



Original Research

Upper Limb Rehabilitation in Facioscapulohumeral Muscular Dystrophy: A Patients' Perspective



Alice Faux-Nightingale, MPhil ^a,
Richa Kulshrestha, MRCPCH ^b, Nicholas Emery, PGDip ^b,
Anand Pandyan, PhD ^a, Tracey Willis, MD ^b,
Fraser Philp, PhD ^{a,c}

^a School of Allied Health Professions, Keele University, Keele

^b Robert Jones and Agnes Hunt Orthopaedic Hospital (RJAH) Foundation Trust, Gobowen, Oswestry

^c School of Health Sciences, University of Liverpool, Liverpool, United Kingdom

KEYWORDS

Exercise;
Joint instability, Muscular dystrophies;
Patient participation;
Questionnaires;
Rehabilitation;
Surveys;
Upper extremity

Abstract *Objective:* To identify (1) what exercise modalities people living with facioscapulohumeral muscular dystrophy (FSHD) are undertaking in the community as a part of their ongoing rehabilitation and (2) what future research projects would gain the support of people with FSHD. *Design:* An online questionnaire composed of open and closed questions. Conventional content analysis was used for open questions, and quantitative analysis was used for closed questions. *Setting:* Online questionnaire distributed to a United Kingdom FSHD registry. *Participants:* A total of 232 patients on the United Kingdom FSHD registry (N=232). *Interventions:* None. *Main Outcome Measures:* None. *Results:* A response rate of 43.6% was achieved with 232 of 532 patients completing the survey. Despite 85.8% (n=199) of patients experiencing shoulder instability that affects daily living, only 44.4% (n=103) engaged with exercises targeting the upper body. The themes from the data were understanding of disease mechanism shaping exercise choice, lack of understanding about the condition and the benefit of exercise, support from professionals, barriers to exercise, and thoughts about future research. Participants (92.2%, n=214) agreed additional research into upper limb exercises is needed and felt a 3-month arm cycling intervention with monthly clinical visits and magnetic resonance imaging would be appropriate.

List of abbreviations: FSHD, facioscapulohumeral muscular dystrophy; MRI, magnetic resonance imaging; UK, United Kingdom.

Supported by the National Institute for Health Research (NIHR) Research Design Service (RDS) West Midlands (grant no. RDS1606).

Disclosures: Professor Anand Pandyan has received unrestricted educational support from Allergan and Biometrics Ltd and Honorarium payments from Allergan, Biometrics Ltd, Ipsen, and Merz. These companies are unlikely to be affected by the research reported in this article. The other authors have nothing to disclose.

Cite this article as: Arch Rehabil Res Clin Transl. 2021;000:100157

<https://doi.org/10.1016/j.arrct.2021.100157>

2590-1095/© 2021 The Authors. Published by Elsevier Inc. on behalf of American Congress of Rehabilitation Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Conclusions: Exercise selection was variable among patients with FSHD, and lack of information, pain, fatigue, availability and access to facilities, cost, and time were identified as barriers to exercise. This may account for the limited engagement with upper limb rehabilitation despite the high percentage of shoulder instability in patients with FSHD. Further research is needed to develop evidence-based exercise interventions, and guidance for upper limb exercise prescription in FSHD, and patients are supportive of this.

© 2021 The Authors. Published by Elsevier Inc. on behalf of American Congress of Rehabilitation Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Facioscapulohumeral muscular dystrophy (FSHD) is one of the most common inherited muscular dystrophies, with an estimated prevalence in the United Kingdom (UK) from 2.9-3.9 per 100,000 in the general population¹⁻³ and affecting approximately 2400 people.⁴ The overall prevalence of FSHD internationally is reportedly between 3.2-4.6 per 100,000 people³ but is thought to be underestimated and varies considerably by country (estimated ranges between 0.8-12/100,000).^{3,5} It is widely stated as the third most common genetic skeletal muscle disease⁶ after Duchene muscular dystrophy and myotonic dystrophy. FSHD affects the upper extremities, torso, and muscles in the leg, negatively affecting muscle mass, shoulder mobility, and functional ability during tasks. This is most noticeable in functional tasks that require arm elevation above shoulder height⁷; however, functional ability at any level can be affected.⁸ Activities of daily living, such as self-care, for example, combing and washing hair, reaching for objects, grasping and lifting, are impaired, with negative effects on participation and recreational activities.⁸ Muscle weakness of shoulder muscles can also cause instability at the shoulder manifesting as downward translation of the humeral head with respect to the glenoid (sulcus), subluxation, and recurrent dislocation, which may contribute to the development of shoulder pain. Secondary features of chronic pain and fatigue also have a negative effect on quality of life.^{7,9}

For people with FSHD, evidence for informing upper limb rehabilitation is limited and does not provide appropriate guidelines for clinical implementation. Exercise prescription for rehabilitation in people with FSHD is difficult given the lack of appropriate guidelines, heterogeneity in patient symptom presentation and disease progression, and existence of comorbidities of pain and fatigue, which affect functional capacity. Despite the disease primarily affecting the upper body and associated musculature, existing studies have predominantly investigated the effect of exercise in the lower limbs for rehabilitation.^{10,11} Moderate intensity lower limb exercises such as cycling or resistance training are reportedly safe,^{12,13} but detrimental effects are possible depending on protocol, such as intensity and load used in resistance training and individual responses to exercise.^{12,14} Current practice for rehabilitation of the upper limb in patients with FSHD is unknown, and there is no equivalent evidence to guide rehabilitation of the upper limb for both exercise type and intensity. Our clinical experience suggests that exercise is an appropriate modality for upper limb rehabilitation patients with FSHD and that current practice is variable, possibly resulting from a lack of best practice or clinical guidelines. The aims of this study are therefore to identify (1) what exercise modalities people living with FSHD are undertaking in the community and (2) what future

research projects would gain the support of patients with FSHD and would be manageable for them.

Methods

Research and Development approval for this work has been received from the Robert Jones and Agnes Hunt Orthopaedic Hospital National Health Service Foundation Trust. No ethical approval was needed as per the principles set put in National Institute for Health Research involve. All participants were fully informed about the study, the voluntary nature of their participation, and their ability to withdraw data at any point prior to them taking part in the study. Because this was not a clinical trial, there is no clinical trial registration number. A web-based survey developed in SurveyMonkey Audience¹⁵ (appendix 1) was distributed electronically using the UK disease-specific FSHD registry.¹⁶ Responses were collected between March and June 2015, during which people received an invite to the study and 2 subsequent reminders. The questionnaire was developed by a team of clinicians (specialist neuromuscular medical consultants and physiotherapists) who routinely work with people with FSHD and had 9 questions, with a mix of open (n=2) and closed (n=7) questions. The 2 open questions asked participants to describe (1) which exercises they considered feasible for their condition and (2) the specific exercises they do for their upper body. The 7 closed questions were related to patients' experiences of instability, exercise, and opinions about future research. Only secondary, anonymized data were analyzed, conventional content analysis was conducted according to the stages outlined by Hsieh and Shannon¹⁷. Codes were generated by a single author (nonclinical) and were then verified with another author (clinical) before being used to construct themes according to prevalence and relevance to the research questions.

Results

Results for response rate to questionnaire

In total, 232 participants completed the survey of 532 who were invited (43.6%). The average response rate of the fixed answer questions was 99.4%. An overview of the fixed-answer responses has been provided in [table 1](#). Of the 232 who completed the survey, 193 participants (83.2%) answered the first open-ended question, and 124 participants (53.4%) answered the second. The responses to the

Table 1 Overview of responses to the fixed answer questions

Q1. Do you think there is need of research on exercises for upper limbs in your condition?		
	n	%
Yes	214	92.2
Not sure	13	5.6
No	4	1.7
Incomplete	1	0.4
Q2. Does shoulder instability affect your daily life?		
	n	%
Agree	199	85.8
Not sure	15	6.5
Disagree	15	6.5
Incomplete	3	1.3
Q3. Do you think arm cycling is a feasible exercise in your condition?		
	n	%
Agree	132	56.9
Not sure	90	38.8
Disagree	9	3.9
Incomplete	1	0.4
Q4. What do you think about the duration of a 3-month home exercise program of arm cycling?		
	n	%
It is sufficient	171	73.7
No comments	51	22.0
It is too long, should be shorter	8	3.4
Incomplete	2	0.9
Q5. This study will need participants to visit a study center for assessment of strength and function of upper limbs. Participants will attend at 4 weekly intervals. What is your opinion about visits?		
	n	%
No change	83	35.8
Would attend all visits if traveling expenses are paid	134	57.8
Need fewer visits	15	6.5
Incomplete	0	0.0
Q6. This study would also involve having an MRI scan before and after the study period. An MRI scan would take about 45 minutes. What is your opinion about an MRI scan?		
	n	%
Yes, it is possible	173	74.6
It would be uncomfortable to lie on scanner for 45 minutes	40	17.2
No comment	19	8.2
Incomplete	0	0.0
Q7. Do you currently do specific exercise targeting your upper body?		
	n	%
Yes, more than once per week	75	32.3
Yes, less than once per week	28	12.1
No	127	54.7
Incomplete	2	0.9

open-ended questions were mostly 1-word to single sentences, with some longer multiple sentence responses.

Results for responses related to exercise

The survey results identified that 85.8% (n=199) of participants agreed that shoulder instability affects their daily life. Despite this, only 44.4% (n=103) of the total population reported engaging with exercises that target the upper body. Of these, 32.3% (n=75) of respondents performed exercises that targeted their upper body more than once a week, and the remaining 12.1% (n=28) performed exercises

targeting the upper body less than once a week. Of those who do exercise, there were a wide range of activities and exercises described by participants summarized in [table 2](#).

Most long-answer responses included some exercises or activities that the participant carried out, with some individuals also describing the positive effect that it has on their condition, for example, in this statement about arm cycling: "I already do arm cycling at [specialist centre] and I can tell the difference with movement and less aches." There were very few who described negative repercussions from exercise, and where these were present, they were often related to a specific exercise or piece of equipment. "I struggle using a cross trainer due to my FSHDM as the arm movements lead to cramps in my

trapezius muscle and severe pain and swelling in both collar bones!” These participants’ experiences suggest that exercise offers a beneficial mechanism to improve flexibility and strength and that a wide range of exercises can be used to target different locations in the body, including the upper limbs. Responses vary between submissions, suggesting that these exercises help participants differently according to their symptoms.

With the application of thematic principles, the following themes were constructed from the data: (1) understanding of condition shaping exercise choice; (2) lack of understanding about the condition and how exercise interacts with it; (3) support from professionals; (4) barriers to exercise; and (5) thoughts about future research.

Understanding of condition shaping exercise choice

Participants were knowledgeable of the importance of exercise to prevent the deterioration associated with the condition, emphasizing the knowledge and understanding that they held in this area. This desire to work to counter the effects of FSHD, or acquire a greater understanding of the condition and use that knowledge to determine useful exercises, is common in the survey responses. Listed exercises were often accompanied with explanations of how it interacts with their condition for example, “1. Pilates to improve core muscle strength 2. Yoga to maintain flexibility and to enable arm cycling while braced on the floor 3. Walking while possible.”

Many responses in the survey mention exercises or equipment that participants have tried, or previous research studies that they have engaged with, with varying levels of success. Participants reported using this accumulated knowledge to assess the potential suitability of exercises or machines. This extends to items that have already been used with problematic results, and there seemed to be a willingness to try again in case a mistake was made or the item has been adjusted in some way: “I have tried to use that piece of equipment several times over the last decade, unfortunately each time it has caused severe pain and breathing difficulties each and every

time. Having said that it has never taken place under supervision, so I think with the correct set of circumstances it is definitely worth a trial.”

Lack of understanding about the condition and the benefit of exercise

Of the participants who do not engage with targeted upper limb exercise, 2 main groups were observed. A minority of participants (<5%) did not participate in specific or additional exercise outside of daily activities/occupational requirements because of a perception that exercise was not beneficial, for example, “Do no specific exercise, [finding] regular movement during the day . . . is of much benefit to the maintenance of my remaining shoulder movement.”

Approximately 10% of participants reported not exercising because of confusion surrounding the benefits of exercises or a lack of knowledge about their condition. These views were captured by the following comments: “Unsure, as have never had any correct exercises suggested,” and “I would definitely benefit from arm exercise but do not know what type would be possible.”

The effect on well-being and quality of life is presented in some of the survey responses with participants reflecting on their lack of knowledge and the effect that it could have had on their life had they known about it, for example: “Not sure but wished I knew more on what I can and can’t do [sic],” and “I haven’t done any exercises at all over the years because I accepted my condition and didn’t realize that exercise would help”

Some participants showed concern about the availability and quality of information that might help an individual with FSHD and were worried that this was leading to inconsistent advice and exercise recommendations.

Support from professionals

Although treating clinicians offered exercise advice, this was described as lacking consistency in some cases. A notable

Table 2 Summary of exercises reported by people with FSHD.

<p>General physical activity—no additional exercises outside of daily activities/occupational requirements Resistance training with load or assistive machines</p>	<p>Regular movement, no specific exercise, general walking, stair walking, daily tasks/everyday activities Rubber band/resistance band exercises; low impact, low weight exercises; strengthening exercises; weights; weights for arms; shoulder rope pulleys/shoulder machines; ab cruncher; gym workout/program; cable multi-gym</p>
<p>Water-based Cardiovascular training</p>	<p>Hydrotherapy/pool-based exercises, swimming, Aquafit Bike riding, gentle rowing, cross trainer, punch bag, arm cycling</p>
<p>Body weight exercises Maintaining range, mobilizing, or stretching</p>	<p>Tai chi, Pilates, plank, floor exercises, wall pushups/pushups Yoga, Qigong, neck exercises, stretching, slow stretches, door-based exercises, rotation</p>
<p>Core exercises Therapist-assisted Other/nondescriptive</p>	<p>Pilates, floor exercises Physiotherapy, osteopathy Arm exercises, palm to palm exercises, deep breathing, adapted game-based exercises (eg, throwing and catching, Wii sports)</p>

number of participants mentioned advice and recommendations that they received from professionals and/or instructors in community settings or alternate professions, which they use to guide their exercises, for example, Pilates instructors, gym instructors, personal trainers, and osteopaths. This was often coupled with an explanation of how the action benefits their strength or mobility, for example: "Working with a level 4 gym instructor, we have been targeting exercises to increase movement of arms to raise to shoulder level and above. We have been trying to isolate specific muscle groups and working to strengthen these."

Barriers to exercise

Lack of knowledge was not the only element that contributed to participants not exercising. In the survey, several other factors or barriers were identified that influence people's propensity to exercise, namely loss of mobility, reduced functional and traveling ability, pain, and fatigue. Discomfort (primarily pain) hindered the ability of patients to engage with specific exercises.

Functional limitations associated with the condition of FSHD were the most common barrier raised. Many participants in the survey noted that their condition affected their traveling ability, limiting their ability to engage with exercise regimes or research studies, saying for example: "I am unable to travel now, and would be unable to take part, other than to give my comments as above."

These limitations are frequently identified in the survey responses, with many participants offering stipulations in their assessment of exercises, such as "doesn't involve," "limited in what I'm able to do," "progression of disease made it impossible," or "used to do this until."

Pain from exercise or problems with exercises were significant barriers discussed in the survey responses. Several participants described situations in which exercises or machines "caused severe pain and breathing difficulties each and every time," some of which resulting in "[having] to refrain from even trying for the last 4 months." However, patients were able to implement a range of compensatory strategies (eg, exercising parts of the body not affected by pain or taking a temporary break from a specific exercise. Although problematic, this was not always a complete barrier because many of the responses reported continuing to exercise areas of their body that were pain-free.

In addition to the condition-based barriers, the survey responses mentioned availability and access to facilities, whether through cost, location, or time, as a barrier contributing to lack of exercise. Although many of these barriers raised cannot be easily overcome, some individuals offered some suggestions of ways to improve exercise engagement.

Thoughts about future research

Most participants (92.2%, n=214) agreed that research into upper limb exercises for people living with FSHD was needed and that engagement with clinical trials would not be a problem if duration was no more than 3 months (73.7%, n=171) and subsistence costs were reimbursed. Patients stated that an arm cycling intervention could be a priority (56.9% agreed (n=132), 38.8% (n=90) unsure) and were

willing to have a magnetic resonance imaging (MRI) scan (76.4%, n=173).

Discussion

The aims of this study were to identify (1) what exercise modalities people living with FSHD are undertaking in the community and (2) what future research projects would gain the support of patients with FSHD and would be manageable for them. We achieved the aims of our study, having identified the range of exercise modalities undertaken by people with FSHD and proportion of participants who use exercise as a part of their upper limb rehabilitation. We were also able to identify participants' perceptions of upper limb exercises and associated barriers for participation, which can be used for informing management and future research.

There is insufficient evidence to inform clinical decision making regarding exercise in FSHD, and this is likely limiting clinicians' ability to prescribe exercise and the ability of people with FSHD to engage with it. Within our study it was identified that more than 50% of the respondents were not engaging in upper limb exercises, despite more than 80% of participants reporting shoulder instability that affects their activities of daily living. Shoulder instability is a complex phenomenon with poorly understood mechanisms.¹⁸ This is particularly true for people with FSHD where the mechanism for shoulder instability may be different as a result of the changes to either the biomechanics (eg, properties of the musculoskeletal architecture/tendon) or the neural control (eg, recruitment of motor units) of the musculoskeletal system associated with the condition.¹⁹ The aforementioned impairments relating to biomechanics and neural control may be assessed using imaging such as MRI and 3D movement analysis in combination with electromyography, respectively. Responses of people with FSHD were supportive of MRI, which may provide further insight into mechanisms of shoulder instability in FSHD and inform upper limb rehabilitation.¹⁸ Of the people who exercised, a broad range of exercise modalities were identified, and many participants suggested that they also seek support outside of their immediate care team. Although variability in exercise selection may be reflective of the heterogeneity within this patient group, our study suggests that the variability may reflect the lack of evidence-based guidelines for FSHD and how exercise interacts with it.

It is important to identify a safe range of exercise modalities and parameters that can be carried out by people with FSHD. Existing research studies had focused predominantly on the lower limbs^{1,4, 6,11-13,20-22} in which some exercise programs have demonstrated effectiveness for increasing cardiovascular fitness in FSHD^{23,24} and other neuromuscular disorders,^{20,21} although others have suggested that some exercise intensities can be detrimental.^{12,14} There are also other secondary benefits associated with physical activity, such as decreased risk of comorbidities and improved overall well-being.²⁵ It is possible that the rate of functional decline in people with FSHD who do not engage appropriately with exercise is faster relative to those who do for both the upper and lower limbs. Further research is needed to confirm this; however, based on the findings from existing lower limb research, it is reasonable to assume that similar benefits

may be achieved for the upper limbs²² and patients' views confirm this: "I already do arm cycling at [specialist center] and I can tell the difference with movement and less aches."

Further research focusing specifically on upper limb exercises for people living with FSHD is therefore needed. It is important that when developing or investigating exercise interventions in FSHD that these have appropriate physiological rationale and sufficiently capture the benefits of exercise. Exercise interventions should aim to address the main mechanisms associated with the disease pathophysiology or subsequent symptoms and consider the limitations associated with the condition to allow it to be delivered safely and effectively.

A series of barriers and facilitators to people with FSHD exercising were presented in the data, highlighting a series of key elements that must be considered when developing future research. Knowledge of the effects of exercise were drivers for participation, and a lack of understanding was a barrier; therefore, in addition to quantifying the benefits from exercise, research should explain physiological mechanisms of action and risk of harm. For example, strengthening exercises may not result in hypertrophy but are likely to have positive secondary effects on psychological well-being²² and may limit the rate of functional limitations associated with the condition.²² Some of the barriers identified were similar to those experienced in the general population, for example, pain associated with exercise, and it is not clear if these events are indicative of normal or detrimental responses to exercise. It is important that professionals engaged in exercise prescription are routinely trained in the state-of-the-art knowledge in terms of benefits and risks associated with exercise to improve consistency in the messages being given to patients.^{10,13} This is particularly important given the degenerative and long-term nature of the condition because patients with FSHD will be reviewed by professionals throughout the course of their condition and be required to self-manage.

Secondary complications associated with the condition, namely pain, although loss of mobility, reduced functional ability, and fatigue were also mentioned by participants as barriers to upper limb exercise. These findings are consistent with other research studies investigating the natural history of people living with FSHD and exercise.²² In addition to the condition-based barriers, the survey responses mentioned availability and access to facilities, whether through cost, location, or time, as a significant barrier contributing to lack of exercise. Limited evidence investigating barriers to exercise for people living with FSHD in the community is available. It is therefore important that these factors are taken into consideration when designing exercise interventions for future studies. For example, arm cycling has the potential to be an effective, low-impact exercise; however, if travel is required to use the necessary equipment, this could limit access and participation.

Study limitations

Within our study we achieved a response rate of 43.6% (N=232) for the questionnaire. This is less than half of all people in the UK FSHD registry; however, it still captures a meaningful proportion of the true population with FSHD. Although

other studies may have higher responses rates and number of responders, this is reflective of a sample rather than the known population, and so it is important to interpret the response rate against this understanding. It is recognized that our study could potentially underestimate the number of people who are not undertaking upper limb exercises given that people with FSHD who do not exercise (1) may be less informed and likely to engage with research investigating modalities that do not feature in their routine management of the condition and (2) may have a lower functional capacity, possibly stemming from the disease progression and limited engagement with exercise, which negatively affects their ability to engage with the questionnaire. Further work may therefore be required to identify exercise interventions for lower functioning patients or methods for engaging people with FSHD not currently doing exercise. A wider range of methods of data collection, for example, qualitative research methodologies or use of paper questionnaires would also be beneficial for capturing information regarding patients experiences of exercise and/or rehabilitation and avoid loss of engagement because of factors like reduced digital access.²⁶

Conclusions

Overall, participants had positive responses and agreed about the need for future research into exercises for people living with FSHD. The responses indicate that people with FSHD are willing and are able to engage in upper limb exercises. Further research is therefore needed to develop appropriate, evidence-based exercise interventions and guidance for informing exercise prescription for upper limb rehabilitation in FSHD. In absence of pharmacotherapy or gene therapy, upper limb rehabilitation is fundamental in the ongoing management of FSHD. The results of our study provide support for the use of a 3-month arm cycling intervention, performed at home or in the clinic, as well as the use of MRI and frequency of clinical visits. The barriers and recommendations identified by participants will also be important for designing research studies because mobility, pain, access, motivation, and fatigue were all identified as factors that may negatively affect research design, recruitment, and overall translation into clinical practice.

Corresponding author

Fraser Philp, PhD, School of Health Sciences, University of Liverpool, Liverpool L69 3BX, United Kingdom. *E-mail address:* f.philp@liverpool.ac.uk.

Acknowledgments

We thank the UK FSHD Patient Registry, the John Walton Muscular Dystrophy Research Centre, Newcastle University, UK, and the Neuromuscular Centre, Winsford, UK.

References

1. Padberg G, Frants R, Brouwer O, et al. Facioscapulohumeral muscular dystrophy in the Dutch population. *Muscle Nerve Suppl* 1995;18:S81-4.

2. Emery AE. Population frequencies of inherited neuromuscular diseases—a world survey. *Neuromuscul Disord* 1991;1:19-29.
3. Theadom A, Rodrigues M, Roxburgh R, et al. Prevalence of muscular dystrophies: a systematic literature review. *Neuroepidemiology* 2014;43:259-68.
4. Orrell RW. Facioscapulohumeral dystrophy and scapulo-peroneal syndromes. *Handb Clin Neurol* 2011;101:167-80.
5. Deenen JCW, Arnts H, van der Maarel SM, et al. Population-based incidence and prevalence of facioscapulohumeral dystrophy. *Neurology* 2014;83:1056-9.
6. Lemmers RJ, Van der Vliet PJ, Klooster R, et al. A unifying genetic model for facioscapulohumeral muscular dystrophy. *Science* 2010;329:1650-3.
7. Bergsma A, Murgia A, Cup EH, et al. Upper extremity kinematics and muscle activation patterns in subjects with facioscapulohumeral dystrophy. *Arch Phys Med Rehabil* 2014;95:1731-41.
8. Bergsma A, Cup EH, Janssen MM, et al. Upper limb function and activity in people with facioscapulohumeral muscular dystrophy: a web-based survey. *Disabil Rehabil* 2017;39:236-43.
9. Bergsma A, Cup EH, Geurts AC, et al. Upper extremity function and activity in facioscapulohumeral dystrophy and limb-girdle muscular dystrophies: a systematic review. *Disabil Rehabil* 2015;37:1017-32.
10. Jansen M, van Alfen N, Geurts AC, et al. Assisted bicycle training delays functional deterioration in boys with Duchenne muscular dystrophy: the randomized controlled trial “no use is disuse”. *Neurorehabil Neural Repair* 2013;27:816-27.
11. Verellen J, Meyer C, Reynders S, et al. Consistency of within-cycle torque distribution pattern in hand cycling. *J Rehabil Res Dev* 2008;45:1295-302.
12. Gianola S, Pecoraro V, Lambiase S, et al. Efficacy of muscle exercise in patients with muscular dystrophy: a systematic review showing a missed opportunity to improve outcomes. *PLoS One* 2013;8:e65414.
13. Milner-Brown H, Miller R. Muscle strengthening through high-resistance weight training in patients with neuromuscular disorders. *Arch Phys Med Rehabil* 1988;69:14-9.
14. Voet NB, van der Kooij EL, van Engelen BG, et al. Strength training and aerobic exercise training for muscle disease. *Cochrane Database Syst Rev* 2019;12:CD003907.
15. SurveyMonkey. Audience. Available at: www.surveymonkey.com/mp/audience. Accessed June 1, 2015.
16. Network T-NN. UK FSHD Patient Registry. Available at: <https://www.fshd-registry.org.uk/>. Accessed June 1, 2015.
17. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005;15:1277-88.
18. Philp F, Faux-Nightingale A, Woolley S, et al. Implications for the design of a Diagnostic Decision Support System (DDSS) to reduce time and cost to diagnosis in paediatric shoulder instability. *BMC Med Inform Decis Mak* 2021;21:78.
19. Moroder P, Danzinger V, Maziak N, et al. Characteristics of functional shoulder instability. *J Shoulder Elbow Surg* 2020;29:68-78.
20. Ørngreen MC, Olsen DB, Vissing J. Aerobic training in patients with myotonic dystrophy type 1. *Ann Neurol* 2005;57:754-7.
21. Svein ML, Jeppesen TD, Hauerslev S, et al. Endurance training improves fitness and strength in patients with Becker muscular dystrophy. *Brain* 2008;131:2824-31.
22. Voet N, Bleijenberg G, Hendriks J, et al. Both aerobic exercise and cognitive-behavioral therapy reduce chronic fatigue in FSHD: an RCT. *Neurology* 2014;83:1914-22.
23. Bankolé LC, Millet GY, Temesi J, et al. Safety and efficacy of a 6-month home-based exercise program in patients with facioscapulohumeral muscular dystrophy: a randomized controlled trial. *Medicine (Baltimore)* 2016;95:e4497.
24. Olsen DB, Ørngreen MC, Vissing J. Aerobic training improves exercise performance in facioscapulohumeral muscular dystrophy. *Neurology* 2005;64:1064-6.
25. Ashe MC, Miller WC, Eng JJ, et al. Older adults, chronic disease and leisure-time physical activity. *Gerontology* 2009;55:64-72.
26. Newman L, Browne-Yung K, Raghavendra P, et al. Applying a critical approach to investigate barriers to digital inclusion and online social networking among young people with disabilities. *Inform Syst J* 2017;27:559-88.