

Analysis of the Mechanism of Daily Fragmented Physical Activity Mediating Physical and Mental Health of Sedentary People

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Abstract: Prolonged sedentary behavior can induce physiological problems such as musculoskeletal strain, disorders of glucose and lipid metabolism, and impaired myocardial function, while also leading to psychological burdens including emotional dysregulation, reduced cognitive efficiency, and the accumulation of anxiety, making it a widespread risk factor affecting population health. Daily fragmented physical activity can effectively regulate the negative effects of sedentary behavior from both physiological and psychological dimensions, with its effects being achieved through three intrinsic pathways: physiological signal transmission, psychological perception intervention, and behavioral habit linkage. Considering spatial constraints in different settings, individual differences among populations, and the patterns of healthy behavior formation, the widespread implementation of such activities can be promoted through three dimensions: scenario-based activity design, stratified and categorized activity guidance, and multidimensional activity incentives.

Keywords: fragmented physical activity; sedentary populations; physical and mental health regulation; health behavior promotion

1. Introduction

Sedentary behavior has become the predominant behavioral pattern among office workers, students, and individuals working from home. The series of physical and mental health problems caused by prolonged sedentary behavior has become a key concern in the field of public health. Most existing intervention strategies targeting the health risks associated with sedentary behavior rely on specialized facilities and equipment, require considerable time investment, and lack broad applicability, making it difficult to meet the practical needs of the majority of sedentary individuals. As a low-threshold form of physical activity, fragmented physical activity is characterized by its adaptability to short periods of free time and its independence from specific venues. However, its scope of effectiveness, underlying mechanisms, and implementation pathways have not yet been systematically understood, limiting its ability to effectively support public health interventions. A systematic examination of the functional dimensions, underlying mechanisms, and implementation pathways of fragmented physical activity can fill the practical research gap in this field, provide actionable strategies for regulating the health of sedentary populations, and offer new directions for advancing public health promotion initiatives.

2. Identification of the Functional Dimensions of Daily Fragmented Physical Activity on the Physical and Mental Health of Sedentary Populations

2.1 Dimensions of Physiological Health Benefits

Sedentary populations maintain fixed postures for prolonged periods, making physiological functions susceptible to multidimensional degenerative changes. The incorporation of fragmented physical activity can effectively alleviate the physiological discomfort associated with sedentary behavior [1]. During prolonged sitting, the muscles of the neck, shoulders, lower back, abdomen, and lower limbs remain under sustained static loading. Restricted local blood circulation and imbalanced muscle tension may lead to joint strain and related problems. Low-intensity fragmented physical activity can stretch tense muscles, relax spasmodic soft tissues, and adjust the load-bearing angles of the spine and joints, thereby gradually restoring the normal contraction–relaxation rhythm of muscle groups and relieving musculoskeletal soreness, stiffness, and other discomfort caused by prolonged sitting [2]. From the perspective of systemic circulation and metabolism, prolonged sitting slows

glucose and lipid metabolism, causing excess glucose and lipids to accumulate in blood vessels and visceral tissues. Fragmented physical activity can increase the basal metabolic rate, accelerate the breakdown and utilization of blood glucose and triglycerides, reduce the likelihood of insulin resistance, and lower the risk of metabolic diseases. In terms of cardiovascular function, prolonged sitting slows blood flow and gradually weakens myocardial contractility. Short bouts of fragmented physical activity can accelerate blood circulation, enhance myocardial blood and oxygen supply, maintain the elasticity of vascular walls, reduce the likelihood of atherosclerosis, and provide fundamental support for the stable functioning of the cardiovascular system [3].

2.2 Dimensions of Psychological Health Benefits

Sedentary populations often remain in fixed work or learning environments for extended periods, during which their mental state tends to remain highly strained. The incorporation of fragmented physical activity can exert multidimensional positive effects on psychological well-being [4]. Under prolonged sedentary conditions, the secretion of neurotransmitters in the brain is prone to imbalance, giving rise to persistent negative emotions such as irritability and low mood. Low-intensity fragmented physical activity can stimulate the normal secretion of positive regulatory neurotransmitters such as dopamine and serotonin, gradually alleviating accumulated negative emotions and helping sedentary individuals maintain a stable and balanced emotional state. Through the positive regulation of neurotransmitters, cortical activity can be effectively enhanced, alleviating problems such as reduced attention and slowed responsiveness caused by prolonged cognitive exertion, improving the efficiency of information processing and decision-making, and maintaining cognitive function at a relatively favorable level. Considering the common realities of heavy workloads and time pressure faced by sedentary populations, fragmented physical activity can temporarily disengage individuals from high-pressure task processing, allowing tense nerves to relax briefly, reducing the accumulation of anxiety, and helping individuals return to subsequent work and study in a calmer psychological state [5].

3. Underlying Mechanisms by Which Daily Fragmented Physical Activity Mediates the Physical and Mental Health of Sedentary Populations

3.1 Physiological Signal Transmission Mechanism

Given that physiological signals in the human body remain chronically deviated from homeostasis under prolonged sedentary conditions, the various physiological responses elicited by fragmented physical activity are transmitted through established pathways, thereby gradually mitigating the physiological damage caused by sedentary behavior [6]. The mild musculoskeletal stress generated by fragmented physical activity is directly transmitted to the muscles and joints of the neck, shoulders, lower back, abdomen, and lower limbs, triggering adaptive regulation of local soft tissues, gradually restoring the normal contraction–relaxation rhythm of muscle groups, improving impaired local blood circulation, and alleviating muscle and joint strain resulting from sustained static loading. The energy expenditure signals generated during physical activity are transmitted to the systemic circulatory and metabolic systems, conveying the demand for the breakdown and utilization of excess glucose and lipids to various visceral organs, accelerating the elimination of metabolic waste, and reducing the likelihood of insulin resistance and various metabolic diseases [7]. The stimulatory signals generated by musculoskeletal activity are also transmitted to endocrine regulatory pathways, modulating the secretion of hormones associated with cardiovascular function, enhancing myocardial blood and oxygen supply, maintaining the normal elasticity of vascular walls, reducing the likelihood of atherosclerosis, and providing fundamental support for the stable functioning of the cardiovascular system [8].

3.2 Psychological Perception Intervention Mechanism

Sedentary populations are subjected to prolonged exposure to single-task environments and persistently high psychological burdens. Fragmented physical activity can alleviate accumulated psychological stress through multilevel psychological perception regulation pathways. Through brief bodily movements, attentional resources that have long been anchored to work or study tasks are temporarily redirected, allowing the cortical regions responsible for task processing to obtain intermittent recovery rather than remaining under continuous high-load operation [9]. From the

perspective of autonomous behavioral choice, fragmented physical activity generally does not depend on specific equipment or venues, enabling individuals to flexibly choose the form and duration of activity according to their current condition. This enhances individuals' sense of control over their own behavior amid high-pressure task schedules, counteracting the sense of helplessness associated with rigid task demands in sedentary settings. In accordance with the patterns of emotional feedback in daily behavior, low-intensity physical activity stimulates the secretion of positive neurotransmitters such as dopamine, gradually relieving accumulated fatigue and negative emotions, enabling individuals to experience a calmer and more relaxed emotional state, and providing a more stable emotional foundation for returning to subsequent work and daily tasks.

3.3 Behavioral Habit Linkage Mechanism

Considering the reality that sedentary populations have developed entrenched sedentary behavioral patterns and lack sufficient motivation to engage in proactive health behaviors, fragmented physical activity can facilitate the positive evolution of behavioral habits through multilevel behavioral pathways, thereby providing behavioral support for the long-term maintenance of physical and mental health [10]. Fragmented physical activity divides prolonged periods of uninterrupted sedentary behavior into multiple shorter sitting intervals, reducing the cumulative duration of each sedentary episode and gradually weakening the behavioral inertia associated with prolonged sitting. From the perspective of adjusting individuals' daily behavioral patterns, routine fragmented physical activity becomes integrated into daily schedules, gradually replacing inefficient and purposeless breaks between work or study sessions and helping individuals establish a balanced daily rhythm that combines movement with rest. Consistent with the intrinsic process of healthy behavior formation, long-term adherence to fragmented physical activity enables individuals to gradually perceive the positive changes in their physical and mental condition before and after activity, internalize the awareness of engaging in physical activity into their own health cognition, proactively avoid unnecessary sedentary behavior, and provide sustained behavioral support for the long-term maintenance of physical and mental well-being [11].

4. Strategies for Optimizing the Promotion of Fragmented Physical Activity Among Sedentary Populations

4.1 Refining Activity Design for Different Usage Scenarios

Given the spatial constraints and behavioral limitations associated with different sedentary settings, the movement amplitude, intensity, and implementation procedures of fragmented physical activity should be specifically adjusted to accommodate the conditions of each scenario [12]. In office settings, where public space characteristics and demanding work schedules prevail, activity design should prioritize low-amplitude movements that require no additional space and do not interfere with the work of others. These include slow shoulder and neck stretching, ankle pump exercises for the lower limbs, and gentle seated trunk rotations. Each activity session should be limited to 1–2 minutes, making it suitable for short breaks during work without disrupting the normal workflow. In home-based sedentary settings, which are characterized by greater privacy and fewer behavioral constraints, activity design can appropriately expand the range of movements. Moderate-amplitude exercises such as standing full-body stretching, light marching in place, and slow waist rotations may be incorporated. Each activity session may be extended to 3–5 minutes to fit naturally into breaks during home-based work or study while accommodating the physical tolerance of sedentary individuals across different age groups. In crowded public commuting environments, where spatial limitations are particularly pronounced, activity design should be fully adapted to the confined range of seated movement. Suitable exercises include fingertip joint relaxation, small-range neck movements, and isometric contractions of the leg muscles, all of which involve little or no body displacement [13]. Each activity session should last between 30 seconds and 1 minute, making effective use of brief intervals during commuting without affecting the comfort of nearby passengers. Across all scenarios, activity design should not require specialized exercise equipment. Movement instructions should be presented in straightforward graphic-text formats and short instructional videos, enabling the general public to quickly master the essential techniques without prior knowledge of exercise science, thereby lowering the threshold for participation. In addition, activity design should fully consider differences in physical capacity among individuals by providing adjustable intensity options for each movement. Individuals with better physical fitness may appropriately increase the frequency of exercises, whereas those with lower

physical capacity may reduce the movement amplitude, ensuring that sedentary individuals with different physical conditions can identify activities that are appropriate for their own capabilities [14].

4.2 Improving Individually Tailored Activity Guidance

Providing stratified and individualized guidance for fragmented physical activity based on the differences among sedentary populations can minimize the risk of exercise-related injuries caused by inappropriate activities and maximize the beneficial effects of fragmented physical activity. Considering the physical characteristics of different age groups, young sedentary individuals generally possess better physical tolerance and can be assigned low- to moderate-intensity muscle stretching exercises. The activity frequency may be set at once every 30 minutes to rapidly relieve muscle stiffness while accommodating the intensive work and study schedules of young adults [15]. In contrast, middle-aged and older sedentary individuals often experience reduced joint flexibility and relatively weaker muscle strength. Therefore, recommended activities should primarily consist of basic joint mobility exercises and isometric muscle contractions, with the activity frequency adjusted to once every 40–50 minutes to better match their physical tolerance. Taking into account individuals' previous physical injuries and habitual levels of physical activity, those with pre-existing chronic injuries to the neck, shoulders, or lumbar spine should perform relaxation exercises that do not increase mechanical loading on the affected areas. The frequency of activity may be flexibly adjusted according to the individual's perceived muscle soreness or discomfort, thereby avoiding additional strain on existing injuries. Individuals with long-term exercise habits may appropriately increase both the movement amplitude and the frequency of activity to further enhance the regulatory effects of fragmented physical activity on physical function. Based on differences in the duration of daily sedentary behavior, individuals who remain sedentary for 6–8 hours per day may be directly matched with conventional-intensity activity programs, for which regular implementation at a fixed frequency is sufficient to achieve favorable physical and psychological benefits. For individuals who remain sedentary for more than 10 hours per day, more moderate isometric exercises should be adopted during the initial stage. After regular activity habits have been established, the movement amplitude can be gradually increased, allowing the body sufficient time to adapt and thereby reducing the risk of exercise-related injuries. All individualized activity guidance should be presented in a clearly structured and stratified format, with population classifications that are intuitive and easy to understand. This enables individuals to quickly identify the activity program most appropriate for their own circumstances without requiring additional guidance from professionals. Furthermore, each activity program should clearly specify the corresponding precautions and advise participants to discontinue the activity immediately if any discomfort occurs, thereby further reducing the likelihood of exercise-related injuries.

4.3 Strengthening Activity Incentives for Habit Formation

Given that sedentary populations generally exhibit poor long-term adherence to fragmented physical activity and are prone to reverting to sedentary behaviors after short-term attempts, implementing multidimensional activity incentive strategies can effectively strengthen individuals' willingness to engage in physical activity and gradually reinforce active behavioral patterns. By leveraging the social connectedness of individuals within the same sedentary settings, peer-support and supervision mechanisms can be established by organizing sedentary individuals in shared office, home, or commuting environments into fixed activity support groups. Group members can remind one another of scheduled activity intervals and share their experiences with activity participation, thereby substantially reducing the inertia associated with exercising alone and improving overall adherence to activity programs. The formation of support groups should be entirely voluntary, allowing individuals to select partners according to their own social preferences without imposing additional social pressure or disrupting their normal work and daily routines. Considering the progressive nature of healthy behavior formation, hierarchical activity goal-setting should be implemented by dividing the long-term objective of maintaining fragmented physical activity into short-term weekly goals. During the initial stage, individuals should only be required to complete activities of minimal intensity. Once they gradually adapt to the activity routine, the performance requirements can be increased progressively. This approach reduces the burden associated with habit formation in the early stages and prevents resistance resulting from overly demanding initial goals. The goal-setting process should be fully controlled by individuals themselves, allowing them to adjust weekly activity requirements according to their own schedules rather than following a uniform mandatory standard. From the perspective of individuals' perceived value of physical activity, immediate feedback on activity outcomes should be

provided by encouraging participants to actively record changes in their physical and mental condition before and after each activity session. Periodic reviews of these records can highlight improvements across different stages, making the positive regulatory effects of fragmented physical activity more tangible and strengthening individuals' intrinsic motivation to remain physically active. A lightweight activity-tracking platform may be established to encourage individuals to voluntarily upload records of their activity participation. Instead of adopting competitive ranking systems, the platform should provide positive feedback in response to individuals' activity performance, thereby avoiding avoidance behaviors caused by excessive pressure. For individuals who consistently maintain long-term participation, appropriate non-material incentives compatible with everyday life may be provided according to their practical needs, further reinforcing the behavioral habit of active participation and enabling fragmented physical activity to become an integral part of their daily routines.

5. Conclusion

Fragmented physical activity represents a low-cost approach to health regulation that is well suited to today's fast-paced lifestyles. It can mitigate the multiple health risks associated with prolonged sedentary behavior at both physiological and psychological levels, providing a lightweight and accessible option for maintaining the physical and mental health of sedentary populations. The promotion of fragmented physical activity should fully accommodate the constraints of different settings and the physical characteristics of different population groups. A comprehensive implementation framework should be established through activity design, activity guidance, and activity incentives to lower the barriers to participation, enhance individuals' willingness to engage in long-term participation, and facilitate the integration of fragmented physical activity into everyday routines. The findings of this study may also provide a reference for the design of future public health intervention programs, further expand the coverage of inclusive health services, and offer new practical approaches for steadily improving the overall health of the population.

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