Management of Hypermobility in Aesthetic Performing Artists: A Review

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ABSTRACT

Background and Purpose: Joint hypermobility is more prevalent in aesthetic performing artists than in the general population and can contribute to injury. The purpose of this review is to describe the prevalence and clinical presentation of hypermobile Ehlers-Danlos syndrome, then discuss physical therapy assessment and management of hypermobile dancers and circus artists to optimize their health and performing arts participation. **Methods:** The authors created an outline for this review to include the topics of classification, prevalence, screening, assessment, and management. PubMed, CINAHL, and Google Scholar were searched for relevant articles published in the last 20 years. **Clinical Relevance:** Clinicians need to recognize that hypermobility is more prevalent in dancers and circus artists, and actively screen for the multi-system effects. Unique strategies need to be employed to decrease injury risk and to rehabilitate the injuries that occur in these hypermobile performing artists. **Conclusion:** Physical therapists can initiate referrals for earlier diagnosis and facilitate collaborative interprofessional management for hypermobile performing artists. Appropriate management can enhance artists' ability to perform and contribute to career longevity.

Key Words: circus, dance, Ehlers-Danlos syndrome, hypermobility spectrum disorders

BACKGROUND AND PURPOSE

Hypermobility can be an advantage for performing arts aesthetics but can also increase risk of injury and other health problems such as anxiety, dysautonomia, and gastrointestinal disorders.[1] Demand for extreme flexibility in performing arts has grown over time. Competitions encourage demonstrations of extreme flexibility by awarding thrill factor points and social media platforms, such as Instagram, YouTube, and TikTok, reward feats of flexibility with likes and followers. A 60-year retrospective study of body postures in ballet, showed progressively increased leg elevation in common dance postures and shapes over time, and an association of a higher gesture leg with a more favorable audience perception.[2]

Joint hypermobility is "the capability that a joint (or a group of joints) has to move, passively and/or actively, beyond normal limits along physiological axes"[3] and considered an impairment in body structure or function.[4] Hypermobility related health conditions range from isolated joint hypermobility to heritable connective tissue disorders with multisystem involvement such as Ehlers-Danlos Syndrome (EDS). Hypermobility can be genetic (eg, Down syndrome, vascular and classical EDS) or acquired (eg, lupus, rheumatoid arthritis, or secondary to repetitive activity). Muscle weakness related to neurologic disorders and myopathies can also result in reduced dynamic joint stabilization leading to hypermobility. The purpose of this review is to describe the prevalence and clinical presentation of hypermobile EDS, then discuss physical therapy assessment and management of hypermobile dancers and circus artists to optimize their health and performing arts participation.

Prevalence

In a literature review, the authors found that hypermobile EDS has an estimated prevalence of 1-3% in the general population or 10 million in the United States, and accounts for 80-90% of individuals with EDS.[5,6] Generalized hypermobility is more common in younger children and females.[7,8] Prevalence is higher in dancers and circus artists with similar age and gender patterns.[9-14] The Beighton scale[15] is the most consistently used measure to determine prevalence of generalized hypermobility but cutoff scores vary between studies. In studies of elite ballet populations, prevalence was 74-95% in adolescents, 81% in adult pre-professionals, and 82-95% in adult professionals (Beighton score ≥ 4/9).[9,10] A study of adult professional jazz dancers showed a prevalence of 65%.[11] Prevalence in university contemporary dancers was 69% with a modified scale excluding lumbar flexion.[12] In a study comparing youth dancers ages 8-16 to matched controls, prevalence was 24% vs 8% (Beighton score ≥ 6/9).[13] Unpublished data from a study of adult pre-professional and professional circus artists shows a prevalence of 41% and 48% (Beighton score ≥ 4/9).[14] Given the higher prevalence of hypermobility among dancers and circus artists, physical therapists should regularly screen for symptomatic hypermobility, such as hypermobile EDS (hEDS) or hypermobility spectrum disorder(s) (HSD), in this population.

Diagnostic Criteria

Hypermobility syndrome, joint hypermobility syndrome, benign joint hypermobility syndrome, EDS Type III, and EDS-Hypermobility Type are former labels for a group of poorly differentiated disorders classified using the Villefranche or Brighton criteria.[5,16] In 2017, the International Consortium on the Ehlers-Danlos Syndromes defined new diagnostic criteria for hEDS: (1) generalized joint hypermobility, (2) presence of specific physical features, family history and/or musculoskeletal pain or joint instability, and (3) absence of skin fragility, other heritable or acquired connective tissue disorders, neuromuscular disorders, and skeletal dysplasias which should prompt consideration of other diagnoses.[16] Symptomatic hypermobility disorders that do not fit the hEDS criteria or another diagnostic category that could explain the patient's symptoms are now labeled HSD.[3] Across their lifespan individuals may move between hEDS and HSD classifications, and may also progress through phases characterized by hypermobility in childhood/teen years, pain in the 2nd to 4th decades, followed by stiffness.[3,5]

Hypermobile EDS is the only subtype without an identified gene mutation but is linked to autosomal dominance influenced by hormones that affect collagen, the main structural support in connective tissue.[5,16-18] This contributes to secondary musculoskeletal manifestations such as tendinopathies, subluxations and/or dislocations, scoliosis, and osteoarthritis most commonly affecting the joints at the shoulder, hip, knee, and

cervical and lumbar spine.[3,19] It also affects the autonomic, cardiovascular, neurological, gastrointestinal, urogenital, integumentary, and immune systems.[3,16,18] The variability in disease presentation of hEDS and HSD, and the overlap with other disorders, can make it challenging to diagnose. It is common for patients to see several health care providers before being diagnosed with EDS. They may initially be diagnosed with an associated comorbidity or misdiagnosed with chronic fatigue syndrome or fibromyalgia.[20] A recent survey revealed that American physical therapists lack knowledge about the diagnostic criteria for generalized joint hypermobility, disease prevalence, and commonly presenting signs and symptoms other than joint pain.[21] It is important for physical therapists to increase their knowledge and understanding of hEDS and HSD.

RELATIONSHIP WITH HEALTH PROBLEMS AND INJURY RISK

Orthostatic intolerance, fatigue, headaches, joint, abdominal or pelvic pain, anxiety, and depression are common symptoms related to hEDS or HSD that often get misinterpreted or downplayed by medical professionals.[8] Orthostatic intolerance prevalence is 41-49% in hEDS.[18,22,23] Symptoms include dizziness, presyncope, syncope, headache, nausea, sweating, or changes in blood pressure upon standing or after exercise.[18,22,23] The most common type is postural orthostatic tachycardia syndrome (POTS), which is characterized by chronic orthostatic symptoms, a 30-40 beats per minute heart rate increase upon standing from a lying position without orthostatic hypotension.[18,24] Mast cell activation syndromes (MCAS) are found in 24-66% of patients with hEDS.[18,19,25] Clinical presentation varies due to multisystem effects resulting in recurrent allergy-like responses of the skin, gastrointestinal tract, neuromuscular tissues, airways, cardiovascular, and central nervous systems.[5,18,26] Cardiac disorders due to collagen abnormalities (eg, mitral valve prolapse) are also associated with hEDS and HSD.[19] Gastrointestinal disorders (GI) such as gastro-esophageal reflux, nausea, vomiting, irritable bowel syndrome, constipation, and bloating are also common (prevalence 46-86%) and can contribute to nutritional deficiencies[19,27,28] that can impact energy availability for training, fatigue, and healing.

In a large study of patients with EDS, 98% of those with hypermobility type reported pain.[29] Earlier in the disease course, nociceptive pain due to joint subluxation/dislocation, arthralgias, myofascial, or visceral pain are common.[30] Later, a widespread and centralized pain presentation becomes more characteristic.[30] Abdominal pain prevalence is 83-93% with joint hypermobility.[28] Causes include dysautonomia, GI tract collagen laxity, constipation, pelvic prolapse, and dysmenorrhea, such as endometriosis or polycystic ovaries.[8,30] Headache causes are multifactorial including neurogenic, vascular, or musculoskeletal sources, such as temporomandibular and cervicogenic dysfunction.[19,30,31] There is also a strong association of pain in EDS with depression and anxiety.[32,33] Behavioral changes such as kinesiophobia and pain catastrophizing can lead to activity avoidance resulting in deconditioning and worsening of disability.[30]

Chronic pain, poor sleep quality, deconditioning, orthostatic intolerance, nutritional deficiency related to bowel disorders, anxiety, depression, and headaches contribute to chronic fatigue in hEDS.[34,35] Prevalence of fatigue peaks in the 4th decade at 90%.[30] Involvement in athletic activity since early childhood may delay the onset.[30] Impaired joint proprioception, joint kinesthesia, and spatial awareness is also common in individuals with hypermobility.[30,36] Joint and tendon receptors rather than cutaneous receptors are the most likely cause.[37] Deficits in proprioception and muscle weakness have been associated with functional limitations.[38] When compared to matched controls, women with EDS hypermobility type had similar muscle mass, but significantly less lower extremity strength and endurance, decreased 5x sit to stand performance with pain, and fatigue exacerbated by testing.[39]

Campbell et al[40] identified hypermobility, fatigue, overuse, increased turnout, neuromuscular dysfunction, lower extremity (LE) range discrepancies, core and lower extremity weakness as 7 intrinsic modifiable risk factors associated with injury in ballet dancers. Hypermobility was associated with chronic ankle instability, anterior cruciate ligament injuries, labral tears, tendinopathies, degeneration and hip instability.[40] Dancers with hEDS might also be more likely to have the other intrinsic risk factors.[40] Joint hypermobility using Brighton criteria but not the Beighton score was correlated with injury risk in contemporary dance students.[39] Another study found significantly greater time loss from injuries in hypermobile university dance students.[41] A systematic review identified hip hypermobility as a risk factor for LE injury in youth recreational dancers.[42] In elite pre-professional modern dancers, both low and high Beighton scores were associated with higher risk of medical attention and time loss injuries.[43] However, two smaller studies of university and professional dance students, and one in professional dancers did not find an increased risk of injury for hypermobile dancers.[44-46] There is not comparable research about the association of generalized hypermobility and injury in circus but a study of injuries in professional circus students found a greater incidence of hip injuries in female students and hypothesized this was related to greater frequency of contortion skill training.[47]

PHYSICAL THERAPY ASSESSMENT AND INTERVENTION

Patient Interview and Screening for Comorbidities

With the high prevalence of musculoskeletal pain and dysfunction, physical therapists, especially those working with performing artists, are likely to encounter patients with hEDS or HSD and can play an important role in screening to facilitate early and accurate diagnosis. A thorough systems review and a review of systems are critical. The authors have created the "Hypermobility Screening Tool" (**Appendix**) for clinicians to facilitate efficient screening, earlier recognition of EDS related conditions, and collaborative interprofessional management. For example, an integumentary screening showing skin hyperextensibility with widened, atrophic scars should lead to referral to genetic testing for classical EDS.[48] The hEDS and HSD presentation varies across the lifespan, so a positive family history can guide referrals to assist with early and accurate EDS diagnoses in younger patients. For example, a family history of sudden death, thin, translucent skin, easy bruising and peripheral hypermobility of fingers and toes should indicate a need for genetic testing to rule out vascular EDS.[16]

If a patient meets the criteria for joint hypermobility using the Beighton[15] or Brighton criteria,[49] the Hypermobility Screening Tool (HST) can be used to screen for multisystem involvement, and guide referral for diagnostic testing or management. The tool will need to be validated, updated as research grows, especially to include larger and more diverse populations, and diagnostic criteria changes with improvements in molecular diagnostics. The HST includes symptoms and diagnostic labels for common comorbidities linked to hypermobility through pleiotropy, or when a gene defect affects multiple tissues, organs or structures.[3] Providers often

do not recognize relationships between EDS comorbidities and diminish their importance with negative physical and mental health impacts in this population.[8,22] The authors recommend providing this checklist to the patient ahead of the visit, as it takes time to process both cognitively and emotionally, so that the patients do not disregard symptoms. The final page of the HST is a guide for clinicians to establish a health care team, or promote coordination and communication of an already established care team.

There are unique personal and environmental factors to consider in performing artists. A biopsychosocial approach, inclusive of the social and psychological domains, is helpful to capture the complex multisystemic effects of hypermobility disorders.[4] Artistic values will strongly influence their internal and external environment (**Table 1**). How do they view their hypermobility? Is it their competitive edge for standing out and attaining certain roles or is it their struggle to keep up with their peers? A performing artist may be able to perform all activities of daily living without difficulty, but do they have difficulty building the strength needed to acquire new dance or circus skills, or keeping up with the rigor of a performance rehearsal schedule? Time away from dance or circus has different implications for different artists; some can afford to step away from a recreational activity, but for others, it is their very livelihood. Performing art is a means of expression and identity; when treating a performer who has been sidelined from performing, it is very important to assess their psychological state and screen for depression/anxiety, as they may need help with coping strategies to optimize their management and return to performance. These issues are key to understanding the priorities of the performing artist and collaborating on meaningful goals for physical therapy intervention.

Physical Examination

The Beighton Score,[15] Brighton criteria,[49] and 5-point screening questionnaire[50] can be used to screen for joint hypermobility. The recently adopted International Consortium Beighton score criteria of ≥ 6/9 in pre-pubertal children, ≥ 5/9 for post-pubertal up to age 50, and ≥ 4/9 for over age 50 is currently recommended.[15-16,40] It may also be useful to examine joint hypermobility throughout the extremities or at specific joints in performing artists depending on which areas are painful or affecting function. The Lower Limb Assessment Score is a validated tool that includes the knee and ankle anterior drawer, assessment of hip, knee, ankle, foot, and great toe passive physiologic mobility, and midfoot pronation in standing.[51-53] The Upper Limb Hypermobility Assessment Tool is a validated tool that includes examination of shoulder, elbow, wrist, and finger passive physiologic motions, sulcus sign, elbow/radioulnar joint play, and hand length.[54] To implicate shoulder multi-directional instability, apprehension with or without laxity with the sulcus sign, and a minimum of 2 of the following: positive anterior or posterior drawer tests between 10° and 30°, and 80° and 100° shoulder abduction, and anterior or posterior apprehension tests is recommended.[55] An alternative 3-test cluster of apprehension, posterior apprehension, and hyperabduction has recently been proposed.[56]

A good starting place in the physical therapy examination for the hypermobile performing artist is an assessment of postures or movements that exacerbate pain or contribute to subluxations. Video can be useful for observation of complex artistic skills or activities that are difficult to reproduce in the clinic. Lack of proximal stability, faulty alignment, and impaired motor control are common movement impairments. For example, impaired lumbopelvic and hip dynamic stability can contribute to faulty alignment and excessive anterior glide of the femoral head with hip extension stretching and active hip flexion with battements (high kicks) in dance or piking/straddling (raising) legs for an aerialist. Similarly, excessive humeral anterior or inferior glide with inadequate scapular upward rotation may occur with overhead positions such as hanging in a circus artist. Hypermobile artists may also rely on passive stability at joint end ranges rather than using dynamic stabilizers to maintain more neutral joint positions in weight-bearing postures such as knee hyperextension of the support leg in a dancer standing on one leg or elbow hyperextension with hand-balancing.

Muscle weakness and proprioceptive deficits can accompany hypermobility[30,36,38,39] making it more difficult to stabilize hypermobile joints especially at the end ranges used in dance and circus. Muscle performance and motor control of lumbopelvic, hip and shoulder stabilizers are important to evaluate. Pelvic girdle stabilization with load transfer can be assessed with the Stork[57] and active straight leg raise tests (**Table 2**).[58] Reproduction of pain with active hip flexion with knee extended in supine that is relieved with passive posterior glide of the femoral head can implicate excessive anterior femoral glide.[59] Similar principles can be used to assess excessive humeral head translation including observation, palpation, and repositioning the humeral head with overhead movements.

Standardized functional tests can help quantify the severity of neuromuscular control deficits and identify compensatory movements. The forward step down test (**Table 2**) evaluates the ability of the hip abductors and deep hip lateral rotators to control femoral alignment in the frontal and transverse planes while descending a 20 cm step without allowing the leading limb to touch down.[60] The Star Excursion Balance Test is useful for evaluating lower extremity neuromuscular control especially in performing artists with a history of ankle instability.[40] The airplane, sauté and topple tests (**Table 2**) are useful dance specific movement assessments of lower extremity neuromuscular control.[61] For the upper extremity, the Closed Kinetic Chain Upper Extremity Stability Test (**Table 2**) is a valid functional test performed in a modified plank position that is highly correlated with maximum grip strength (r=0.78-0.79) and peak torque of shoulder internal and external rotators (0.87-0.94).[62]

Management

Successful management of symptomatic hypermobility in aesthetic artists is a lifelong process critical to career longevity that includes appropriate self-management in partnership with a supportive medical team. Physical therapists can be instrumental in patient education, strength, movement, proprioceptive and motor control training, in addition to collaboration with other health care and performing arts professionals.

Pain management education will differ depending on whether pain is primarily nociceptive, as with acute joint subluxation/dislocation, neurogenic, or centralized. Techniques to manage acute joint dislocations/subluxations recommended in a helpful Ehlers-Danlos Society patient resource[63] include mindfulness techniques for relaxation, redirecting focus or distraction, use of analgesics, supportive devices like pillows or slings, heat, and self-massage for reducing muscle spasm to encourage joint relocation.[63] Patients should seek medical attention after dislocation if a limb becomes numb or discolored due to blood flow occlusion, or if self-management techniques prove unsuccessful.[63] If subluxations/dislocations occur with specific postures or skills in their performing art, clinicians can collaborate with the patient and coaches to modify activities to minimize recurrence. Understanding that joint subluxation/dislocation in hypermo-

Table 1. Specific Patient History Considerations for the Aesthetic Performing Artist with Hypermobility

Artist identity and participation level	Is artist identity tied to hypermobility? How long have they been training in their art form? Is dance or circus a hobby, key component of fitness and mental health, career aspiration, primary income source, etc? Timeframe around upcoming auditions, performances or competitions? Flexibility to modify training load or participation during rehabilitation? Upcoming travel?
Mechanism of onset	Microtraumatic vs macrotraumatic event vs chronic widespread pain? Magnitude of forces to cause subluxations/dislocations and frequency? Nociceptive, neurogenic and/or central pain mechanisms?
Prior treatment	Past experiences with health care providers? Providers experience with performing artists/EDS? Effective/ineffective past interventions?
Self-management	Self-management strategies including medication, alcohol, marijuana usage? Usage and efficacy of supportive tools like braces, taping, pillows?
Habitual postures	Habitual postures in their activities of daily living and with participation in dance or circus (eg, Swayback posture or hyperextended knees with brushing teeth or excessive lumbar extension hanging from aerial apparatus)?
Fatigue	Frequency and severity? Effects on training, performance, socialization?
Sleep	Quality, duration and consistency? Effects on fatigue, mental health, and pain?
Nutrition	Disordered eating due to GI symptoms vs aesthetic demands of artistic role?
Menstrual history	Impacts of menstrual cycle on abdominal pain, joint laxity, motor control, and artistic performance?
Support systems	Are all their friends part of their artist community? Do peers, family, instructors, and/or artistic directors understand and take into consideration their medical condition or do they push them beyond what is safe for their bodies? Do they have adequate knowledge to support artist's health?
Other activities and participation	Away from dance/circus are they a student? Do they have another occupation/job? Are these active, sedentary, involve repetitive movements. or prolonged postures?
Performing arts participation	What are their dance styles and/or circus disciplines? Participation at a recreational, pre-professional or professional? Enrolled as student in intensive training program? Hours per week and intensity of training and performance? Do they participate in other fitness activities, cross training or strength training? How do they warm-up/cool down? Do they have specific exercises to work on strength through their range and motor control? Any periodization of training/usual rest periods? Any maintenance/conditioning during rest periods? Are they the most flexible person in their cohort? Can they do contortion movements or tricks that others cannot? Do they get casted for the "bendy" roles always perform choreography emphasizing flexibility? What is the culture of their training environment or company? Competitive vs. supportive; rigid vs. flexible; recreational vs. performance/competition focused; minimally vs. highly trained coaches?

Abbreviations: EDS, Ehlers-Danlos syndrome; GI, gastrointestinal

bile individuals is less likely to cause tissue damage may help decrease associated fear or contribution to a centralized pain response. Acute nociceptive pain can also be triggered by gynecological and gastrointestinal dysfunction, potentially inhibiting lumbopelvic stabilizers. During these episodes, education is needed for activity modification due to diminished joint stability, followed by neuromuscular activation training for return to full participation.

Bracing can enhance proprioception and joint stability,[64] such as the use of an ankle support for dancers with recurrent ankle instability. Affordable bracing options for the shoulder, back, hip, knee, and ankle can be purchased through online retailers. In situations where a brace cannot be worn for performance, taping or lower profile compression garments may be helpful. It is helpful for menstruating patients to track their menstrual cycle and proactively brace problematic joints during pre-ovulation, because higher progesterone levels increase joint laxity.[65]

In patients with centralized pain presentations, pain neuroscience education (PNE) combined with exercise, including spinal stabilization and especially aerobic exercise, has been shown to decrease pain, fear-avoidance, pain catastrophization, and promote movement.[66-67] Both "Why Do I Hurt?"[68] and "Explain Pain"[69] are helpful resources to facilitate PNE. Patients with hEDS often have psychosocial risk factors such as pain catastrophization, kinesiophobia, and low pain self-efficacy.[30,32,33] Cognitive behavioral therapy (CBT) can also be an effective intervention to address chronic pain and

Table 2. Selected Physical Examination Measures

Test	Description	Scoring
Stork Test[57]	Patient stands with feet apart, examiner palpates S2 SP with 1 thumb and PSIS with other thumb on stance leg. Patient flexes opposite hip and knee to 90°.	**Positive test**, anterior rotation of innominate, cephalad movement of PSIS of stance leg, **Negative test**, innominate should posteriorly rotate relative to sacrum, PSIS moves caudad or no movement.
Active Straight Leg-Raise (to assess pelvic girdle load transfer)[58]	Patient is supine legs extended/20 cm apart, lifts straight leg 20 cm off table. Patient scores difficulty on 0-6. Repeat with manual compression at the pelvis.	**0-No difficulty, 1-Minimally difficult, 2-Somewhat difficult, 3-Fairly difficult, 4-Very difficult, 5-Unable** **Test is positive** for any score >0 that decreases with pelvic compression or pelvic compression relieves symptoms.
Active Straight Leg Raise (to assess anterior femoral glide syndrome)[59]	Patient is supine with legs extended, examiner palpates femoral head at inguinal crease, then cups ankle and passively flexes hip to 70° with knee extended. Next patient asked to actively hold their leg at that position as examiner releases hold on ankle.	**Positive test:** Examiner palpates femoral head glide anteriorly at inguinal crease when support released. **Negative test:** No movement of femoral head detected at inguinal crease (femoral head posterior glide and spin in acetabulum).
Forward Step-Down Test[6]	Patient stands on 20 cm step with hands on hips. With foot in maximal dorsiflexion, patient reaches heel to the ground below step without touching down 5 times on each leg.	***1 point each:*** 1. arm strategy to recover LOB, 2. trunk movement to recover LOB, 3. one side of the pelvis rotates in transverse plane, or elevates in frontal plane, 4. reaching foot touches down or stance limb foot moves, 5. if tibial tuberosity moved medially past second toe (1 points) past medial border of stance foot (2 points). Higher scores indicate impaired motor control and proximal hip muscle weakness.
Airplane Test[61]	Patient stands on one leg, then hinges forward so arms, trunk, pelvis and back leg are parallel to floor with arms at 90° abduction. They plié (bend) the standing leg while both fingertips reach towards the ground and return to start 5 times.	**Pass** is defined as completion of 4 out of 5 repetitions with neutral alignment of the lower extremities.
Single-Leg Sauté Test[61]	Patient stands on one leg, hands on hips, non-stance leg in coupé (touching stance leg at base of calf) leg. They perform 16 jumps.	**Pass is completing 8 out of 16 jumps with:** 1. Neutral pelvis; 2. Upright and stable trunk; 3. Knee extended in the air; 4. Pointed foot in the air; 5. No movement in the leg maintaining the coupé; and 6. Controlled landing in plie, rolling toe-ball-heel through the foot.
Topple Test[61]	Patient performs 3 pirouettes en dehors, turning on 1leg toward leg in passé (knee bent, toe placed at stance leg knee), starting from 4th position (stance limb in front, both legs externally rotated).	**Assess best turn each side with the following: (1 point each):** 1. In 4th starting position, pelvis squared, hips turned out, most weight on forefoot, and strong arms, 2. Lift to passé in one count; 3. Stance knee extended; 4. Torso rotates as a unit; 5. Strong, well-placed arms; 6. Quick spot; and 7. Controlled landing. Sum scores with higher scores indicating better motor control and strength.
Closed Kinetic Chain Upper Extremity Test[62]	Patient starts in plank with both hands on tape in push up position 36 in apart They alternate touching tape below opposite hand and returning to starting position for 15 sec.	Number of repetitions completed in 15 seconds is recorded. **Mean time** for healthy adults 13.31 ± 4.78 sec.

Abbreviations: cm, centimeters; in, inches, LOB, loss of balance; PSIS, posterior superior iliac spine; sec, seconds; SP, spinous process

kinesiophobia, including to enhance coping strategies.[70] The goal of this collaborative approach between therapist and patient is to decrease negative thoughts or feelings about the pain experience.[71] Cognitive behavioral therapy can be administered over the phone[71] or independently with utilization of workbooks. Physical therapists can also implement CBT-related strategies such as pain education, collaboration with the patient on a weekly walking goal, graded activity plan, using distraction techniques, replacing negative thoughts with positive ones, and identifying high risk situations that can cause setbacks.[71]

Individuals with hypermobility often need posture and movement retraining both to avoid overstretching passive structures at end range and improve dynamic stability and alignment throughout their range both with daily life activities as well as specific to performing arts participation. Hip pain related to hypermobility is common in dancers, gymnasts, and circus artists[72-73] and can be associated with faulty movement patterns like femoral adduction leading to microtrauma and ultimately hip pain.[59,74] Educating patients on correcting femoral adduction, strengthening hip flexors, deep hip lateral rotators, and hip extensors has been shown

to decrease pain and improve function in patients with chronic hip pain.[74] Dance and circus movements emphasizing hip hyperextension and external rotation also contribute to increased hip laxity and excessive femoral anterior glide.[59,72] For this reason addressing swayback posture during standing and hip hyperextension through terminal stance with cues such as "push off more with your foot" can decrease the hip extension moment in gait[75] and stress on the anterior hip structures with daily activities.

In addition, aesthetic artists need education as to when and how to use their full range of motion (ROM) and when to use more mid-range positions for joint protection. Excessive reliance on hypermobile passive structures for sustaining prolonged postures or to stop a movement ("hanging on your joints") with lack of motor control in the mid-range can contribute to injury. Genu recurvatum with pes cavus is an advantageous aesthetic for some performers in audition and performance. These hypermobile performers should learn to use their full knee hyperextension range for non-weight-bearing movements as the gesture leg, and to keep knee extension closer to neutral when using the leg for support in weight-bearing. This concept can apply similarly for the elbows of a hand balancer in circus. Artists relying on passive stability with weight-bearing activities may need significant proprioceptive and muscle endurance training to sustain more neutral positions. In addition, as hypermobile artists move through extremes of ROM, it is important to ensure they have strength and good control through the entire range and are not relying solely on momentum and passive structures to achieve end range movements.

Performing artists need to do additional strength and proprioceptive training to improve joint stability due to lack of passive support. Resistance training is thought to improve musculotendinous stiffness that contributes to passive stability[76] and can decrease shoulder rotation hypermobility.[77] Individuals with hEDS/HSD typically present with increased weakness compared to controls, taking 3 to 4 months longer to make strength gains.[78] Despite some question as to whether inefficient force transfer due to increased musculotendinous extensibility limits the trainability of muscle strength in hEDS,[79] these individuals have been found to make strength gains at the same rate as people with asymptomatic hypermobility, and without hypermobility.[78] Improvements in strength correlated with statistically significant decrease in pain, and improvement in function.[78] It is important for artists as well as their support network (family, coaches, etc) to understand that although they may make similar strength gains, injured hypermobile artists often need a longer course of rehabilitation and graded return to activity due to baseline weakness, need for joint protection and the multi-system effects of hEDS/HSD.[78]

Participation in strength combined with balance training can improve pain, physical function, and proprioception in the hypermobile population.[80-82] While muscle weakness is the primary factor associated with activity limitations, muscle weakness and proprioceptive deficits often exist together,[79] which supports the need to focus on motor control training in addition to muscle force production. Addressing correct muscle activation patterns without compensation including coactivation of spinal stabilizers when performing limb movements is critical from foundational to advanced performing arts technique. Exercises that combine strength and proprioception also decrease the risk for overtraining and fatigue.

Fatigue should be addressed due to the prevalence in hEDS/HSD and as an intrinsic risk factor for injury in dance.[30,40] Preventative measures include pacing to conserve energy during performance or heavy rehearsal periods, using a modified exercise program with lower demand and adequate joint protection strategies with an emphasis on correct muscle activation during symptomatic flares, altering a training schedule to allow for adequate rest, modification of practice (such as mental practice) as well as the use of cross training during recovery periods to stave off deconditioning. Professional performing artists often have a full schedule, but it may not provide the needed cross training for strength and cardiovascular capacity needed to mitigate fatigue. Twitchett et al[83] suggest replacing 2-3 of the typical 5 dance technique classes per week with physical conditioning classes to prevent overtraining without the loss of technique/skill. These strategies can help hypermobile performing artists manage fatigue and joint stresses, hopefully contributing to longevity and performance in their art.

Adolescent dancers and circus artists often stop participation once diagnosed with hEDS. Unfortunately, this may inadvertently lead to deconditioning often resulting in the worsening of symptoms, including fatigue, and an increase in fear-avoidance behavior. Relative rest and activity modification should be recommended rather than complete cessation of performing arts activities. Adolescents with hypermobility who participated in a formal dance program were shown to have less pain, joint instability, fatigue, and higher health related quality of life.[84] Early education, on managing hypermobility in the context of the performing arts, should be emphasized to enhance their strength and well-being.

Education and collaboration with performing arts professionals is another important part of management. It is important for performers to understand where a healthy challenge ends and increased injury risk begins. Studio environments can vary from competitive to collaborative, so clear communication with the directors and staff about the specific needs of the hypermobile performer is important to facilitate artistic growth. Physical therapists can be an advocate to validate and explain the performer's experience to family, friends, or performing arts professionals who may not understand or believe the performer.

CONCLUSION

Hypermobility disorders such as hEDS/HSD are more prevalent in performing artists including dancers and circus artists but are often overlooked or improperly managed. Physical therapists can help to screen for multi-system involvement in patients with hypermobility and facilitate referrals for earlier diagnosis and improved collaborative interprofessional management. Hypermobile aesthetic artists also need additional assessment and unique management strategies to optimize their participation and performance.

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Appendix. Hypermobility Screening Tool

Hypermobility can sometimes occur with other health problems that may not seem related. To help your provider screen for these, please ***check off the symptoms that you have experienced in the past 6 months*** and then ***circle the top three symptoms that most affect your life***.

Section A: I had pain…

- ☐ in one area
- ☐ in a few areas
- ☐ all over my body
- ☐ with light touch
- ☐ when I even think about moving
- ☐ with sex
- ☐ in my pelvis that is worse with standing, but better with lying down
- ☐ in my stomach/abdomen

Section B: I experienced…

- ☐ severe fatigue
- ☐ unrefreshing sleep
- ☐ difficulty sleeping or staying asleep
- ☐ sleep apnea (interrupted breathing)
- ☐ brain fog/ forgetfulness
- ☐ fatigue all the time that limits my ability to do daily activities
- ☐ heat or cold intolerance

Section C: Sometimes/often I…

- ☐ felt like I was going to faint
- ☐ fainted (lost consciousness)
- ☐ had difficulty remembering things
- ☐ had difficulty processing information
- ☐ had a racing or pounding heart
- ☐ had headaches/migraines
- ☐ had low blood pressure
- ☐ had heart palpitations
- ☐ had difficulty concentrating
- ☐ felt faint, dizzy or had vision go black when sitting or standing or standing up

Section D: My skin…

- ☐ was soft/silky/velvety
- ☐ was thin, I can see my veins easily
- ☐ was mildly stretchy
- ☐ was very stretchy
- ☐ was fragile
- ☐ took a long time to heal
- ☐ healed with flattened or widened scars
- ☐ had stretch marks from growing
- ☐ bruised easily

Section E: I felt…

- ☐ anxious
- ☐ depressed
- ☐ panicked at times
- ☐ low in self confidence
- ☐ negative about things
- ☐ hopeless
- ☐ desperate
- ☐ afraid of doing certain things
- ☐ resentful of healthcare providers
- ☐ distrustful of healthcare providers
- ☐ scared or worried about physical movement

Section F: Sometimes I had:

- ☐ flushing (skin turning red)
- ☐ hives (red bumps on skin)
- ☐ itching
- ☐ allergic reactions
- ☐ sensitivity to foods, chemicals, medicines, or the environment

Section G: I often had…

- ☐ constipation
- ☐ diarrhea
- ☐ abdominal bloating
- ☐ abdominal cramping
- ☐ heartburn
- ☐ recurring abdominal pain

Section H:

- ☐ I had difficulty getting numb during dental procedures
- ☐ My teeth moved quickly with braces/ moved back quickly after braces
- ☐ I have been told my teeth had higher cusps and deeper fissures
- ☐ I had jaw issues/difficulty keeping my mouth open during dental procedures

Section I: In my childhood, I experienced…

- ☐ clumsiness
- ☐ stomach problems
- ☐ difficulty with toilet training, bedwetting
- ☐ sprained ankles
- ☐ being double jointed
- ☐ emotional difficulties
- ☐ learning difficulties
- ☐ writing difficulties

Hypermobility can sometimes be connected to other health problems that have been diagnosed by a doctor or specialist. Please let us know if you have ever been diagnosed with any health problems below by ***checking the associated box***. Also, if anyone in your family has been diagnosed with any health problems below, please **underline**.

Gastrointestinal

- ☐ Irritable bowel syndrome (IBS)
- ☐ Functional gastrointestinal disorder
- ☐ Gastroesophageal Reflux Disease (GERD)
- ☐ Dysphagia
- ☐ Rectal evacuatory disorder
- ☐ Eosinophilic esophagitis

Cardiovascular

- ☐ Postural Orthostatic Tachycardia Syndrome (POTS)
- ☐ Syncope
- ☐ Aneurysm
- ☐ Neurally mediated hypotension
- ☐ Mild aortic root dilation
- ☐ Mitral valve prolapse
- ☐ Dysautonomia

Musculoskeletal/ Connective Tissue

- ☐ Temporomandibular (TMJ) issues
- ☐ Upper cervical instability
- ☐ Joint subluxations/ dislocations
- ☐ Scoliosis
- ☐ Low back pain
- ☐ Degenerative joint disease/ osteoarthritis
- ☐ Periodontitis
- ☐ Hernias
- ☐ Prolapses
- ☐ Any sort of organ rupture (i.e. spontaneous pneumothorax)
- ☐ Chronic regional pain syndrome (CRPS)

Neurological/ Neurodevelopmental

- ☐ Small Fiber Neuropathy
- ☐ Headaches
- ☐ Chiari-like headaches and/or Chiari malformation
- ☐ Migraines
- ☐ Headaches with ear symptoms
- ☐ Headaches with tinnitus
- ☐ Headaches with ear fullness
- ☐ Tethered cord syndrome
- ☐ Tarlov cyst
- ☐ Attention-Deficit Hyperactivity Disorders (ADHD)
- ☐ Autism or Autism Spectrum Disorders
- ☐ Developmental coordination disorder

Immunological

- ☐ Asthma
- ☐ Allergies or sensitivities – food
- ☐ Allergies or sensitivities - medication
- ☐ Allergies or sensitivities - environmental
- ☐ Celiac disease
- ☐ Mast Cell Activation Syndrome (MCAS)
- ☐ Autoimmune disorder

Genitourinary/Pelvic

- ☐ Menorrhagia (heavy menstrual bleeding)
- ☐ Endometriosis
- ☐ Pelvic floor disorders, including pain
- ☐ Pelvic organ prolapse
- ☐ Incontinence and/or urinary retention
- ☐ Sensory abnormalities

Psychological/ Behavioral/ Fatigue

- ☐ Anxiety
- ☐ Depression
- ☐ Panic disorder
- ☐ Affective disorder (depression, bipolar, etc.)
- ☐ Eating disorder (anorexia, bulimia)
- ☐ Chronic Fatigue Syndrome
- ☐ Fibromyalgia
- ☐ Insomnia
- ☐ Restless leg syndrome
- ☐ Sleep apnea

(Continued on page 142)

Clinician Guideline for the Hypermobility Screening Tool (HST)

For the Symptom checklist (Page 1):

- Sections A-H identify recent issues; Section I is historical to lend perspective on chronicity
- Note the number of symptoms and sections with checks for a better understanding of the number of body systems affected and extent. If the patient has symptoms but not a formal diagnosis, this may indicate the need for a referral (see table below).
- Use the three symptoms circled to prioritize a discussion about the extent of the effects on their life, physical therapy management, and outside referrals, particularly if they are negative prognostic indicators for physical therapy.

For the Diagnoses checklist (Page 2):

- Again note the number of diagnoses and sections with checks for an understanding of multisystem involvement.
- Use the checked diagnoses here and symptoms page 1 to guide a discussion of patient's understanding of health problems and how the health problems are being managed (unmanaged vs. self-managed vs. by an appropriate provider)

Using the HST to initiate or enhance interprofessional communication and collaboration with the other providers (see table below) that are actively managing or could manage related diagnoses is strongly encouraged. With patient consent, sharing information gained from physical therapy evaluation and management may assist other providers in differential diagnosis and management decisions. Information about exercise tolerance, psychological considerations and other provider perspectives can also enhance our care as physical therapists. This team approach will optimize outcomes for patients with hypermobility.

RECOMMENDED PROVIDERS	RELATED HST FINDINGS AND/OR ROLE IN CARE
Genetics	Diagnosis of hEDS/HSD, to rule out other molecular diagnoses
Gastroenterology	Gastrointestinal symptoms **(Page 1: Sections A, B, G)**
Cardiology	Dysautonomia (i.e. POTS) **(Page 1: Sections B and C)**
Pain management	Centralized pain presentation **(Page 1 Sections A and B)** and diagnostic injections
Neurology (autonomic or behavioral subspecialty)	Dysautonomia, neuropathies, headaches, autism/autism spectrum disorders **(Page 1: Section C)**
Plastic surgery	Scar management **(Page 1: Section D)**
Psychiatry, psychology, mental health	Coping strategies for chronic pain and fear of movement, Cognitive Behavioral Therapy, psychotherapy, medication **(Page 1: Section E)**
Immunology/Allergy	MCAS management, sensitivities and allergies **(Page 1: Section F)**
Nutrition	Disordered eating/food intolerance **(Page 1: Section F and G)**
Dentistry	Management of fragility involving oral mucosa **(Page 1: Section H)**
Obstetrics/gynecology/ urogynecology	Pregnancy, endometriosis, hormone related symptoms and pelvic floor issues including hernias/prolapses, pregnancy
Occupational therapy	Writing difficulties, fine motor skill difficulties, ring splints
Social work	Social support and advocacy
Orthopedics/Rheumatology	Musculoskeletal/connective tissue issues
Podiatry	Foot/ankle issues, support devices for flexible foot
Sleep specialist	Insomnia, sleep apnea, restless leg syndrome

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