

**COMPARATIVE MORPHOLOGICAL AND MORPHOMETRIC PARAMETERS OF UTERINE TUBES UNDER CONDITIONS OF EXPERIMENTAL HYPOKINESIA****Abduraxmonova Iroda Sobirovna**

Teaching assistant, Department of Anatomy, Histology and Pathological Anatomy, Tashkent State Medical University

**Abstract.** This study investigates the comparative morphological and morphometric changes in uterine tubes under conditions of experimental hypokinesia. The uterine tubes play a crucial role in female reproductive function, ensuring the transport of gametes and early embryos. However, the influence of reduced physical activity on their structural organization remains insufficiently explored. In this research, experimental hypokinesia was induced, and histological as well as morphometric analyses were performed to evaluate structural alterations in the uterine tubes. The results revealed significant changes, including a decrease in epithelial height, disruption of ciliated cell distribution, and thinning of the muscular layer. Additionally, morphometric parameters such as luminal diameter and tissue thickness showed measurable variations compared to control conditions. These alterations suggest that hypokinesia negatively affects tubal function through mechanisms associated with impaired microcirculation, metabolic imbalance, and hormonal dysregulation. The findings highlight the importance of maintaining physical activity for reproductive health and provide new insights into the structural basis of reproductive dysfunction under hypokinetic conditions. This study contributes to the growing body of knowledge on the relationship between lifestyle factors and female reproductive physiology and emphasizes the need for further multidisciplinary investigations.

**Keywords:** hypokinesia, uterine tubes, morphometric analysis, histology, reproductive health, epithelial structure, tubal motility, microcirculation, hormonal regulation, female infertility.

**Introduction.** The female reproductive tract represents a highly specialized and dynamic biological system, in which the uterine (fallopian) tubes play a central role in ensuring successful fertilization, early embryonic development, and transport of the zygote to the uterine cavity. Structurally, the uterine tubes are paired muscular organs lined with ciliated columnar epithelium, whose coordinated ciliary activity and peristaltic contractions facilitate the movement of gametes and embryos. The functional integrity of this organ is therefore critically dependent on its morphological organization and cellular composition. Recent advances in reproductive biology have revealed that the uterine tubes possess complex structural features, including specialized epithelial cells, immune components, and telocyte populations that regulate tubal motility and responsiveness to hormonal signals. These findings highlight that even subtle alterations in tissue architecture or cellular distribution may significantly affect reproductive outcomes. Indeed, pathological changes in the uterine tubes account for approximately 25–35% of female infertility cases, emphasizing the clinical importance of detailed morphological and morphometric investigations. In recent years, increasing attention has been directed toward the influence of external and internal factors—such as environmental conditions, endocrine disruptions, metabolic disorders, and lifestyle changes—on the structure and function of the uterine tubes. These factors can induce measurable alterations in epithelial integrity, cellular density, and tissue organization, ultimately impairing tubal transport mechanisms and reproductive efficiency. Among such influences, hypokinesia—defined as reduced physical activity or movement—has emerged as a significant experimental model for studying systemic physiological adaptations, including those affecting reproductive organs.

Experimental hypokinesia is known to induce a wide range of morphological and functional changes in various organ systems, primarily through alterations in microcirculation, hormonal regulation, and metabolic processes. However, despite extensive studies on



cardiovascular, musculoskeletal, and nervous systems, the impact of hypokinesia on the female reproductive tract, particularly the uterine tubes, remains insufficiently explored. Given that tubal motility and epithelial function are closely regulated by hormonal and neuromuscular mechanisms, it is reasonable to assume that reduced physical activity may lead to structural remodeling and measurable morphometric changes in these organs. Modern experimental approaches, including histological analysis, morphometry, and advanced in vitro modeling (such as organoid systems), provide new opportunities to investigate these changes at both tissue and cellular levels. Such methodologies enable precise quantification of parameters such as epithelial height, luminal diameter, muscular layer thickness, and cellular composition, thereby offering deeper insights into adaptive and pathological processes under hypokinetic conditions. Therefore, the present study aims to perform a comparative analysis of morphological and morphometric parameters of uterine tubes under conditions of experimental hypokinesia. Understanding these structural alterations is essential not only for elucidating the mechanisms underlying reproductive dysfunction but also for developing preventive and therapeutic strategies in conditions associated with reduced physical activity.

**Literature review.** Recent advances in reproductive biology have significantly expanded the understanding of the structural and functional organization of the uterine (fallopian) tubes. Traditionally considered a passive conduit for gamete transport, the uterine tube is now recognized as a highly specialized organ with complex morphological, cellular, and biochemical properties that are essential for successful fertilization and early embryonic development. Contemporary literature emphasizes that the functional efficiency of the uterine tube is closely linked to its microanatomical integrity, including epithelial architecture, smooth muscle organization, and stromal composition. Modern histological studies have demonstrated that the uterine tube consists of distinct anatomical regions—infundibulum, ampulla, isthmus, and intramural segment—each characterized by unique morphological and functional features. The mucosal layer, lined with ciliated and secretory epithelial cells, plays a critical role in the transport of oocytes and embryos. Coordinated ciliary activity, together with rhythmic contractions of the muscular layer, ensures the proper movement of reproductive cells along the tube. Alterations in this finely regulated system may lead to impaired transport mechanisms and subsequent reproductive disorders.

In recent years, particular attention has been given to newly identified cellular components within the uterine tube. Among these, telocytes have emerged as a key element in regulating tubal motility and intercellular signaling. These specialized interstitial cells form extensive networks within the tubal wall and express receptors for steroid hormones, suggesting their involvement in hormonal regulation of peristalsis. Disruption in telocyte distribution or function has been associated with pathological conditions such as ectopic pregnancy and tubal infertility, highlighting their importance in maintaining structural and functional homeostasis. Another important direction in contemporary research is the investigation of immune cell populations within the uterine tube. Contrary to earlier assumptions, the tubal environment is not immunologically inert but contains a diverse array of immune cells, including macrophages, lymphocytes, and natural killer cells. These cells contribute to the establishment of a controlled immune environment that allows tolerance to sperm and the semi-allogenic embryo while still providing protection against pathogens. This dual role underscores the complexity of the uterine tube as both a reproductive and immunological organ. Recent literature has also highlighted the presence of a unique tubal microbiome and its potential influence on reproductive health. The recognition that the uterine tube is not sterile but harbors a dynamic microbial community represents a paradigm shift in reproductive biology. Changes in microbiome composition may affect epithelial integrity, ciliary function, and local immune responses, thereby influencing fertility outcomes. These findings open new avenues for investigating the relationship between environmental factors, microbial balance, and tubal morphology.



A growing body of research has focused on the impact of pathological, environmental, and lifestyle factors on the morphology and function of the uterine tube. Factors such as infections, endocrine disorders, exposure to toxic agents, and metabolic imbalances can induce structural alterations, including epithelial damage, smooth muscle disorganization, and changes in tissue vascularization. These alterations can significantly impair tubal transport mechanisms and are considered major contributors to infertility. Indeed, it is estimated that tubal pathologies account for approximately 25–35% of female infertility cases, underscoring the clinical relevance of detailed morphological studies. Experimental and clinical studies have further demonstrated that functional disturbances in the uterine tube are often accompanied by measurable morphometric changes. For instance, variations in epithelial height, luminal diameter, and muscular layer thickness have been observed under different physiological and pathological conditions. Histomorphological investigations in animal models have revealed that hormonal status, reproductive stage, and external influences can significantly affect tubal dimensions and tissue composition. Such findings highlight the importance of morphometric analysis as a quantitative tool for assessing structural adaptations. In addition to pathological conditions, recent studies have begun to explore the influence of systemic physiological states, including hypokinesia, on the reproductive system. Hypokinesia, characterized by reduced physical activity or restricted movement, has been widely used as an experimental model to study adaptive changes in various organ systems. Although its effects on the cardiovascular, musculoskeletal, and nervous systems are well documented, its impact on the female reproductive tract remains relatively underexplored. However, indirect evidence suggests that hypokinesia may influence reproductive organs through alterations in hormonal balance, blood circulation, and metabolic activity.

Reduced physical activity has been associated with impaired microcirculation and decreased tissue oxygenation, which may affect the structural integrity of reproductive tissues. Furthermore, hypokinesia can disrupt endocrine regulation, leading to changes in estrogen and progesterone levels—hormones that play a crucial role in maintaining the functional state of the uterine tube. Given that tubal motility and epithelial function are hormonally regulated, it is plausible that hypokinetic conditions may lead to structural remodeling and morphometric alterations. Recent methodological advancements have provided new tools for investigating these changes. Techniques such as high-resolution histology, immunohistochemistry, and digital morphometry allow for precise quantification of structural parameters and enable the detection of subtle tissue alterations. Additionally, the development of three-dimensional organoid models and in vitro systems has facilitated the study of tubal physiology under controlled experimental conditions. These approaches have significantly enhanced the ability to analyze the relationship between structure and function in the uterine tube.

Despite these advances, there remains a lack of comprehensive studies specifically addressing the effects of hypokinesia on the morphology and morphometric parameters of the uterine tubes. Most existing research focuses on general reproductive dysfunction or systemic physiological changes, leaving a gap in understanding the direct structural impact of reduced physical activity on this organ. This gap highlights the need for targeted experimental studies that combine morphological and morphometric analyses to provide a more complete picture of hypokinesia-induced changes. In summary, the current body of literature underscores the complexity of the uterine tube as a multifunctional organ whose structure is closely linked to its reproductive role. Recent discoveries regarding cellular composition, immune function, and environmental influences have significantly advanced the field. However, the specific effects of hypokinesia on tubal morphology remain insufficiently studied, justifying further investigation into this area.

**Research discussion.** The present study provides a comparative analysis of the morphological and morphometric parameters of uterine tubes under conditions of experimental



hypokinesia, revealing significant structural alterations that may have functional implications for female reproductive capacity. The findings demonstrate that reduced physical activity induces measurable changes in epithelial architecture, muscular layer organization, and overall tissue integrity, supporting the hypothesis that hypokinesia affects not only systemic physiology but also reproductive organs at the microstructural level. One of the key observations of this study is the alteration in the epithelial layer of the uterine tubes. A decrease in epithelial height and disruption of ciliated cell distribution were noted under hypokinetic conditions. These findings are consistent with recent studies indicating that epithelial integrity is highly sensitive to hormonal and metabolic disturbances. Since ciliary activity plays a crucial role in gamete and embryo transport, any structural impairment in the epithelium may lead to reduced transport efficiency and increased risk of reproductive complications. Similar epithelial changes have been reported in conditions associated with hormonal imbalance and reduced estrogen levels, suggesting that hypokinesia may exert its effects through endocrine-mediated mechanisms.

In addition to epithelial changes, the present study identified significant modifications in the muscular layer of the uterine tubes. A reduction in smooth muscle thickness and disorganization of muscle fibers were observed, which may impair peristaltic activity. The coordinated contraction of the muscular layer is essential for the propulsion of the oocyte and early embryo toward the uterine cavity. Therefore, structural alterations in this layer may contribute to delayed transport or abnormal implantation, including an increased risk of ectopic pregnancy. These results are in agreement with recent literature emphasizing the importance of neuromuscular regulation in maintaining tubal function. Another important aspect of the findings is the potential involvement of microcirculatory disturbances in the observed morphological changes. Hypokinesia is known to reduce blood flow and tissue oxygenation, leading to hypoxic conditions that can negatively affect cellular metabolism and tissue maintenance. The observed thinning of tissue layers and changes in stromal organization may reflect adaptive or degenerative responses to reduced perfusion. Previous experimental studies have demonstrated that impaired microcirculation can lead to structural remodeling in various organs, including reproductive tissues, further supporting this interpretation.

The role of hormonal regulation in mediating these changes should also be considered. The uterine tubes are highly responsive to fluctuations in estrogen and progesterone levels, which regulate epithelial proliferation, ciliary activity, and muscular contractility. Hypokinesia has been associated with endocrine alterations, including decreased estrogen levels, which may contribute to the observed structural changes. The reduction in epithelial height and muscular thickness observed in this study may therefore be partially explained by diminished hormonal stimulation. This is consistent with contemporary research highlighting the interplay between physical activity, endocrine function, and reproductive health. Furthermore, recent studies have identified specialized interstitial cells, such as telocytes, as important regulators of tubal motility and structural organization. Although not directly examined in the present study, it is plausible that hypokinesia-induced changes may also affect the distribution or function of these cells. Disruption of telocyte networks could contribute to impaired coordination of muscular contractions and altered tissue homeostasis. Future studies incorporating immunohistochemical analysis would be valuable in elucidating the role of these cellular components in hypokinesia-related changes.

The morphometric data obtained in this study provide quantitative support for the observed histological alterations. Changes in parameters such as luminal diameter, epithelial thickness, and muscular layer thickness indicate that hypokinesia leads to measurable structural remodeling. These findings highlight the importance of combining qualitative and quantitative approaches in morphological research, as morphometric analysis allows for more precise evaluation of tissue adaptations and facilitates comparison with other experimental models. Despite the significance of these findings, certain limitations should be acknowledged. The study



was conducted under controlled experimental conditions, which may not fully replicate the complexity of human physiological and pathological states. Additionally, the absence of functional assessments, such as measurements of ciliary activity or tubal motility, limits the ability to directly correlate structural changes with functional outcomes. Future research should aim to integrate morphological, functional, and molecular analyses to provide a more comprehensive understanding of the effects of hypokinesia on the uterine tubes. The results of this study demonstrate that experimental hypokinesia induces significant morphological and morphometric changes in the uterine tubes, potentially impairing their functional capacity. These findings contribute to the growing body of evidence that reduced physical activity can negatively impact reproductive health and underscore the need for further research in this area. Understanding the mechanisms underlying these changes may provide new insights into the prevention and management of reproductive disorders associated with sedentary lifestyles.

**Conclusion.** The present study demonstrates that experimental hypokinesia induces significant morphological and morphometric alterations in the uterine tubes, reflecting the sensitivity of reproductive organs to reduced physical activity. The observed changes, including decreased epithelial height, disruption of ciliated cell organization, and thinning of the muscular layer, indicate structural remodeling that may impair essential functions such as gamete transport and embryo movement. These findings suggest that hypokinesia can negatively affect the functional capacity of the uterine tubes through combined mechanisms involving microcirculatory disturbances, metabolic imbalance, and endocrine alterations. The quantitative morphometric data further confirm that these structural modifications are measurable and consistent, emphasizing the importance of integrating morphometric analysis into reproductive research. Although the study was conducted under experimental conditions, the results provide valuable insights into potential mechanisms linking sedentary lifestyles with reproductive dysfunction. Overall, this research highlights the need for further multidisciplinary investigations combining morphological, functional, and molecular approaches to better understand the impact of hypokinesia on female reproductive health and to develop effective preventive strategies.

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