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2. Title Page

Low-load high-repetition resistance training improves strength and gait speed in middle-aged and older adults

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Low-load high-repetition resistance training improves strength and gait speed in middle-aged and older adults

Abstract

Objectives: To determine the effect of 26 weeks of low-load high-repetition resistance training (BodyPump™) on maximal strength, gait speed, balance and self-reported health status in healthy, active middle-aged and older adults.

Design: Two-group randomised control trial

Methods: Sixty-eight apparently healthy, active adults aged over 55 years completed either 26 weeks of BodyPump™ training (PUMP) or served as control participants (CON). The BodyPump™ group (n=32, age = 66±4 years) trained twice per week for 26 weeks while the control group (n=36, age = 66 ± 5 years) continued with their normal activities. Leg-press and Smith-machine bench-press one repetition maximum (1RM), gait speed, balance, and self-reported health status were all assessed at baseline and follow-up.

Results: Significant group-by-time interactions in favour of the BodyPump™ group were found for leg-press 1RM (PUMP +13%, CON +3%, p = 0.007, partial eta² = 0.11), Smith-machine bench-press 1RM (PUMP +14%, CON +5%, p = 0.001, partial eta² = 0.18), normal gait speed (PUMP +23%, CON +9%, p = 0.028, partial eta² = 0.08) and single leg balance right (PUMP +24%, CON -7%, p = 0.006, partial eta² = 0.12). There were no group-by-time interactions for health status measures. Three participants in the BodyPump™ group withdrew from training due to injury or fear of injury related to training.

Conclusions: Low-load high-repetition resistance training in the form of BodyPump™ is effective at improving maximal strength, gait speed and some aspects of standing balance in adults over 55 years. The training was well tolerated by the majority of participants.

Key words: BodyPump; Postural Balance; Exercise; Ageing; Health status
1. Introduction

The age-related deterioration in measures of strength\textsuperscript{1}, balance\textsuperscript{2} and gait speed\textsuperscript{3} are well established and are typically observable from the fourth and fifth decades of life. Also well recognized is the effectiveness of resistance training at improving these measures in middle-aged and older adults.\textsuperscript{4,6} Many resistance training interventions in middle-aged and older adults have successfully utilised high-load\textsuperscript{4,6,7} protocols equivalent to \(~80\%\) one-repetition maximum (1RM) but less attention has been given to low-load (<40\% 1RM) resistance training utilising very high (>60) repetitions.

There are conflicting reports as to whether low-load/high-repetition resistance training is effective at improving maximal strength compared to high-load resistance training in older adults.\textsuperscript{8-10} Many of these differences are due to the great variability in the prescribed load and repetition range. Only one study in older adults\textsuperscript{10} has utilised a very high-repetition protocol at low-loads similar to that used by Anderson and Kearney (1982) when they identified a repetition training continuum\textsuperscript{11}. Significant gains in strength, muscle volume and function were reported after 12 weeks of training in this manner.

Improvements in gait speed and balance performance have been reported following high\textsuperscript{-} and low-load\textsuperscript{12} resistance training although there is still only weak evidence that resistance training can be moderately effective at improving balance in older adults.\textsuperscript{13} To date, no ideal resistance training load or dose has been identified for the improvement of gait speed and balance. Maintenance of health is a primary motivator for exercise participation in older adults\textsuperscript{14} and the use of self-reported tools can provide additional insights into the effect of exercise interventions. Currently the evidence\textsuperscript{15,16} suggests that resistance training does not improve self-reported health status in healthy older adults but the effect of low-load/high-repetition resistance training on these measures has yet to be determined.

A widely available form of low-load/high-repetition resistance training is BodyPump\textsuperscript{TM} - a pre-choreographed group class that utilises light weights and very high-repetitions (70-100 per body
part) in each workout. The class is available in some 14,000 facilities globally and is the most utilised
group class produced by Les Mills International. The pre-choreographed nature of the classes
provides uniformity between fitness facilities which allows for an easily reproducible resistance
training program. Despite the growing number of older adults undertaking gym based activities and
the exposure of such a program, there has been no peer reviewed research on the effectiveness of
BodyPump™ in middle-aged or older adults.

The aim of this study was to determine the effect of 26 weeks of low-load/high-repetition
resistance training (in the form of BodyPump™) on measures of maximal strength, gait speed,
balance and self-reported health status in active middle-aged and older adults. An age range of 55-75
years was chosen to allow the inclusion of adults in both late middle-age and early old-age. It was
hypothesised that 26 weeks of BodyPump™ would increase lower and upper body one-repetition
maximum strength; improve static balance and gait speed; and would have no impact on self-reported
health status.

2. Methods

A two-group, repeated measures, randomised control trial was used to investigate the effects
of 26 weeks of BodyPump™ training on adults aged 55-75 years. Based on results of a pilot study and
previous resistance training interventions, a priori power calculation with power set at 0.8 and an
alpha of 0.05 identified a required sample size of 34 per group. To account for a 20% attrition rate a
sample size of 41 per group was required. Due to space and equipment restrictions at the local fitness
facility, the sample size for the BodyPump™ group was limited to 40.

Participants were recruited through an adult education facility and via local advertising.
Ninety-five participants were initially assessed for eligibility of which 11 did not meet inclusion
criteria and a further three declined to participate (Figure 1). Eighty-one apparently healthy men and
women undertook baseline testing after providing informed consent conforming to the Declaration of
Helsinki, approved by the Human Research Ethics Committee of the University. Participants were
allocated to either the intervention (PUMP) or control group (CON) on a 1:1 ratio using a computer
generated random number list (stratified for age and gender) after baseline data collection. All participants were physically active, taking part in regular exercise such as walking, cycling and swimming, but had not been involved in formal resistance training in the previous six months. Exclusion criteria included: acute or terminal illness, myocardial infarction in the past six months, recent low impact fracture, or any condition that would interfere with participation in moderate intensity exercise.

PUMP participants undertook 26 weeks of BodyPump\textsuperscript{TM} classes in total. The first four weeks of the intervention served as an orientation and were used to appropriately teach exercise technique and larger rest periods were included. During this phase participants were able to determine appropriate weights for each exercise. From week five onwards all classes were instructed at a level that one would expect to encounter if they took part in a BodyPump\textsuperscript{TM} class at a local fitness centre. Participants were provided with free access to a local fitness facility and were instructed to attend two out of three available classes per week. All classes were instructed by experienced BodyPump\textsuperscript{TM} instructors who were not associated with testing or recruitment of participants. The weights lifted for each exercise were self-selected but were guided by general recommendations provided by the experienced instructor. BodyPump\textsuperscript{TM} program release 83 was used for the duration of the program (supplementary material Appendix 1). Participants recorded the weights lifted during each class for squats, chest press and back exercises (Appendix 1) and any adverse events were also recorded. An adverse event was defined as any incident that occurred during a class that resulted in the participant seeking advice from a health professional or resulted in an inability to undertake normal activities of daily living for at least two days. CON participants did not undergo any training and were instructed to maintain their current level of physical activity for the duration of the study.

A series of assessments were conducted at baseline and post-intervention. One-repetition maximum (1RM) strength was assessed during session one, while gait and balance performance was assessed during session two. Each testing session was separated by 3-5 days. A familiarisation session was held approximately one week prior to 1RM testing to ensure correct lifting technique and to practice lifting sub-maximal loads. During session one lower limb maximal strength was assessed on
an incline leg-press (Calgym, Australia) and upper body strength was assessed on a Smith-machine
bench press (Elite, Australia). Testing commenced after a light cycling warm-up using established
protocols with leg-press assessed prior to bench-press.

All balance and mobility measures were assessed with participants unshod. Participants
performed a series of four different standing balance tasks on a strain gauge Bertec 4060-08 force
platform (Bertec Corporation, USA) that was calibrated in accordance with the manufacturer’s
recommendations. Signal processing and data analysis were performed using Qualisys Track Manager
(Gothenburg, Sweden). Data were sampled at a rate of 50 Hz with a cut-off frequency of 10 Hz. The
same order was followed for all participants at each testing session with an increasing level of
difficulty – comfortable-stance eyes open, followed by comfortable-stance eyes closed then narrow-
stance eyes open and finally narrow-stance eyes closed. For the comfortable-stance positions
participants stood with their feet at pelvic width, while for the narrow-stance position they stood with
their feet together with the first metatarsal-phalangeal joints and medial malleoli approximating.
Participants were instructed to keep their hands by their sides and to remain as still as possible while
looking straight ahead. Two successful repetitions of 30 seconds in each position were performed with
60 seconds rest between trials. Centre of pressure (COP) displacements were assessed for each task.
COP mean velocity and COP range were assessed in the antero-posterior (AP) and medio-lateral
(ML) direction. Five clinical balance assessments were then conducted in the following order: single
leg stance left and right (60 second limit), the timed-up-and go, 6 metre walk normal speed, 6 metre
walk fast speed and 30 second chair stand test. The mean of two successful trials was used for
analysis for all tasks. Six metre walk times were converted to gait speed (m/s) for analysis.

The SF-36v2® Health Survey (Australian version) was used to assess the self-reported health
status of each participant. The SF36v2® percentage scores were converted to T-scores (Health
Outcomes Scoring Software 4.5) for analysis and interpretation. Energy expenditure derived from
exercise and physical activity was estimated by a seven day activity diary. A metabolic equivalent
(METs) value was assigned to each activity-intensity combination and was used to calculate the
average amount of energy used for exercise by each participant.
Statistical analyses were performed using IBM SPSS version 20 (Armonk, New York). Normal distribution was assessed by descriptive statistics and visual inspection of histograms. All data are reported as mean and standard deviation (SD) except for data not normally distributed which is presented as median and range. Differences between groups at baseline were assessed by independent t-tests for normally distributed data, and the independent Mann-Whitney U test for data not normally distributed. To assess between-group differences in changes over time, a general linear model (GLM) was used, with time as repeated factor and group as fixed factor for normally distributed data. Baseline values were used as covariates in the GLM for any measures that were different between groups at baseline. Mann-Whitney U tests were used to assess the distribution of change between-groups for outcome measures not normally distributed. A repeated measures GLM with pairwise comparisons and Bonferroni correction was used to detect change in the weight lifted for squats and chest press at week one, five, 13 and 26 of the BodyPump™ program. Effect size estimates were included to provide information regarding the magnitude of any time or group effect. Participants who withdrew from the project or were ineligible for final testing were not included in the final statistical analysis. Statistical significance was set at p < 0.05.

3. Results

Sixty eight participants (PUMP n=32, CON n=36) aged between 58 and 75 years completed all baseline and follow-up testing (Figure 1 and Table 1). All data was normally distributed except for COP derived data. There were baseline group differences in four outcome measures - normal gait speed (p = 0.023), fast gait speed (p = 0.008), role-physical domain of the SF36v2 (p = 0.004), and medio-lateral COP range for narrow-stance eyes closed (p = 0.028).

Significant group-by-time interactions in favour of the PUMP group (Table 2) occurred for 1RM leg-press (F (1, 63) = 7.82, p = 0.007, partial eta² = 0.11), 1RM Smith-machine bench-press (F (1, 62) = 13.12, p = 0.001, partial eta² = 0.18), right single leg stance (F (1,63) = 8.16, p = 0.006, partial eta² = 0.12), normal gait speed (F (1, 63) = 5.03, p = 0.028, partial eta² = 0.08) and weekly METs (F (1, 62) = 9.05, p = 0.004; partial eta² = 0.12). There were significant group differences in
mean change for mean medio-lateral velocity in narrow-stance eyes open (p = 0.006, effect size = 0.01) and narrow-stance eyes closed (p = 0.014, effect size = -0.46). The group differences in these two COP parameters did not provide a consistent direction for improvement in either group (Table 3, supplementary material).

There were significant time effects for 1RM leg-press (F (1, 63) = 20.95, p < 0.001, partial \( \eta^2 = 0.25 \)), Smith-machine bench-press (F (1, 62) = 31.27, p < 0.001, partial \( \eta^2 = 0.34 \)), fast gait speed (F (1, 63) = 23.93, p < 0.001, partial \( \eta^2 = 0.28 \)), 30 second chair stand (F (1, 63) = 14.63, p < 0.001, partial \( \eta^2 = 0.19 \)) and the role-physical domain of the SF36v2 health survey (F (1, 63) = 30.88, p < 0.001, partial \( \eta^2 = 0.33 \)). There were also significant time-by-baseline score effects for the role-physical domain (F (1, 63) = 30.60, p < 0.001, partial \( \eta^2 = 0.33 \)).

There was a significant increase in the amount of weight lifted during PUMP (in terms of percentage of 1RM) for squats between week one (4.4 ± 2.5) and five (8.1 ± 3.6%, p < 0.001), week one and 13 (11.4 ± 6.4%, p<0.001), week one and 26 (11.8 ± 5.1%, p<0.001). There was also an increase in weight between week five and 13 (p<0.001), and between week 5 and 26 (p<0.001). Chest press weight increased between week one (12.8 ± 6.6%) and five (21.6 ± 10.2%, p<0.001), week one and 13 (27.0 ± 12.1%, p<0.001) and week one and 26 (29.0 ± 10.9%, p<0.001). There was also an increase in weight between week five and 13 (p = 0.019), and between week five and 26 (p = 0.006). There was no significant increase in the amount of weight lifted between week 13 and 26 for squats (p = 1.0) or chest press (p = 0.53).

PUMP participants attended 50 ± 12 classes over 26 weeks (range = 16-70 classes) which resulted in a compliance of 89%. Eleven participants attended more than 52 (100%) classes. To avoid a misleading inflation of the compliance, the attendance rate of anyone attending more than 52 classes was 100%. There were nine adverse events reported by nine participants (eight from PUMP) over the course of testing and training. There were two adverse events related to 1RM strength testing - one CON participant reported prolonged (six days) leg muscle soreness after baseline leg-press testing and one PUMP participant injured his supraspinatus tendon during follow-up testing on the Smith-
machine bench-press. Adverse events during BodyPump™ were solely musculoskeletal in nature and were reported by seven participants (21%). Two participants ceased their involvement in the BodyPump™ intervention after exacerbations of knee pain and neck pain, respectively (Figure 1). A further five participants had to modify or omit certain exercises after reporting persistent knee pain (n = 1), low back pain (n = 1) and neck/shoulder pain (n = 3) and were able to continue for the duration of the intervention.

4. Discussion

Supporting the majority of our hypotheses, 26 weeks of low-load/high-repetition resistance training (BodyPump™) increased maximal strength and gait speed in adults aged 58-75 years without improving self-reported health status. Contrary to our hypothesis, there were limited improvements in measures of static balance. To our knowledge, this is the first study to demonstrate that resistance training using low-loads (10-30% 1RM) and very high repetitions can improve maximal strength and gait speed in middle-aged and older adults.

The improvement for leg-press 1RM in the PUMP group (13%) is less than some high-\textsuperscript{4,23} and low-load\textsuperscript{10} resistance training interventions but comparable to others.\textsuperscript{7,9,24} Further gains in strength were likely limited by the lack of progressive overload in the latter part of the intervention. There were negligible increases in the amount of weight lifted for squats between week 13 and 26 of the intervention and as such the amount of weight lifted for squats remained at ~10% of predicted\textsuperscript{25} squat 1RM for the entire program. Exercises were not strictly performed to fatigue or momentary muscular failure which could also limit strength gains. The 14% increase for the Smith-machine bench-press in the BodyPump™ group was similar to results from traditional and power-based resistance training interventions.\textsuperscript{24,26}

The mean increase of 0.31m/s in the PUMP group for gait speed is notable as improvements in gait speed predict a substantial reduction in mortality in older adults.\textsuperscript{27} This level of improvement is greater than the typically modest but significant change of 0.08m/s found with resistance training in
older adults\textsuperscript{15} and also represents a substantial meaningful change.\textsuperscript{28} Although single leg stance (right) performance improved in the PUMP group, there were no consistent improvements among force platform derived measures of static balance. While some have reported improved balance following resistance training in middle-aged and older adults\textsuperscript{5}, our results align with previous studies that have not found consistent improvements in measures of static balance following resistance training.\textsuperscript{4,29} The good baseline balance ability\textsuperscript{3} of the cohort may have reduced the opportunity for improvement and the tasks assessed may not have sufficiently challenged those with adequate balance. Furthermore, the BodyPump\textsuperscript{TM} classes may not have challenged participants’ balance sufficiently.

The lack of change observed for self-reported health status was hypothesised and has been observed previously with resistance training interventions in older adults.\textsuperscript{16} Baseline mean \textit{T}-scores for all domains of the SF26v2 were higher than previously reported Australian data\textsuperscript{30} which may have reduced the likelihood of substantial change in this cohort.

This study provides the first information relating to the potential safety and effectiveness of BodyPump\textsuperscript{TM} in middle-aged and older adults. The program was well attended with a near 90\% compliance. The number of adverse events reported during testing and training are comparable to other resistance training interventions in middle-aged and older adults.\textsuperscript{24} Overall, the majority (~80\%) of participants in the BodyPump\textsuperscript{TM} group did not experience an adverse event nor did they require substantial lifting modifications or omissions.

Some study limitations require attention. Firstly, the lack of progressive overload is a key limitation. The control group received no placebo intervention nor was there an alternative training group for comparison. The balance assessment tasks used in this study may not have provided enough challenge to those with good balance ability, therefore creating a ceiling effect. Post-hoc power analysis revealed insufficient power to detect differences between groups for some clinical balance tasks. Because a healthy, active cohort was utilised for this study, generalizability of these results in sedentary persons, recurrent fallers or those with musculoskeletal impairments or chronic disease cannot be determined.
5. Conclusions

Low-load/high-repetition resistance training in the form of BodyPump™ was effective at improving maximal strength and gait speed in healthy, community dwelling middle-aged and older adults. There were no evident improvements for force plate derived balance measures or self-reported health status. Future research should compare BodyPump™ with other forms of low-load/high-repetition training and traditional progressive resistance training.

6. Practical Implications

- Twenty-six weeks of BodyPump™ training improved maximal leg-press and bench press strength in well-functioning, healthy, active adults aged 58-75 years
- BodyPump™ training improved normal gait speed in individuals aged 58-75 years
- It appears appropriate lifting technique modification and lifting options are required to enable the safe execution of BodyPump™ for some people in the 58-75 age group

Acknowledgements

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1 References


<table>
<thead>
<tr>
<th></th>
<th>Pump (N=40)</th>
<th>Control (N=41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>66.4 ± 4.0</td>
<td>66.3 ± 4.7</td>
</tr>
<tr>
<td>Height, cm</td>
<td>167.6 ± 7.3</td>
<td>167.5 ± 8.6</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>74.1 ± 11.2</td>
<td>70.2 ± 12.2</td>
</tr>
<tr>
<td>&quot;BMI, kg/m²</td>
<td>26.3 ± 3.1</td>
<td>24.9 ± 2.8</td>
</tr>
<tr>
<td>Number of prescribed medications</td>
<td>1.6 ± 1.7</td>
<td>1.1 ± 1.3</td>
</tr>
<tr>
<td>Fallers, ≥1 fall in previous 12 months (%)</td>
<td>2 (5)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Males, n (%)</td>
<td>9 (23)</td>
<td>10 (24)</td>
</tr>
</tbody>
</table>

"Values reported as mean ± SD; "significant difference (p = 0.034) between groups at baseline"
### Table 2: Pre- and post-intervention values for maximal strength, balance, energy expenditure and self-reported health status

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>1RM leg press (kg)</strong></td>
<td>145.7 ± 40.5</td>
<td>164.6 ± 48.4</td>
<td>&lt;0.001</td>
<td>0.25</td>
<td>0.007</td>
<td>0.11</td>
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<td><strong>1RM bench (kg)</strong></td>
<td>26.6 ± 11.7</td>
<td>30.4 ± 12.4</td>
<td>&lt;0.001</td>
<td>0.34</td>
<td>0.001</td>
<td>0.18</td>
</tr>
<tr>
<td>SLS (L) (sec)</td>
<td>34.4 ± 19.9</td>
<td>35.5 ± 20.3</td>
<td>0.36</td>
<td>0.01</td>
<td>0.87</td>
<td>0.00</td>
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<tr>
<td>SLS (R) (sec)</td>
<td>30.4 ± 17.9</td>
<td>37.6 ± 19.5</td>
<td>0.15</td>
<td>0.03</td>
<td>0.006</td>
<td>0.12</td>
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<tr>
<td>TUG (sec)</td>
<td>6.15 ± 0.85</td>
<td>6.12 ± 0.77</td>
<td>0.72</td>
<td>0.00</td>
<td>0.89</td>
<td>0.00</td>
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<tr>
<td>Normal Gait (m/s)</td>
<td>1.33 ± 0.19</td>
<td>1.64 ± 0.42</td>
<td>0.074</td>
<td>0.05</td>
<td>0.028</td>
<td>0.08</td>
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<td>Fast gait (m/s)</td>
<td>1.86 ± 0.24</td>
<td>2.00 ± 0.20</td>
<td>&lt;0.001</td>
<td>0.28</td>
<td>0.99</td>
<td>0.00</td>
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<tr>
<td>30s CST (reps)</td>
<td>19.8 ± 4.6</td>
<td>21.0 ± 4.7</td>
<td>&lt;0.001</td>
<td>0.19</td>
<td>0.50</td>
<td>0.01</td>
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<td><strong>Weekly exercise METs</strong></td>
<td>31.9 ± 20.6</td>
<td>41.3 ± 18.2</td>
<td>0.001</td>
<td>0.15</td>
<td>0.004</td>
<td>0.12</td>
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<td>Physical Function</td>
<td>53.9 ± 2.8</td>
<td>54.3 ± 2.4</td>
<td>0.78</td>
<td>0.00</td>
<td>0.14</td>
<td>0.04</td>
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<td>Role-Physical a,b</td>
<td>52.7 ± 5.2</td>
<td>54.5 ± 4.7</td>
<td>&lt;0.001</td>
<td>0.33</td>
<td>0.28</td>
<td>0.02</td>
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<tr>
<td>Bodily Pain</td>
<td>53.1 ± 8.1</td>
<td>52.2 ± 6.6</td>
<td>0.40</td>
<td>0.01</td>
<td>0.94</td>
<td>0.00</td>
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<td>General Health</td>
<td>57.5 ± 4.4</td>
<td>58.3 ± 4.9</td>
<td>0.44</td>
<td>0.01</td>
<td>0.15</td>
<td>0.03</td>
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<td>Vitality</td>
<td>56.4 ± 6.1</td>
<td>57.2 ± 7.2</td>
<td>0.83</td>
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<td>Social Function</td>
<td>53.5 ± 5.2</td>
<td>54.8 ± 5.1</td>
<td>0.36</td>
<td>0.01</td>
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<td>0.01</td>
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<td>Role-Emotional</td>
<td>50.6 ± 7.2</td>
<td>52.6 ± 5.7</td>
<td>&lt;0.001</td>
<td>0.45</td>
<td>0.30</td>
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<td>Mental Health</td>
<td>54.6 ± 6.1</td>
<td>55.2 ± 6.0</td>
<td>0.48</td>
<td>0.01</td>
<td>0.62</td>
<td>0.00</td>
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<td>PCS</td>
<td>54.4 ± 4.7</td>
<td>54.5 ± 4.0</td>
<td>0.36</td>
<td>0.01</td>
<td>0.08</td>
<td>0.05</td>
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<td>MCS</td>
<td>53.3 ± 6.6</td>
<td>54.7 ± 7.0</td>
<td>0.37</td>
<td>0.01</td>
<td>0.98</td>
<td>0.00</td>
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</table>

Values presented as mean ± SD; SF36v2 used to measure self-reported health status; SLS = single leg stance; TUG = timed-up-and-go; 30s CST = 30s chair stand test; Weekly exercise METs = energy expenditure in metabolic equivalents (METs) based on 7-day exercise diary; PCS = physical components summary of SF36v2; MCS = mental components summary of SF36v2; a significant (p<0.05) difference between groups at baseline; b significant (p<0.05) time-by-baseline score effect.
Enrolment

Assessed for eligibility (n=95)
- Excluded (n=14)
  - Not meeting inclusion criteria (n=11)
  - Declined to participate (n=3)
- Completed Baseline testing (n=81)

Randomisation & Allocation
- Allocated to intervention (n=40, 12m, 28f)
- Allocated to control (n=41, 12m, 29f)

Follow-Up
- Lost to follow-up (n=8)
  - Family commitments (n=2), moved overseas (n=1), knee pain during intervention (n=1), neck pain during intervention (n=1), fear of injury from intervention (n=1), fractured radius (n=1, fall at home), travel commitments (n=1)
- Lost to follow-up (n=5)
  - Moved interstate (n=1), fractured scaphoid (n=1, cycling injury), fractured rib (n=1, during holiday), heart attack (n=1, during holiday), knee surgery (n=1)

Final Analysis
- Analysed (n=32, 9m, 23f)
- Analysed (n=36, 10m, 26f)

Figure 1. Project flow chart