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THE CORRELATION BETWEEN LIFESTYLE AND PREVALENCE OF HIP JOINT DISEASE IN PLATEAU AREAS

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Abstract: This study systematically analyzed the relationship between lifestyle habits and the incidence of hip joint disease in high-altitude areas, focusing specifically on the mechanisms by which factors such as low oxygen levels, strong ultraviolet radiation, traditional infant swaddling methods, and unique walking patterns influence hip joint health. This study provides a scientific basis for the prevention and control of hip joint disease in high-altitude areas.
Keywords: Plateau area; Prevalence of hip arthritis; Relevance

1 INTRODUCTION

Hip disorders severely impact patients' quality of life and encompass a wide range of conditions, including developmental dysplasia of the hip (DDH), osteoarthritis (OA), and avascular necrosis of the femoral head. Population growth and the increasingly aging population in high-altitude regions worldwide have made hip disease a growing concern in these high-altitude areas. The unique geographical and cultural characteristics of these plateaus, such as low oxygen levels, intense ultraviolet radiation, and distinct lifestyles and customs, can profoundly impact hip health. According to statistics, approximately 500 million people worldwide live permanently at altitudes above 1,500 meters. This is particularly true of China's Qinghai-Tibet region Plateau, the world's highest and largest plateau, with an average elevation exceeding 4,000 meters and home to approximately 5 million Tibet region ans. The epidemiological characteristics of hip disease in these regions and its association with lifestyle have become a key research topic in orthopedics and public health.

2 EPIDEMIOLOGICAL CHARACTERISTICS OF HIP ARTHRITIS IN PLATEAU AREAS

2.1 Prevalence of Developmental Dysplasia of the Hip (DDH)

Developmental dysplasia of the hip (DDH) is a common childhood condition, particularly in high-altitude areas. A 2019 study in Shigatse, Tibet region , China, found a prevalence of DDH of 174.9‰ (106/606) among 606 infants aged 0-6 months. This rate was significantly higher than reported data from the plains. Interestingly, the study demonstrated a significant positive correlation between the prevalence of DDH and altitude (r=0.82, P=0.004). This suggests that the incidence of DDH increases with increasing altitude [1]. This finding was further validated in subsequent studies. A 2021 survey showed an average prevalence of DDH of approximately 32.4‰ in Shigatse, Tibet region . Unilateral cases were more common than bilateral cases, with the ratio of right to left being 1.00:2.06.
Meanwhile, a study conducted in Luoma Township, Seni District, Nagqu City, Tibet region Autonomous Region, revealed that the prevalence of knee osteoarthritis was 36.1%, while hand osteoarthritis reached 50.5%. Furthermore, rheumatoid arthritis accounted for 4.4%, slightly higher than other relevant data from China and abroad (0.18% to 1.07%). These data indicate that, particularly in the Qinghai-Tibet region Plateau, the incidence of hip and other joint diseases is generally higher than in the plains.

2.2 Epidemiology of Hip Fracture and Osteoarthritis

Hip fractures are a common hip disease and have unique epidemiological characteristics in high-altitude areas. A study of hip fracture incidence at different altitudes in Norway found that women living at higher altitudes had a significantly increased risk of hip fracture (IRR = 1.04, 95% CI: 1.02, 1.05), while men showed no significant difference. The study also showed that the risk of hip fracture increases with distance from the coast. The data showed that women who lived farther from the coast had a higher risk of hip fracture (relative risk ratio = 1.04, 95% confidence interval: 1.02 to 1.06).
A study of the Peruvian highland city of Juliaca (at an altitude of approximately 3,800 meters) revealed a prevalence of hip osteoarthritis of 0.37% among residents. A Japanese study showed that the prevalence of radiographic hip osteoarthritis in the general population was 1.1% in men and 0.9% in women [2], while in rural areas, the prevalence was 0.59%. Although comparisons of prevalence rates across studies require caution, these data suggest that the prevalence of hip osteoarthritis in highland areas may differ from that in lowland areas.

3 ASSOCIATION MECHANISM BETWEEN PLATEAU ENVIRONMENTAL FACTORS AND HIP JOINT DISEASE

3.1 Effects of Hypoxic Environment on Hip Joint Health

3.1.1 Effects of hypoxia on hip joint blood circulation

Low oxygen levels at high altitudes are one of the main factors affecting hip joint health. Studies have shown that low oxygen levels trigger the kidneys to release angiotensin II and vasopressin, increasing blood volume and cardiac output to ensure adequate oxygen supply to tissues. However, this compensatory mechanism can cause blood to become more viscous, increasing the risk of blood clots and thus affecting blood flow in the hip joint area.

A research team from Peking University, studying the effects of high altitude on human hemodynamics, found that in the initial stages of acute high altitude exposure, the subjects' diastolic blood pressure (DBP) increased significantly by 11%, their stroke volume (SV) decreased by 17% [3], and their subendocardial myocardial viability ratio (SEVR) decreased by 19%. These changes indicate an imbalance in myocardial oxygen supply and demand. While this study focused on cardiac function, it also indirectly revealed adaptive changes in systemic blood circulation under hypoxic conditions, which may also affect blood flow in the hip joint area.

Research by the Human Phenome Research Institute at Fudan University has further demonstrated that low-pressure, low-oxygen environments can trigger functional problems in the vascular endothelium, which is closely linked to dysregulation of energy metabolism. Under hypoxic conditions, glycolysis in endothelial cells increases, while oxidative phosphorylation decreases, leading to the production of a large amount of lactate. This lactate promotes the lactylation of PKM2 [4], preventing its degradation, leading to dysregulation of endothelial energy metabolism and worsening endothelial dysfunction. This endothelial dysfunction may adversely affect nutrient delivery to the cartilage and bone tissue of the hip joint, thereby promoting the development and progression of hip joint disease.

3.1.2 Hypoxia and avascular necrosis of the femoral head

Multiple studies have demonstrated a link between oxygen-deficient environments and avascular necrosis of the femoral head. Studies have shown that in SD rats treated with glucocorticoids, hypoxia exacerbates femoral head necrosis in the presence of sustained hypoxia (simulating an altitude of 4,000 meters) [5]. This phenomenon is closely linked to a hypercoagulable state and increased thrombosis.

A study investigating the hidden blood loss associated with intertrochanteric fractures in patients living at high altitudes found that hypoxia may be an independent risk factor for increased blood loss in elderly patients with intertrochanteric fractures at high altitudes. This suggests that hypoxia may alter blood flow characteristics, increasing the risk of thrombosis in blood vessels near the hip joint, thereby affecting blood supply to the femoral head and ultimately causing avascular necrosis.

The circumflex branches of the femoral artery, particularly the medial retinaculum, supply blood to the hip head, with the medial retinaculum responsible for approximately two-thirds of blood flow. In an oxygen-poor environment, these vessels are more susceptible to spasm, narrowing, or thrombosis, leading to localized blood deficiency in the femoral head and potentially avascular necrosis.

3.1.3 Effects of hypoxia on hip cartilage metabolism

An oxygen-deficient environment may promote the progression of hip joint disease by altering chondrocyte metabolism. Studies have shown that moderate levels of reactive oxygen species (ROS) can support essential cellular functions, such as promoting chondrocyte proliferation and cartilage matrix remodeling [6]. However, excessive ROS accumulation can lead to oxidative stress, triggering cell aging, loss of differentiation, and death, and promoting an increase in matrix-degrading enzymes, leading to cartilage matrix destruction.

In oxygen-deficient conditions, chondrocytes may experience increased oxidative stress. A research team from Soochow University found that by enhancing the antioxidant capacity of chondrocytes, for example by increasing the expression of SOD3, they could effectively alleviate cartilage degradation, restore the balance between anabolism and degradation, and thus improve athletic performance. This demonstrates the importance of the antioxidant defense system under hypoxic conditions and the potential role of oxidative stress in the development of hip joint disease at high altitudes.

3.2 Impact of Strong Ultraviolet Radiation on Hip Joint Health

3.2.1 Direct damage to articular cartilage caused by ultraviolet radiation

Intense ultraviolet radiation at high altitudes is a key environmental factor affecting hip joint health. Studies have shown that ultraviolet radiation can directly damage skin and articular cartilage cells while stimulating the production of free radicals, leading to oxidative stress. Ultraviolet radiation can stimulate keratinocytes to produce large amounts of prostaglandin E2 (PGE2), which promotes the release of inflammatory mediators and further exacerbates inflammatory responses in joint tissue.

Studies of articular cartilage's UV absorption properties have shown that 365-nanometer UV rays are significantly attenuated as they pass through the cartilage, particularly in the cartilage's surface layer. This attenuation decreases with increasing depth [7]. This suggests that the surface cells of articular cartilage may be more susceptible to direct damage from UV radiation. Furthermore, studies have shown that intact cartilage sheets exhibit significant light absorption properties when exposed to UV radiation, particularly at wavelengths below 300 nm. These characteristics may explain why articular cartilage is more susceptible to degeneration after long-term exposure to strong UV radiation.

3.2.2 Ultraviolet radiation and oxidative stress

Oxidative stress caused by ultraviolet radiation is a key factor in the destruction of articular cartilage. Studies have shown that ultraviolet radiation can increase the concentration of reactive oxygen species (ROS) in chondrocytes, triggering oxidative stress and subsequently damaging DNA [8], proteins, and lipids within the cells. A study examining the impact of environmental factors on the inflammatory changes in articular tuberculosis found that the risk of articular tuberculosis in people who have lived at high altitudes for a long time is positively correlated with the intensity of ultraviolet radiation.

Selenium plays a key role in protecting against DNA damage caused by ultraviolet radiation. Studies have shown that selenium can offset the effects of DNA damage caused by UV radiation, such as by reducing DNA damage and enhancing DNA repair. In high-altitude environments with strong ultraviolet radiation, adequate supplementation of antioxidant nutrients such as selenium may help protect joint cartilage from damage.

3.2.3 Epidemiological evidence of ultraviolet radiation and hip joint diseases

Indirect evidence from epidemiological surveys suggests a possible link between UV radiation and hip problems. One study of residents at different altitudes in Ecuador found that UV radiation levels at altitudes between 2,800 and 3,000 meters were approximately 40% higher than those at lower altitudes. Intense UV exposure may increase the likelihood of oxidative damage to hip cartilage, thereby impacting hip joint health.

An orthopedic research team led by Professor Zhu Xuesong found that in articular cartilage, SOD3 (superoxide dismutase 3) expression increased, while APOE (apolipoprotein E) expression decreased. This suggests that enhancing cartilage's antioxidant capacity and restoring cholesterol balance may be crucial for preventing hip joint disease in high-altitude areas. This further supports the hypothesis that ultraviolet radiation may affect hip joint health through oxidative stress mechanisms.

3.3 Impact of the Special Lifestyle in Plateau Areas on the Hip Joint

3.3.1 Walking habits and hip joint load

The walking habits of residents in high-altitude areas have a significant impact on hip health. Research has found that the stress on the hip joint varies significantly depending on the slope of the walk. Hip torque increases significantly when walking uphill. While hip torque changes less during downhill walking, knee extension torque increases significantly. This may indicate that people who walk in high-altitude areas for a long time are more susceptible to hip and knee problems.

People living in mountainous areas and plateaus, due to long periods of walking on steep terrain, place greater stress on their knees and hips, making them more susceptible to joint degeneration. In contrast, people living in plains, where the terrain is flatter, experience less stress on the hip joints and are therefore less likely to develop joint problems. This difference may contribute to the higher incidence of hip joint problems in plateau areas.

A simulation study analyzed the forces acting on lower limb joints during weight-bearing walking at different inclines. The results showed that when walking uphill, the torques in almost all joints increased, and the load on the hip joint also increased with increasing incline. For instance, at a 15-degree incline, the average hip joint torque measures 0.4693 Nm/kg, and the peak torque reaches 1.7221 Nm/kg, which is notably higher than the values observed at a 0-degree incline, where the average and peak torques are 0.3893 Nm/kg and 1.4880 Nm/kg, respectively. Based on these data, the complex terrain conditions in plateau areas may significantly increase the mechanical load on the hip joint, leading to faster wear and degeneration of articular cartilage.

3.3.2 Traditional clothing and joint protection

The traditional attire of plateau residents may affect hip joint health. Among Tibet region ans, long, open-fronted robes and riding boots are typical clothing styles, which, to some extent, expose joints more readily. In low temperatures, exposed joints can cause local blood circulation impairment and increased muscle tension, which can affect joint stability and function and increase the risk of hip problems.

In high-altitude areas, low temperatures may increase the viscosity of joint fluid and reduce the elasticity of surrounding joint tissues, thereby increasing friction and resistance during joint movement. Studies have shown that falling temperatures make joint fluid more viscous, increasing resistance to joint movement and potentially exacerbating cartilage wear. Therefore, the cold climate at high altitudes and traditional clothing practices may jointly affect hip joint health.

3.3.3 Impact of religious activities such as circumambulation

Religious practices such as circumambulation, performed by ethnic groups like Tibet region ans in high-altitude areas, may affect hip health. Circumambulation involves repetitive hip rotation, and prolonged performance can cause fatigue and chronic damage to the soft tissue surrounding the hip joint. Standard hip rotation movements are generally harmless. However, training errors or pre-existing hip conditions can lead to soft tissue damage or hip dislocation.

Furthermore, the constant shift in the body's center of gravity and the repetitive rotation of the hip joint during prayer wheel rotation may increase shear stress on the hip cartilage, accelerating cartilage degeneration. For patients with congenital hip dysplasia or hip dislocation, performing hip rotations may exacerbate their condition or even lead to serious complications. Therefore, individuals at high risk of hip disease may need to adjust the style and intensity of their religious activities, such as prayer wheel rotation, while in the plateau.

3.4 Traditional Baby Swaddling and Hip Dysplasia

3.4.1 Traditional Tibet region an baby wrapping methods

Traditional Tibet region an infant swaddling has a significant impact on hip formation. In Shigatse, Tibet region , infants are traditionally swaddled, where their legs are tied together for up to two months. Studies have shown a strong link between this swaddling method and the development of developmental dysplasia of the hip (DDH).

A study showed that all infants diagnosed with developmental dysplasia of the hip (DDH) in the Shigatse region of Tibet region had been wrapped with their legs tied for more than two months. Statistical analysis revealed a significant association between DDH and wrapping the hips in extension ($P<0.001$). This suggests that traditional Tibet region an infant wrapping is a major environmental risk factor for developmental dysplasia of the hip.

3.4.2 Epidemiological Characteristics of DDH in the plateau area

Research conducted in the Shigatse region of Tibet region reveals that the average prevalence of developmental dysplasia of the hip (DDH) in this area is approximately 32.4 per 1,000 individuals. Unilateral cases surpass bilateral ones, with 33 instances affecting the right side and 68 affecting the left, resulting in a right-to-left ratio of 1.00 to 2.06. This prevalence is much higher than that in inland cities, suggesting that the occurrence of DDH in the plateau may be related to multiple factors.

Recent studies have reaffirmed this conclusion. A study published in 2019 reveals that the prevalence of DDH in the Shigatse region of Tibet region is approximately 174.9 per 1000 (106 out of 606), or around 17.5%. This figure is much higher than previously reported, which may be related to the research methods used, the number of samples, or regional differences. The study also revealed a significant positive correlation: there was a positive correlation between altitude and the prevalence of DDH ($r=0.82$, $P=0.004$), which means that plateau areas may be an independent risk factor for DDH.

3.4.3 Interaction between infant wrapping method and altitude

Studies have shown that swaddling method and altitude may jointly influence the incidence of DDH. In the Shigatse region of Tibet region , studies have shown a significant correlation between the incidence of DDH and the local altitude ($r=0.820$, $P=0.046$). Furthermore, swaddling with the legs tied was also significantly associated with the incidence of DDH ($P=0.0017$). This suggests that using traditional infant swaddling methods at high altitudes may have a greater negative impact on hip development.

A study of Tibet region an infants revealed significant associations between altitude, leg-binding wrapping, nomadic lifestyle, and breech presentation and the development of DDH. Leg-binding wrapping was identified as a major environmental risk factor for DDH. These findings highlight the crucial role of changes in traditional infant wrapping methods in preventing DDH at high altitudes.

4 CHARACTERISTICS OF HIP JOINT DISEASE IN DIFFERENT POPULATIONS IN PLATEAU AREAS

4.1 Hip Dysplasia in Tibet Region an Infants and Children

Tibet region an infants and young children are at high risk of developmental dysplasia of the hip. Studies have shown that the incidence of DDH in Tibet region an infants is significantly higher than that in infants of Han and other ethnic groups. In the Xigaze region of Tibet region , the prevalence of DDH reaches 174.9 per 1,000 (106 out of 606), equating to approximately 17.5%. In contrast, urban areas in mainland China typically experience a DDH prevalence rate ranging between 1 to 2 per 1,000.

Developmental dysplasia of the hip (DDH) in Tibet region an infants is influenced by a combination of factors. The traditional Tibet region an practice of leg binding and wrapping is a significant environmental risk factor. Furthermore, studies have revealed a significant positive correlation between altitude and the prevalence of DDH ($r=0.82$, $P=0.004$), suggesting that the high-altitude environment itself may increase the risk of DDH. Furthermore, breech delivery is considered a risk factor for developmental dysplasia of the hip in Tibet region an infants ($P=0.0082$).

Tibet region an infants with developmental dysplasia of the hip (DDH) often exhibit unique clinical features. Studies have shown that DDH is more common on the left side of the body in Tibet region an infants, with a ratio of 1:2.06. This finding may be related to the delivery method used by Tibet region an women, the position of the fetus in the womb, or traditional swaddling practices, and warrants further investigation.

4.2 Hip Joint Diseases in Tibet Region an Adults

Hip joint problems in Tibet region an adults present with unique manifestations. A survey conducted in Luoma Township, Seni District, Nagqu City, Tibet region Autonomous Region, revealed a prevalence of knee osteoarthritis of 36.1% and a prevalence of 50.5% in finger joints. The survey found that the distal interphalangeal joints and carpometacarpal joints of the thumb were particularly common, while the proximal interphalangeal joints of the little finger were particularly prone to deformity. While the study focused on the knee and hand joints, it also revealed the prevalence of joint problems in the plateau region.

Studies have shown that sustained hypoxic conditions or environments may increase the incidence of avascular necrosis

of the femoral head. In conditions simulating the long-term hypoxic environment of 4,000 meters above sea level, SD rats treated with glucocorticoids experienced worsening femoral head necrosis. This condition is associated with increased hypercoagulability and thrombosis. This finding may, to some extent, explain the frequent occurrence of avascular necrosis of the femoral head in high-altitude areas.

Hip diseases among adult Tibet region ans are related to their occupation and lifestyle. Tibet region ans who engage in manual labor, particularly herders and farmers, often engage in weight-bearing activities, which leads to a higher incidence of hip degenerative disease. Prolonged standing, walking, and repetitive movements such as bending over can put constant pressure and wear on the hip joint, increasing the risk of degenerative disease.

4.3 Changes in Hip Joint Health among People Migrating to the Plateau

Studying changes in hip health among people who migrate to high altitudes is a topic of great research interest. Studies have shown that the risk of hip problems may change when people move from low-altitude to high-altitude areas. Oxygen deprivation may increase the risk of avascular necrosis of the femoral head. Furthermore, migrants may maintain their existing lifestyles, and these habits can interact with the high-altitude environment, impacting hip health.

Research has shown that after long-term acclimatization to the low oxygen and low pressure conditions of high altitude, the body and structure undergo a series of adjustments. After prolonged exposure to high-altitude hypoxia, red blood cell count increases to improve oxygen delivery. This adaptive change may affect blood flow and metabolism in the hip, impacting hip joint health. When these individuals return to the plains, the increased red blood cell count may trigger oxidative stress damage, resulting in symptoms such as dizziness, drowsiness, and fatigue. This phenomenon is known as "altitude deacclimatization."

However, there is currently little research on changes in hip health in people who migrate to the plateau. Future studies could further analyze the specific impacts of environmental and genetic factors on the development of hip disease by comparing the incidence of hip disease in people who have lived in the plateau for a long time, those who have recently moved to the plateau, and those who have previously migrated to the plains.

5 PREVENTION AND TREATMENT STRATEGIES FOR HIP JOINT DISEASE IN PLATEAU AREAS

5.1 Prevention and Intervention of Infantile Developmental Dysplasia of the Hip

To address the high incidence of DDH in Tibet region an infants, implementing preventive measures and timely early intervention are extremely critical. Based on existing research results, the following measures are recommended:

First, changing the conventional infant wrapping method is key to preventing DDH. Studies have shown that DDH in Tibet region an infants is primarily affected by the way the legs are tied and wrapped, a significant environmental risk factor. It is recommended that the hip-abduction wrapping technique be promoted to prevent the forced straightening and closing of the infant's legs, thereby supporting healthy hip development.

Furthermore, it is crucial to establish DDH screening programs for infants in high-altitude areas. The study recommends that government-level measures be taken to establish programs to screen high-risk infants for developmental dysplasia of the hip. This study, for the first time, reveals the high prevalence and influencing factors of DDH in Tibet region ans living at high altitudes, providing important insights for the formulation and management of relevant policies.

Third, we should increase training for medical staff in high-altitude areas to improve their skills in early recognition and diagnosis of DDH. Early recognition and treatment of DDH are crucial for improving prognosis, so improving the awareness and professional capabilities of primary health care workers is a key step in prevention and treatment.

Finally, we need to organize health education activities to raise awareness of the dangers of DDH among Tibet region an families and guide them to change traditional habits that are detrimental to hip health. Research has shown that increasing public understanding of DDH and implementing behavioral interventions can effectively reduce the incidence of the disease.

5.2 Protective Measures for Hip Arthritis Related to High Altitude Hypoxia

In response to the impact of the plateau hypoxic environment on hip joint health, the following protective measures can be taken:

First, promoting blood flow in the hip joint area is key. Studies have shown that an oxygen-deficient environment can cause blood to become more viscous, increasing the risk of blood clots and negatively impacting blood flow to the hip joint. Therefore, moderate exercise, adequate hydration, and avoiding prolonged sitting can help promote blood circulation and reduce the risk of hip joint disease.

Furthermore, improving antioxidant defenses may help mitigate damage to the hip joint caused by hypoxia and UV radiation. Studies have shown that trace elements such as selenium can protect cells from UV-induced DNA damage by reducing DNA damage and enhancing DNA repair capacity. Therefore, increasing antioxidant intake may help improve hip joint health in residents of high-altitude areas.

Third, appropriate protective equipment, such as hip braces, can be used to reduce the stress on the hip joint while walking and working. Studies have shown that people who walk on steep mountain roads for long periods of time experience increased stress on their hip joints, and wearing appropriate protective gear may be effective in reducing this

stress.
Finally, for high-risk groups, such as military personnel and herdsmen stationed in plateau areas for a long time, regular hip joint examinations are needed to detect and treat potential hip joint problems in a timely manner.

5.3 Interventions for Hip Arthritis Associated with Traditional Lifestyle

In view of the impact of traditional lifestyle in plateau areas on hip joint health, the following intervention measures can be taken:
First, adjusting infant swaddling techniques is crucial for preventing developmental dysplasia of the hip. Research clearly shows that the traditional Tibet region an method of swaddling the legs is a primary environmental factor contributing to DDH. Therefore, promoting scientific infant care methods that avoid excessive hip extension and adduction is crucial for preventing DDH.
Additionally, hip joint stress can be reduced by changing work and walking habits. Studies have shown that the load on the hip joint changes significantly with changes in slope during walking. During climbing, the rotational stress on the hip joint increases significantly. Walking downhill significantly increases knee extension force. Therefore, it is recommended that residents living in plateau areas slow down when ascending hills and use assistive devices to reduce hip joint stress. Protect your knees and prevent overextension when descending.
Third, improve hip joint stability by strengthening the hip muscles. Proper hip muscle training through appropriate activities can strengthen the muscles surrounding the joint, improve hip joint stability, and reduce pressure on the cartilage. For example, resistance training such as hip abduction and extension can be performed. However, excessive weight and strenuous exercise should be avoided.
Patients with hip problems should adopt a comprehensive treatment approach that includes physical therapy, medication, and surgery when needed. Studies have shown that for early-stage hip problems, non-surgical treatments such as reducing weight bearing, using medication, and physical therapy may be effective in slowing the progression of the disease.

6 CONCLUSION AND OUTLOOK

6.1 Main Research Conclusions

This study systematically analyzed the association between lifestyle and the prevalence of hip arthritis in plateau areas and drew the following main conclusions:
The incidence of hip joint diseases, especially developmental dysplasia of the hip (DDH), osteoarthritis, and avascular necrosis of the femoral head, increases significantly in high-altitude areas. In the Shigatse region of Tibet region , the prevalence of DDH reaches 174.9 per 1000 (106 out of 606), significantly higher compared to mainland cities.
2. Plateau environmental conditions are closely linked to the onset and progression of hip joint disorders. Hypoxic environments may impair blood circulation and energy metabolism in the hip joint, increasing the risk of avascular necrosis of the femoral head. Intense ultraviolet radiation may damage articular cartilage through oxidative stress. The unique topography and gait patterns of the plateau may increase mechanical stress on the hip joint, accelerating joint degeneration.
3. Traditional Tibet region an infant swaddling is a key environmental risk factor for DDH. Studies indicate that there is a significant association between tandem lower limb swaddling and the occurrence of DDH ($P<0.001$). Furthermore, there exists a notable positive correlation between altitude and the prevalence of DDH ($r=0.82$, $P=0.004$).
4. Hip problems vary significantly among different ethnic groups in high-altitude areas. Among Tibet region an infants, developmental dysplasia of the hip (DDH) is more common on the left side, with a left-right ratio of 1.00:2.06. Hip problems in Tibet region an adults are often closely related to their occupation and lifestyle.
5. For the prevention and treatment of hip joint diseases in plateau areas, multiple strategies should be adopted, including changing the traditional baby wrapping method, strengthening screening and early intervention, improving blood circulation in the hip joint, enhancing antioxidant defense mechanisms, and adjusting work and walking methods.

6.2 Research Limitations and Prospects

This study has several limitations. The current study was primarily cross-sectional in nature and lacked long-term observational data, making it difficult to establish causal relationships. Furthermore, differences in diagnostic criteria and methods used across studies preclude direct comparison of the results. Furthermore, the pathogenesis of hip joint disease in plateau regions remains largely unexplored, particularly regarding the specific mechanisms of action of hypoxia and ultraviolet radiation on hip cartilage and bone, which require further exploration.
Future research should focus on the following directions:
A large-scale and long-term follow-up cohort study should be conducted to clarify the incidence and risk factors of hip joint diseases in the plateau area and confirm their causal relationship.
2. Conduct detailed research on the mechanisms by which plateau climate conditions (e.g., low oxygen levels and strong ultraviolet radiation) affect hip cartilage and bone tissue, with a particular focus on changes in oxidative stress, apoptosis, and extracellular matrix metabolism.

3. Analyze how genetic and environmental factors interact to influence hip joint disease in the plateau region, with a particular focus on the genetic susceptibility of the Tibet region an population.
4. Conduct intervention studies to evaluate the effectiveness of strategies such as modifications to traditional infant swaddling practices and antioxidant supplementation in preventing hip disease.
5. Establish an early detection and intervention system for hip joint diseases in plateau areas to enhance the efficiency of prevention and treatment.
These studies help to deeply analyze the relationship between lifestyle and hip joint diseases in plateau areas, provide theoretical support for the formulation of special prevention and treatment measures, and thus improve the hip joint health of residents in plateau areas.

6.3 Policy Recommendations

Based on the findings of this study, the following policy recommendations are put forward:
1. Promote scientific infant care methods in high-altitude areas, especially changing the traditional leg-binding wrapping method to prevent developmental dysplasia of the hip (DDH).
2. Carry out infant hip screening programs in high-altitude areas to achieve early detection, timely diagnosis and effective treatment.
3. Strengthen training for primary medical personnel in plateau areas to improve their skills in identifying and managing hip joint diseases.
4. Organize health education activities to enhance the knowledge of hip joint health among residents in plateau areas and encourage them to improve bad living habits to maintain hip joint health.
5. Integrate hip joint health into the public health service system in plateau areas, carry out regular screening and follow-up, and form a long-term mechanism for the prevention and control of hip joint diseases.
6. Conduct research on hip joint diseases in plateau areas, paying special attention to the interaction between environmental and genetic factors, to provide a scientific basis for the prevention and treatment of diseases.
7. Provide hip joint protection advice to special occupational groups in plateau environments, such as soldiers and herdsmen, to reduce the risk of occupational hip injuries.
8. Strengthen the allocation of medical resources in plateau areas, improve the diagnosis and treatment capabilities of hip joint diseases, and especially popularize hip replacement surgery techniques.
These policy measures can effectively reduce the incidence and disability of hip joint diseases in plateau areas and improve the quality of life of local residents.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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