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Perceptions of Neuromuscular Control Following Long-Term Therapeutic Horseback Riding in Individuals with Charcot-Marie-Tooth Disease Type 1A: A Small-Scale Case Study

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ABSTRACT

Charcot-Marie-Tooth disease is a group of inherited, progressive genetic disorders causing peripheral nerve damage affecting muscles in the arms, legs, hands, and feet. Studies on CMT disease have found that it damages the peripheral nerves of the body, which hinders the neuromuscular control, or the subconscious communication between the muscular and nervous systems, of those affected. Type 1A, or CMT1A, is the most common subtype of the disease and is generally a later-onset and milder form. Currently, there exists no pharmacological remedies for the disorder, with spinal surgery and rehabilitation serving as the only ways to mitigate its effects. One understudied approach is therapeutic horseback riding, which uses the rhythmical movement of the horse to strengthen a participant's balance, strength, and coordination. Few studies, however, have examined the implementation of this therapy in a CMT population, and even fewer so for CMT1A. To help fill this gap, this small-scale case study collected primary, qualitative data through interviews to assess the self-perceived neuromuscular outcomes of individuals with CMT1A who have participated in therapeutic horseback riding over a long-term time frame. The extent to which the therapy positively impacted their neuromuscular control varied, though both participants described forms of improvement. Thus, this study's findings indicate that therapeutic horseback riding could serve as an effective therapeutic rehabilitation for CMT1A, although more quantitative research is necessary.

Keywords: Therapeutic horseback riding, Charcot-Marie-Tooth Disease (CMT), CMT1A, neuromuscular control

INTRODUCTION

Charcot-Marie-Tooth disease (CMT) is a hereditary neuromuscular disorder that affects the peripheral nerves, which connect the brain and spinal cord to the rest of the body. It leads to muscle weakness from atrophy, the constant deterioration of muscles, as well as sensory loss and impaired coordination, as described by the National Institute of Neurological Disorders and Stroke (2025). Although it is the most commonly inherited neuropathy, which is a nerve condition that causes pain and swelling, CMT currently remains without effective pharmacological or surgical treatments, leaving patients of all encompassing genetic subtypes to rely on supportive interventions that manage symptoms over time (Ferraro et al., 2023).

Clinicians Nagappa et al. (2024) explain that while several genetic subtypes of CMT differ in their severity, age of onset, and inheritance pattern, all forms share impairments in neuromuscular control that result in functional decline. This holds for the most common form of CMT, CMT Type 1A (CMT1A), which accounts for around 30 percent of all CMT cases, as noted in a definition of the disease by the Muscular Dystrophy Association (n.d.). Neuromuscular control refers to the coordination between sensory input, central nervous system (CNS) processing, and the subsequent motor output and coordinated movement that enables a person to maintain their posture, balance, and adaptive movement, as defined by Van Leeuwen (1999) in an overview of neuromuscular control. In individuals with CMT, disruption in this system contributes to the distinctive characteristics of the disease. One notable detriment of CMT1A was weakened proprioception, defined as the body's ability to sense joint position and movement, delayed postural responses, and weakness in muscles, particularly in the lower limbs (Lencioni et al., 2015).

Given the lack of curative treatments that can reverse the progression of this disease, rehabilitation for CMT and CMT1A instead emphasizes preserving existing functional mobility. For this supportive form of therapy to be effective, it must engage the remaining neuromuscular pathways through an emphasis on repetitive, adaptive movement (Zambon et al., 2023). One such movement-based approach is therapeutic horseback riding, defined by Koca and Ataseven (2016) as the use of the rhythmic movement of a horse to provide motor and sensory input. Since horseback riding requires one to balance oneself on the horse, this approach requires constant postural adjustment, which actively engages balance mechanisms and coordinated muscular response. Therapeutic horseback riding has been shown to improve neurological function, sensory processing, balance, mobility, posture, and muscle control, as outlined by the American Hippotherapy Association (n.d.), a nonprofit that trains equine-based therapists.

Therapeutic horseback riding is most commonly used for conditions that share impairments in balance and motor coordination, like cerebral palsy, Down syndrome, stroke recovery, and spinal cord injury (Koca & Ataseven, 2016), and has been proven effective in such contexts. An example of this is McGibbon et al. (1998), who found that children with spastic cerebral palsy had improved mobility following therapeutic horseback riding. Thus, therapeutic horseback riding can cause positive outcomes for a population affected by a neuromuscular disease or disorder.

However, research that explores therapeutic horseback riding in individuals with CMT1A is extremely limited. Ferraro et al. (2023) note that there is much room for expansion of research on this intersection of CMT1A and therapeutic horseback riding, and that one limiting factor may be the remuneration of financial coverage for therapeutic horseback riding. High costs, limited availability of certified facilities, and inconsistent insurance coverage make therapeutic horseback riding difficult to access (Hamm, 2025). For example, Kaiser Permanente, one of the largest and most prominent health insurance companies in the US, asserts in its policy that equine-based therapy is experimental and investigational, since existing scientific evidence is "insufficient and not clinically proven to establish its effectiveness" (Kaiser Permanente, 2025).

LITERATURE REVIEW

To further understand the topic of therapeutic horseback riding and its implications for CMT1A, this literature review will first provide an overview of CMT subtypes. From here, it will follow the neuromuscular control pathway and how CMT1A disrupts it, then focus on movement-based therapy, and finally on therapeutic horseback riding as an intervention. It ultimately narrows toward the gap that will be addressed in this study, which will be defined by the lack of research exploring how long-term engagement in therapeutic horseback riding influences the self-perceived neuromuscular control in individuals with CMT1A.

Genetic Subtypes

Since CMT is a group of genetic disorders, there exist various subtypes beneath the umbrella term that differ in their severity and onset of symptoms. The difference in subtype is denoted by the specific gene in the body that mutates, or changes its microscopic sequence, during the DNA replication process. Over 80 causative genes of CMT have been identified, though many more remain unknown (CMT Research Foundation, n.d.). Type 1, which accounts for nearly two-thirds of all cases, is caused by damage to the myelin sheath covering nerves. The subtype CMT1A represents 70% to 80% of cases of Type 1, and is caused by a duplication in the PMP22 gene on chromosome 17 (Muscular Dystrophy Association, n.d.). CMT1A does not affect life expectancy and is generally a less severe type of CMT (Fridman et al., 2014).

Neuromuscular Control Pathway

Neuroscientists Proske and Gandevia (2012) explain the neuromuscular control pathway as the process by which sensory information from the muscles and joints is input to the CNS and output as coordinated movement. It does so through transmitting signals from the CNS to the rest of the body through peripheral nerves, which run throughout the entire body. Since this system is driven by sensing information, it allows individuals to maintain their balance and move adaptively in response to environmental factors as they inevitably vary. However, it is effective only when sensory-motor feedback is clear and consistent, especially during dynamic tasks (Van Leeuwen, 1999).

Neuroanatomy

To understand how CMT1A disrupts the neuromuscular control pathway, it is important to situate the way peripheral nerves transmit information among the central nervous system, muscles, and sensory receptors. At the cellular level, neurons are the basic signaling units of the nervous system. A neuron includes dendrites, a cell body, and an axon. Dendrites receive incoming signals from other neurons or sensory receptors, while the cell body contains the nucleus and supports the neuron's basic function. The axon carries electrical impulses away from the cell body toward another neuron, muscle, or target tissue (Purves et al., 2001).

In the peripheral nervous system, many axons are surrounded by myelin, a modified plasma membrane wrapped around the axon. This myelin is produced by Schwann cells and acts as an insulating layer that allows electrical impulses to travel more quickly and efficiently. Rather than covering the axon in one continuous layer, the myelin sheath is interrupted by small gaps called nodes of Ranvier, where the axon is exposed (Morell & Quarles, 1999; Grider et al., 2023). These nodes contain ion channels that allow the electrical signal to be regenerated as it moves down the axon, meaning the impulse effectively "jumps" from node to node instead of moving continuously along the entire nerve fiber (Grider et al., 2023). This process, known as saltatory conduction, allows myelinated nerves to transmit signals much faster than unmyelinated nerves (Morell & Quarles, 1999).

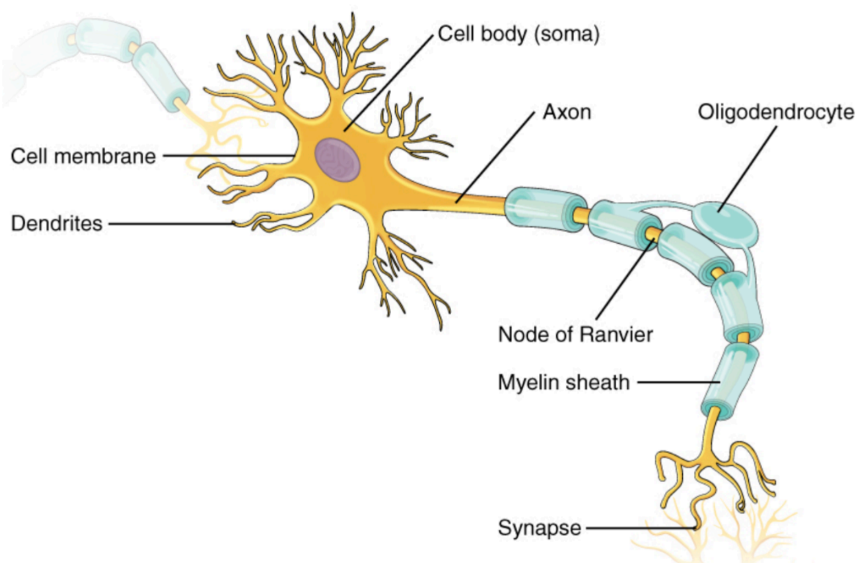

Figure 1. Basic structure of a myelinated neuron. Dendrites, cell body, axon, myelin sheath, and nodes of Ranvier are located on a myelinated neuron, which facilitates the transmission of electrical signals through the nervous system. Adapted from OpenStax (2019).

This structure is relevant to neuromuscular control because body movement depends on the speed and accuracy of nerve communication. Sensory signals must travel from the muscles and joints to the central nervous system, and motor signals must then travel back from the central nervous system to the muscles. When myelin is damaged or disrupted, nerve signals can slow or become less reliable, and severe disruption can contribute to conduction block (Grider et al., 2023). As a result, impairments in myelin can affect the timing of sensory feedback and motor output, which are both necessary for balance, posture, and coordinated movement.

CMT1A-linked Neuromuscular Dysfunction

In CMT1A, the neuromuscular control pathway is disrupted because the disease primarily affects the myelin sheath surrounding peripheral nerves. Since myelin helps nerve signals travel quickly and efficiently, damage to this structure slows communication between the central nervous system, sensory receptors, and muscles. This makes CMT1A a demyelinating form of CMT, in which impaired myelin reduces the speed and reliability of nerve signal transmission (Nagappa et al., 2024). Consequently, sensory feedback from the muscles and joints may reach the central nervous system more slowly or less clearly, making it harder for the body to detect changes in position, balance, or movement. The body's ability to produce quick and coordinated corrective movements is also weakened since motor signals traveling from the central nervous system back to the muscles may also be delayed. As such, individuals with CMT often have problems with proprioception, postural reactions, and strength in the lower limbs, which are critical in maintaining stability during movement (Lencioni et al., 2015).

CMT1A thereby interferes with balance, spatial awareness, gait, and coordinated movement. These impairments often emerge in daily life as frequent tripping or falling, difficulty sensing body position, and trouble with small, precise hand movements (National Institute of Neurological Disorders and Stroke, 2025). Although CMT1A is primarily demyelinating, long-term nerve dysfunction can also contribute to secondary axonal damage, which may further weaken muscle activation and contribute to muscle atrophy (Nagappa et al., 2024). In some cases, neurodegenerative diseases like CMT can also contribute to orthopedic complications like hip dysplasia, when abnormal muscle tone offsets the joint in the hip. Impaired hip structure can further contribute to muscle imbalance, altered gait, and reduced stability, which may worsen movement-related challenges in individuals with neuromuscular conditions (Presedo, 2024).

Supporting Neuromuscular Function Through Movement-Based Therapy

Movement-based therapy has been previously utilized as a way to address the balance, coordination, and postural deficiencies associated with CMT1A. However, it cannot modify the underlying nerve damage that causes these impairments (Kenis-Coskun & Matthews, 2016). Therapists guide patients through repeated task-oriented movements, which are effective because they mirror real-life physical demands (Zambon et al., 2024). These movements support balance during motion, even in an activity as basic as walking (Lencioni et al., 2015). Repetitive strengthening of the lower-leg and foot muscles can also improve gait consistency, a key aspect of coordination (Rose et al., 2010). Furthermore, training the body to respond to balance disturbances like unstable or changing surfaces has been found to help improve the timing of responses from these sensed cues (Bao et al., 2025). Therefore, movement-based therapy can address the neuromuscular deficits brought on by CMT in a way that goes beyond increasing strength.

Therapeutic Horseback Riding in Similar Neuromuscular Disorders

One such movement-based therapy is therapeutic horseback riding, which demonstrates a high potential for rehabilitation from research that has examined its implementation in neurological and developmental conditions. Across these populations, studies commonly measure endpoints such as gross motor function, sitting ability, functional balance, gait efficiency, energy expenditure, spasticity, mobility, postural control, and quality of life.

Stergiou et al. (2017) found that therapeutic riding was associated with positive trends in balance and gross motor function across 16 trials, including populations with cerebral palsy, multiple sclerosis, stroke, and age-related mobility impairments. The strongest recurring improvements involved balance-related endpoints, especially scores on the Berg Balance Scale (BBS) and Pediatric Balance Scale (PBS), as well as gross motor outcomes, calculated through the Gross Motor Function Measure (GMFM). However, the meta-analysis did not find statistically significant benefits across the measured BBS/PBS or GMFM outcomes. The authors addressed that these findings should be interpreted cautiously because of the inadequacies in the available research due to few controlled trials, insufficient sample size in the interventions, lack of quantified data, and inconsistent outcomes between studies.

Despite these limitations, findings from individual studies identify several results that may be relevant to CMT1A. Therapeutic horseback riding yielded improvements in postural stability for individuals with cerebral palsy, a neurological condition affecting movement due to early brain injury (Matusiak-Wieczorek et al., 2020). In a separate study of children with spastic cerebral palsy, equine-movement therapy was associated with improved gait efficiency and motor function, furthering that riding-based interventions may also affect coordinated movement beyond seated posture (McGibbon et al., 1998). Similar outcomes have also been observed in adult neuromuscular populations, including multiple sclerosis, a neurological condition that has similar neuromuscular effects of hindered balance and coordination. It was found that a group notably improved in balance performance and perceived mobility following therapeutic horseback riding, even given the progressive nature of the disease, which reinforces the therapy’s capacity to influence movement control even in the presence of an ongoing neurological impairment (Vermöhlen et al., 2018).

Therapeutic Horseback Riding in Similar Neuromuscular Disorders

Rider safety is an important consideration in assessing horseback riding therapy as a form of rehabilitation. As compared to regular exercise and physical therapy conducted in the clinic, therapeutic horseback riding therapy presents certain hazards since it requires being around a live animal, working at heights above the ground, as well as mounting and dismounting the horse. However, adverse events during hippotherapy are relatively uncommon when recommended safety procedures are followed. Peters et al. (2020) found that 0.05% of treatment sessions required basic first aid and 0.01% required additional medical care or follow-up. Likewise, Hays et al. (2025) concluded there was a small number of adverse incidents during hippotherapy sessions among adults within the span of five years of data collection, with injuries occurring in less than 0.001 to 0.01 sessions annually. As a result, hippotherapy is not risk-free, but injury rates are low in structured clinical settings.

Role of Therapeutic Horseback Riding Within Broader CMT Rehabilitation

Compared with conventional physical therapy, pharmaceutical treatment, and surgery, therapeutic horseback riding is primarily a supportive rehabilitation approach. Standard CMT management is primarily symptom-based because there is currently no cure. Rather, physical therapy, occupational therapy, orthopedic devices, surgery, and medication for nerve pain are used to preserve function and manage symptoms (National Institute of Neurological Disorders and Stroke, 2025). Physical therapy for CMT usually focuses on strengthening and stretching muscles, preventing muscle tightening and loss, maintaining mobility, improving stability, and reducing disability through low-impact exercise and regular stretching (Charcot-Marie-Tooth Association, 2018). Surgery may help correct foot deformities, ease pain, or improve walking, but it does not reverse weakness or sensory loss (Mayo Clinic, 2025).

Therapeutic horseback riding overlaps with the broader goals of rehabilitation because it targets balance, posture, gait, mobility, and muscle control, but it differs by using the horse’s variable, rhythmic, and repetitive movement to provide motor and sensory input (Koca & Ataseven, 2016). Comparative research indicates the possibility that hippotherapy – an intensive, one-on-one form of therapeutic horseback riding that requires a license from the American Hippotherapy Association – can induce benefits similar to, and even better in some indicators than those provided by general exercise like treadmill training. In a study on stroke patients, eight weeks of hippotherapy training resulted in significant gains in BBS score, gait velocity, and step length asymmetry ratio compared to significant changes in step length asymmetry ratio in the treadmill training group (Lee et al., 2014). No statistically significant differences were found between groups in the BBS, but the hippotherapy group had a significantly higher gain in gait velocity and step length asymmetry ratio. In a study of elderly adults, both the hippotherapy and treadmill-training groups showed improvements in step length, step time, and sway path length after 12 weeks of treatment. However, the hippotherapy group showed a greater reduction in sway path length, correlating with improved balance (Kim & Lee, 2014).

Therefore, while therapeutic horseback riding may offer a distinct sensory-motor addition to rehabilitation, the current evidence does not show that it is superior to physical therapy, pharmaceutical management, or surgery. Because equine-assisted therapies are commonly described as complementary or adjunct interventions, therapeutic horseback riding may be most valuable as a supportive therapy within a multifaceted CMT treatment plan (White-Lewis, 2020).

Current Gap and Approach

Currently, no cure for CMT exists, so treatment is limited to supportive rehabilitation therapy (Kenis-Coskun & Matthews, 2016). While therapies have been proven to have the potential to improve motor function in individuals with neuromuscular disorders (Koca & Ataseven, 2016), little research has been conducted that examines therapeutic horseback riding's impact on people with CMT, and especially CMT1A, over an extended period of time (Ferraro et al., 2023). A database search of JSTOR, EBSCO, and PubMed using the keywords "therapeutic horseback riding" and "Charcot-Marie-Tooth disease" identified only one relevant study by Meneghetti et al. (2012) in which therapeutic horseback riding is directly linked to improving the neuromuscular function of patients with the rarer CMT4A subtype. As a result, existing research fails to represent the majority of people living with CMT, who have subtype 1A, since no studies examine this overlap as of 2026.

Consequently, understanding how therapeutic horseback riding affects neuromuscular control in individuals with CMT1A is very important, as it may help define whether this kind of treatment has more far-reaching applications than just for people suffering from rarer and more aggressive forms of CMT. Thus, this study will explore participants' self-perceived changes in balance, posture, and muscle control following long-term engagement in therapeutic horseback riding. This gap will be further investigated in this paper with the following research question. To what extent does the long-term use of therapeutic horseback riding contribute to the perceived neuromuscular control of someone with Charcot-Marie-Tooth disease Type 1A?

Hypothesis

Based on the current literature review, therapeutic horseback riding has been shown to improve coordination between the nervous and muscular systems, known as neuromuscular control (Van Leeuwen, 1999), which is an essential part of therapies designed for CMT (Meneghetti et al., 2012). Thus, it is hypothesized that long-term participation in therapeutic horseback riding will positively influence the self-perception of neuromuscular control of an individual with CMT1A. Specifically, the participant is expected to perceive improvements in balance, posture, and muscle coordination following the intervention.

METHODS

Research Design

A small-scale case study was conducted on two individuals who met the criteria of having a diagnosis of CMT1A and having participated in long-term therapeutic horseback riding, determined as a period of time surpassing one year, to assess the perceived effects of therapeutic horseback riding on an individual's neuromuscular control. This range was chosen because of the very limited number of potential participants. Not only is CMT1A a rare disease (National Institute of Neurological Disorders and Stroke, 2025), but access to therapeutic horseback riding is also limited in many locations; therefore, recruiting a large number of participants would have been unrealistic. A small group also allowed for a more thorough analysis of each participant's experiences, as I was able to focus my time on longer interviews rather than many shorter ones. The qualitative reflection prompted by interview questions best showcases how participants interpret dynamic changes, as it allows for the sharing of complex emotions that would be hard to transfer through a written medium like a sample survey (Leedy and Ormrod, 2015). This is important given that therapeutic horseback riding is highly individualized in nature and engages both physical and emotional systems (Koca & Ataseven, 2016), which the emphasis on self-perception aims to measure in an effective manner.

This study was observational rather than interventional. Participants were not assigned to therapeutic horseback riding as part of the study, and I did not administer, control, or modify any treatment. Instead, the study examined the self-reported experiences of individuals with CMT1A who had already participated in therapeutic horseback riding long-term. Although a form of experimental design would offer impactful, quantitative data, it was not suitable for this research, as such a design would have needed a large sample size, controlled treatment conditions, and repeated measures to compare pre- and post-intervention outcomes (Leedy & Ormrod, 2015), all of which are unrealistic given the challenges of obtaining a sufficiently large participant pool with this study's time parameters. It would also raise issues of experimental control, since therapeutic horseback riding programs differ greatly in what techniques, levels, and horses (Peters et al., 2020).

Sampling

Participants were located through a snowball sampling method. The interest form (see Appendix C) was initially sent to organization members of the CMT Association, as well as to certified therapeutic horseback riding centers (see Appendix B), with a request to refer any contacts they knew who had a CMT1A diagnosis and experience with therapeutic horseback riding. From here, I distributed the link for an interest form directly to the CMT Association's online community posts. I asked for the contact information of any potential participants on the initial interest form, to which I would send a letter of intent (see Appendix F) that explained the study, their voluntary participation, and collected background information like their age and the years that they have engaged with therapeutic horseback riding.

Once all forms were signed, I scheduled and conducted semi-structured interviews over Zoom in which I asked questions about their experience with CMT1A before starting therapeutic horseback riding and if they felt like their balance and coordination were engaged during the horse's movement (see Appendix H). A qualitative coding analysis was conducted on the interview's transcript (see Appendix G) using three preset codes – CNS processing, motor output, coordinated movement – which were related to perceived neuromuscular control.

Limitations

Due to the rarity of CMT1A and its uncommon overlap with therapeutic horseback riding, narrowing the scope of the sample by sub-demographic characteristics would have overly restricted the already limited participant pool. However, the smaller sample size and geographic scope may limit the generalizability of the findings. Still, this focus ensured both feasibility and qualitative depth within the timeframe, and can still contribute to academic discussions on an underrepresented neuromuscular disease.

The results of this study may also be tempered by selection bias, as both participants already had experience with therapeutic horseback riding. Those who chose to continue their treatment might be the ones who had access to it, found it tolerable, liked it, or benefited from it. Consequently, this study does not reflect the population of individuals with CMT1A who have chosen to stop therapeutic horseback riding for various reasons, such as cost, intolerance, non-improvement, safety concerns, or disease progression.

Phenotypic variation among patients with the same CMT1A subtypes should also be considered, as even with the same subtype, one can differ from another when it comes to symptom severity, age of onset, disease progression, sensory dysfunction, muscle weakness, fatigue, orthopedic problems, and decreased mobility (CMT Research Foundation, n.d.). As a result, the effects of therapeutic horseback riding in CMT1A manifest differently in various participants, making conclusions, especially with a small participant sample pool, uncertain.

Ethical Considerations

Ethical considerations primarily revolved around confidentiality, as participants represented a rare medical population that could potentially lead to easier participant identification. Although contextual information was included to support the data analysis, including factors such as age range, genetic subtype, and personal therapy experience, all personally identifying information that could have directly revealed one's identity, especially names, was removed. To further protect each participant's anonymity, both were assigned a pseudonym present on all documents related to this research.

The letter of intent (see Appendix F) and interest form (see Appendix C) ensured that all participants were recruited voluntarily and transparently, since all participants had a complete understanding of the study's potential implications before deciding to participate. If the participant was under 18, I obtained both consent from their guardian and the participant's assent (see Appendix E). These documents also included how I would be recording the interview for the purpose of acquiring a transcript to code. Disclosing this information is important to uphold professional interview etiquette and also to adhere to California state law, which makes it illegal to record a private conversation without the consent of everyone involved (Judicial Branch of California, 2025).

This study posed very minimal risk as it was solely a discussion on experiences with therapeutic horseback riding. However, if participants felt like they were experiencing emotional discomfort in any form while reflecting on their personal physical progress, they could choose not to answer a question or to exit the research at any point without consequences.

Before any data collection took place, this methodology was reviewed and approved by the Institutional Review Board of my high school. The IRB reviewed my research proposal based on the guidelines provided by the Social and Behavioral Sciences Working Group on Human Research Protections to ensure that my research project would be done safely, ethically, and appropriately, without any harm inflicted.

Positionality

There was a small risk of my own personal bias coming from my indirect link to the CMT community due to my sibling's CMT diagnosis. To avoid any form of influencing participant responses that this relation may have caused, I used a standard recruitment message and also applied the same interview structure and questions for all participants. As for avoiding personal bias whilst transcribing the interviews, I used Otter AI's transcription tool during my interviews rather than taking physical notes to eliminate any aspect of selective hearing, though I also double-checked the transcription job so that I did not rely solely on artificial intelligence.

RESULTS

The qualitative data collected from the interviews were deductively coded with three pre-set themes – "CNS Processing," "Motor Output," and "Coordinated Movement" – to explore the perceived effects of long-term therapeutic horseback riding on neuromuscular control in someone with CMT. These themes are based on the stages of the neuromuscular control pathway (Proske and Gandevia, 2012), in which sensory information from muscles and joints is processed by the CNS, translated into motor output commands, and manifested as coordinated movement. These three were chosen because they allow for the analysis of participants' self-perceived changes following therapeutic horseback riding by comparing their experiences to the common problems caused by CMT, which include impaired sensory feedback, muscle atrophy, and slowed balance corrections (Lencioni et al., 2015; Nagappa et al., 2024).

Firstly, any sentiments related to an awareness of their body and anticipation of movement were categorized under the "CNS Processing" theme. This is because this code and phrases under it relate to how the brain and nervous system process information from the body, per the definition of neurological processing of feedback detailed by Proske and Gandevia (2012). Secondly, statements related to muscle activation, strength, and endurance were placed under the "Motor Output" theme since they match motor control, which is defined as the nervous system's ability to activate muscles to create force. As riders respond to the horse's multidirectional movement, they repeatedly activate core and limb muscles, making participants' reflections on strength and muscular effort a logical representation of motor output in the context of therapeutic riding. Lastly, the theme "Coordinated movement" encompassed reflections on balance, gait stability, trunk control, and automatic postural adjustments, which correspond to the functional manifestations of neuromuscular control defined in the movement-based rehabilitation research of Lencioni et al. (2015).

Throughout the paper, participants will be referred to with pseudonyms to ensure privacy and anonymity (see Figure 2).

Name	Age	Gender	Years of therapeutic riding	CMT Subtype
Jude	26	Male	12	Type 1A
Blake	19	Male	11	Type 1A

Figure 2. Participant profiles. This table provides background for the participants included in this study. Individual demographic data is included to contextualize the findings during the final analysis.

CNS Processing

Across both interviews, participants described therapeutic horseback riding as something that influenced how they perceive and interpret their body's movement, especially through an increased awareness of their balance and physical capabilities.

As Blake and Jude reflected on their experiences riding, both associated therapeutic horseback riding with helping yield an unprecedented understanding of how their bodies respond to movement. Jude described riding as a confidence-boosting activity, calling it "something that [he] could actually do," noting a higher perception of his physical capabilities following his long-term participation. Blake described the most significant change somewhat differently, as he explained that riding helped him better understand his condition and how his body functioned in response to this movement, stating that the effect of riding was "more mental" than physical.

Both described horseback riding as an environment that required continuous attention to body position and stability, as maintaining balance on a moving horse required them to be hyperaware of their posture, body alignment, and shifts, such as those necessitated by the movement of the horse. Through prolonged exposure to this environment, both participants described becoming more comfortable keeping up with the horse's movement changes, indicating that riding was associated with improved confidence in responding to altered balance conditions.

Motor Output

In their interviews, participants also discussed therapeutic horseback riding as requiring continuous muscular engagement, especially in the core and lower body. Both Blake and Jude identified the core as a primary muscle group activated during their sessions, which, in conjunction with the lower body, helped stabilize their bodies as the horse moved beneath them. Still, Jude highlighted that riding is truly a full-body activity that requires sustained muscular engagement, in accordance with the many other physical aspects of riding beyond balancing on the horse. These included preparing the horse through grooming, feeding, and tacking up, which often require lifting heavier weights and bending down.
Furthermore, Blake noted that his fine motor skills in his hands and fingers were one of the largest outcomes, which he attributed to holding the reins. He also perceived his leg strength as improved from the action of posting, in which a rider rises and sits with the weight to shift off the horse's back to the rhythm of the horse's trot, while his foot was in a stirrup.

At an early age, Blake's doctors found that he had hip dysplasia, one of the factors that prompted his doctors to recommend therapeutic horseback riding, since it helps align the pelvis and places the body in a proper upright position. However, when he was tested over the years following his introduction to the therapy, the dysplasia never progressed, and surgery was no longer necessary, which, although he said may not have been directly correlated with therapeutic horseback riding, was one of the largest potential outcomes.

Both Blake and Jude also referred to endurance and fatigue when describing the physical demands of riding. Blake noted that he gradually adapted to the physical effort required to maintain his posture during sessions, with his muscular engagement becoming more manageable over time. Jude experienced a perceived increase in strength and endurance through his continued participation in riding, which he found allowed him to pursue other physically demanding activities.

Coordinated Movement

Blake and Jude both described coordination and balancing as common difficulties in their daily lives. Jude recollected that he experienced frequent falls and ankle injuries in his childhood, which he attributed largely to tripping from balance problems. Blake similarly described experiencing "general challenges with balance and coordination," and said that these difficulties affected many aspects of his daily activities, and pinpointing specifics was difficult.

Blake and Jude described needing to alter their body position during therapeutic horseback riding as a way of responding to the horse's movement, since, as the horse is instructed to change direction, speed, and gait, riders must shift their weight and engage stabilizing muscles to remain balanced. Jude indicated that his ability to alter his position fluidly and his ability to manage balance more effectively carried over into his "normal day-to-day activities" by allowing him to remain stable during activities he was previously unable to safely partake in, such as riding a dirt bike. Blake, however, characterized the improvements as more gradual, saying that his balance off the horse just improved "marginally" over time.

DISCUSSION

The study's findings suggest that long-term therapeutic horseback riding may be linked to perceived improvements in several areas of the neuromuscular control pathway within individuals with CMT1A, especially in body awareness, muscular engagement, and balance during activity.

Result	Participant evidence	Connection to study focus
Balance and postural control	Blake showed greater steadiness during riding-related activities.	Likely improvement in balance, body awareness, and neuromuscular control.
Lower-body muscle activiation	Jude showed increased use of the leg muscles during mounted activities.	Shows engagement of muscles commonly affected by CMT.
Coordination and gait-related movement	Repetitive riding movements required coordinated use of the trunk, legs, and feet in both participants	Connects therapeutic riding to movement patterns involved in walking and overall coordination.
Fine motor function	Jude's handwriting improvement was noted over the course of participation.	Improved fine motor control in area beyond lower-body movement.

Figure 3. Table showing key findings observed in participants and their connection to movement, coordination, and neuromuscular control.

The improvements in mobility that both participants reflected on align with Ferraro et al. (2023), who hypothesized that a continuous exercise program with high treatment frequency is needed to avoid functional loss in CMT and sustain improvements. Although it initially seems that therapeutic horseback riding had an unsubstantiated impact on participant Blake, who described his mobility changes as marginal, even this slight improvement suggests his condition was at least stabilized rather than deteriorating. Thus, Ferraro et al. (2023)'s proposition that therapy can still be effective even when it doesn't yield prominent results but instead serves to avert additional deterioration by the muscle atrophy of the disease corroborates my own findings.

Matusiak-Wieczorek et al. (2020) found that therapeutic horseback riding improved postural stability in children with cerebral palsy. Similarly, McGibbon et al. (1998) found that equine-movement therapy enhanced gait efficiency and decreased energy expenditure in children with spastic cerebral palsy. These results are consistent with participant reflections regarding improvements in balance and motor control in the present study, which may indicate how the horse's rhythmic movement can enhance neuromuscular coordination and balance regulation. That said, these studies do examine different neurological conditions; however, the function deficits of impaired balance, trunk instability, and difficulty coordinating movement that they addressed are in tune with those of CMT (Lencioni et al., 2015). This correspondence in perceived effects indicates that the neuromuscular mechanisms that were proposed in previous therapeutic horseback riding research may also be relevant to those with CMT, which helps to bridge a significant gap in the literature in the field.

Both of the aforementioned studies examined adolescents, but research on adult populations also reflects similar results. Vermöhlen et al. (2018) found that individuals with multiple sclerosis experienced improvements in balance performance after participating in therapeutic horseback riding programs. They were able to sit up straighter, which is consistent with the present study, in which both participants reported improved stability in the saddle and in daily activities following their long-term riding participation.

The present study contributes to the literature by examining long-term engagement, whereas many previous studies focus on relatively short intervention periods. In this regard, the participants' reflections on over ten years of riding offer insight into the potential long-term effects of therapeutic horseback riding on perceived neuromuscular control, a period of time that Ferraro et al. (2023) note is an anomaly given that current CMT research lacks sustained experiences.

At the same time, these results hold some limitations and should thus be interpreted with caution. This focused on participants' self-perceived changes in neuromuscular control, which, while valuable for understanding how they interpret these improvements in daily life, cannot fully substantiate physiological changes without sufficient quantitative backing. The current findings support this viewpoint, especially in the CNS processing theme, where participants reported that riding improved their understanding of their body's movements and gave them greater confidence to react to changes in balance. Therefore, while the results do not provide exact measurements of improvement, they support existing research suggesting that therapeutic horseback riding can influence both physical and perceptual aspects of movement control in riders.

CONCLUSION & FUTURE DIRECTIONS

This study explored how long-term therapeutic horseback riding may influence individuals’ perceptions of neuromuscular control while living with CMT1A. Because the study relied on self-reported data rather than direct physiological measurement, its conclusions were drawn by comparing participant reflections with existing literature on neuromuscular mechanisms. This comparison was especially focused on balance regulation and coordinated muscular response, which are central to neuromuscular control (Proske & Gandevia, 2012).

The findings indicate that long-term therapeutic horseback riding may be linked to perceived improvements in several areas of the neuromuscular control pathway, including body awareness, muscular engagement, and coordinated movement. These findings align with previous research showing improvement, or limited deterioration, in individuals with other neuromuscular disorders after therapeutic horseback riding (Vermöhlen et al., 2018; Matusiak-Wieczorek et al., 2020; McGibbon et al., 1998). By examining CMT1A specifically, this study contributes to a field in which this population has received limited attention.

This study's findings offer an initial step toward understanding how long-term participation in therapeutic horseback riding may influence both physical and perceptual aspects of neuromuscular control. This is especially relevant for individuals with CMT1A because current treatment options focus on symptom management rather than reversing nerve damage. For this reason, supportive rehabilitation approaches remain important to explore.

Future research should examine the long-term potential of therapeutic horseback riding for individuals with CMT1A and other peripheral neuropathies. Studies could use quantitative measures, such as gait analysis, balance testing, or other functional assessments, to evaluate neuromuscular changes more directly. A larger participant pool with varying levels of riding experience and multiple CMT subtypes would strengthen the generalizability of study findings. As more research examines the relationship between CMT and therapeutic horseback riding, this therapy may become better understood as a supportive rehabilitation option. This could also help inform future insurance coverage decisions by providing stronger evidence for its therapeutic value.

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