Understanding and Optimizing the Hypermobile Dancer

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Introduction

Any current or former dancer has at some point in their lives received the comment, "you must be so flexible." At the heart of these comments is one of the most controversial topics in the realm of dance science: joint hypermobility. Increased range of motion in the joints is widely considered to be one of the hallmarks of the stereotypical "dancer's body" and helps dancers achieve extreme physical positions for aesthetic purposes. Hypermobility has been a focus of dance science research since the late 20th century, with studies mainly investigating prevalence of the phenotype among dancers and the possibility of an increased injury risk associated with it. While some dancers have naturally-occurring hypermobility not caused by genetic abnormalities, others may have connective tissue disorders such as Ehlers-Danlos and Marfan syndrome, which can present with other health problems. This area of research is still grossly underdeveloped, so physical therapists and physicians must continue to work toward a goal of establishing clearer guidelines for identifying and treating hypermobile dancers. This paper will explore current findings about the prevalence of connective tissue disorders and joint hypermobility in dancers, rates of injury among this population, and recommended approaches to treatment.

Clinical Question

What is the prevalence of hypermobility as a phenotype among dancers, what is the injury rate among this population, and how can physical therapists provide treatment to optimize performance and minimize injury risk?

Background

Joint hypermobility is defined as the ability to move joints beyond the normal active or passive range of motion as determined by age, gender, and ethnicity norms[4,15]. It can be asymptomatic, and can be inherent or acquired, such as through extensive dance training. Some texts refer to asymptomatic hypermobility as generalized joint hypermobility (GJH). Symptomatic joint hypermobility was previously referred to as Joint Hypermobility Syndrome (JHS) and Benign Joint Hypermobility Syndrome (BJHS). While these terms are used in some of the older research that will be discussed in this paper, the most up-to-date term is Hypermobility Spectrum Disorder (HSD). One way to classify HSD places individuals in one of four categories of hypermobility: localized, generalized, peripheral, and historical[1]. Localized involves less than 5 joints, generalized involves more than 5 joints, peripheral includes only joints in the hands and feet, and historical means an individual displayed hypermobile joints in the past but no longer presents as such.

In the general population, hypermobility has a reported prevalence of 13.7% in males and 36.7% in females[1]. Females typically have a greater joint range of motion and higher rate of hypermobility, likely due to the female hormone progesterone, which can destabilize collagen. As a phenotype, hypermobility is present in many connective tissue disorders, including Ehler-Danlos Syndrome (EDS), Marfan syndrome, and osteogenesis imperfecta[15]. There are 13 types of EDS, a connective tissue disorder caused by genetic changes that alter the production of collagen. Hypermobile Ehlers-Danlos Syndrome (hEDS), formerly known as EDS Type III, is the most common form of EDS, but does not have a genetic marker for identification.

Hypermobility is most often identified using the Beighton index, a 9-point scale that examines different joints and determines whether an individual has overall increased joint mobility. Points are awarded for being able to place one's hands flat on the floor in a forward bend, as well as for each hyperextended first metacarpophalangeal joint, fifth metacarpophalangeal joint, elbow, and knee. The Brighton criteria is a more thorough method for diagnosing JHS or HSD, considering the Beighton score in addition to other factors such as arthralgias, soft tissue lesions, joint dislocations, eye signs, and Marfanoid habitus (long arms and legs in proportion to height). Individuals who meet two major or one major and two minor criteria on the Brighton are hypermobile[1,12]. The Lower Limb Assessment Score (LLAS) is a more recently developed set of criteria thought to be superior to the Beighton index because it corrects the over-emphasis on upper limb joints for which the Beighton has been criticized[4,6]. A score of seven out of 12 points on the LLAS indicates lower limb hypermobility[6].

Many forms of dance favor hypermobility due to the aesthetic value placed on moving the joints through a greater than normal range of motion. Most of the current studies on hypermobility in dance focus on western dance forms: ballet, modern, and contemporary. The physical demand of these styles has increased over the past half century, with choreographers demanding higher leg extensions and spines that appear to fold in half. There is an understanding that dance students must work toward these extreme ideals if they have hopes of pursuing a professional career. It stands to reason that dancers who are naturally hypermobile can more successfully fulfill these expectations and will be rewarded with solos, scholarships, company contracts, and promotions. This de facto selection process creates a higher prevalence of hypermobility among dancers than in the general population. However, it is also known that

extensive dance training increases the range of motion of the joints. Dance selects for hypermobility, but it also helps to create it.

Injury rate among hypermobile dancers is also a hotly debated topic. Individuals with connective disorders or generalized hypermobility are considered to have increased tissue laxity along with reduced proprioception due to the greater stretch placed on tissues, both of which are theoretically linked to injury risk. Hypermobile individuals have been shown to have higher incidences of sprains, dislocations, and arthralgias[1]. The interest around hypermobility in dance science research mainly revolves around determining if hypermobile dancers can train and perform safely, and what kind of additional strengthening and stabilization they require to optimize their performance.

Literature Search

To review the available research on hypermobility in dance, PubMed was used to conduct a search using the terms "Ehlers-Danlos syndrome AND dance," "connective tissue disorders AND dance," "connective tissue disorders AND ballet," "Beighton index AND dance," "Beighton index AND ballet," "hypermobility AND dance," "hypermobility AND ballet." 14 articles were chosen from the results based on relevance.

Prevalence of Hypermobility in Dancers

The general consensus among existing studies is that there is a greater proportion of hypermobile individuals in dance groups than in non-dance groups. McCormack *et al* conducted one of the most widely referenced studies on this topic. 149 ballet students and 71 professional

company ballet dancers were compared to age-matched control groups of non-dancers. 90% of dancers were found to be hypermobile using the Beighton score. In the student group, there was a significant difference between dancers and controls, with dancers having higher rates of hypermobility. However, there was no difference between the company and its controls. This suggests that hypermobility is more common in groups of younger dancers, but prevalence decreases in the professional setting. McCormack *et al* also found that in the company, the highest prevalence of hypermobility existed in the corps de ballets, which is the lowest rank. Meanwhile, none of the highest-ranking principal dancers were hypermobile. These trends could demonstrate that hypermobile dancers either self-select out of pursuing a professional career, that they are not hired or favored by companies, or that hypermobility does not provide advantages for a dance career[9]. These possibilities are too nuanced to be explained by this study alone, and would require career-long prospective cohort studies and extensive interviewing of dancers, directors, and choreographers to determine exactly why dancers were successful or not.

Findings from the McCormack *et al* study were replicated by other researchers. Armstrong and Grieg found that 88% of female dancers in their cross-sectional study were hypermobile based on the Beighton index[1]. Similarly, a cross-sectional study by Chan *et al* found a prevalence of 89% hypermobility in the professional dancers and 81% in students[4]. This study utilized the LLAS in addition to the Beighton index and revealed higher scores among professionals than students. Despite finding a similar prevalence, this distinction is the opposite of what was found by McCormack *et al*, and suggests that the intense training required for a dance career increases the range of motion of at least the lower extremity joints. This is the same reason that many studies forgo the forward bend element of the Beighton index because almost

all trained dancers have undergone adaptive changes in the hips and spine to make this mobility possible. Ruemper and Watkins found a lower prevalence of hypermobility in a population of contemporary dance students. In their sample, 69% of dancers had generalized joint hypermobility and 33% had JHS[12]. This lower prevalence could reflect the different physical demands between contemporary dance and ballet, which was the focus of the other studies. Styles of dance dubbed "contemporary" can vary widely, but generally require less joint range of motion than classical ballet.

A cross-sectional study by Vera *et al* attempted to explain the high prevalence of a hypermobile phenotype among dancers with the presence of connective tissue gene variants. While the study did find a high percentage (88%) of genetic variants in the group of individuals who completed a blood test for genetic testing (n=32), the authors noted that the presence of a variant was not correlated with the individual's score on the Beighton index. These results lack external validity due to the small sample size and lack of a control group but present an interesting potential topic for future studies, perhaps with the use of the Brighton criteria[15].

Rate of Injury

According to a systematic review by Smith *et al*, the musculoskeletal injury rate among ballet dancers is between 0.97 and 1.24 injuries per 1000 dance hours, indicating that injuries are common among dancers[13]. Since the first studies on dancer hypermobility, researchers' main concern has been that hypermobile dancers are at greater risk for injury, citing increased tissue laxity, altered proprioception, and insufficient strength to counteract their above-average range of motion.

Ruemper and Watkins determined the statistical correlation between GJH, JHS, and injury rate and found a significant correlation between the Brighton criteria and both total number of injuries and number of time-loss injuries[12]. This indicates that hypermobile dancers had more injuries, and specifically more injuries that required them to take time off from dancing.

In contrast, Roussel *et al* found in a prospective cohort study that GJH was not a predictor of musculoskeletal injury or of poor lumbopelvic control[11]. This refutes the theory that hypermobile dancers have reduced control of their joints, or at least not the spine and hips. An explanation for this could be that these dancers learned to compensate to create lumbopelvic stability, thus avoiding injury. Unfortunately, this study included a small sample size of only 32 dancers, so it lacks external validity but offers a starting point for future research.

Briggs *et al* conducted a 5-year follow-up to the McCormack *et al* study, in which they collected questionnaires from the original participants about occurrence of injuries. For back pain, dislocations, ankle sprains, ligament injuries, shoulder capsulitis, and fractures they found no significant difference in injury rate between those dancers who were identified as having JHS and those who were not. However, they did find a significant difference in the occurrence of tendon injuries, with JHS dancers reporting a higher rate in this category and requiring more time off to recover[3]. A possible mechanism behind this finding is altered collagen production in syndromic hypermobility, which could lead to either more severe injury or longer healing time for tendons. A definite explanation cannot be determined from this report alone.

Marulli *et al* performed a cross-sectional study considering the theory of altered proprioception as a risk factor for injuries. They examined whether hypermobile or

non-hypermobile dancers performed better on an eyes-closed single-limb balance test and found no significant difference. These results may imply that hypermobile dancers have learned to compensate for any lack of proprioception, but it is more likely that a static balance test is not an effective way to test a dancer's balance or risk for injury[8].

Recommendations for Future Research

Several general themes can be derived from the articles in this literature review regarding the need for further research on this topic. There is an almost universal agreement that the Beighton index is not sufficient for identifying hypermobility in dancers. If it is used, the forward flexion element should be removed, and it should be combined with the LLAS or used as part of the Brighton criteria to offer the most complete picture of a dancer's hypermobility[4,8]. Multiple authors also highlighted the need to indicate whether dancers are warmed up before taking range of motion measurements, as this can have an impact on mobility[12].

It is also agreed upon that studies on prevalence and injury rate need to be more sufficiently powered, as many of the authors cited small sample size as a weakness in their studies. Uniform definitions of injuries must be utilized. Future studies should also be prospective in nature rather than cross-sectional so that dancers' injuries and career trajectories can be tracked over time[14].

While it is unlikely that exercise hinders performance in hypermobile dancers, there is clearly a need for research on whether strengthening programs decrease the risk of injury in this population. A potential design would be a randomized control trial assigning hypermobile dancers to a control group or an experimental group completing a strengthening program.

Injuries and symptoms could be tracked during and after completion of the program. Research of this nature could demonstrate the potential benefits of physical therapy for creating more stability for hypermobile dancers and helping extend their careers.

Recommendations for Clinical Application

The first recommendation for healthcare providers working with a dance population is to screen all dancers for hypermobility. This should be performed at different stages throughout a dancer's training and career because joint range can change over time. The best option for screening is to utilize the Brighton criteria, which includes the Beighton index, in addition to the Lower Limb Assessment Score (LLAS). Providers must be aware that screening results indicating hypermobility are two major or one major and two minor criteria on the Brighton, and seven out of 12 points on the LLAS[1,6,12]. In addition to quantifying hypermobility by counting the number of joints with increased range, it is suggested that clinicians explore why each joint is hypermobile[7]. Information about whether the cause is ligament laxity, a loose joint capsule, adaptive changes due to training, or something else may illuminate the course of action that should be taken with treatment. Strength and dynamic balance, particularly in positions relevant to dance, should also be assessed.

Dancers with the hypermobility cutoff scores listed above should also be screened for symptoms that can accompany a connective tissue disorder including paroxysmal orthostatic tachycardia syndrome (POTS), dysautonomia, anxiety, gastrointestinal disturbances, organ prolapse, and pelvic pain. If a dancer presents with symptomatic hypermobility, they can be referred to medical specialists to treat these additional symptoms. These referrals may still

include physical therapy specialties in the case of chronic pain management and pelvic floor dysfunction. Once symptoms are under control, individuals will benefit from orthopedic physical therapy.

Not all dancers with Brighton and LLAS scores indicating hypermobility have connective tissue disorders or systemic symptoms, but all can benefit from physical therapy treatment as a means of injury prevention and enhancing performance. The main goal is to improve stability, strength, proprioception, and motor control. As noted by several of the previously mentioned studies, hypermobile dancers with advanced training have typically already adopted compensatory strategies to create stability with their increased ranges. Physical therapists should ensure that these dancers are properly recruiting spinal, abdominal, scapular, and hip musculature to provide proximal stability. Stabilization exercises should be performed without hyperextending into unnecessary ranges, such as severe lumbar lordosis. Strengthening exercises should be low-impact with a mixture of isometric and eccentric activities, while avoiding excessive stretching and high-force movements at least in extreme cases. Neuromuscular re-education will be beneficial for dancers with proprioception deficits who cannot yet effectively compensate. Strapping and bracing may be beneficial interventions for dancers with subluxations, dislocations, and joint pain, but should not replace stabilization exercises[1].

Perhaps the most important role physical therapists play in this field is education for dancers as well as their parents and teachers. Despite claims by Foley and Bird that good dance teachers recognize individual students' needs and give them the necessary support, it is a sad reality that many dance teachers still praise and reward dancers who achieve extreme ranges of motion to the point of jeopardizing those dancers' careers[7]. Those who are hypermobile with no

underlying health complications should not be fearful or convinced that they have a higher injury risk, but they should be well-informed about the benefits of an exercise program overseen by a physical therapist to optimize their performance.

Key Points

- Current evidence shows a high prevalence of hypermobility among dancers, ranging from 60-90% depending on the population studied. There is also a high prevalence of connective tissue variants in dance populations, although more research needs to be done to determine the correlation between this and hypermobility.
- Some studies have shown an increased rate of injury (particularly tendon injuries) among hypermobile dancers, while others have shown no significant difference. In general, underlying health conditions should be of greater concern than injury risk in these dancers.
- Future research on prevalence of hypermobility and injury rate should include sufficiently powered prospective studies with clear definitions of injuries. Research should also be conducted on the benefits of strengthening and stabilization exercise programs for hypermobile dancers.
- When working with dancers, physical therapists should perform a thorough screening using a combination of the LLAS and Brighton criteria with the forward flexion element removed. This will make it possible to refer individuals to other healthcare providers for treatment of underlying health conditions related to connective tissue variants.

- Physical therapists can establish exercise programs for hypermobile dancers to provide strength and stability to optimize performance and prevent injury.

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