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Exercise and motivational text messaging to support physical activity behaviour change in a population with obstructive sleep apnoea: a feasibility study

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ABSTRACT

Introduction. Patients with obstructive sleep apnoea (OSA) commonly present in primary care. Increasing physical activity reduces symptoms and severity of OSA. Low motivation is a barrier to physical activity in adults with OSA. **Aim.** To investigate the feasibility and acceptability of an exercise and personalised text messaging programme to enhance motivation and support physical activity behaviour change in adults with OSA. **Methods.** Participants were recruited from the local Sleep Clinic. Exclusion criteria were unstable angina, and/or poorly controlled hypertension. The intervention comprised three groups, who received either individual exercise prescription, personalised text messages or both over a 24-week period. Participants were allocated to one of the three groups. The primary outcome was feasibility of study design including participant recruitment and retention. Secondary outcomes were a change in 6-min walk distance and exercise self-efficacy over time. **Results.** Thirty participants were recruited, 17 male and 13 female, with a mean age of 54.6 years. The study design appears feasible and the outcome measures used were acceptable to participants. Recruitment and retention rates were lower than anticipated. A trend towards increased functional exercise capacity was identified in all three groups, along with a corresponding increase in exercise self-efficacy over time. **Discussion.** Exercise and personalised text messaging both appear to offer an acceptable and feasible means to increase physical activity in adults with OSA. A larger scale trial may provide justification for physiotherapist input to support patients with OSA to address physical inactivity.

Keywords: behaviour change, health promotion, motivation, obstructive sleep apnoea, physical activity, physiotherapy, sleep health, telehealth.

Introduction

In New Zealand, obstructive sleep apnoea (OSA) affects 4% of males and 2% of females with higher rates in Māori and Pasifika.[1] Symptomatic patients commonly present initially to their general practitioner (GP), who may refer them to a sleep clinic for further investigation. Although a large number of sleep disorders go undiagnosed,[2] better recognition of OSA is increasing the demands on New Zealand sleep services, which highlights the need for simple cost-effective interventions.[2] OSA is associated with increased cardiovascular disease, morbidity and mortality.[3] There are often contributing lifestyle factors such as low physical activity, which remain unaddressed. Physical activity confers protection against the development of OSA[4] and is a known moderator for cardiometabolic risk.[2,5] Low motivation is a key barrier to being physically active in this population.[6] It is necessary to develop effective strategies to support regular physical activity that take into account factors that influence uptake such as self-efficacy, and beliefs regarding perceived benefits.[2,7] The primary aim of this study was to establish the feasibility of an exercise and motivational text messaging intervention to increase physical activity behaviour and enhance

WHAT GAP THIS FILLS

What is already known: Physical activity is beneficial in the management of obstructive sleep apnoea. It has been shown to improve both the severity of the condition and the quality of life of those living with the condition.

What this study adds: Text messaging offers a feasible means of supporting physical activity in adults with OSA. Results show a trend towards increased cardio-respiratory fitness and exercise self-efficacy. This has potential as a low-cost option in primary care to support adults with OSA to engage in physical activity behaviour change.

self-efficacy in an adult population with OSA. The secondary outcomes were a change in 6-min walk distance and exercise self-efficacy.

Methods

The study was a three-arm feasibility study developed in accordance with the Consolidating Standards of Reporting Trials (CONSORT) 2010 statement: extension to randomised pilot and feasibility trials (Supplementary File S1)].[8]

The protocol was approved by the NZ Health and Disability Ethics Committee (reference: 17/STH/105) and the trial was registered with the Australia–New Zealand Trials Registry (ACTRN12617000961347). All participants provided written informed consent.

Recruitment

Participants were recruited from among adults referred to the Sleep Clinic at Dunedin Public Hospital by either their GP or specialist, via letters sent to eligible participants on the waiting list. Eligibility criteria were: (1) an Epworth Sleepiness Scale[9] score of ≥11 and other symptoms of obstructive sleep apnoea syndrome,[10] and diagnosis of OSA or awaiting prioritisation for an overnight sleep study to confirm a diagnosis; (2) the ability to be physically active; and (3) the ability to complete a consent form in English. Exclusion criteria were: (1) poorly controlled hypertension (systolic blood pressure of ≥180 mm Hg, or diastolic blood pressure of ≥110 mm Hg, at rest); and (2) unstable angina (chest pain at rest or with minimal physical exertion).

Randomisation

Participants were randomised to one of three groups using a computer-generated random numbers system. The allocation ratio was 1:1:1. Due to practical considerations, four participants from rural Otago, defined as those people who lived ≥50 km from Dunedin, were excluded from the randomisation process and allocated to the text messaging-only group.

Intervention

All individuals received a personalised physical activity prescription (Supplementary File S2). This was devised in conjunction with each participant and took into account of beliefs, preferences, health concerns, barriers and goals (Supplementary File S2). In addition, group one received exercise supervision and no motivational text messaging (group EXE), group two received exercise supervision plus motivational text messaging (group EXE + TXT), group three received motivational text messaging and no exercise supervision (group TXT). The supervised exercise was provided via a weekly hour-long community exercise class, run by a physiotherapist unconnected to the study. The class was largely unstructured, with participants following their own individual programme, which included a mix of aerobic and resistance exercises, within the group setting. Text messages were sent to TXT and EXE + TXT group participants five times a week for 12 weeks and then at a reducing rate for a further 12 weeks. Texts were a combination of tailored and targeted messages.

Outcome measures

Measures were undertaken to determine whether a trial to support physical activity behaviour change using telehealth in the population with OSA was feasible in terms of trial design and recruitment of participants, and to assess the acceptability of the intervention and the efficacy of outcome measures used.

Primary outcomes: feasibility measures

Feasibility outcomes were recruitment and study completion rates; acceptability of the exercise class; wear rates and acceptability of the accelerometer; acceptability of the 6-min walk distance (6MWD) and acceptability of the questionnaires used. Acceptability of text messages was explored in exit interviews with participants and these outcomes are outside the scope of this study.

Secondary outcomes: between-group measures

Demographic and baseline characteristics of participants were measured at baseline, 12 and 24 weeks (Table 1). Outcomes measures were anthropometrics and physical performance outcome measures – 6MWD,[11] gait speed measured over a 5-m walk distance,[12] grip strength measured using a handheld dynamometer (Jamar, Patterson Medical),[13,14] and five times sit-to-stand.[15] In addition, movement and sleep data were obtained using an Actigraph GTX3 accelerometer, Manufacturing Technology, Inc., FL, USA,[16] and participants completed six self-administered questionnaires: the Functional Outcomes of Sleep questionnaire (FOSQ),[17] the Patient Health Questionnaire (PHQ-9),[18] the Short Form-

Table 1. Mean baseline demographics and anthropometrics by group allocation ($n = 30$).

Characteristics	Total sample ($n = 30$)	Group EXE ($n = 10$)	Group EXE + TXT ($n = 10$)	Group TXT ($n = 10$)
Male, *n*	17	6	5	5
Age (years), mean (s.d.), range	54.6 (14.1)	53.8 (15.8)	55.9 (12.4)	54.0 (16.7)
	22–74	22–68	35–74	28–72
Ethnicity NZ Euro, *n*	25	6	9	10
Employed, *n*	18	5	7	6
Non-smoker, *n*	15	5	4	6
Height (m), mean (s.d.), range	1.7 (0.1)	1.7 (0.12)	1.7 (0.12)	1.7 (0.12)
	1.50–1.94	1.50–1.94	1.52–1.92	1.52–1.91
Weight (kg), mean (s.d.), range	100.0 (24.1)	95.1(12.2)	107.3 (19.9)	101.2 (29.8)
	69.5–171.5	82.3–118.0	81.8–137.1	69.5–171.5
BMI (kg/m^2), mean (s.d.), range	34.1 (8.0)	31.1 (7.9)	36.2 (6.7)	34.3 (9.3)
	22.1–58.7	22.1–39.9	27.7–50.4	25.8–58.7
Neck circumference (cm), mean (s.d.), range	40.6(4.9)	39.7 (5.4)	41.9 (4.1)	40.0 (5.5)
	33.0–52.3	33.0–49.1	37.2–48.5	34.0–52.3
Waist circumference (cm), mean (s.d.), range	108.7 (17.2)	105.4 (11.0)	111.3 (13.1)	113.0 (19.2)
	91.0–157.5	95.5–127.8	93.5–135.1	91.0–157.5
Hip circumference (cm), mean (s.d.), range	114.0 (14.9)	110.1 (13.8)	117.2 (14.5)	114.0 (16.8)
	87.1–156.5	87.1–125.5	102.0–150.2	98.9–156.5
Waist-to-height ratio	0.6 (0.1)	0.5 (0.1)	0.6 (0.1)	0.6 (0.2)
	0.72–1.09	0.72–1.03	0.84–1.09	0.89–1.08
Waist-to-hip ratio	1.0 (0.9)	0.9 (0.1)	1.0 (0.1)	1.0 (0.1)
Grip strength left hand (kg), mean (s.d.), range	32.9 (13.9)	32.0 (10.8)	34.3 (15.0)	35.4 (15.6)
	14–66	14–40	14–66	18–57
Grip strength right hand (kg), mean (s.d.), range	34.2 (14.0)	33.3 (12.3)	36.0 (14.2)	36.3 (16.1)
	14–63	15–48	14–63	18–58
5XSTS (s), mean (s.d.), range	9.9 (2.3)	9.8 (2.0)	9.5 (2.6)	10.3 (2.3)
	6.1–14.9	6.1–13.2	6.4–13.6	7.7–14.9
Gait speed (m/s), mean (s.d.), range	1.5 (0.3)	1.5 (0.4)	1.5 (0.2)	1.6 (0.4)
	1.1–2.2	1.1–2.2	1.3–1.7	1.3–2.2
6MWD (m), mean (s.d.), range	484.1 (89.7)	456.6 (98.5)	492.5 (81.2)	497.0 (95.1)
	330–655	330–655	367–615	359–645

BMI, body mass index; 5XSTS, Five times sit-to-stand; 6MWD, 6-min walk distance; EXE, exercise group; EXE + TXT, exercise group plus text messaging; TXT, text messaging only group.

36 (SF36),[19] the Exercise Barriers/Benefits Scale,[20] the RM-FM1 Stages of Change questionnaire[21] and the Self-efficacy for Exercise Scale.[22]

Data analysis

Descriptive statistics – means, standard deviations, and confidence intervals – were calculated for the outcome measures (Supplementary File S3). The Shapiro–Wilks test was used to determine normality of distribution. There were no significant between-group differences at baseline. All data were analysed using IBM SPSS Statistics 26, IBM, Armonk, NY, USA. Where a participant had dropped out before the study completion, the last observation carried forward method was used for the missing data. For between-group outcomes, where data were normally

distributed and all other assumptions held, ANOVA was used for continuous data. Confidence intervals have also been reported. As this was a feasibility study, it was not powered to test hypotheses about the effectiveness of the intervention; the focus was on identification of trends in the data and clinical significance rather than statistical significance. As a result, *P* values are not reported.

Results

Feasibility outcomes

Recruitment

Recruitment of participants was via referrals to the Sleep Clinic at Dunedin Public Hospital and was slower than anticipated. This was partly due to difficulty in accessing individuals as the contact details on medical records were sometimes out of date. Follow-up phone calls to discuss the study with potential participants were limited by outdated or incorrect phone numbers ($n = 18$ cases). Of the remaining 78 people who were contacted by telephone to further discuss the study and/or make an appointment, 11 did not meet the eligibility criteria and 35 opted not to be involved (Table 2). All study participants were subsequently confirmed as having OSA except two; their data were excluded from the final analysis.

There were other potential reasons for the slow rate of recruitment. The population with OSA commonly experience symptoms such as fatigue and excessive daytime sleepiness,[10] which may represent an additional barrier to undertaking a physical activity-based intervention. Additionally, recruitment via referrals from the Sleep Clinic directly may have been a sub-optimal approach, as it was dependent on a number of personnel and also relied on potential participants receiving and reading the study's participant information sheet.

Recruitment of rural participants was additionally challenging because there were cost and time implications for the participants in attending the initial and the follow-up appointments, particularly if they lived more than an hour's drive from Dunedin.

Table 2. Reasons for not being included in the study.

Reasons for exclusion from the study	***N***
Already exceeding WHO guidelines for activity	10
Unstable angina*	1
Reasons for not wanting to be involved in the study	***N***
Too busy/work commitments	16
Too many other health issues	4
Not interested	2
Not keen to travel/no transport	5
Rural	3
No cell phone	1
Unable to commit to exercise classes	4

*Patient reported experiencing angina at low exercise intensities and was advised to make an appointment with his GP. WHO, World Health Organization.

Study completion rates

As can be seen from the flow chart (Fig. 1), a number of participants dropped out during the course of the study. Of the 30 participants who were enrolled in the study, seven dropped out between baseline assessment and 12-week follow up, and two were lost to follow up before the 24-week appointment. The final number of data sets at 24 weeks was $n = 21$. Where possible, reasons for dropping out were elicited, but some participants were lost to follow up. One participant went overseas on an extended trip; another decided they were too active to gain any benefit from the study; one moved out of the area.

Analysis of the baseline data for the nine participants who did not complete the study showed that their baseline demographic and other characteristics did not differ greatly from those of the total sample. The only difference of note was that the mean pain score on the SF-36 for this subgroup was lower at 52% than the mean pain score for the remainder of the group (64%) at baseline, suggesting pain had a greater impact on quality of life in this subgroup.

Exercise class attendance

Being randomised to one of the exercise class arms required a commitment to attend at a specific time on a specific day, which several potential participants reported was too difficult to manage with work and other daytime commitments. Work commitments and lack of time are both commonly cited barriers to activity in the literature.[23–25] This was further highlighted by the fact that, of those participants randomised to an exercise class arm, 33% had a $<70\%$ attendance rate during the study period. For the study, we used a pre-existing exercise class for people with long-term conditions, which was convenient and cost-effective for the study design (but possibly not the participants). Seeking more information from potential users regarding an alternative is required. For example, a selection of classes at different times of day via telehealth might be more acceptable in terms of time and cost, and has been demonstrated to deliver improved outcomes in terms of muscle strength and endurance and quality of life in other populations, such as cardiac rehabilitation patients.[26]

Feasibility of accelerometry

Wearing of the accelerometer. Accelerometry wear rates were determined by hours of data obtained from the Actigraph software, Manufacturing Technology, Inc., FL,

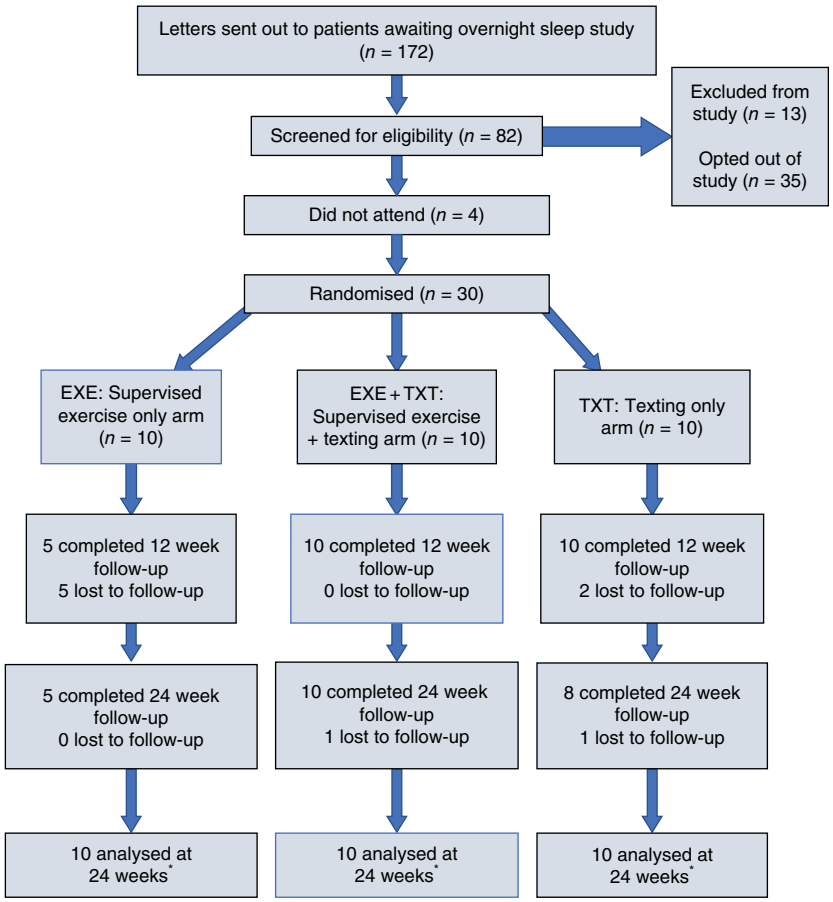

Fig. 1. Flow chart of participants through the intervention study from recruitment to end point at 24 weeks. *Analysis of all 30 participants was undertaken at each time period, despite drop-outs, using last observation carried forward.

USA. Most participants wore the accelerometer for the entire programmed time period (7 days/168 h). At 24 weeks, results showed all 21 participants wore accelerometers for seven whole days. Of the four participants who wore the accelerometer for ≤5 days at baseline, all of them dropped out before completion of the study. This suggests there is scope to introduce a preliminary wear period prior to data collection to ascertain who is likely to comply and thus remain in the study, thereby enhancing participant retention rates.

Reliability of accelerometry in capturing physical activity. Some activities were captured more readily by accelerometry than others. Participants in the study were instructed to: (1) wear the accelerometer on their wrist and to; (2) remove it for water-based activity. For these reasons, accelerometry was limited in the inability to capture largely stationary activities (such as static cycling or strengthening exercises) and there was potential for mis-classification of water-based activities as non-active time, due to the participant having removed the device.

Comfort/acceptability of the accelerometer. Feedback from most participants was quite favourable regarding the wearing of the device, as evidenced by the wear rates detected. Three participants reported that the device was too bulky and the strap was tight and uncomfortable. A further two participants reported that it was inconvenient and embarrassing to wear.

The most regularly received feedback on wearing the device was that, unlike other wearable devices, there was no visible feedback on progress such as step count and this was construed as a negative feature by participants.

Feasibility of the 6-min walk distance

The 6MWD was able to be carried out by almost all participants at all three timepoints without issue. It was simple and easy to administer and a practice test was not required as stated in the American Thoracic Society guidelines.[11] As walking is a functional activity, there was low risk of learning effect being a confounding factor. In addition, the 6MWD was a good measure of functional exercise capacity and more accurately captured changes than the accelerometer. The only limitation of the 6MWD was that, for three participants, other conditions impacted on their ability to mobilise at the 12- week follow up; a flare up of their gout or their knee osteoarthritis severely restricted their walking ability. In these circumstances, the 6MWD was not an accurate proxy for cardio-respiratory fitness.

It is also necessary to note that although the 6MWD has been validated in the population with obesity, several participants in our sample were not classified as obese, and it may have had a ceiling effect for these participants.

Acceptability of questionnaires

Prior to the study commencing, one adolescent and one adult unconnected to the study independently completed the set of questionnaires to determine the average time to completion and reading ease, in terms of sentence length and language content. The average time to completion was 22 min and, based on this, the time estimated for participants in the study to complete all questionnaires was 30 min. The completion rate for questionnaires was 100% at baseline, 87% at 12 weeks and 83% at 24 weeks. All returned questionnaires were at least 95% complete. In cases where observations were missing, the participant involved was contacted and asked the relevant questions in order to obtain the missing information.

Between-group outcomes

6-min walk distance

There was a trend towards increased mean distance for 6MWD across all three groups (Fig. 2). The mean improvements for groups EXE, EXE + TXT and TXT were 37.9 m (95% CI −4.1 to 79.7 m), 30.4 m (95% CI −1.9 to 62.7 m) and 33.7 m (95% CI −1.4 to 68.7 m) respectively. The minimal clinically important difference for 6MWD of 30.5 m[27] was reached in all three groups. This mean increase in 6MWD appeared to plateau at 12 weeks in groups EXE and TXT, whereas the increase appeared to continue in group EXT + TXT beyond 12 weeks.

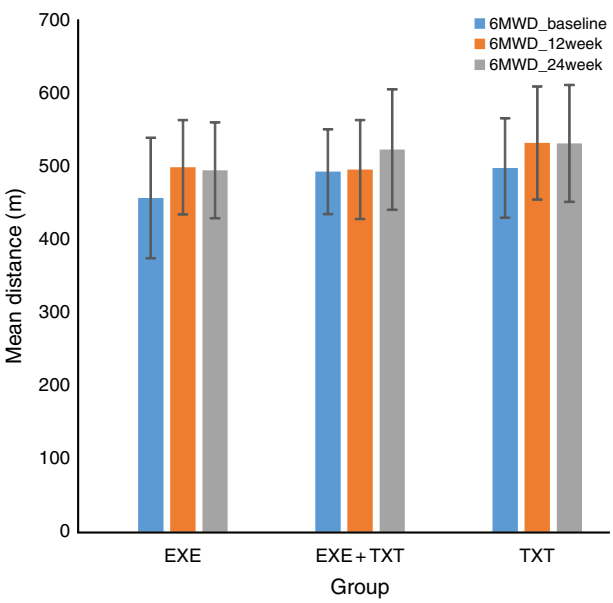

Fig. 2. Change in 6MWD by group from baseline to 24 weeks.

Self-efficacy for exercise scale

The mean Self-efficacy for Exercise score was slightly lower in group TXT at baseline (36.9) than group EXE (41.4) and group EXE + TXT (40.1). There was a trend towards improvement in self-efficacy score over time of 6.75, 6.1 and 13.1 points in groups EXE, EXE + TXT and TXT respectively between baseline and 24 weeks (Fig. 3).

Discussion

This study aimed to determine the feasibility of an exercise and text messaging intervention to support physical activity behaviour change in adults with OSA. A strength of the study is that the intervention appeared to be acceptable to participants, and secondary outcomes showed promise in supporting increased physical fitness levels. This suggests a low-cost intervention such as text messaging, with the inclusion of behavioural change techniques, may offer potential as a tool in primary care to support adults with low physical activity to be more active.[2] Other studies have highlighted the need for tailored support, such as personalised text messaging, to assist participants in increasing their physical activity levels.[25] The behavioural change techniques used in the study appear promising in increasing exercise self-efficacy, which is recognised as a key aspect of maintaining increases in physical activity over time.[28] With an increasing number of patients with sleep disordered breathing being assessed in primary care,[2] a time efficient intervention that addresses lifestyle modification may offer value as a part of an inter-disciplinary service.

Consideration needs to be given to adapting future recruitment strategies. This may be achieved through public education sessions to raise the profile of sleep disorders, which could be promoted through general practices and

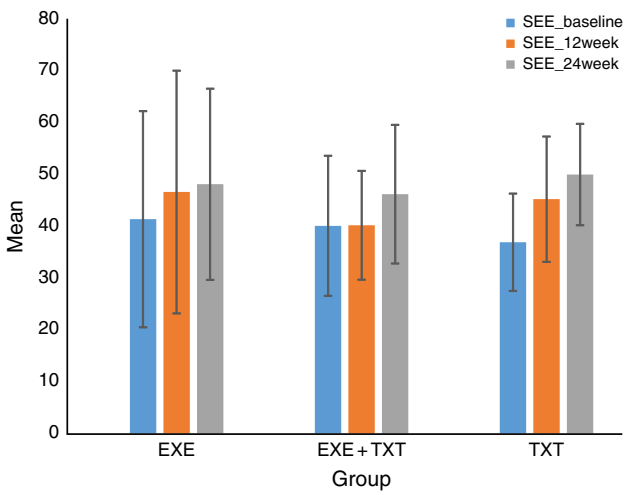

Fig. 3. Changes in Self-efficacy for Exercise scores* by group over time. *Higher Self-efficacy for Exercise scores indicates higher levels of exercise self-efficacy.

Sleep Clinics. Attendees who had symptoms indicative of OSA could be given the option to express interest in being involved in the study at the end of the education session and this might serve to aid recruitment rates. Another option to aid recruitment of participants may be to provide some recognition of the time commitment and cost required to travel to participate in the study through offering financial reimbursement. Recruitment of rural participants could be potentially addressed through sourcing a venue in the locality of each rural participant, which would enable all assessments to be carried out in a standardised manner (e.g. a minimum 15-m corridor for administering the 6MWD).

The use of alternative methods to improve study completion rates also requires consideration. Given the finding that those participants who did not wear the accelerometer for the required 7 days in the baseline period all dropped out of the study, a preliminary wear period of the Actigraph device to identify those participants most likely to remain in the study might be useful. The key secondary outcome measures – 6MWD and self-efficacy scores – appeared to be effective at determining change in cardiorespiratory fitness and self-efficacy respectively. However, the 6MWD may have a ceiling effect in younger and/or fitter participants.

A key limitation of the study was the low representation of Māori and Pasifika participants. Additionally, the sample size was small, so caution must be exercised in interpretation of trends in the data. Outliers could have skewed the mean in such a small data set.

It was not possible to stratify by sex due to the small sample size, and it is acknowledged that some of the variables could have been different in males compared to females.

The inclusion of rural participants, and the geographical location of the exercise group, prevented random allocation of these participants.

Conclusion

In conclusion, an exercise and text messaging intervention to increase physical activity behaviour in an adult population with OSA was acceptable and the study design appeared to be feasible. A larger sample size is needed to confirm the observed trends in the data.

Supplementary material

Supplementary material is available online.

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