Individualized Aerobic Exercise in Neuromuscular Diseases: A Pilot Study on the Feasibility and Preliminary Effectiveness to Improve Physical Fitness

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Abstract

Objective. Clear guidelines to prescribe aerobic exercise in neuromuscular diseases (NMD) are lacking, which hampers effective application in neuromuscular rehabilitation. This pilot study evaluated the feasibility and preliminary effectiveness of an individualized aerobic exercise program according to a recently developed training guide (B-FIT) to improve physical fitness in individuals with NMD.

Methods. Thirty-one individuals who were ambulatory and had 15 different slowly progressive NMD participated in a 4-month, polarized, home-based, aerobic exercise program. The program included 2 low-intensity sessions and 1 high-intensity session per week. Feasibility outcomes were the following: completion rate, proportion of followed sessions, adverse events, and participant and therapist satisfaction based on a self-designed questionnaire. Submaximal incremental exercise tests were used to assess the effects on physical fitness.

Results. Twenty-six participants (84%) completed the B-FIT program, and the proportion of followed sessions was >75%. Three adverse events were reported and resolved. Regarding satisfaction, participants (based on n = 9) reported feeling fitter, but training was considered insufficiently challenging. Physical therapists (n = 5) reported that B-FIT provides a clear, well-grounded guidance. They perceived the time investment for initiating the program and the carry-over to primary care as the main barriers. The mean (SD) submaximal heart rate (based on n = 20) reduced significantly by −6.5 beats per minute (95% CI = −11.8 to −1.2), from 121.7 (16.5) at baseline to 115.2 (14.3) after intervention. Submaximal ratings of perceived exertion, anaerobic threshold, and peak workload also improved significantly (P < .05).

Conclusion. The outcomes of this pilot study suggest that individualized aerobic exercise according to B-FIT is feasible and has potential to improve physical fitness in a wide variety of slowly progressive NMD. However, some barriers must be addressed before investigating the efficacy in a randomized controlled trial.

Impact. The outcomes of this study demonstrate the feasibility of individualized aerobic exercise according to the B-FIT training guide and the potential to improve physical fitness in NMD. Physical therapists indicated that the use of B-FIT provides a clear, well-grounded guidance. The training guide can support health care professionals in the application of aerobic exercise in adult neuromuscular rehabilitation.

Lay Summary. Individualized exercise according to the B-FIT training guide is feasible in a wide variety of slowly progressive NMD and might help improve physical fitness.

Keywords: Aerobic Exercise, Neuromuscular Diseases, Feasibility, Rehabilitation, Physical Fitness
Introduction

Physical inactivity is a common problem in individuals with neuromuscular diseases (NMD) and is caused by symptoms of muscle weakness, fatigue, and pain. Inactivity leads to reduced physical fitness, further compromising daily activities and social participation. Therefore, an important goal of rehabilitation programs in NMD is to promote physical fitness by means of aerobic exercise.

There is increasing evidence for the beneficial effects of aerobic exercise in a wide variety of slowly progressive NMD, such as facioscapulohumeral muscular dystrophy and Charcot-Marie-Tooth disease, but the evidence is inconclusive. Most studies on aerobic exercise in NMD applied conventional programs. In these studies, exercise intensity was gradually increased from 50% to 80% of the peak oxygen uptake \( (\text{VO}_2\text{peak}) \) or heart rate reserve (HRR) for the entire training group. Yet, previous studies in several different slowly progressive NMD demonstrated that the anaerobic threshold (AT), a direct indicator of the aerobic capacity, occurred on average between 40% and 47% of the \( \text{VO}_2\text{peak} \) or HRR and varied widely between individuals. This may indicate that the exercise intensities were relatively high and therefore difficult to sustain for prolonged periods of time. Moreover, exercise intensities were often based on predicted fitness level and not on the individual's actual fitness level as determined from exercise testing. This lack of individualization and the relatively high intensity prescription could have led to low adherence rates and therewith reduced effectiveness, which may have contributed to the inconsistent results so far.

The inconclusive evidence on the efficacy of aerobic exercise in NMD hampers the development of clear guidelines, and, consequently, adequate application of aerobic exercise in daily practice. In a recent survey among health care professionals, more than three-quarters of the respondents indicated that they needed support to improve the application of aerobic exercise in adult neuromuscular rehabilitation. Most support was required with respect to screening procedures (to assess the need and safety for aerobic exercise) and dosing of exercise programs. This is in line with previous studies identifying the difficulties health care professionals experience with regard to finding a balance between improving physical fitness and preventing overburden in NMD.

Therefore, we recently developed a training guide, called B-FIT, to support health care professionals in the application of individualized aerobic exercise in slowly progressive NMD. B-FIT includes an exercise program that is highly personalized in that it is adapted to the individual's actual fitness level as determined from submaximal exercise testing. This is expected to improve the efficacy as well as adherence. In addition, the program uses so-called polarized protocols, involving long bouts of low-intensity aerobic exercise alternated with short bouts of high-intensity exercise, which appears to be a promising alternative to conventional programs in this population. This novel approach is derived from high-class endurance athletes for whom it was demonstrated that further improvement of the aerobic capacity required adding high-intensity sessions to high-volume (low-intensity) exercise. Similar to high-class athletes, the muscles of individuals with NMD may already have been optimally adapted because they perform daily activities at relatively high intensities due to their reduced muscle mass. Whether polarized exercise is also beneficial in NMD has not yet been investigated.

We conducted a pilot study to evaluate the feasibility and preliminary effectiveness of an individualized polarized aerobic exercise program according to the B-FIT training guide in individuals with slowly progressive NMD. We hypothesized that the B-FIT exercise program would be feasible and would demonstrate potential to improve physical fitness in individuals with NMD. The outcomes of this study will be used to consider further study in a randomized controlled trial (RCT).

Methods

Development of the B-FIT Training Guide

A multidisciplinary working group consisting of rehabilitation physicians \((n = 3)\), physical therapists \((n = 10)\), clinical exercise physiologists \((n = 2)\), and individuals with different slowly progressive NMD \((n = 5)\) was invited to participate in 4 expert meetings over a period of 18 months. Participants were selected from various care settings (university hospital, rehabilitation center, or physical therapy practice) and geographical locations. The first 3 expert meetings covered the following topics: (1) aims of the B-FIT training guide, (2) aerobic exercise (principles) in NMD, and (3) recommendations for prescription, evaluation, and monitoring of aerobic exercise in NMD. Draft versions of the B-FIT training guide were prepared by 2 authors of this study (E.V. and M.B.) based on findings of 2 recent RCTs on aerobic exercise in NMD, experiences of patients and care professionals, and current insights from scientific literature on clinical exercise physiology focusing on novel approaches such as polarized and high-intensity interval training and exercise testing. The expert meetings were used to discuss and adjust draft versions of the training guide. A first complete draft version was tested by several physical therapists of the working group, with emphasis on readability of the training guide, clarity of instructions and protocols, and completeness of worksheets. During the fourth expert meeting, they shared their first experiences in using B-FIT, and this information was used to prepare a final draft of the training guide. This final draft was sent for feedback to the Dutch patient association for neuromuscular diseases (“Spierziekten Nederland”), the Netherlands Society of Rehabilitation Medicine, and the Royal Dutch Society for Physical Therapy. After incorporating their comments, the final version of the B-FIT training guide was approved.

Content of the B-FIT Training Guide

The B-FIT training guide consists of a therapist and patient manual. The therapist manual includes background information about aerobic exercise (principles), practical instructions and protocols, and worksheets to prescribe, monitor, and evaluate aerobic exercise in NMD. The patient manual includes practical instructions, the exercise program, and a logbook. A website (https://www.amc.nl/trainingswijzer) was developed containing all the protocols and worksheets of B-FIT. It also contains an instruction video for therapists outlining the use of B-FIT.

Design

A multicenter prospective pilot study was conducted at the departments of rehabilitation medicine of 2 university
| Visit                | Measurement                                      |
|---------------------|--------------------------------------------------|
| Visit 1 (week 0)    | Set treatment goals                               |
| Visit 2 (week 1)    | Determine baseline fitness and target intensity   |
| Visit 3 (week 2)    | Initiate exercise program                         |
| Visit 4 (week 10)   | Re-define target intensity zones                  |
| Visit 5 (week 18)   | Evaluate fitness                                  |

**Visit**
- Visit 1 (week 0): Set treatment goals
- Visit 2 (week 1): Determine baseline fitness and target intensity
- Visit 3 (week 2): Initiate exercise program
- Visit 4 (week 10): Re-define target intensity zones
- Visit 5 (week 18): Evaluate fitness

**Measurement**
- T0
- T1

Figure 1. Schematic presentation of the study design. Participants performed a submaximal incremental exercise test before (T0, visit 1), midway (visit 4), and directly after (T1, visit 5) the exercise program.

hospitals in the Netherlands that were specialized in treating patients with NMD and implemented the B-FIT training guide. Participants followed a 4-month exercise program according to the B-FIT training guide. Measurements were performed 1 week before start of the intervention (T0) and directly post-intervention (T1). The exercise program and measurements were performed as part of the regular physical therapy treatment, and the Medical Ethics Review Committee gave a waiver for official approval of this study. We followed the recommendations for reporting the results of pilot studies,36 which are adopted from the CONSORT Statement.

**Participants**

All individuals with NMDs who were referred to one of the involved physical therapists between March 2016 and June 2018 were considered for participation. The inclusion criteria were diagnosis of an NMD (except rapidly progressive NMD, such as amyotrophic lateral sclerosis), motivated to improve a reduced physical fitness level, and age of ≥18 years. Exclusion criteria were contraindication for being physically active, unable to follow verbal or written instructions, and insufficient mastery of the Dutch language. During the physical therapy intake, the therapist verbally discussed the fitness and activity levels and verified that potential participants were motivated to follow and complete the exercise program. Eligible individuals received an information letter from their therapist including the study purpose.

**Intervention**

Participants visited the hospital 5 times during the course of the exercise program. The first 3 visits took place before the start of the exercise program to set the treatment goals (visit 1), to determine the baseline fitness level and target intensity zones for training (visit 2), and to initiate the exercise program (visit 3). Visit 3 included a practice training session to check whether the participant was able to keep up with the schedule. Visits 4 and 5 were scheduled midway and directly after the exercise program, respectively, to monitor progress based on the participant’s logbook and re-define the target intensity zones and to evaluate the patient’s fitness level (Fig. 1). In addition to the 5 visits, the training guide advises brief contact moments by telephone or email to monitor training progress and to adjust the schedules if needed.

The aerobic exercise intervention consisted of a 4-month, polarized, home-based program, with 2 low-intensity sessions (ie, below the AT) and 1 high-intensity session (ie, above the AT) per week. Each training session consisted of 2 or 3 exercise bouts interspersed with 5- or 3-minute recovery periods, for low and high intensity, respectively. High-intensity training sessions were always preceded by a 3-minute warming up, and followed by a 3-minute cooling down. The duration was gradually increased from 10 to 17 minutes per bout for low-intensity sessions and from 3 to 8 minutes per bout for high-intensity sessions (Fig. 2). This resulted in approximately 75% of the total training volume being performed at low intensities and approximately 25% at high intensities. Training sessions were performed in the home environment (eg, at home or in the local gym), preferably on a stationary ergometer, and the exercise program was coordinated and supervised by trained physical therapists experienced in treating patients with NMD.

Participants were supplied with a logbook containing training instructions to register the number of training sessions followed, their heart rate and perceived exertion on the Borg Scale (range, 6–20),37 and any physical complaints they experienced during or after training. Participants were responsible themselves for taking care of the necessary equipment (ie, heart rate monitor and ergometer) and facilities (eg, local gym, physical therapist practice).

**Incremental Submaximal Exercise Test**

Participants performed an incremental submaximal exercise test, which previously showed to be feasible in PPS and could be used to determine the AT.19 The test was supervised by the treating physical therapist and performed before (T0, visit 1), midway (visit 4), and directly after (T1, visit 5) the exercise intervention period (Fig. 1). The test was executed on a bicycle ergometer, or on a treadmill in case of a walking program. The exercise test consisted of 3 minutes unloaded cycling (or walking at 2 km/h), after which the workload was increased by 5 to 10 W (0.5–1.0 km/h in case of walking) every minute, depending on the patients’ physical capacity. Criteria for stopping the test were the heart rate exceeding 80% of the estimated HRR, the pedal frequency dropping below 60 revolutions per minute, or the participant being unable to continue the test for any reason. Heart rate was monitored throughout the test with a heart rate monitor. Midway each workload and at the end of the exercise test, participants rated their perceived exertion (RPE) on the Borg Scale (range, 6–20), and the physical therapist registered this on a worksheet together with the heart rate.

**Target Intensity Zones**

Target intensity zones for the aerobic exercise program were based on the AT, which was determined from the submaximal exercise test (Fig. 2). The AT was indirectly assessed by determining the heart rate corresponding to an RPE of 12 on the Borg Scale. A previous study in PPS demonstrated a high correlation ($r = 0.86$) with the AT.19 The preferred way of training was based on heart rate, but if necessary (eg, for participants using beta-blocking agents), training could also be based on the RPE using the Borg Scale (range, 6–20).

**Outcome Measures**

**Primary Outcomes**

Feasibility was evaluated by (1) the completion rate, (2) the proportion of followed sessions, (3) adverse events, and
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Figure 2. Overview of the B-FIT exercise program. Low-intensity training sessions (twice weekly) consisted of 2 exercise bouts interspersed with 5-minute recovery periods (A). High-intensity training sessions (once weekly) consisted of 3 exercise bouts interspersed with 3-minute recovery periods. High-intensity sessions were preceded by a 3-minute warming-up and followed by a 3-minute cooling down (B). The lower and upper limits of the target intensity zones were calculated using the heart rate at the anaerobic threshold as determined from submaximal exercise testing as a reference value (100%) (C).

(4) patient and therapist satisfaction with the use of the B-FIT training guide.

For the completion rate, the number of participants completing the exercise program was expressed as a percentage of the number of participants who started the program. The proportion of possible sessions followed was determined based on the logbooks and patient records. A completion rate and proportion of followed sessions of 75% or higher were considered as good.10 Adverse events (such as severe muscle fatigue, joint pain, or other events considered to be related to the exercise program) were obtained from the logbooks and patient records.

We used self-designed web-based questionnaires to evaluate the satisfaction of patients and physical therapists with B-FIT. It contained 15 questions for patients and 19 questions for therapists about their experiences working with the B-FIT training guide. Questions were close-ended and scored on a 5-point Likert scale (with 1 = strongly disagree and 5 = strongly agree). Several questions contained “please specify” to ensure the most appropriate response. We also asked respondents to report their top 3 reasons for recommending or not recommending the use of the B-FIT training guide to others. A web-based tool, Google Forms (https://docs.google.com/forms/u/0/), was used to distribute the surveys. The questionnaire required approximately 15 minutes to complete.

Secondary Outcomes
Physical fitness was expressed as the change in submaximal heart rate (HRsubmax) from baseline (T0) to directly post-intervention (T1). A reduced post-intervention HRsubmax at the same workload (or walking speed) indicates improved physical fitness.38 Other indicators of improved physical fitness were a reduced post-intervention resting heart rate (HRrest) and submaximal RPE (RPEsubmax), and an increased peak workload (Wpeak), and workload at the AT (WAT).39 For HRsubmax and RPEsubmax, the HR and RPE were assessed at the highest submaximal workload achieved during the baseline test (T0) and compared with the HR and RPE at the same workload during the post-intervention test (T1). We also evaluated physical fitness outcomes at the individual level. Participants with at least 3 improved physical fitness outcomes were considered responders, while the remaining participants were considered non-responders.

Data Analysis
Descriptive statistics were used to present baseline and clinical characteristics of participants. The questionnaire data from the items scored on a 5-point Likert scale were reduced by combining “agree” and “strongly agree” responses to form an “agree” category, and response options of “strongly disagree” and “disagree” were combined to form “disagree.”
We used paired-samples t tests to analyze the change in physical fitness outcomes from baseline (T0) to directly post-intervention (T1). Data analysis was performed using SPSS (version 26.0, SPSS Inc, Chicago, IL, USA). The level of significance was set at \( P < .05 \).

**Role of the Funding Source**

The funders played no role in the design, conduct, or reporting of this study.

**Results**

Between March 2016 and June 2018, 31 participants (17 men; median age = 58 years, range = 20–76 years) started the B-FIT exercise program. Participants were all ambulatory and diagnosed with post-polio syndrome (n = 11), inclusion body myositis (n = 3), facioscapulohumeral muscular dystrophy (n = 3), congenital myopathy (n = 2), myotonic dystrophy (n = 2), primary lateral sclerosis (n = 1), Charcot–Marie–Tooth disease (n = 1), ocular pharyngeal muscular dystrophy (n = 1), hereditary spastic paraparesis (n = 1), myasthenia gravis (n = 1), dermatomyositis (n = 1), sensorimotor axonal polyneuropathy (n = 1), polyneuropathy associated with monoclonal gammopathy of undetermined significance (n = 1), limb girdle muscular dystrophy type 2 (n = 1), and Bethlem myopathy (n = 1).

Nineteen participants were treated at the outpatient clinic of the Department of Rehabilitation of the Amsterdam UMC (location AMC) supervised by 3 physical therapists. Two other physical therapists treated 12 participants at the rehabilitation department of the UMC Utrecht. The primary treatment goal of participants was improving physical fitness (n = 27). Other primary treatment goals were maintaining muscle strength (n = 2), improving walking capacity (n = 1), and advice for structured exercise (n = 1). Twenty-five participants trained based on the heart rate, and 6 participants trained based on the Borg Scale. Different exercise modes were used: bicycle ergometry (n = 25), outdoor walking (n = 2), rowing ergometry (n = 1), and a combination of bicycle ergometry and swimming (n = 3).

**Primary Outcomes**

Twenty-six participants completed the exercise program (84%). Reasons for discontinuation were fatigue (n = 1), joint pain (n = 2), preference for another exercise program (n = 1), and warm weather (n = 1). Three adverse events were reported: joint pain at the knee and hip, and fatigue. All 3 adverse events were resolved. All participants who completed the training program reported to have followed >75% of the training sessions over a median period of 18 weeks (interquartile range, 5 weeks).

Nine patients and all 5 physical therapists returned the questionnaire. Items that were most often reported as “agree” by patients were “frequent adaptations in workload were required to remain within the target intensity zones” (n = 7), “the exercise program matched my own needs and physical capacity” (n = 6), and “the exercise program benefited me” (n = 6). The items most often reported as “disagree” were “the exercise program was sufficiently diverse and challenging” (n = 4) and “it worked well to maintain within the target intensity zones” (n = 4). The most important reasons to recommend the use of B-FIT to others were “the program leads to improved physical fitness,” “the feedback based on the exercise tests motivates to continue training,” and “the program provides structure.” “Following the program requires discipline” and “makes you feel fatigued” were mentioned as reasons for not recommending B-FIT to others.

Items that were most often reported as “agree” by physical therapists were “B-FIT offers better guidance than currently applied methods” (n = 5), “working according to B-FIT is fun and will improve the quality of care” (n = 5), and “B-FIT fits with my own perception regarding the role of aerobic training in NMD” (n = 5). The most often “disagreed” item was “the design of B-FIT makes it easy to use” (n = 2). The most important reasons to recommend the use of B-FIT to others were it provides a clear, well-grounded guidance; gives more structure than currently applied methods; and enhances uniformity among care professionals. The carry-over to primary care and time investment for initiating the program were mentioned as reasons for not recommending B-FIT to others.

**Secondary Outcomes**

The preliminary effects on physical fitness were assessed among 20 of 26 participants who completed the training program, because in 5 participants data from the submaximal exercise tests were missing, and in 1 other participant different protocols were used for baseline and post-intervention testing. There were no significant differences in patient and training characteristics between the subgroup used for this analysis and the group that started (n = 31) and completed (n = 26) the program.

The mean (SD) HRsubmax reduced significantly by −6.5 beats per minute (95% CI = −11.8 to −1.2) from 121.7 (16.5) at baseline to 115.2 (14.3) after intervention. A significant reduction was also found for RPEsubmax (−1.5 points on the Borg Scale, 95% CI = −2.4 to −0.6), and significant increases were found for Wpeak (15.4 W, 95% CI = 8.5 to 22.3) and WAT (11.2 W, 95% CI = 3.9 to 18.6) (Table; Fig. 3). HRrest did not change (\( P = .199 \)). The AT occurred at a mean of 38% of the estimated HRR (range, 13%–71%). Sixteen participants (80%) were identified as responders. There were no significant differences in patient and training characteristics between responders and non-responders.

**Discussion**

The outcomes of this pilot study demonstrated that a 4- month, individualized, polarized, home-based aerobic exercise program according to the B-FIT training guide is feasible and has the potential to improve physical fitness in a wide variety of NMD. Patients and physical therapists were generally satisfied, but they also identified some barriers to the use of the B-FIT training guide.

The completion rate of 84% and proportion of followed training sessions of >75% as well as the low number of adverse events indicate the feasibility of the B-FIT exercise program. The proportion of followed training sessions is in line with other aerobic exercise studies in NMD,10–15,24–26,40–44 while the completion rate that we found is higher in reference to previous studies, reporting completion rates ranging from 44% to 74%.10,11,15,16,24–28 In these studies, intensities were similar for the entire training group and gradually increased from 50% to 80% of the VO2peak or HRR. However, the AT in NMD seems to occur at relatively low intensities. In the current study, it occurred
at an average of 38% of the estimated HRR and ranged from 13% to 71% of the HRR. This is in line with previous findings in PPS and Charcot–Marie–Tooth disease \(^{19-21}\) and indicates that exercise intensities as applied in conventional programs in NMD were relatively high, and therefore difficult to sustain. \(^{22}\) In the B-FIT exercise program, target intensity zones were individually determined based on the estimation of the AT by RPE. Combined with using a polarized exercise program, this may explain the relatively high completion rate and proportion of followed training sessions in our study.

In general, patients and physical therapists were satisfied with the use of the B-FIT training guide. Patients reported that the exercise program benefited them, and they felt fitter, which corresponds with the improved physical fitness levels that we found. In addition, the program closely matched their needs and physical capacity. If a program does not align with the patient’s physical capacity, it will be difficult to incorporate it into the daily routine. Consequently, patients might become demotivated, leading to discontinuation of their exercise program. \(^{31}\) Nevertheless, patients experienced the B-FIT program as insufficiently challenging. This issue was also raised by others \(^{3}\) and needs further attention, particularly because poor motivation has been reported as a barrier to exercise both from a patient and health care professional perspective. \(^{3,29,31}\)

Physical therapists indicated that the use of B-FIT provides clear, well-grounded guidance; enhances uniformity among care professionals; and improves the quality of care. Therewith, the training guide appears to meet the needs for support of health care professionals regarding the application of aerobic exercise in adult neuromuscular rehabilitation. \(^{29}\) A main barrier to the use of the B-FIT guide that should be addressed is the time investment required to initiate the program. Most of the worksheets, such as the results of the submaximal exercise tests and the training schedules, needed to be filled out by hand. It is therefore conceivable that physical therapists found this time consuming. Another reported barrier was the carry-over to primary care. The fact that most of the training sessions take place at or close to home in a primary care setting highlights the importance of addressing this barrier.

Potentially, some important barriers that were reported may be addressed through the use of technology. More specific, technology can be used to develop tools to automatically calculate the limits of the training intensity zones and transfer these into the individual’s training schedule. Further, the use of smartphone apps combined with heart rate monitors could benefit patients as they would no longer have to keep logbooks, and it allows providing interactive and enjoyable forms of exercise. \(^{45}\) Physical therapists could use such apps to better guide and monitor from a distance. Moreover, the
incorporation of technology appears to be linked with sustainable exercise intervention effects. 46

Along with feasibility, we also assessed the preliminary effectiveness of the B-FIT exercise program. Comparison of baseline with directly post-intervention submaximal exercise testing results suggests that the exercise program has potential for improving fitness in individuals with various slowly progressive NMD. Our results were highly consistent with significant improvements in 4 of the 5 assessed physical fitness outcomes. This contrasts with most previous aerobic exercise studies in NMD using submaximal exercise tests to evaluate the effects on multiple physical fitness outcomes. Some of these studies reported similar improvements as we found, 17,18 but others found no changes in any of the outcomes studied 23,27 or inconsistent effects. 23,25,27 All of these studies used conventional exercise programs, and hence the use of a polarized exercise program with individualized intensity prescription might explain the consistent positive results that we found. The small proportion of non-responders that we found (20%) is in line with findings in the general population. Possibly, direct assessment of the AT improves the accuracy of the exercise dose prescription, which may eliminate the non-response. 47

Study Limitations

Because of the pilot nature of this study, we did not include a control group. Consequently, no definite conclusions can be made about the efficacy of the B-FIT exercise program. Another limitation may be that treating physical therapists were all working in a specialized NMD center. Adult neuromuscular rehabilitation in the Netherlands is organized and coordinated by specialized centers, and consequently physical therapists were highly experienced in treating patients with NMD. This may imply that additional training for the use of B-FIT is needed in countries or settings with different organizational structures, where physical therapists may have more limited experience in treating NMD. Finally, the number of responding patients was relatively low, which may have resulted in response bias. This most likely occurred due to the questionnaire distribution, that is, treating physical therapists were responsible for informing patients, and the self-designed questionnaire was only available via a web-based tool.

The present pilot study evaluated the feasibility and preliminary effectiveness of an individualized, polarized, home-based aerobic exercise program according to the B-FIT training guide in individuals with NMD. The results suggest that the program is feasible and has the potential to improve physical fitness in a wide variety of NMD. Patients and physical therapists appear to be satisfied with the use of B-FIT. Yet, they also identified some barriers that must be addressed before investigating the efficacy of B-FIT to improve physical fitness in the short and long term in an RCT.

Author Contributions

Concept/idea/research design: E.L. Voorn, F.S. Koopman, F. Nollet, M.-A. Brehm
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Ethics Approval

The exercise program and measurements were performed as part of the regular physical therapist treatment, and the Medical Ethics Review Committee gave a waiver for official approval of this study.

Disclosures

The authors completed the ICMJE Form for Disclosures of Potential Conflicts of Interest and reported no conflicts of interest.

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