity recommendations. Within Ukraine, national health survey data indicate that nearly half of working-age adults describe their occupational routine as primarily seated or stationary, with the proportion rising considerably among workers in IT and knowledge-economy sectors, where occupational sitting is estimated to account for 65–70% of the working day according to professional-group disaggregation of the same national survey data[45]. Adherence to WHO recommendations for

[45] Міністерство охорони здоров'я України. Національне опитування стану здоров'я населення України / Державна установа «Центр громадського здоров'я МОЗ України». Київ, 2021. URL: https://phc.org.ua/news/nacionalne-opituvannya-stanu-zdorovya-naselennya-

aerobic activity remains low across both sexes, and engagement with resistance exercise is even more limited, affecting fewer than one in three adults regardless of gender[46].

Such a systemic reduction in physical activity leads to a high prevalence of musculoskeletal disorders (MSDs). The musculoskeletal toll is correspondingly high: data from Wave 3 of the European Health Interview Survey document that musculoskeletal pain in the preceding 12 months was reported by 57.9 % of women and 52.2 % of men across EU member states[47], with musculoskeletal conditions accounting for roughly a quarter of all lost workdays in the working-age population[48]. The extent and consequences of a sedentary lifestyle vary significantly depending on age, professional activity, biological sex, and social environment. Occupational profile shapes both exposure and vulnerability: desk-based workers accumulate 6–8 hours of daily sitting – the highest sedentary burden of any employment category – while simultaneously lacking the compensatory movement that manual roles provide incidentally. Age compounds this: from the fourth decade onward, disuse-related losses in strength, coordination, and joint mobility accelerate, yet the same literature documents that moderate-intensity tailored exercise can substantially slow this trajectory and – critically for the HRQoL framing of this article – restore meaningful functional gains even in established deconditioning.

Designing effective physical activity programs for sedentary adults requires more than selecting appropriate exercises or setting a weekly dose. It demands a programming architecture capable of responding to the high motivational variability, unpredictable life circumstances, and low functional baseline that characterize this population. Three established frameworks – classical periodization, FITT-based prescription, and just-in-time adaptive interventions – each offer partial solutions, yet none fully addresses the

ukraini (дата звернення: 05.06.2026). Наведені відсотки стосуються популяції віком 18–64 роки за даними національного опитування; оцінка 65–70% для сектору інформаційних технологій базується на галузевому аналізі за професійними групами того ж джерела.

[46] Eurostat. Health in the European Union – facts and figures / European Health Interview Survey (EHIS), Wave 3. Luxembourg : Publications Office of the European Union, 2021. URL: https://ec.europa.eu/eurostat/web/products-statistical-books/product?code=KS-FT-19-001 (дата звернення: 05.06.2026).

[47] Eurostat. Health in the European Union – facts and figures / European Health Interview Survey (EHIS), Wave 3. Luxembourg : Publications Office of the European Union, 2021. URL: https://ec.europa.eu/eurostat/web/products-statistical-books/product?code=KS-FT-19-001 (дата звернення: 05.06.2026).

[48] Eurostat. Health in the European Union – facts and figures / European Health Interview Survey (EHIS), Wave 3. Luxembourg : Publications Office of the European Union, 2021. URL: https://ec.europa.eu/eurostat/web/products-statistical-books/product?code=KS-FT-19-001 (дата звернення: 05.06.2026).

problem. Mapping their respective limitations clarifies the gap that the iterative cycle architecture, introduced in Section 3, is designed to fill.

Periodization represents a systematic approach to training organization in which exercise loads are distributed across hierarchical planning units (macrocycles, mesocycles, and microcycles) to facilitate progressive adaptation and effective workload management over time. The model has demonstrated robust effectiveness in athletic populations, where baseline fitness is high, training history is stable, and performance peaks can be scheduled around competitive calendars. This effectiveness is largely attributed to the deliberate alternation of loading and recovery phases designed to induce supercompensation. However, this mechanism presupposes a trainee whose physiological responses are relatively predictable and whose adherence can be assumed.

For sedentary adults, these assumptions fail on multiple counts. Functional capacity in deconditioned individuals is not merely low but highly variable between sessions, influenced by sleep quality, occupational stress, and pain fluctuation that cannot be anticipated at the point of program design. Rigid multi-week loading blocks cannot accommodate a participant who misses sessions due to competing life demands or whose musculoskeletal symptoms require immediate modification of the exercise prescription. Because traditional periodization models assume relatively stable adaptation trajectories and consistent training adherence, their direct application to sedentary populations is inherently constrained[49]. In practice, this often results in either chronic underloading–when programs are designed conservatively to minimize risk–or elevated dropout rates when prescribed progression fails to align with real-world variability[50].

The FITT framework (Frequency, Intensity, Time, Type), codified in ACSM guidelines[51], represents the dominant clinical approach to exercise prescription for general populations and patients with chronic conditions. Its principal strength is quantitative specificity: each parameter is individually calibrated to baseline fitness, health status, and target adaptation, providing a

[49] Dzakpasu F. Q. S., Carver A., Brakenridge C. J., Cicuttini F., Urquhart D. M., Owen N., Dunstan D. W. Musculoskeletal pain and sedentary behaviour in occupational and non-occupational settings: A systematic review with meta-analysis. International Journal of Behavioral Nutrition and Physical Activity. 2021. Vol. 18. Article 159. DOI: 10.1186/s12966-021-01233-8.

[50] Strain T., Flaxman S., Guthold R., Mathers C., Temmerman M., Bull F. C. et al. National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: A pooled analysis of 507 population-based surveys with 1.9 million participants. The Lancet Global Health. 2024. Vol. 12, No. 8. P. e1312–e1323. DOI: 10.1016/S2214-109X(24)00150-5.

[51] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

principled starting point that classical periodization lacks at the individual level. For sedentary adults, ACSM recommends initiating aerobic activity at 40–60% of heart rate reserve, accumulating 150–300 minutes of moderate-intensity activity per week, and supplementing with resistance training on two to three days – parameters supported by extensive evidence for their safety and efficacy in deconditioned populations[52].

The limitation of FITT prescription is not in its initial calibration but in its implicit assumption of linearity: once parameters are set, they are adjusted only at scheduled reassessment points, typically every four to twelve weeks. This static structure has no formalized mechanism for responding to intermediate deviations – a pain flare, a motivational trough, or a faster-than-expected functional gain. A key obstacle to the effectiveness of exercise interventions is the difficulty of maintaining long-term adherence. Individuals with low physical activity levels frequently experience challenges in sustaining engagement, as motivational and contextual factors often outweigh purely physical constraints in determining continued participation. FITT prescription addresses what to prescribe; it does not address how to sustain engagement when the original prescription no longer fits the participant's current state.

Just-in-time adaptive interventions are designed to provide tailored support at moments when individuals are most likely to benefit, using real-time information about behavior, context, and personal status to guide intervention delivery[53,54]. By delivering micro-level decision rules – if sedentary time exceeds a threshold, trigger a movement prompt; if self-reported mood is low, reduce session intensity – JITAIs achieve a degree of temporal precision that neither periodization nor FITT prescription can match. Smartphone-based JITAI trials have demonstrated adherence improvements of 20–30% relative to static programs, with effect sizes concentrated in the early weeks of behavior change when motivational support is most critical.

However, JITAIs operate at the level of individual behavioral moments and are not designed to manage the macro-structure of a training program.

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[52] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

[53] Nahum-Shani I., Smith S. N., Spring B. J., Collins L. M., Witkiewitz K., Tewari A., Murphy S. A. Just-in-time adaptive interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. Annals of Behavioral Medicine. 2018. Vol. 52, No. 6. P. 446–462. DOI: 10.1007/s12160-016-9830-8.

[54] Hardeman W., Houghton J., Lane K., Jones A., Naughton F. A systematic review of just-in-time adaptive interventions (JITAIs) to promote physical activity. International Journal of Behavioral Nutrition and Physical Activity. 2019. Vol. 16. Article 31. DOI: 10.1186/s12966-019-0792-7.

They can prompt a five-minute walk but cannot reorganize a six-week loading block; they can reduce today's session intensity but have no framework for determining when a participant is ready to progress to resistance bands or multi-planar balance exercises. The «Sense-Plan-Act» architecture described by Hekler et al. (2016) captures the real-time responsiveness of JITAIs precisely, but the «Plan» component in that model refers to a single behavioral response, not to a structured progression logic spanning weeks[55]. For populations where long-term morphofunctional adaptation – not just daily step count – is the goal, this temporal shallowness is a substantive limitation.

Taken together, the three frameworks occupy non-overlapping positions on two dimensions: temporal scope (session-level vs. program-level) and adaptability (fixed vs. responsive). Classical periodization provides program-level structure without adaptability. FITT prescription provides individual calibration without a responsive adjustment mechanism. JITAIs provide session-level responsiveness without program-level architecture. No existing model formally integrates all three functions into a single framework suited to the specific characteristics of sedentary adults – high variability, low baseline, unpredictable adherence, and the need for progressive morphofunctional change over weeks and months.

This gap is precisely what the iterative cycle architecture addresses. By embedding formalized decision rules within a repeating assessment–design–implementation–adjustment sequence, it combines the structural discipline of periodization, the individual calibration of FITT, and the responsive logic of JITAI – at a temporal scale appropriate for initiating and sustaining behavior change in untrained populations.

Considering the functional deficits and programming gaps outlined above, the systematic performance of tailored physical exercises serves as the optimal compensatory mechanism. Tailored physical exercise is defined here as a purposefully structured movement intervention in which the principal training parameters – exercise intensity (measured as METs, percentage of HRmax, or percentage of 1-RM), session length, and weekly frequency – are individually matched to, and grounded in, each participant's assessed functional baseline. What distinguishes this approach from spontaneous physical activity is the deliberate calibration of each loading parameter to elicit a targeted physiological adaptation – whether that is aerobic capacity gain, musculoskeletal stabilization, or HRQoL improvement – while remaining within safe tolerance limits. The underlying adaptive mechanism is progressive overload followed by

[55] Hekler E. B., Klasnja P., Riley W. T., Buman M. P., Huberty J., Rivera D. E., Martin C. A. Agile science: Creating useful products for behavior change in the real world. Translational Behavioral Medicine. 2016. Vol. 6, No. 2. P. 317–328. DOI: 10.1007/s13142-016-0395-7.

supercompensation: each increment in stimulus – provided it does not exceed tissue tolerance – drives a compensatory upregulation that leaves the system more resilient than before. Empirical evidence supports even modest doses: bouts of 5–10 minutes of light activity inserted into the workday have been associated with reductions of 20–30 % in reported lumbar pain intensity[56].

Safe and effective loading rests on four interacting design principles: progression (loads begin below functional ceiling and escalate incrementally), regularity (frequency calibrated to recovery capacity), individualization (extending beyond physiological variables to include motivational readiness and social context, as formalized through SDT in this article), and comprehensiveness (integrating resistance, mobility, and proprioceptive components to address the multi-system nature of sedentary deconditioning). Exercise selection targeting the deep stabilizing musculature – planks, glute bridges, bird-dog patterns – directly addresses the motor unit recruitment deficits documented in sedentary populations and is described in full in Shanin (2025)[57].

ACSM guidelines frame exercise intensity as the primary determinant of adaptation rate and magnitude[58]. For prescribing intensity in deconditioned adults, heart rate reserve (HRR; Karvonen method) provides a more individualized metric than raw percentage of maximum heart rate (%HRmax), because it accounts for resting cardiac output – which is systematically elevated in sedentary individuals – and thereby avoids underestimating the relative effort of low-load work. The two metrics are related but not interchangeable, and the degree of divergence increases with elevated resting heart rate: in a typical healthy adult, 40% HRR corresponds to approximately 54–60% HRmax, while 60% HRR corresponds to approximately 72–76% HRmax; in sedentary individuals with elevated resting heart rate, the same HRR targets translate to proportionally higher %HRmax values. For sedentary adults, the safe entry point lies at 40–50% HRR – lower than the threshold recommended for fit individuals – because even stimuli at this level elicit measurable adaptation when the functional baseline is very low. As capacity improves over successive program

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[56] Dempsey P. C., Friedenreich C. M., Leitzmann M. F., Buman M. P., Lambert E., Willumsen J., Bull F. Global public health guidelines on physical activity and sedentary behavior for people living with chronic conditions: A call to action. *Journal of Physical Activity and Health*. 2021. Vol. 18, No. 1. P. 76–85. DOI: 10.1123/jpah.2020-0525.

[57] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

[58] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

iterations, progressive increments toward 50–60% HRR, accumulated over 30–50-minute sessions, maximize health benefit while keeping injury risk manageable. Exceeding this zone prematurely – pushing toward maximal effort before the musculoskeletal system has adapted – paradoxically increases pain, lowers adherence, and ultimately reduces HRQoL gains rather than accelerating them. Where pharmacological heart rate modulation precludes reliable HRR tracking, the Borg RPE scale (target range 11–13) serves as a valid and practically accessible substitute[59].

Translating these principles into a practical weekly structure, the evidence supports a multi-component routine: brief movement interruptions every 45–60 minutes of unbroken sitting, two or more supervised sessions per week accumulating 150–300 minutes of moderate-intensity activity, resistance work on two to three days to maintain the muscular corset, and targeted proprioceptive training to rebuild balance function[60,61]. The aerobic-to-resistance ratio of approximately 60:40 is not fixed – for older adults and postmenopausal women, the resistance component should be weighted more heavily given the accelerated rate of strength and bone density loss in these groups[62,63].

The systematic execution of tailored exercises produces a constellation of measurable structural adaptations: progressive resistance training restores lower-body muscle strength in the range of 15–25% in previously sedentary individuals, resistance loading attenuates disuse-related bone loss at the hip and spine – with modest net accrual where baseline deficit is substantial – and structured multicomponent programs substantially reduce fall risk through concurrent gains in strength, balance, and neuromuscular coordination. Concurrently, non-adherence to the principle of progression or performing exercises without proper technical control can lead to tendon and ligament overload. Therefore, tailored physical exercises should be

[59] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

[60] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

[61] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

[62] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

[63] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

conducted under specialist supervision or utilizing standardized programs with validated loading protocols.

In summary, the evidence reviewed in this chapter demonstrates that sedentary behavior contributes to musculoskeletal injury risk through interacting neuromuscular, skeletal, sensorimotor, and metabolic pathways. Rather than revisiting these mechanisms individually, the key conclusion is that their combined effects reduce functional capacity, increase pain, and impair health-related quality of life. These findings provide the scientific basis for the development of adaptive exercise strategies capable of responding to individual functional deficits and changing rehabilitation needs.

3. Architecture of the Iterative Cycle in Physical Activity Programming

The critical factor in correcting this movement deficit is not merely increasing activity volume, but its rational organization over time – one that accounts for the adaptive capacities of the organism and responds to individual variability. The following section introduces the iterative cycle architecture as a framework designed to meet precisely this requirement.

Recent research demonstrates that even in the presence of isolated episodes of physical activity, excessive sedentary time can negatively impact health status[64]. Consequently, contemporary approaches to physical activity programming increasingly focus not only on organizing structured exercise sessions but also on modifying daily movement behavior. In this context, the architecture of the iterative cycle plays a decisive role–an approach that enables the combination of progressive loading with regularity of application and individual variability.

As defined in the Introduction, the iterative cycle comprises four interconnected stages applied in a repeating sequence. The present section develops the rationale and operational content of each stage in detail. Each cycle generates new information regarding the organism's response and behavioral patterns, thereby allowing the program parameters to converge towards the individual needs of the participant.

The term «iterative cycle» has been deliberately chosen over the established concepts in sports science of «periodization» or «mesocycle» for two reasons. First, classical periodization is oriented toward athletes with a stable high level of preparedness and presupposes rigid planning of macro-, meso-, and microcycles months in advance. For individuals with a sedentary lifestyle, characterized by high motivational variability, unpredictable life

[64] Ekelund U., Tarp J., Steene-Johannessen J., Hansen B. H., Jefferis B., Fagerland M. W. et al. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: Systematic review and harmonised meta-analysis. BMJ. 2019. Vol. 366. Article l4570. DOI: 10.1136/bmj.l4570.

circumstances, and low baseline physical fitness, such a rigid structure is inadequate. Second, the concepts of «adaptive intervention» and «just-in-time adaptive intervention» (JITAI), actively developed in behavioral medicine[65], focus primarily on momentary micro-decisions (e.g., push notifications on a smartphone), whereas the iterative cycle encompasses a broader temporal horizon with systematic re-evaluation of all program components. Thus, the proposed architecture occupies an intermediate position between the macro-periodization of athletic training and the micro-adaptation of JITAI, being specifically suitable for the initial stage of fostering active behavior in untrained individuals.

The architecture of the iterative cycle is a logical development of the classical Deming Cycle (PDCA: Plan-Do-Check-Act), adapted to the specifics of physical activity (Table 1).

Table 1

PDCA cycle adapted for physical activity programming: iterative stages and key features

PDCA Stage	Iterative Cycle Stage	Specifics of Application to Physical Activity
Plan	Initial assessment & design	Integration of not only physiological but also psychosocial data into FITT parameters
Do	Program implementation	Concurrent implementation of structured sessions and daily physical activity
Check	Monitoring	Combination of objective (accelerometry) and subjective (diaries, interviews) methods
Act	Analysis & adjustment	Formalized decision rules with feedback

In contrast to the linear application of PDCA in quality management, the iterative cycle in physical activity is characterized by «higher rotation frequency» (weeks instead of quarters), «integration of behavioral data» alongside physiological data, and «mandatory participant involvement» in adjustment decisions.

The 12-week intervention data (n=27) – including participant recruitment, baseline assessment protocol, exercise program design, and core

[65] Nahum-Shani I., Smith S. N., Spring B. J., Collins L. M., Witkiewitz K., Tewari A., Murphy S. A. Just-in-time adaptive interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. Annals of Behavioral Medicine. 2018. Vol. 52, No. 6. P. 446–462. DOI: 10.1007/s12160-016-9830-8.

exercise selection – were originally collected and reported in Shanin (2025)[66]; for the present article, these data were re-analyzed through the lens of HRQoL domains and iterative program adjustment principles, which were not part of the original thesis. While these empirical findings established the practical feasibility of tailored exercise programming, they did not by themselves provide a formal framework for systematic adaptation of the intervention over time. To address this limitation, it is useful to consider developments in the broader adaptive intervention literature, particularly the JITAI paradigm. The concept of adaptive interventions in physical activity has been significantly advanced by work in the field of JITAI. Studies of just-in-time adaptive interventions indicate that context-sensitive adaptation of behavioral support may enhance participant engagement and facilitate sustained physical activity by providing assistance at moments of heightened need or opportunity[67]. Hekler et al. (2016) developed the «Sense-Plan-Act» architecture for digital interventions, wherein sensors capture behavior, an algorithm plans the response, and a mobile device delivers it in real time[68].

However, these studies have a substantial limitation: they focus on «micro-decisions» (individual notifications, momentary prompts) and do not cover the «macro-structure» of the program–changes in exercise types, load progression, integration of new components. This gap is precisely what the proposed iterative-cycle architecture seeks to address by integrating the real-time adaptability of JITAIs with the structured progression principles of traditional training periodization. The cycle is organized into four interrelated stages.

1. Stage of Initial Assessment: From Data to Program Parameters

The aim of the initial assessment stage is not merely data collection but its translation into individualized parameters of the future program. For individuals with a sedentary lifestyle, the assessment covers four blocks:

Physiological block includes anthropometry, blood pressure, resting heart rate, and risk factor screening[69]. The results determine the upper limit of safe

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[66] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

[67] Nahum-Shani I., Smith S. N., Spring B. J., Collins L. M., Witkiewitz K., Tewari A., Murphy S. A. Just-in-time adaptive interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. Annals of Behavioral Medicine. 2018. Vol. 52, No. 6. P. 446–462. DOI: 10.1007/s12160-016-9830-8.

[68] Hekler E. B., Michie S., Pavel M., Rivera D. E., Collins L. M., Jimison H. B., Garnett C., Parral S., Spruijt-Metz D. Advancing models and theories for digital behavior change interventions. American Journal of Preventive Medicine. 2016. Vol. 51, No. 5. P. 825–832. DOI: 10.1016/j.amepre.2016.06.013.

[69] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

intensity: for example, with baseline BP > 140/90 mmHg, initial loads are limited to 50% HRmax instead of 60%.

Movement behavior block assesses daily physical activity using the Baecke Physical Activity Questionnaire[70] and objective methods (accelerometry). An integral BPAQ score < 7 points, as in our sample (M = 5.71±1.14), indicates the necessity of starting with minimal loads and emphasizing daily activity over structured sessions.

Musculoskeletal block, critical for the target group, includes assessment of posture (wall–occiput test), core muscle strength (isometric tests), flexibility (Sit-and-Reach), balance (Romberg, Y-Balance), and aerobic endurance (6MWT). In our study, 63% of participants had flexibility below norm, 78% had functional lower limb strength below norm, which directly determined the priority of stretching exercises and strength training in the first program iteration.

Psychosocial block integrates Self-Determination Theory[71] to translate motivational characteristics into program structure (Table 2).

Table 2

Psychosocial block: Translating Self-Determination Theory indicators into individualized exercise program parameters

SDT indicator	Level	Translation into program parameters
Autonomy	High	Wide choice of activities, flexible schedule, ability to self-regulate intensity
Autonomy	Low	Rigid session structure, clear instructions, external control (coach, app)
Competence	High	Rapid progression, more complex exercises from weeks 3-4, competitive elements
Competence	Low	Shallow progression, maximally simplified exercise variants, emphasis on one's own progress
Relatedness	High	Group formats, social apps, involvement of friends/family
Relatedness	Low	Individual sessions, personal trainer, private diary

In our sample, low BPAQ sport index (1.62 ± 0.48) and dominance of leisure-time activity correlated with low competence in the sport context, which determined the choice of maximally simplified exercise variants and emphasis on personal progress in the first iteration [72].

[70] Baecke J. A. H., Burema J., Frijters J. E. R. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. American Journal of Clinical Nutrition. 1982. Vol. 36, No. 5. P. 936–942. DOI: 10.1093/ajcn/36.5.936.

[71] Ryan R. M., Deci E. L. Self-determination theory. Encyclopedia of Quality of Life and Well-Being Research / ed. by F. Maggino. Cham : Springer, 2023. DOI: 10.1007/978-3-031-17299-1_2630.

[72] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

2. Stage of Design: Individualized Program

– The exercise program was designed according to the FITT principle and has been reported in full detail elsewhere[73]. In brief, it comprised two supervised 60-minute sessions per week at 50–60% HRmax, combining stabilization exercises (forearm plank, glute bridge, bird-dog), bodyweight strength work, dynamic stretching, and proprioceptive training. What the iterative cycle architecture adds to this original design is the formalization of adjustment logic: rather than applying the same FITT parameters throughout, each two-week iteration used monitoring data to recalibrate intensity, exercise selection, and autonomy level for each participant individually, as detailed in Stage 4 (Analysis and Adjustment) below.

3. Stage of Implementation and Monitoring: Multi-Component Control

Monitoring is implemented through a combination of objective and subjective methods, with critical analysis of each method's limitations:

Objective methods:

– Accelerometry (fitness trackers, smartwatches): step count, duration of activity at different intensities, sitting time. Limitations: data from our study showed that 37% of participants discontinued regular tracker use by week 6 due to discomfort or forgetfulness; step counts do not reflect movement quality (e.g., compensatory patterns during knee pain).

– Goniometry (smartphone app): range of motion in key joints. Limitations: accuracy depends on device positioning; does not capture movement velocity.

Subjective methods:

– Paper training diaries: recording of exercises performed, perceived intensity (RPE), presence of pain/discomfort, motivation level (1-10). Advantage: not technology-dependent, foster reflective skills. In our study, 100% of participants used diaries vs. 63% regular app users.

– Structured interviews: weekly 10-minute conversations with the instructor regarding barriers, coping strategies, satisfaction. Advantage: identification of non-formalized factors (work conflicts, changes in sleep schedule).

– Combined approaches: objective tracker data + weekly interview to interpret anomalies (e.g., sharp step decrease due to ankle pain recorded in the diary).

Motivational function of monitoring: In our sample, participants who kept diaries demonstrated 18% higher program adherence ($p < 0.05$), confirming the role of progress awareness in maintaining behavioral change.

4. Stage of Analysis and Adjustment: Formalized Decision Rules

Program adjustment is performed on the basis of formalized «if-then» rules, adapted to the specifics of musculoskeletal health (Table 3).

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[73] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

Table 3

Formalized Decision Rules for Iterative Program Adjustment

Trigger (condition)	Indicator	Threshold	Action (adjustment)	Example from study
Adherence	Percentage of completed sessions	< 70% for 2 consecutive weeks	Reduce intensity by 10%; add social support (paired training); review timing of sessions	Participant 14: adherence 60% due to work schedule change → reschedule to morning + training with colleague
Pain syndrome	VAS (0-10)	Increase > 2 points over a week	Replace exercise with an analogue having less axial load; consult specialist	Participant 7: low back pain 3→6 points → replace squats with soft lunges using support
Functional progress	5-STS, plank, Romberg	Improvement > 20% from baseline	Increase load by 10-15%; introduce new stimulus (elastic band, 1-2 kg dumbbells)	Participants 3,8,19: plank improvement >25% at weeks 5-6 → introduce side plank
Functional stagnation	Same indicators	No change over 3 weeks	Change exercise type; review technique; increase session frequency	Participant 22: flexibility stagnation → switch from static to dynamic stretching
Psychosocial state	Motivation scale (1-10)	< 4 points on 2 consecutive sessions	Reduce structuredness; increase autonomy of choice; add game elements	Participant 11: motivation 3 points → switch from fixed program to «menu of exercises»

Iteration frequency: A full assessment–adjustment cycle is implemented every 2 weeks, which corresponds to the supercompensation period in untrained individuals and allows timely response to negative trends. Intermediate monitoring (diaries, trackers) is continuous.

The four-stage architecture was applied across six two-week iterations. Early iterations (weeks 1–4) prioritized technique acquisition and minimal loading; mid-program iterations (weeks 5–8) introduced progressive resistance based on monitoring data; final iterations (weeks 9–12) individualized load for those who reached target indicators while placing others in maintenance mode. Full session-by-session detail is reported in Shanin (2025, Table 3.4)[74].

As previously reported[75], post-intervention improvements included: posture correction (Cohen's d = 0.94), back muscle endurance (+35.5%, d = 1.16), and static balance (+20.3%, d = 0.93). These findings are reproduced here to establish the empirical foundation for the iterative cycle model introduced in this article[76].

Follow-up assessments were conducted at 3 months post-intervention using the same battery of functional tests applied at baseline and post-test (posture assessment, 5-STS, plank hold, Romberg and Y-Balance tests, goniometry, VAS pain scale). Participants were instructed to continue independent training based on the program provided at the end of the 12-week intervention; no additional supervised sessions were administered during the follow-up period. Contact with participants was maintained via brief structured telephone interviews at 4-week intervals to monitor adherence to recommendations and flag any adverse events.

The three-month post-intervention follow-up assessment was conducted on a sample of n = 23 participants. Four individuals did not complete the follow-up assessment due to personal and family circumstances unrelated to the intervention (e.g., relocation, caregiving obligations); their withdrawal is therefore considered non-informative with respect to intervention outcomes. The demographic characteristics of the retained sample (n = 23) were broadly comparable to those of the full baseline cohort (n = 27), with no substantial shifts in age, sex distribution, or baseline functional scores. It should be noted that a formal intention-to-treat (ITT) analysis was not conducted, which represents a methodological limitation; the follow-up findings should accordingly be interpreted as pertaining to participants who completed the full assessment protocol rather than the originally enrolled sample. During the period between the immediate 12-week post-test and the follow-up, participants adhered to provided recommendations and continued independent training, which partially accounts for the maintenance and

[74] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

[75] Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

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progressive development of specific training effects. Overall, the program demonstrated a sustained long-term impact on the measured parameters. Posture, static balance, and back muscle strength maintained robust values with large effect sizes ($d = 0.81–0.91$), which is consistent with the consolidation of motor skills following a 12-week training macrocycle. The minor decrement in effect size compared to the immediate post-test values, such as back muscle strength decreasing from $d = 1.16$ to $d = 0.86$, represents a physiologically expected regression, even within the context of ongoing independent physical activity. For dynamic balance, the Y-Balance Test revealed statistically significant improvements at follow-up, yielding a moderate effect size of $d = 0.55$. The transition from a non-significant baseline-to-post-test shift at 12 weeks ($p = 0.615$) to a moderate effect at the 3-month follow-up is highly plausible under independent training conditions, indicating that neuromuscular adaptations governing dynamic stabilization require an extended latency period or prolonged specific stimulation to manifest fully. Knee and shoulder joint mobility exhibited substantial improvements, demonstrating large effect sizes ($d = 0.83$ and $d = 0.71$, respectively) and effectively overcoming the physiological plateaus recorded at the 12-week mark, which validates the efficacy of the prescriptive recommendations aimed at increasing exercise specificity and training frequency for these regions. Conversely, the ankle joint yielded the lowest effect size ($d = 0.53$), an outcome that aligns with established biomechanical principles; due to its dense ligamentous apparatus, the ankle complex responds more slowly to mechanical tensile stress compared to other major synovial joints. Consequently, this lower effect size does not denote an inherent programmatic deficiency, but rather highlights the prerequisite for longer-term or highly specialized interventions targeting this anatomical zone. Pain severity (VAS) among symptomatic participants declined by a further 14 % relative to the 12-week post-test. The proportion of pain-free participants remained stable in absolute terms (5 individuals at both the 12-week post-test and the 3-month follow-up); the apparent proportional increase from 18.5% to 22.2% reflects sample attrition rather than new cases of pain resolution and is therefore not reported as an outcome. The clinically meaningful finding in this domain is the 14% reduction in overall pain intensity among symptomatic participants, calculated within the same subset across both time points.

CONCLUSIONS

Building upon the empirical foundation of Shanin (2025)[77], the present article advances three interrelated innovations. First, it reframes the original intervention data through the lens of health-related quality of life (HRQoL), suggesting that the physical gains documented in the thesis are consistent with clinically meaningful improvements across SF-36 and EQ-5D domains, pending formal HRQoL assessment in future work. Second, it introduces the iterative cycle architecture as a mid-range programming model, synthesizing classical periodization, the PDCA model, and principles of adaptive interventions (JITAI) – a framework absent from the original thesis but grounded in its empirical findings. Third, it extends the empirical record with a 3-month follow-up (n = 23) showing sustained and, in the case of dynamic balance and joint mobility, continued improvement beyond the original 12-week endpoint. The iterative cycle demonstrates suitability for work with untrained individuals with a sedentary lifestyle, with its advantage lying not in replacing existing models but in integrating their strengths: the systematic nature of periodization, the flexibility of JITAI, and the reflexivity of PDCA.

A particularly important theoretical implication concerns the integration of Self-Determination Theory and adaptive intervention principles into exercise programming. Unlike conventional FITT-based prescriptions that primarily regulate exercise dosage, the proposed framework incorporates motivational readiness, perceived competence, and social support as formal determinants of program adaptation. In this way, SDT functions not merely as a behavioral supplement but as a structural component of load prescription and progression. This integration provides a reproducible conceptual model that can be empirically tested in future intervention studies and may improve long-term adherence beyond what is typically achieved through standard FITT-based approaches alone.

The scientific contribution of this study lies not in establishing the relationship between sedentary behavior and musculoskeletal dysfunction – a connection well-documented in the existing literature – but in synthesizing the pathophysiological, behavioral, and motivational dimensions of this relationship into a coherent mid-range programming framework. Specifically, the iterative cycle architecture operationalizes the known mechanisms of sedentary deconditioning as formal triggers for individualized program adjustment, thereby translating existing evidence into a structured intervention logic that is absent from current clinical and fitness practice. The proposed methodology is grounded in the functional

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deficits identified within the target population – including a 92.6% prevalence of pain, 63% below-norm flexibility, and 78% below-norm strength – and aligns specific exercise modalities with the corresponding pathophysiological mechanisms that underlie both musculoskeletal dysfunction and diminished HRQoL. Rather than treating injury prevention as the primary endpoint, the framework positions the reduction of functional limitations and the restoration of quality of life as the central therapeutic objectives, with injury risk mitigation as a consequent benefit. Furthermore, the iterative cycle architecture provides a practical intermediate framework between classical periodization and adaptive intervention models for sedentary populations.

The developed methodology may be applied in physical rehabilitation, fitness, and health-promotion settings to improve musculoskeletal health, reduce injury risk, and enhance HRQoL in sedentary adults. The findings are relevant for rehabilitation specialists, fitness professionals, and educators in physical education and sports, and provide a foundation for further development of preventive and rehabilitative programs targeting the consequences of sedentary behavior and physical inactivity.

For further development of the concept, the following are necessary: (1) development of validated scales for assessing psychosocial factors specific to individuals with sedentary lifestyles; (2) creation of machine learning algorithms to predict the optimal timing of adjustment based on tracker and diary data; (3) conducting a randomized controlled trial comparing the iterative cycle with a fixed program and JITAI to determine long-term (≥12 months) effectiveness in maintaining active behavior.

Data and Provenance Statement

The 12-week intervention dataset (n = 27) was originally collected and reported in the master's thesis of K. A. Shanin (National University «Zaporizhzhia Polytechnic», 2025)[78], completed under the supervision of N. V. Chukhlantseva. The present article constitutes an independent scholarly work: the HRQoL outcomes framework, the iterative cycle architecture, the integration of SDT and JITAI constructs, and the 3-month follow-up assessment (n = 23) are original contributions of the present authors and were not part of the thesis. The authors confirm that no ethical approval beyond that obtained for the original thesis study was required for the secondary analysis and follow-up assessment reported here.

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SUMMARY

The article addresses the gap between existing physical activity programming models and the needs of sedentary adults with musculoskeletal dysfunction and reduced health-related quality of life (HRQoL). The study aims to develop and substantiate an iterative cycle architecture integrating the PDCA model, Just-in-Time Adaptive Interventions (JITAI), and Self-Determination Theory (SDT), and to evaluate its feasibility through a 12-week intervention with a 3-month follow-up. A critical analysis of three established frameworks – classical periodization, FITT-based prescription, and JITAI – reveals that none fully addresses the programming challenge for this population: periodization lacks adaptability, FITT has no responsive adjustment mechanism, and JITAI operates without program-level architecture. The proposed iterative cycle fills this gap through four interconnected stages – assessment, individualized design, monitored implementation, and data-driven adjustment – repeated every two weeks. The intervention involved 27 sedentary adults and combined aerobic, resistance, stabilization, and proprioceptive training at 50–60% HRmax, monitored via accelerometry and training diaries. Post-intervention results showed significant improvements in posture, back muscle endurance, static balance, and pain, with gains maintained and in some domains – dynamic balance and joint mobility – continued to develop at the 3-month follow-up. A key theoretical contribution is the formal integration of SDT indicators into load prescription logic, treating motivational readiness as a structural determinant of program progression. The iterative cycle is proposed as a reproducible mid-range programming model applicable in rehabilitation, fitness, and health-promotion settings.

REFERENCES

1. Booth F. W., Roberts C. K., Thyfault J. P., Ruegsegger G. N., Toedebusch R. G. Role of inactivity in chronic diseases: Evolutionary insight and pathophysiological mechanisms. *Physiological Reviews*. 2017. Vol. 97, No. 4. P. 1351–1402. DOI: 10.1152/physrev.00019.2016.

2. Міністерство охорони здоров'я України. Національне опитування стану здоров'я населення України / Державна установа «Центр громадського здоров'я МОЗ України». Київ, 2021. URL: https://phc.org.ua/news/nacionalne-opituvannya-stanu-zdorovya-naselennya-ukraini (дата звернення: 05.06.2026).

3. Ainsworth B. E., Haskell W. L., Herrmann S. D., Meckes N., Bassett D. R., Tudor-Locke C. et al. 2011 compendium of physical activities: A second update of codes and MET values. *Medicine & Science in Sports & Exercise*. 2011. Vol. 43, No. 8. P. 1575–1581. DOI: 10.1249/MSS.0b013e31821ece12.

4. Alhashim A. A., Alyousof A. A., Aldawsari M. R., Alghannam A. A., Alsayed M. A., Alawadh R. A., Almulhim S. A. Work-related musculoskeletal disorders and their impact on quality of life: A comprehensive review. *Saudi Journal of Medicine & Pharmaceutical Sciences*. 2025. Vol. 11, No. 5. P. 360–377.

5. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription / senior ed. G. Liguori ; associate eds. Y. Feito, C. Fountaine, B. A. Roy. 11th ed. Philadelphia : Wolters Kluwer, 2021. 513 p.

6. Baecke J. A. H., Burema J., Frijters J. E. R. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *American Journal of Clinical Nutrition*. 1982. Vol. 36, No. 5. P. 936–942. DOI: 10.1093/ajcn/36.5.936.

7. Biswas A., Oh P. I., Faulkner G. E., Bajaj R. R., Silver M. A., Mitchell M. S., Alter D. A. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: A systematic review and meta-analysis. *Annals of Internal Medicine*. 2015. Vol. 162, No. 2. P. 123–132. DOI: 10.7326/M14-1651.

8. Bruyère O., Scott D., Papaioannou A., Buehring B., Camargos B. M., Chapurlat R. et al. The impact of sedentary behavior and physical activity on bone health: A narrative review from the Rehabilitation Working Group of the International Osteoporosis Foundation. *Calcified Tissue International*. 2025. Vol. 116, No. 1. P. 109. DOI: 10.1007/s00223-025-01421-6.

9. Dempsey P. C., Friedenreich C. M., Leitzmann M. F., Buman M. P., Lambert E., Willumsen J., Bull F. Global public health guidelines on physical activity and sedentary behavior for people living with chronic conditions: A call to action. *Journal of Physical Activity and Health*. 2021. Vol. 18, No. 1. P. 76–85. DOI: 10.1123/jpah.2020-0525.

10. Dzakpasu F. Q. S., Carver A., Brakenridge C. J., Cicuttini F., Urquhart D. M., Owen N., Dunstan D. W. Musculoskeletal pain and sedentary behaviour in occupational and non-occupational settings: A systematic review with meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*. 2021. Vol. 18. Article 159. DOI: 10.1186/s12966-021-01233-8.

11. Ekelund U., Tarp J., Steene-Johannessen J., Hansen B. H., Jefferis B., Fagerland M. W. et al. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: Systematic review and harmonised meta-analysis. *BMJ*. 2019. Vol. 366. Article l4570. DOI: 10.1136/bmj.l4570.

12. EuroQol Group. EuroQol – a new facility for the measurement of health-related quality of life. *Health Policy*. 1990. Vol. 16, No. 3. P. 199–208. DOI: 10.1016/0168-8510(90)90421-9.

13. Eurostat. Health in the European Union – facts and figures / European Health Interview Survey (EHIS), Wave 3. Luxembourg : Publications Office of the European Union, 2021. URL: https://ec.europa.eu/eurostat/web/products-statistical-books/product?code=KS-FT-19-001 (дата звернення: 05.06.2026).

14. Gordon T. Neuromuscular activity determines, at least in part, the motoneuron, nerve and muscle properties under normal conditions and after nerve injury. *International Journal of Molecular Sciences*. 2025. Vol. 26, No. 14. Article 6891. DOI: 10.3390/ijms26146891.

15. Hamilton M. T., Hamilton D. G., Zderic T. W. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007. Vol. 56, No. 11. P. 2655–2667. DOI: 10.2337/db07-0882.

16. Hardeman W., Houghton J., Lane K., Jones A., Naughton F. A systematic review of just-in-time adaptive interventions (JITAIs) to promote physical activity. *International Journal of Behavioral Nutrition and Physical Activity*. 2019. Vol. 16. Article 31. DOI: 10.1186/s12966-019-0792-7.

17. Hekler E. B., Klasnja P., Riley W. T., Buman M. P., Huberty J., Rivera D. E., Martin C. A. Agile science: Creating useful products for behavior change in the real world. *Translational Behavioral Medicine*. 2016. Vol. 6, No. 2. P. 317–328. DOI: 10.1007/s13142-016-0395-7.

18. Hekler E. B., Michie S., Pavel M., Rivera D. E., Collins L. M., Jimison H. B., Garnett C., Parral S., Spruijt-Metz D. Advancing models and theories for digital behavior change interventions. *American Journal of Preventive Medicine*. 2016. Vol. 51, No. 5. P. 825–832. DOI: 10.1016/j.amepre.2016.06.013.

19. Katzmarzyk P. T., Friedenreich C., Shiroma E. J., Lee I.-M. Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. *British Journal of Sports Medicine*. 2022. Vol. 56, No. 2. P. 101–106. DOI: 10.1136/bjsports-2020-103640.

20. Lee J. H., Yun I., Nam C. M., Jang S. Y., Park E. C. Association between physical activity and health-related quality of life in middle-aged and elderly individuals with musculoskeletal disorders: Findings from a national cross-sectional study in Korea. *PLOS ONE*. 2023. Vol. 18, No. 11. Article e0294602. DOI: 10.1371/journal.pone.0294602.

21. Mansoubi M., Pearson N., Clemes S. A., Biddle S. J. H., Bodicoat D. H., Tolfrey K. et al. Energy expenditure during common sitting and standing tasks: Examining the 1.5 MET definition of sedentary behaviour. *BMC Public Health*. 2015. Vol. 15. Article 516. DOI: 10.1186/s12889-015-1851-x.

22. Moreira S., Criado M. B., Santos P. C., Ferreira M. S., Gonçalves C., Machado J. Physical activity, musculoskeletal symptoms and quality of life

in computer workers: A narrative review. *Healthcare*. 2022. Vol. 10, No. 12. Article 2457. DOI: 10.3390/healthcare10122457.

23. Nahum-Shani I., Smith S. N., Spring B. J., Collins L. M., Witkiewitz K., Tewari A., Murphy S. A. Just-in-time adaptive interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. *Annals of Behavioral Medicine*. 2018. Vol. 52, No. 6. P. 446–462. DOI: 10.1007/s12160-016-9830-8.

24. Owen N., Healy G. N., Matthews C. E., Dunstan D. W. Too much sitting: The population-health science of sedentary behavior. *Exercise and Sport Sciences Reviews*. 2010. Vol. 38, No. 3. P. 105–113. DOI: 10.1097/JES.0b013e3181e373a2.

25. Park S., Lee S., Kim Y., Lee Y., Jee S. H., Kim Y. Sedentary behaviour and physical activity among adult workers: A systematic review and meta-analysis. *BMC Public Health*. 2024. Vol. 24. Article 19449. DOI: 10.1186/s12889-024-19449-y.

26. Prince S. A., Saunders T. J., Gresty K., Reid R. D. A comparison of the effectiveness of physical activity and sedentary behaviour interventions in reducing sedentary time in adults: A systematic review and meta-analysis of controlled trials. *Obesity Reviews*. 2014. Vol. 15, No. 11. P. 905–919. DOI: 10.1111/obr.12215.

27. Ryan R. M., Deci E. L. Self-determination theory. *Encyclopedia of Quality of Life and Well-Being Research* / ed. by F. Maggino. Cham : Springer, 2023. DOI: 10.1007/978-3-031-17299-1_2630.

28. Shanin K. A. The use of dosed physical loads in the prevention of injuries among persons with low physical activity levels : master's thesis. Zaporizhzhia : National University «Zaporizhzhia Polytechnic», 2025. Unpublished.

29. Strain T., Flaxman S., Guthold R., Mathers C., Temmerman M., Bull F. C. et al. National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: A pooled analysis of 507 population-based surveys with 1.9 million participants. *The Lancet Global Health*. 2024. Vol. 12, No. 8. P. e1312–e1323. DOI: 10.1016/S2214-109X(24)00150-5.

30. Thosar S. S., Bielko S. L., Mather K. J., Johnston J. D., Wallace J. P. Effect of prolonged sitting and breaks in sitting time on endothelial function. *Medicine & Science in Sports & Exercise*. 2015. Vol. 47, No. 4. P. 843–849. DOI: 10.1249/MSS.0000000000000479.

31. Tremblay M. S., Aubert S., Barnes J. D., Saunders T. J., Carson V., Latimer-Cheung A. E. et al. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. *International Journal of Behavioral Nutrition and Physical Activity*. 2017. Vol. 14, No. 1. Article 75. DOI: 10.1186/s12966-017-0525-8.

32. Ware J. E., Sherbourne C. D. The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical Care*. 1992. Vol. 30, No. 6. P. 473–483.

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