Title: Differences in Long-Term Physical Activity Trajectories among Individuals with Chronic Widespread Pain: A Secondary Analysis of a Randomized Controlled Trial

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Manuscript Category: Original Review

Funding Sources: The MUSICIAN trial was funded by Arthritis Research UK, Chesterfield, UK (Grant award number 17292) and the MELODIC study was funded by NHS Grampian Endowment Grant, Project No: 14/40.

Conflicts of Interest: *None declared.*

Significance: Chronic pain can be a major barrier to engaging in exercise, a popular self-management strategy. Our findings identify three distinct long-term physical activity trajectories for individuals receiving the same exercise intervention. This suggests an approach by health care providers which identifies individuals who would benefit from additional support to enhance initiation and long-term physical activity maintenance could deliver better outcomes for such patients.

Abstract

Background: Little is known about long-term physical activity (PA) maintenance in those with chronic widespread pain (CWP) following an exercise intervention. This study examined PA over time to identify the existence and characteristics of subgroups following distinct PA trajectories.

Methods: Data come from individuals with CWP who took part in a 2x2 factorial randomized controlled trial, receiving either exercise or both exercise and cognitive behavioural therapy treatment. Information, including self-report PA, was collected at baseline recruitment, immediately post-intervention, 3, 24 and 60+ month post-treatment. Analyses were conducted on 196 men and women with ≥3 PA data-points. Group-based trajectory modelling was used to identify latent PA trajectory groups and baseline characteristics (e.g., demographics, pain, self-rated health, fatigue, coping-strategy use, kinesiophobia) of these groups.

Results: The best fitting model identified was one with three trajectories: “non-engagers” (n=32), “maintainers” (n=144) and “super-maintainers” (n=20). Overall, mean baseline PA levels were significantly different between groups (non-engagers: 1.1; maintainers: 4.6; super-maintainers: 8.6, $p<0.001$) and all other follow-up points. Non-engagers reported, on average, greater BMI, higher disabling chronic pain, poorer self-rated health, physical functioning, as well as greater use of passive coping strategies and lower use of active coping strategies.

Conclusions: The majority of individuals with CWP receiving exercise as part of a trial were identified as long-term PA maintainers. Participants with poorer physical health and coping response to symptoms were identified as non-engagers. For optimal symptom management, a stratified approach may enhance initiation and long-term PA maintenance in individuals with CWP.

What’s already known about this topic?

People with CWP often stop being active and struggle with PA adherence after an exercise intervention has ended.

What does this study add?

This study illustrates important differences in long-term PA levels by identifying three distinct trajectories post-exercise intervention among individuals with CWP. Clinical promotion of standard exercise in a CWP population should be encouraged to improve pain symptoms, overall health and well-being, yet some individuals with CWP may require additional support and clinical management.

Background

Prevalence of chronic widespread pain (CWP), i.e., pain lasting at least 3 months which is contralateral, above and below the waist, and includes spinal involvement (Wolfe et al., 1990), is estimated to be around 10% in the general population (Andrews et al., 2018; Mansfield et al., 2016). Although CWP characterizes fibromyalgia, many researchers now consider chronic pain to be a condition in its own right (Siddall and Cousins 2004). CWP is more common in women, peaks around age 60 and is associated with poor psychosocial health (e.g., depression, anxiety), functional limitations, poor sleep quality, and health-related quality of life (Walitt et al., 2011). With CWP, the likelihood of symptom improvement is low and symptoms typically worsen over time (Hagen et al., 2000).

Individuals with CWP frequently seek medical care from specialist providers or primary care providers/GPs for their musculoskeletal pain (Lee et al., 2014). Fibromyalgia patients use more healthcare resources, and have higher direct and indirect costs (e.g., prescriptions, medical visits, hospitalizations) than individuals without fibromyalgia (Ghavidel-Parsa et al., 2015; Lachaine et al., 2010; Sicras-Mainar et al., 2009). Estimates suggest chronic pain costs the UK tens of billions of pounds, largely due to work absenteeism and benefits claims (Lee et al., 2014). Treatment is challenging and recent recommendations focus on non-pharmacological therapy as the first line approach to management (Arnold et al., 2012). This includes physical activity (PA), e.g., aerobic exercise and resistance-exercise training, which has been shown to improve pain, physical function, and fatigue (Busch et al., 2007; Busch et al., 2013; Hauser et al., 2010a).

Despite PA being beneficial for CWP, low PA is both associated with (Dansie et al., 2014), and a consequence of the condition (McBeth et al., 2010). Among these individuals, behavioural interventions have been shown to successfully increase PA levels (Cunningham and Kashikar-Zuck 2013; McBeth et al., 2012), and that regular PA is needed for sustained, long-term symptom relief (Gowans and deHueck 2004; Wigers et al., 1996). Yet, people with CWP often stop being active and struggle with PA adherence after the intervention has ended (Cunningham and Kashikar-Zuck 2013;

Hauser et al., 2010b). Little is known about long-term PA maintenance and the characteristics of individuals who do, or do not, successfully maintain increased PA following short term intervention trial with an exercise component. This could guide practice decisions related to who could potentially benefit most from such approaches to management.

The aim of the current study was two-fold: 1) to determine whether subgroups of individuals with CWP who received an exercise intervention follow distinct post-exercise intervention long-term activity trajectories, and 2) to examine the characteristics of these subgroups which may be potentially useful in developing future stratified interventions for individuals with CWP.

Methods

This study, Maintaining Exercise Long-term: On Determining Influences on Chronic-Widespread Pain (MELODIC), involved persons who took part in the Managing Unexplained Symptoms (CWP) In Primary Care: Involving Traditional and Accessible New Approaches (MUSICIAN) Trial.

MUSICIAN was a 2x2 randomized control trial (RCT) that estimated the clinical and cost-effectiveness of a telephone-delivered cognitive behaviour therapy (tCBT), exercise programme, and combined (tCBT and exercise) intervention compared with treatment as usual (McBeth et al., 2012). Briefly, the goal of tCBT was to guide participants to identify and understand their current issues and define specific goals to work towards. Therapists accredited by the British Association for Behaviour and Cognitive Psychotherapies delivered the intervention which used a self-management CBT manual developed specifically for the study. Following a 45-60 minute initial assessment, participants received seven weekly sessions (each 30-45 minutes), and an additional session at 3 and 6 months after randomisation.

The goal of the exercise programme was to increase exercise as appropriate and to improve cardiorespiratory fitness according to the American College of Sports Medicine guidelines (i.e. to achieve 40% to 85% of heart rate reserve) (Whaley et al., 2006). Participants were given a leisure-facility/gym pass and worked with an experienced fitness instructor to devise an individualized exercise programme. Six further fitness instructor-led monthly appointments were available and participants were advised to use the provided facilities to undertake their exercise regimen at least twice weekly for 20 to 60 minutes per session. Participants were also encouraged to engage in everyday activities such as brisk walking on non-gym days (McBeth et al., 2012).

In 2007, a mailed questionnaire identified eligible participants with CWP, defined using the American College of Rheumatology criteria for fibromyalgia (Wolfe et al., 1990), who had consulted a physician about their CWP in the past year. In total, 442 people were randomised into one of the four treatment arms (described above). As part of the MUSICIAN trial, all participants had completed a baseline questionnaire at recruitment, were followed-up immediately post-intervention, 3 months (3) and 24 months (24) post-treatment, and both short- and long-term trial results have been reported previously (Beasley et al., 2015; McBeth et al., 2012).

In 2015, MUSICIAN trial participants who had given consent for future contact (n=374) were mailed a pre-notification letter indicating they would be invited to participate in the MELODIC study, as a follow-up study to the original trial. A questionnaire was posted one week later to all eligible participants, which comprised validated instruments, including physical activity, and socio-demographics previously used in the MUSICIAN trial follow-ups.

Physical Activity (PA)

Physical activity was assessed at baseline, immediately post-intervention, 3, 24, and 60+ months. A validated, 2-item assessment tool (2Q-PA) asked about the number of weekly sessions spent doing moderate-intensity PA for walking for ≥30 minutes (i.e. increases heart rate or requires breathing harder than normal); and doing vigorous-intensity PA for ≥20 minutes (i.e. results in sweating, puffing or panting) (Smith et al., 2005). A total number of PA sessions per week can be calculated from the midpoint in each ordinal response category, using the number of moderate intensity sessions per week plus 2 times the number of vigorous intensity sessions per week. The total number of PA sessions per week can be classified as either minimal (0 to 2 sessions per week), low (3 to 4 sessions per week), adequate (5 to 7 sessions per week), or high (≥8 sessions per week) for ease of interpretation of total weekly activity (Smith et al., 2005).

Participant characteristics

Age, employment status, body mass index (BMI, (kg/m^2)), total activity, condition severity and health-status were assessed at baseline. Global pain severity was assessed with the Chronic Pain Grade questionnaire, with four categories from, I [low disability, low intensity] to IV [high disability, severely limiting] (Smith et al., 1997; Von Korff et al., 1992). Physical and mental health were measured using the 36-Item Short Form Health Questionnaire (SF-36) (Ware and Sherbourne 1992).

The physical component summary (SF-36 PCS) and the mental health component summary (SF-36 MCS) scores range from 0-100; higher scores indicate better functioning. A single question assessed general health, with participants self-rating from 'excellent' to 'poor'. Fatigue was assessed with the 14-item Chalder Fatigue scale (Chalder et al., 1993), where scores range from 0-42; higher scores indicates worse state. Psychological distress was determined with the General Health Questionnaire (GHQ-12), which has 12-items. The total score ranges from 0 to 12; higher scores indicate greater distress (Goldberg et al., 1988). Active and passive coping strategy use was captured with the Vanderbilt Pain Management Inventory Pain. Active (7-items) scores range from 7 to 35 and passive (11-items) scores range from 11-55; higher scores indicate greater use of each strategy (Brown and Nicassio 1987). The 17-item Tampa Scale for Kinesiophobia measured fear of movement (range 17-68, higher scores indicate greater fear) (Roelofs et al., 2004). Sleep was assessed with a four-item scale (sleep onset, maintenance, early wakening, and nonrestorative sleep); scores range from 0-20; higher scores indicate greater sleep disturbance (Jenkins et al., 1988).

In addition, social desirability was assessed at 60+ months with the Marlowe-Crowne Social Desirability Scale (Strahan and Gerbasi 1972), as reporting of PA is often subject to such bias. Scores on this scale range from 0-10, with higher scores indicating a greater tendency to provide perceived socially desirable answers.

Analysis

To determine whether differences existed by treatment condition, a comparison of the total number of PA sessions/week was initially undertaken for each time-point by comparing the means and standard deviations of total PA sessions/week for those in either exercise only or combined condition, using the usual care group as a benchmark. Latent PA trajectories were then identified using group-based trajectory modelling (GBTM). GBTM clusters individuals with similar progressions of scores over time and can inform between-group comparisons of participant profiles, or differences in outcome such as physical activity (Nagin 2014).

Specifically, GBTM for censored normal data was used, as PA was captured on a continuous scale, with a minimum value of 0 and a maximum value of 11 following Smith et al., 2005. Initially, the existence of four plausible cubic trajectories was proposed – improved PA, worsened PA, constant low PA and constant high PA. Trajectories were then added or removed in consultation with model-fit statistics until the best-fitting model was identified. In GBTM, the best-fitting number of trajectories is determined as the model with the lowest Bayesian Information Criterion (BIC), provided there is sufficient support for the complexity of a model. Models with additional trajectories should only be accepted if the log Bayes factor is greater than six ($2\log_e(B_{10} \geq 6)$). Model fit was then further improved by specification of the correct order polynomial (e.g. liner, cubic, quadratic) for each trajectory.

Mean PA levels at all follow-ups were examined in each trajectory group, and chi-squared, Fisher's exact tests and ANOVAs were used to examine for the presence of between-group differences by trajectories in domains reported at baseline. Statistical analysis was conducted using Stata 13 (College Station, TX) using an available-case approach to missing data, with additional analyses exploring missing data and non-response. Ethical approval was from NRES Committee Yorkshire & The Humber–Leeds West (Reference Number: 15/YH/0026); http://www.controlled-trials.co: ISRCTN67013851.

Results

Of 374 questionnaires posted, 66 (17.6%) were refusals, 58 (15.5%) questionnaires were not returned and 26 (7%) were undeliverable to last known address. Two participants reported cognitive issues and one was reported deceased. A total of 221 questionnaires were completed (6 of which were a short survey via telephone) by those who took part in the MUSICIAN trial for a final response rate of 64.0% of those eligible to take part (221/345). Time elapsed from the MUSICIAN trial to the MELODIC study follow-up was on average 72 months post-treatment, with a range of 60-82 months (i.e. 60+ months). Of the original 221 participants who received the exercise therapy and/or combined exercise tCBT therapy, 113 completed the MELODIC questionnaire and 112 contributed physical activity data (Figure 1).

At baseline, most participants taking part in either the exercise or combined therapy were female (68%), with an average age of 56 years and most commonly working full or part time (47.5%). At baseline participants were, on average, overweight (BMI: 28.0) with low activity (4.3). Men were more likely than women to have low disability, i.e. CPG-I or CPG-II (70.0% v 54.3%), lower average passive coping scores (27.9 v 30.0), lower fatigue scores (18.3 v 20.3) lower average psychological distress (2.1 v 3.6), and a higher average SF-36 mental component score (49.0 v 43.9) (Table 1).

Total baseline PA data are presented in Figure 2 by treatment group (exercise only, combined), with usual care presented as a reference group. Baseline means of total PA did not differ among exercise only (n=109) and combined groups (n=109). An increase in mean PA was observed immediately post-intervention for both treatment groups with similar patterns observed at 3, 24, and 60+ months (Figure 2). Considerable variation was observed in total PA within both treatment groups, i.e. scores ranged from 0-11 at all time-points, warranting further investigation to better understand total PA trajectories among those who received the exercise intervention.

We then ran a group based trajectory model (GBTM), unadjusted for treatment condition, on a subsample of 196 men and women who provided total PA data at least 3 time-points. The majority, 98% (n=193) contributed data at baseline and at least two other time points. (Figure 1).

The GBTM identified three trajectories as best-fitting the progression of total PA data over time according to BIC statistic, with model fit improving with further specification of the order polynomial for each trajectory (original model - BIC all data points: -2004.5, BIC per participant: -1993.6; final model - BIC all data points: -1995.6, BIC per participant: -1986.94). The trajectories informed by BIC statistics were supported by clinical interpretation and then characterised as “non-engagers” (Group 1), “maintainers” (Group 2) and “super-maintainers” (Group 3; Figure 3). A similar number of participants were found to be in each trajectory group across both treatment groups, non-engagers: 16 exercise; 16 combined; maintainers: 70 exercise; 74 combined; super-maintainers: 10 exercise, 10 combined.

PA levels over follow up

Baseline total PA differed significantly between groups, with non-engagers and maintainers reporting below adequate levels of PA and super-maintainers reporting high PA (non-engagers; mean): 1.1, maintainers: 4.6 and super-maintainers: 8.6, $p<0.001$). By treatment end, total PA scores were higher in all groups (non-engagers: 2.2, maintainers: 6.2, super-maintainers: 9.9), but only those in the maintainer and super-maintainer groups ever reported ‘adequate’ or ‘high’ PA.

Trajectory group characteristics

No significant differences existed between groups’ baseline demographic variables (Table 2), with the exception of BMI (non-engagers: 30.5, maintainers: 27.6, super-maintainers: 25.0, $p<0.01$). In general, members of the non-engager group reported the poorest health state at baseline. Specifically, they reported the greatest prevalence of fair or poor health status (non-engagers:

46.9%, maintainers: 33.6%, super-maintainers: 10%, p<0.05), the highest mean scores for passive coping (non-engagers: 30.9, maintainers: 29.6, super-maintainers: 24.9, p<0.05) and the lowest mean scores of active coping (non-engagers: 23.7, maintainers 25.0, super-maintainers: 26.4, p<0.05). Finally, though they reported the lowest mean SF-36 physical component score (non-engagers: 36.2, maintainers: 41.0, super-maintainers: 44.3, p<0.001), the proportions of participants reporting moderate-severely disabling chronic pain (CPG-III or CPG-IV) were comparable between non-engagers and maintainers (41.4% vs 42.9%). Nevertheless, significant between-group differences were observed in comparison with the super-maintainers (CPG-III or IV: 15%, p<0.05). Also, no difference was observed by trajectory group with regard to mean social desirability bias scores which were measured at 60+ months (non-engagers: 6.8, maintainers: 6.8, super-maintainers: 5.8, p=0.298).

Discussion

In general, individuals who took part in an exercise intervention, either alone or combined with tCBT as part of the prior MUSICIAN trial, reported increased physical activity levels post-intervention. Within this population, we identified three distinct long-term physical activity trajectories of individuals with CWP using GBTM. The majority of individuals (n=164, 83.7%) were either (1) activity maintainers or (2) super-maintainers. These individuals had increased PA levels from baseline and maintained these gains over time, i.e. they remained higher than pre-intervention levels. A further subgroup of participants classified as (3) non-engagers (n=32, 16.3%) did not substantially increase or maintain activity levels post-exercise intervention.

Non-engagers' total activity was lowest at baseline and these individuals did not achieve or maintain adequate levels of activity. This was despite receiving an exercise programme designed and tailored to their specific abilities and needs by an experienced fitness instructor trained in exercise prescription for CWP patients. Several key differences were observed between non-engagers and maintainers. At baseline, non-engagers were statistically significantly more likely have higher BMI (i.e. overweight/obese), have higher pain intensity, lower physical functioning, and engage poorer coping strategies. They tended to also have greater psychological distress, yet there were no differences observed by fatigue, mental functioning, kinesophobia or sleep.

Data from a population study shows that individuals with CWP spend less time in beneficial moderate-to-vigorous intensity activity than those without (Dansie et al., 2014). It appears our study is the first use a novel approach, GBTM, to highlight the variation in moderate-vigorous activity among individuals with CWP before and after an exercise intervention, with subsets reporting both very high and minimal/low levels of total activity. Previous observational research examining PA trajectories in general and older populations have identified four (e.g., consistent high, consistent low, increasing and decreasing; inactive, increasers, active and decreasers) trajectories (Barnett et al., 2008; Xue et al., 2012), while another conducted in a rheumatoid arthritis population identified three (e.g., stable high, decreasing, stable low) (Demmelmaier et al., 2016).

Participants' baseline PA levels appeared to foretell of activity levels over time, which has been previously observed in the literature (Borodulin et al., 2012). In particular, individuals with minimal/low levels or high levels of activity at baseline tended to continue on that same long-term activity trajectory. The noted differences in baseline characteristics may indicate additional barriers to engaging with and thriving in the provided exercise intervention, and that additional support may be needed for suspected non-engagers to initiate and maintain an exercise programme. Maintainers, i.e. the majority of individuals with CWP who were not quite achieving an adequate level of activity at baseline, increased their activity levels up to an adequate level by working with an experienced fitness instructor to devise an individualized 6-month exercise programme. While this activity was maintained post-intervention, but slightly diminished over time, it reflects that exercise as a non-pharmacological treatment may be generally acceptable among those with CWP. This is particularly important as many GPs and health care practitioners may find it difficult to prescribe exercise (Hebert et al., 2012) despite good evidence that it should be incorporated into health management strategies (Macfarlane et al., 2017) as exercise confers multiple health benefits for those with CWP (i.e., improves pain, depression, fatigue and quality of life) (Ambrose and Golightly 2015) and is unlikely to cause harm (Geneen et al., 2017).

Strengths of the study are that data come from a well-designed randomised controlled trial in an exclusively CWP population. In addition the use of a methodology, GBTM, facilitated an enhanced understanding of the granularity of the data that extended beyond a simple comparison of means. This enabled the categorisation of change in activity trajectories over time, as well as, the characteristics of participants in each trajectory group. The trial had a very high follow-up rate (McBeth et al., 2012) and response rates (50% overall; 56% among exercise and combined treatment groups) were respectable at 60+ months considering nearly three years had passed since the last study team contact. Yet findings should be understood within the context of study limitations. The main study was not specifically designed or powered to examine PA as an outcome. Physical activity was self-report rather than objectively measured with an activity monitor, and was captured with a brief 2-item scale. This may have resulted in misclassification, as adults with CWP may inaccurately perceive intensity of PA (Patel et al., 2016). However, the current study is unique in that activity data was captured at numerous time-points, including post-intervention time-points at 24 and 60+ months. This can be considered well beyond the norm for studies examining post-intervention activity (i.e. 12 months). In addition, no differences were observed by key participant characteristics (i.e., demographics, condition severity, pain, self-rated health, fatigue, coping strategies, kinesophobia) among those contributing fewer than three (<3) or three or more (≥3) total PA data points (Supplementary Table A).

Information about attitudes and beliefs about exercise was not collected at baseline or at follow-up in this study. This includes exercise self-efficacy, which has previously been shown to be associated with future activity behaviours among individuals with pain (Quicke et al., 2017), therefore we cannot know whether PA maintenance was influenced by self-efficacy in this study. Despite this, participants were asked at baseline about their previous experience of exercise as treatment for chronic pain or other conditions, level of positivity to receiving exercise therapy, exercise treatment preference, as well as exercise treatment expectations. There were no statistically significant response differences to these questions by non-engagers, maintainers and super-maintainers (data not shown), indicating that these may not have been contributing factors for trajectory membership.

Finally, social desirability associated with self-report data, particularly self-reported PA levels may have influenced study results. Social desirability levels were not explored at baseline or throughout the trial, however it was quantified at 60+ months. Findings indicated those responding had only a moderate level of social desirability and that this did not differ significantly between trajectory groups. Social desirability remains unknown for those not consenting for future follow-up or not taking part in the 60+month follow-up, however the likelihood that social desirability influenced PA reporting and biased study results is considered to be relatively modest, despite previously expressed concern that social desirability may be higher in an exercise/physical activity intervention study (Crutzen and Goritz 2010). In addition, additional analyses explored loss-to-follow up by comparing baseline characteristics of those who did or did not take part in the 60+ month follow-up study. Supplementary Table B illustrates that no differences were observed by key participant characteristics (i.e., demographics, condition severity, pain, self-rated health, coping strategies, kinesophobia), save for fatigue which was higher among those taking part in the 60+ month follow-up.

Overall, this work suggests that sub-groups of individuals with CWP may require different strategies to increase activity levels. It follows that stratification may enable a more focused effort to identify early those with the greatest need and the greatest potential for improvement to ensure appropriate intervention. This is of particular importance for those individuals at risk of non-engagement with an exercise programme such as the one undertaken in this study. Research is needed to explore whether chronically inactive individuals with CWP find beginning with lower intensity exercise (Jones et al., 2006) or reduced activity duration goals (Dunlop et al., 2017) a more acceptable way to reengage with exercise rather than programmes designed to meet ACSM or population-level guidelines. Indeed, a stratified approach may allow for more directly attending to beliefs and behaviours (e.g., fear-avoidance and/or misdirected problem solving) commonly held by chronic pain patients and potentially held by potential non-engagers that may as barriers to undertaking activity or a structured exercise programme. Previous research has profiled the approach individuals with chronic MSK pain take when engaging in general life activities, finding variations suggesting adaptive individuals are characterised by high persistence, low avoidance and higher optimism (Esteve et al., 2017). Understanding the relationship between these profiles and activity levels may enable future research to devise individualised exercise programmes that moves individuals with CWP to the highest possible levels of sustainable activity. And while not explored in this study, it should be noted that external barriers, such lack of social and/or medical support, limited resources (e.g., financial, transportation), time constraints, or availability of community resources for physical activity can influence uptake and maintenance of physical activity levels among a chronic pain population (Blair et al., 2009; Stone and Baker, 2015). Future programmes should consider the wider context when supporting individuals with chronic pain to be active. Finally, little is known about the role of boosters following a RCT intervention in supporting long-term activity maintenance (Müller-Riemenschneider et al., 2008), particularly for those living with rheumatic and musculoskeletal diseases (Martin 2015). Future research might also examine ways to prevent inactivity or activity decline among individuals with CWP in the first instance.

In conclusion, this study examined long-term activity levels among individuals with CWP following secondary analysis of a RCT with an exercise intervention. This study uncovered important differences in long-term PA levels among individuals with CWP by identifying subgroups who followed different post-exercise intervention long-term activity trajectories. Distinct characteristics differentiated the subgroups with clear implications for future research and clinical management of non-engagers, i.e. those with greater BMI, higher disabling chronic pain, poorer self-rated health, and physical functioning, or use passive coping strategies rather than active coping strategies. These individuals with the greatest need require additional clinical support to overcome physical and psychosocial barriers to ultimately increase their PA levels, and as such resources should be particularly focused on this group. Overall, the majority of individuals with CWP will respond well to a standard exercise intervention, and therefore clinical promotion of exercise in this population should be encouraged to improve pain symptoms, overall health and mental well-being.

Acknowledgements

The MUSICIAN study team is Professor G. J. Macfarlane (chief investigator), Professor Phil Hannaford, Dr Philip Keeley, Professor Karina Lovell, Dr John McBeth, Professor Paul McNamee, Professor Deborah Symmons and Dr Steve Woby (investigators), M. J. Beasley (research assistant), Chrysa Gkazinou (trial manager), Dr E. A. Jones (PhD students), Dr Gordon Prescott (statistician) and Dr Graham Scotland (health economist). We are grateful to the following GP practices and their patients for participating in the study in Aberdeen: Carden Medical Centre, Elmbank Medical Practice, Great Western Medical Practice, Garthdee Medical Group; and in Macclesfield: Readsmoor Medical Group Practice, Lawton House Surgery, Bollington Medical Centre and Park Lane Surgery.

Author contributions:

All authors meet the ICMJE authorship criteria. All were involved and made 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approvial of the version to be publsihed.

Table 1. Baseline Participant Characteristics of Exercise and Combined Treatment groups, by gender (n=221). Values are mean (SD) or % unless otherwise specified.

	Total	n	Men	n	Women	n
Treatment Group						
Exercise	49.3	109	52.9	37	47.8	72
Combined	50.7	112	47.1	33	52.3	79
Age in years	56.0 (12.9)	221	60.1 (13.1)	70	54.2 (12.5)	151
Body Mass Index, kg/m^2	28.0 (5.9)	213	28.1 (5.8)	68	27.9 (6.0)	145
Total Activity Sessions/week , range 0-11	4.3 (3.3)	218	4.7 (3.4)	70	4.2 (3.2)	148
Employment Status						
Working full time	33.5	74	40.0	28	30.5	46
Working part time	14.0	31	10.0	7	15.8	24
Retired	37.1	82	41.4	29	35.1	53
Unable to work due to ill health or disability	5.4	12	4.3	3	6.0	9
Student	2.3	5	0	0	3.3	5
Unemployed	3.2	7	2.9	2	3.3	5
At home, not looking for employment	4.5	10	1.4	1	6.0	9
Self-rated Health						

Fair or poor (vs Excellent, Very Good, Good)	24.9	55	24.3	17	25.2	38
Chronic Pain Grade						
I, Low disability, low intensity	23.9	53	34.3	24	19.2	29
II, Low disability, high intensity	35.3	78	35.7	25	35.1	53
III, High disability, moderately limiting	22.2	49	12.9	9	26.5	40
IV, High disability, severely limiting	18.6	41	17.1	23	19.2	29
Psychological distress, range 0-12	3.1 (3.5)	221	2.1 (3.0)	70	3.6 (3.7)	151
SF-36						
Physical component summary, range 0-100	40.6 (7.5)	218	41.3 (8.1)	67	40.3 (7.3)	151
Mental component summary, range 0-100	45.4 (10.2)	218	49.0 (9.9)	67	43.9 (9.9)	151
Fatigue, range 0-42	19.6 (5.6)	214	18.3 (5.2)	67	20.3 (5.7)	147
Coping strategy						
Passive, range 13-52	29.4 (7.2)	218	27.9 (7.0)	68	30.0 (7.2)	150
Active, range 10-34	24.9 (4.1)	221	24.6 (3.7)	70	25.0 (4.2)	151
Kinesophopia, range 17-68	35.6 (5.2)	213	37.3 (5.6)	67	34.8 (4.9)	146
Sleep, range 0-20	8.9 (5.7)	221	7.5 (5.6)	70	9.5 (5.7)	151

Table 2. Baseline Participant Characteristics by Groups identified by Group-Based Trajectory Model (n=196). Values are mean (SD) or % unless otherwise specified.

	Group 1 Non-engagers N=32	n	Group 2 Maintainers N=144	n	Group 3 Super-maintainers N=20	n	*p*-value
Treatment Group							
Exercise	50.0	16	48.6	70	50.0	10	0.985
Combined	50.0	16	51.4	74	50.0	10	
Age in years	59.6 (13.1)	32	55.4 (13.2)	144	52.3 (12.1)	20	0.124
Sex							
Female	78.1	25	68.8	88	50.0	10	**0.103**
Body Mass Index, kg/m^2	30.5 (5.2)	32	27.6 (5.5)	140	25.0 (3.6)	18	**0.002**
Employment Status							
Working full time	28.1	9	31.3	45	65.0	13	**0.039**
Working part time	25.0	8	13.2	19	10.0	2	
Retired	37.5	12	6.9	57	15.0	3	
Unable to work due to ill health or disability	0	0	6.9	10	0	0	
Student	6.5	2	1.4	2	0	0	
Unemployed	0	0	4.2	6	0	0	
At home	3.1	1	3.5	5	10	2	

Chronic Pain Grade							
I, Low disability, low intensity	3.4	1	18.0	26	40.0	8	**0.032**
II, Low disability, high intensity	55.2	18	39.1	56	45.0	9	
III, High disability, moderately limiting	20.7	6	24.1	35	10.0	2	
IV, High disability, severely limiting	20.7	6	18.8	26	5.0	1	
Self-rated Health							
Fair or poor (vs Excellent, Very Good, Good)	46.9	32	33.6	143	10.0	20	**0.019**
Psychological distress, range 0-12	3.9 (3.7)	32	3.2 (3.6)	144	1.7 (2.0)	20	0.072
SF-36							
Physical component score, range 0-100	36.2 (8.8)	30	41.0 (6.9)	143	44.3 (5.7)	20	**<0.001**
Mental component score, range 0-100	44.2 (10.4)	30	45.5 (10.3)	143	47.4 (9.7)	20	0.570
Fatigue, range 0-42	19.2 (5.7)	31	19.9 (5.6)	140	18.4 (4.9)	19	0.442
Coping strategy							
Passive, range 13-52	30.9 (6.2)	31	29.6 (7.3)	143	24.9 (5.2)	19	**0.010**
Active, range 10-34	23.7 (3.9)	32	25.0 (4.0)	144	26.4 (3.5)	20	**0.049**
Kinesiophobia, range 17-68	36.5 (5.3)	30	35.5 (5.0)	139	34.4 (4.6)	19	0.337
Sleep, range 0-20	10.1 (5.7)	32	8.8 (5.9)	144	7.6 (4.8)	20	0.296
Social Desirability (at 60+ m), range 0-10	6.8 (1.7)	13	6.8 (2.0)	81	5.9 (2.1)	14	0.298

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Figure Legends

Figure 1: Participant Recruitment / Data Contribution Flow Diagram

Figure 2: Total Activity by treatment group (exercise, combined) and usual care at baseline, post-intervention, 3, 24, and 60+ months

Figure 3: Long-term Physical Activity Trajectories in 196 participants, with 95% confidence intervals.

Figure 1: Participant Recruitment / Data Contribution Flow Diagram

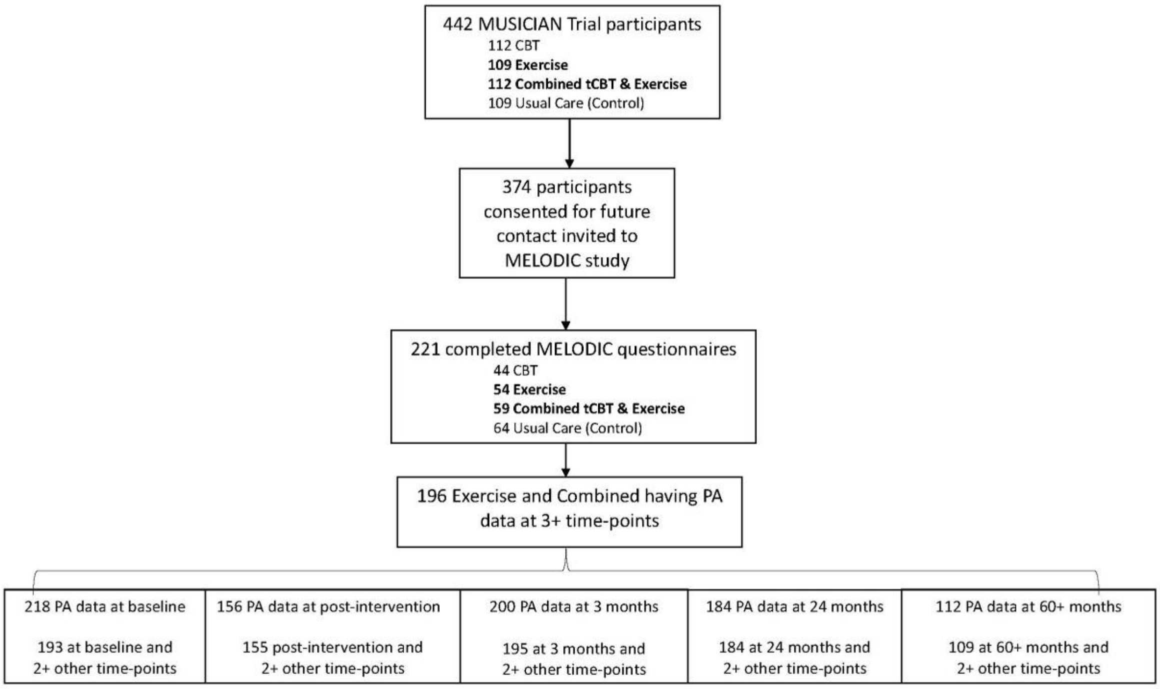
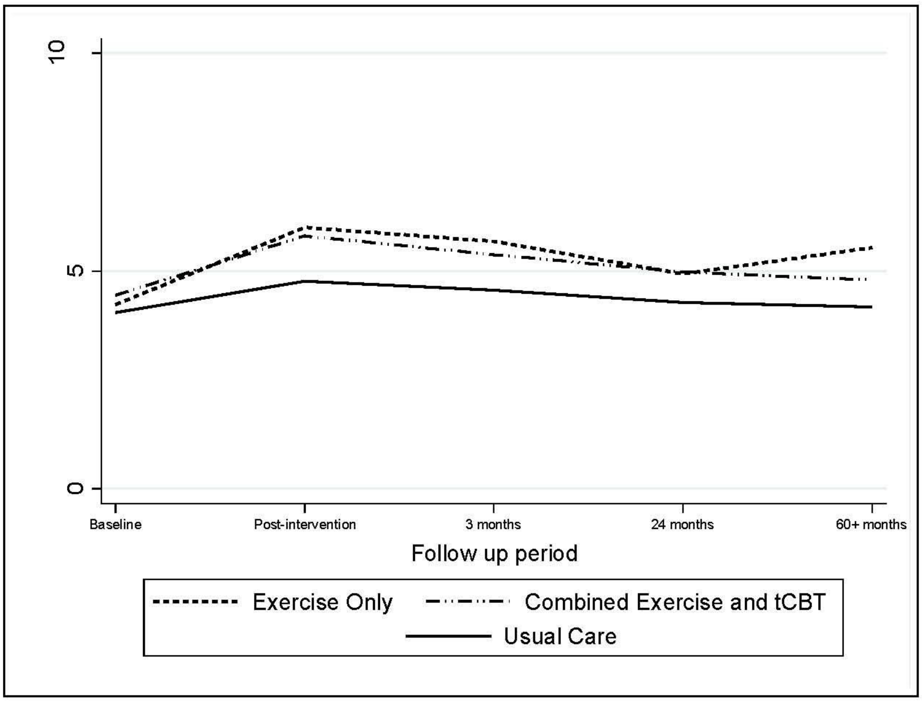


Figure 2: Total Activity by treatment group (exercise, combined) and usual care at baseline, post-intervention, 3, 24, and 60+ months



Follow up period	Baseline recruitment	Post-intervention	3 months	24 months	60+ months
Exercise Only Mean (SD) N	 4.23 (3.22) 109	 6.00 (3.03)[¥] 79	 5.68 (3.12)[¥] 99	 4.93 (3.52) 92	 5.54 (3.62) 54
Combined Exercise tCBT Mean (SD) N	 4.44 (3.29) 109	 5.81 (3.18) 77	 5.38 (3.28) 101	 4.98 (3.37) 92	 4.79 (3.53) 58
Usual Care Mean (SD) N	 4.04 (3.32) 108	 4.76 (3.46) 73	 4.56 (3.51) 97	 4.27 (3.52) 93	 4.18 (3.57) 64
ANOVA Model statistics	*F*=0.41, p=0.663	*F*=3.20, p=0.043	*F*=3.03 p=0.049	*F*=1.20, p=0.304	*F*=2.11, p=0.124

*Note all range from 0-11 Total Activity Sessions/Week; [¥]p<0.05 comparison of mean Exercise Only and Usual Care group

Figure 3: Long-term Physical Activity Trajectories in 196 participants, with 95% confidence intervals.