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Exercise behaviour change in 40 to 65-year-old women: The SWEAT Study (Sedentary Women Exercise Adherence Trial)

K. L. Cox[1], T. J. Gorely[2]*, I. B. Puddey[1], V. Burke[1] and L. J. Beilin[1]

[1]Department of Medicine, University of Western Australia;
Western Australian Institute for Medical Research and HeartSearch WA, Australia
[2]School of Sport and Exercise Sciences, Loughborough University, UK

Objective. The purpose of this study was to examine the relation between self-reported psychological processes and changes in exercise behaviour in an 18-month longitudinal stage-based intervention trial in 115 initially sedentary women aged 40–65 years.

Design. A two-way factorial design was used.

Methods. Participants were assigned randomly to either moderate or vigorous and either home or centre-based exercise. After six months, all participants exercised at home. Participants completed questionnaires at baseline, six, 12 and 18 months which assessed stage of exercise behaviour, self-efficacy, decisional balance and processes of change.

Results. 28 patterns of stage change were identified across the 18 months with 6.1% remaining sedentary and 45% demonstrating linear movement from contemplation to action to maintenance to continued maintenance. Two interpretable clusters were identified within both the contemplation (at baseline) and action (at six months) stages. Cluster membership, however, did not influence behaviour change. For participants demonstrating a linear pattern of change, self-efficacy for overcoming barriers and behavioural processes increased from contemplation to action. Self-efficacy for exercise competence increased from contemplation to action but was more pronounced for the vigorous exercise groups. Decisional balance showed a three-way interaction and there was no change for experimental processes. There was no change in any variable from action to maintenance.

Conclusions. The intervention was seen to be effective regardless of location or intensity of exercise. The relevance of substages is questionable in stage-based

*Requests for reprints should be addressed to Dr Trish J. Gorely, School of Sport and Exercise Sciences, Loughborough University, Loughborough LE11 3TU, UK (e-mail: p.j.gorely@lboro.ac.uk).

interventions as women with a profile suggesting less readiness to change or sustain change were just as likely to adopt or maintain exercise.

There is no doubt that participation in regular physical activity confers a wide range of health benefits to the participant (Biddle, Fox, & Boutcher, 2000; Bouchard, Shephard, & Stephens, 1993). Despite widespread awareness of these benefits, practitioners in the field of physical activity promotion are constantly challenged to find ways to facilitate the sedentary to adopt and maintain a physically active lifestyle (Dishman & Sallis, 1993; Marcus & Simkin, 1993). One approach has been to apply the transtheoretical model (TTM; Prochaska & DiClemente, 1983) to investigate the process of exercise behaviour change. Initially developed to help explain change in addictive behaviours, the TTM has since been employed to help explain change in a number of health behaviours (e.g. smoking cessation, weight control, mammography screening) including physical activity (Prochaska, 1994). The TTM is based on the idea that health behaviour change is a dynamic process that occurs through a series of interrelated stages that represent different levels of readiness for a given behaviour. It is hypothesized that the stages are invariant, but the time spent in a stage may vary and progress is not necessarily linear (i.e. there will be periods of progression and regression). While this cyclical pattern of behaviour change is generally accepted, empirical evidence is limited.

The stages and their definitions with respect to exercise behaviour change are: precontemplation (not participating in exercise and not thinking about starting, usually in the next six months); contemplation (not participating in exercise but thinking about starting); preparation (doing some exercise but below a criterion level); action (started participating in exercise above a criterion level in the last six months); and maintenance (participating above a criterion level for longer than six months). The criterion level has typically been set in accordance with the American College of Sports Medicine (ACSM, 1990) guidelines to improve aerobic fitness (i.e. at least three times a week, for at least 20 minutes each time, in activities that require effort and make you breathe harder). Although there is now evidence that a lower level of physical activity will result in health benefits to the individual (ACSM, 1993), the criterion for fitness remains a valid standard, particularly from a measurement perspective (Gorely & Bruce, 2000). For example, the existing stage of change instruments are validated for the 1990 definition and have been used most frequently in the past, thus allowing for comparisons with previous literature. In addition, the measurement technology for assessing accumulated exercise, as outlined by the ACSM (1993), is poorly developed.

Associated with movement through the stages are changes in three constructs: processes of change, self-efficacy and decisional balance. The processes of change are cognitive and behavioural techniques and strategies that individuals may employ to modify thoughts, feelings and behaviours. Ten processes of change have been proposed reflecting two higher order constructs: cognitive and behavioural (see Appendix). Studies of smoking cessation and exercise behaviour have demonstrated that different processes seem to be important at different stages (Gorely & Gordon, 1995; Marcus, Rossi, Selby, Niaura, & Abrams, 1992; Prochaska, DiClemente, & Norcross, 1992), with cognitive processes being used more in the early stages (e.g. contemplation) and behavioural processes being used more in the later stages (e.g. action). However, this pattern of stage-process interaction has recently been questioned (Marshall & Biddle, 2001).

Self-efficacy is a person's belief that he or she can enact a specific behaviour

(Bandura, 1986). Cross-sectional research has shown a consistent positive relationship between self-efficacy and stage of change (e.g. Marcus & Owen, 1992; Marcus, Selby, Niaura, & Rossi, 1992). Work outside the stage approach has also demonstrated that self-efficacy is predictive of exercise adoption and maintenance (Armstrong, Sallis, Hovell, & Hofstetter, 1993; McAuley, 1992).

Decisional balance is based on a cost-benefit analysis of a given behaviour change (Janis & Mann, 1977). The assumption is that an individual will not change his or her behaviour unless he or she perceives the benefits of change (pros) to outweigh the negatives (cons). Cross-sectional research has generally shown that pros increase and cons decrease across the stages (e.g. Marcus & Owen, 1992; Marcus, Rakowski, & Rossi, 1992).

It is now well established that stage membership is associated with differential levels of physical activity, self-efficacy, pros and cons, and processes of change (Marshall & Biddle, 2001). However, the predominance of cross-sectional designs in the extant literature has limited the examination of temporal changes in core constructs to a few studies (e.g. Armstrong *et al.*, 1993; Marcus, Simkin, Rossi, & Pinto, 1996). The challenge must now be for researchers to move away from describing differences between stages and start to identify the moderators and mediators of stage transition (Marshall & Biddle, 2001). In addition, TTM researchers have recently been criticized for failing to determine whether the stages are genuine, with qualitative progressive transformations and differences in determinants between stages (Bandura, 1997) or simply reflect arbitrary divisions along a single continuum (Sutton, 2000; Weinstein, Rothman, & Sutton, 1998). These new challenges can be met through prospective longitudinal designs and intervention studies.

Where longitudinal studies have been conducted, the results have generally supported the tenets of the TTM. For example, in a six-month longitudinal, non-intervention study with initially sedentary Australian adults (contemplators), Gorely and Bruce (2000) demonstrated that there were significant increases in self-efficacy for those who had adopted exercise (in action or maintenance) but no change for those who remained sedentary. In addition, at six months the positives of exercise were significantly increased in recent adopters (action) but not for those who remained sedentary or had moved to maintenance. The possible existence of substages within contemplation was also reported, with three interpretable clusters emerging. Each cluster had a different profile of self-efficacy, pros and cons, which was interpreted as indicating differing levels of readiness to change. This interpretation was supported as each cluster was associated with different levels of actual behaviour change across the six months. Because of limitations within the study, the authors reiterated the call for prospective longitudinal work. In particular, because of the practical implications of substages, the authors stressed the importance of further investigation of the potential existence of substages and how these relate to actual behaviour change.

Intervention studies based on the TTM have worked from the premise that the differences between stages in the core constructs suggest that different interventions will be required at different stages and interventions will be most successful when they are matched to the individual's current stage (Prochaska & Marcus, 1994). Investigating this premise, Marcus and colleagues have demonstrated the efficacy of stage-matched exercise interventions in a non-controlled study (Marcus, Banspach *et al.*, 1992) and in two randomized controlled studies (Marcus, Bock *et al.*, 1998; Marcus, Emmons *et al.*, 1998).

Sallis and colleagues (Calfas, Sallis, Oldenburg, & Ffrench, 1997; Sallis, Calfas, Alcaraz, Gehrman & Johnson, 1999) have taken this process further and investigated

the effect of interventions on the potential mediators of behaviour change (e.g. processes of change, self-efficacy). They have argued that where interventions are based on models which specify variables believed to mediate behaviour change, the impact of the intervention on these potential mediators should be taken into account when considering the efficacy of the intervention. For example, Calfas *et al.* (1997) reported that an intervention with sedentary adults based on social cognitive theory and stages of change was effective in enhancing the use of cognitive and behavioural processes of change but not self-efficacy or social support. Furthermore, behavioural processes and self-efficacy for making time were the most strongly supported mediators of physical activity. These results were taken as demonstrating some construct validity for the intervention, social cognitive theory and the TTM while at the same time suggesting that modifications to theories and models may be required if future research replicates these results. Sallis and his colleagues suggest that further research on the mediators of behaviour change holds promise as we continue to strive to understand the difficult but important issue of human behaviour change.

The purpose of the present 18-month longitudinal study was to examine the effects of a stage-based intervention on exercise behaviour change in a group of initially sedentary middle-aged (40–65 years) women. Women were chosen as the focus of this study because rates of inactivity are higher in women than men and older women have been reported to be less active than their younger counterparts (Stephenson, Bauman, Armstrong, Smith, & Bellew, 2000). In addition, previous research has reported on data collected from male and mixed gender studies and few have investigated strategies to promote physical activity for women (Pinto, Marcus, & Clark, 1996). This study was part of a larger project investigating the impact of exercise location and intensity on compliance and adherence (Cox, Burke, Gorely, Beilin, & Puddey, 2003); as a result, although all participants received the same intervention, the women were assigned randomly to exercise either at home or at an exercise centre and at either a moderate or vigorous intensity. As explained in more detail by Cox *et al.*, these distinctions were made because some studies have shown high participation rates for middle-aged and older adults with group-based training (King, Rejeski, & Buchner, 1998; Rikli & Edwards, 1991; Shephard, 1992), while others have reported higher adherence in home-based compared to group-based programmes (King, Frey-Hewitt, Dreon, & Wood, 1989; King, Haskell, Taylor, Kraemer, & DeBusk, 1991). In addition, the impact of exercise intensity on a change in exercise behaviour has not been widely evaluated and moderate activities are more likely to be adopted than demanding fitness programmes (Pinto *et al.*, 1996). Key research questions addressed in the current study are:

(1) What are the patterns of behaviour change for this group of middle-aged and older women?
(2) Are there identifiable subgroups who are more or less ready to adopt or maintain exercise?
(3) Did the core constructs of the TTM change in the predicted manner as individuals adopted a physically active lifestyle?

Method

Design

This paper reports a subset of results from the Sedentary Women Exercise Adherence Trial (SWEAT). SWEAT was a two-way factorial study that assessed the effects of

initiating exercise in a centre-based programme versus a home-based programme at two levels of exercise intensity (moderate 40–55% heart rate reserve or vigorous 65–80% heart rate reserve). Participants were assigned randomly to either centre or home-based exercise and within these to either vigorous or moderate exercise. After six months, the centre-based participants became home-based for a further 12 months. Data were collected at four time points: baseline, six months, 12 months and 18 months.

Participants

The participants were 115 women, aged 40–65 years ($M = 48.2$ years, $SD = 5.6$ years), who met the following entry criteria. They were sedentary (i.e. no regular physical activity participation in the last six months, with regular physical activity defined as two or more sessions a week of 20 min or more), non-smokers, and non-drinkers or with an average weekly alcohol intake below 210 ml/week. Sedentary status was confirmed by results which show that the participants were in the sedentary range for fitness (VO_{2max}) and activity levels on the seven-day recall. Smokers and heavy drinkers were excluded because of safety concerns and because health outcome measures such as fitness, blood pressure and cholesterol included in the parent study were likely to be affected by smoking and heavy alcohol consumption. In addition, participants had to be unlimited in their capacity to participate in an exercise programme because of musculoskeletal disorders, mental incapacity or difficulty in communicating in English, and have no history of cardiovascular, respiratory or other serious illness.

Measures

Current stage of exercise behaviour was assessed using the Stage of Change Instrument (SCI; Marcus, Selby *et al.*, 1992). The SCI contains five items which match the definitions of the five stages of change and participants select the one that best applies to them. For this measure regular exercise was defined for the respondents as 'three times or more per week for 20 minutes or longer each time in activities that require effort and make you breather harder'. Marcus, Selby *et al.* report a Kappa Index of Agreement for the SCI over a two-week period of .78 indicating adequate reliability. Concurrent validity for the SCI has been demonstrated by a significant association with the seven-day physical activity recall questionnaire (Marcus & Simkin, 1993).

Self-efficacy was assessed in two ways. The five-item Self-Efficacy Questionnaire (SEQ; Marcus, Selby *et al.*, 1992) was used to measure self-efficacy for overcoming barriers. Respondents indicate on a 5-point scale (1 = not at all confident, 5 = very confident) how confident they are that they will exercise in each of five different adverse situations. Adequate internal consistency scores (Cronbach's $\alpha = .80$–$.85$) have been reported for the SEQ (Marcus & Owen, 1992; Marcus, Selby *et al.*, 1992). The internal consistency in the current study ranged from .79 to .85 across the four time points. Marcus and Owen (1992) report a two-week test–retest correlation of .90 for the SEQ.

Self-efficacy for the actual exercises used in the intervention was assessed following the approach of Ewart and Taylor (1985). Respondents were asked to rate how confident they were (0–100%) for increasingly difficult levels of walking, jogging, aerobics and circuit training. The score for each exercise was calculated as the sum of the estimates divided by the total number of levels for that exercise. Because the exercise scores were correlated, a composite score (self-efficacy for exercise competence) was calculated from the sum of the four separate exercise scores. Internal

consistency in the current study ranged from .59 to .71 across the four time points. The low internal consistency score was at Data Collection 2 (six months); at all other time points the alpha coefficient exceeded .67.

Decisional balance was assessed using the Decisional Balance Questionnaire (DBQ; Marcus, Rakowski, & Rossi, 1992). This contains 16 items that form two subscales: pros of exercise (10 items) and cons of exercise (six items). Respondents rate the importance of each item in their decision to exercise or not (1 = not at all important, 5 = extremely important). Marcus, Rakowski, and Rossi report adequate internal consistency scores for the subscales (pros = .95, cons = .79). The alpha coefficients in the current study ranged from .91 to .94 for pros and .52 to .78 in the current study. The low internal consistency score for cons was at Data Collection 3 (12 months); at all other time points the cons alpha coefficient exceeded .75.

The processes of change were measured using the Processes of Change Questionnaire (PCQ; Marcus, Rossi *et al.*, 1992). The PCQ comprises 39 items which form 10 subscales representing the 10 processes of change. Respondents rate on a 5-point Likert-type scale how frequently the listed events have happened to them in the last month (1 = never, 5 = repeatedly). Marcus, Rossi *et al.* report adequate internal consistency (alpha) coefficients across the 10 subscales (range = .62–.89). The alpha coefficients in the current study ranged from .61 to .92 across the 10 subscales and four time points.

Procedures

The participants were recruited from the community via advertisements in the media. Upon contacting the research team, prospective participants were screened according to the criteria stated above. After screening, respondents who fully met the criteria were entered into the study and began a six-week familiarization and baseline testing period. The centre-based groups attended supervised exercise sessions three times per week for six months, while the home-based group attended 10 training sessions in the first five weeks and then exercised unsupervised at home three times per week thereafter. These training sessions included information on how to measure the heart rate and perceived exertion, how to warm up, cool down, stretch, walk/jog safely, and do aerobics and circuit programmes. All participants were home based (unsupervised) for the second 12 months. Throughout the entire study (18 months), exercise comprised 30 min sessions (plus 10 min warm up and 10 min cool down) with four walks/jogs, one aerobics session and one circuit session each fortnight. The home-based group were provided with written instructions on all activities and recording procedures, provided with videotapes for the aerobics and audiotapes, instruction cards and tips for improvised equipment for the circuit programme.

Participants completed the questionnaires and fitness assessments at baseline, six months, 12 months and 18 months. In addition, when home based, they completed weekly activity logs in which they self-reported the activity completed, heart rate during exercise and perceived rate of exertion, and returned them by mail every two weeks. Centre-based participants had similar logs completed by the exercise leader during the first six months, before moving to self-reported logs for the remainder of the project. The log books were checked against seven-day recall diaries given during interview sessions at the end of each intervention period. Further details of the log books are given in Cox *et al.* (2003).

Written materials based on the stage of change anticipated for each of the six monthly phases of the programme were developed to assist participants as they first

adopted and then maintained an active lifestyle. The materials consisted of worksheets and information packs described briefly here and more fully in Cox *et al.* (2003). As a result of recruitment procedures, all participants were in contemplation at baseline and received information and worksheets on how to exercise, the benefits, costs and rewards for exercise and goal setting as well as being exposed to short bouts of low intensity exercise in the first few weeks. In the 6–12 month period, participants were assumed to initially be in the action stage, and intervention material based on Marcus, Banspach *et al.* (1992) and designed to promote maintenance examined feedback on progress, troubleshooting, injury prevention and overcoming obstacles and barriers. In the final period (12–18 months), longer-term maintenance was promoted through information and worksheets focused on goal setting, preventing injuries and finding an exercise partner. All participants received the worksheets at regular intervals throughout each phase to both reinforce and act as a prompt for action. Differential rates of progression through the stages were catered for in the protocol as the hand-outs in each period had some overlap with the previous period, and newsletters tended to reinforce and review material that had been given out previously. Centre-based participants received their worksheets during an exercise session and home-based participants received their worksheets by mail. Some of the information was in worksheet format and some was included within special 'project newsletters'. After the 18-month intervention, the participants were given a hand-out, 'Moving On', to promote continued adherence. Exercise leaders encouraged centre-based participants to talk about their progress and ask questions during the exercise sessions. Home-based participants were offered the same support via regular phone calls (bi-weekly for two weeks and monthly thereafter). When all participants were home-based (6–18 months), they were contacted by telephone approximately every six weeks.

Results

Retention and adherence rates for the study have been detailed and discussed elsewhere (Cox *et al.*, 2003). However, a brief summary of the frequency and chi-square analysis is provided here. Retention rates (i.e. number of people remaining in the programme) at six, 12 and 18 months were 92%, 85% and 71%, respectively. The centre-based group had higher retention rates than the home-based group at all time points. Adherence (i.e. completion of the required number of sessions) was higher in the centre-based group at six months (84% vs. 63%, $p < .001$), but there was no difference between the groups at 12 (67% vs. 77%, $p > .05$) and 18 (73% vs. 79%, $p > .05$) months. The intensity of exercise had no significant effect on retention rates at six and 12 months; at 18 months, however, moderate exercise retained significantly more participants. Intensity of exercise did not significantly influence adherence rates at six months, but at 12 months the moderate group had higher adherence than the vigorous group (78% vs. 64%, $p < .05$). However, by 18 months adherence was similar at both intensity levels (79% vs. 72%, $p > .05$).

The complexity of human behaviour change was evidence by the 115 participants demonstrating 28 patterns of change in exercise behaviour across the 18 months of the study (see Table 1); consequently verbal description is used to address the question 'What are the patterns of behaviour change for this group of older, initially sedentary women?' The largest group (45.2%) was of participants who demonstrated a linear pattern from contemplation to action to maintenance to continued maintenance at 0, 6,

12 and 18 months, respectively. Eight of the patterns (involving 29.6% of participants) resulted in drop-out from the study at some time point. There was no significant difference for any baseline characteristic for those who remained in the programme and those who dropped out, and drop-out was not associated with exercise group or intensity. The reasons for drop-out have been detailed elsewhere (Cox *et al.*, 2003) and for the purposes of the present study it is sufficient to say that the majority of reasons for drop-out were incidental to the programme (e.g. relocation). The remaining patterns evidence the periods of stagnation, progression and regression hypothesized to occur during behaviour change but resulted in only 6.1% of participants remaining sedentary at 18 months. There was no difference between the four exercise intervention groups with respect to the patterns of change, $\chi^2(3) = .359$, $p > .05$.

Table 1. Patterns of change in exercise behaviour from the contemplation stage over 18 months

	Stage							Stage						
Pattern	0 m	6 m	12 m	18 m	*N*	%	Pattern	0 m	6 m	12 m	18 m	*N*	%
1	C	d/o			14	12.2	15	C	AX	PC	AX	1	0.8
2	C	C	?	PC	1	0.8	16	C	AX	C	d/o	2	1.7
3	C	C	d/o		1	0.8	17	C	AX	C	PR	6	5.2
4	C	C	C	d/o	1	0.8	18	C	AX	C	MN	1	0.8
5	C	C	C	C	1	0.8	19	C	AX	PR	d/o	1	0.8
6	C	C	C	PR	1	0.8	20	C	AX	PR	C	1	0.8
7	C	C	C	AX	1	0.8	21	C	AX	PR	PR	2	1.7
8	C	C	PR	MN	1	0.8	22	C	AX	PR	MN	1	0.8
9	C	C	AX	MN	2	1.7	23	C	AX	AX	AX	1	0.8
10	C	PR	PC	d/o	1	0.8	24	C	AX	MN	d/o	2	1.7
11	C	PR	C	C	1	0.8	25	C	AX	MN	PC	1	0.8
12	C	PR	C	PR	1	0.8	26	C	AX	MN	C	2	1.7
13	C	PR	MN	MN	2	1.7	27	C	AX	MN	PR	2	1.7
14	C	AX	d/o		12	10.4	28	C	AX	MN	MN	52	45.2

Notes: PC = precontemplation; C = contemplation; PR = preparation; AX = action; MN = maintenance; d/o = dropout; ? = no data available at 12 months for this participant.

Cluster analysis was used to address the second question, 'Are there identifiable subgroups within stages reflecting different levels of readiness to change?' Cluster analysis is employed to identify relatively homogenous groups within a dataset based on selected attributes (Manly, 1986). The cluster procedures outlined by Hair, Anderson, Tatham, and Black (1998) guided the analysis. To ensure that all attributes are equally important within the analysis, standardized scores (*t* scores, $M = 50$, $SD = 10$) were used. An initial hierarchical cluster analysis using Ward's linkage and squared Euclidean distance was employed to identify the number of potential clusters (groups) within the data. Ward's linkage minimizes within cluster differences and avoids the formation of chain-like clusters that may be found with other methods (Aldenderfer & Blashfield, 1984). Squared Euclidean distance is the recommended distance measure for Ward's method (Hair *et al.*, 1998). There is no standard, objective selection procedure for determining the number of clusters and Hair *et al.* suggest researchers base their

decision on a combination of stopping rules, practical judgment, common sense and theoretical foundations. The stopping rules applied in this study were: visual inspection of the dendogram (visual representation of cluster formation); changes in agglomeration coefficients (large changes in agglomeration coefficients indicate dissimilar clusters are now being merged and therefore the 'ideal' number of clusters has been passed); and the 'objective' stopping rule proposed by Milligan and Cooper (1985). The final rule aims to minimize within cluster heterogeneity while maximizing between cluster heterogeneity. The number of clusters is identified where the rule returns the largest value.

While all of these stopping rules have limitations, confidence in the number of clusters identified is gained if each suggests the same number of clusters. Because cluster analysis solutions can be unstable, Hair *et al.* (1998) suggest a follow-up non-hierarchical cluster analysis, such as K-means. K-means uses the group centroid means from the hierarchical analysis as seed points for cluster formation. Final cluster centroid values and cluster size are compared with the initial hierarchical solution and, if similar, provide further confidence for the number of clusters chosen (Wang & Biddle, 2001). Having determined the number of clusters, the next step is to interpret and name the clusters, with the final step being validation of the clusters using variables not included in the original analysis. In this study, behaviour change over the next six months was used for validation, as this would indicate whether the identified substages were meaningful in the behaviour change process. Separate cluster analyses were carried out for the baseline to six-month time, and for the six- to 12-month time period (i.e. examining potential subgroups within the action stage so including only participants in action at Time 2). The 12- to 18-month time period was not investigated due to the diminishing sample size ($n = 61$).

All participants were in contemplation at baseline and the cluster analysis examined whether within this stage there were subgroups based on self-efficacy for overcoming barriers, self-efficacy for exercise competence, pros and cons of exercise, and use of experiential and behavioural processes of change. Visual inspection of the dendogram produced by the hierarchical cluster analysis suggested that either a two or four-cluster solution may be appropriate. The agglomeration schedule showed a smaller increase from three clusters merging to two, compared to five clusters merging to four, indicating that the two-cluster solution may be more suitable. In addition, Milligan and Cooper's (1985) stopping rule also identified the two-cluster solution as most suitable. The suitability of a two-cluster solution was confirmed by the K-means analysis and the profile of these two clusters is presented in Figure 1. Cluster 1 contained individuals ($n = 55$, 56.7%) who were below average in self-efficacy for overcoming barriers, pros of exercise, and use of both experiential and behavioural processes of change. This cluster was labelled 'likely non-changers', as this profile suggests these individuals may be less ready to change their behaviour. Cluster 2 contained individuals ($n = 42$, 43.3%) who were above average in self-efficacy for overcoming barriers, pros of exercise, and use of both the experiential and behavioural processes of change. This cluster was labelled 'likely changers', as this profile suggests they may be ready to change their behaviour. There was no difference between the clusters for cons of exercise (mean t score 50.57 vs. 50.32) or self-efficacy for exercise competence (mean t score 49.44 vs. 50.53), with t scores indicating that within both clusters the mean score was approximately equal to that of the entire sample of contemplators. ANOVA showed that there were no differences in physical activity or fitness levels between the two clusters ($p > .05$). To ascertain whether cluster membership influenced behaviour

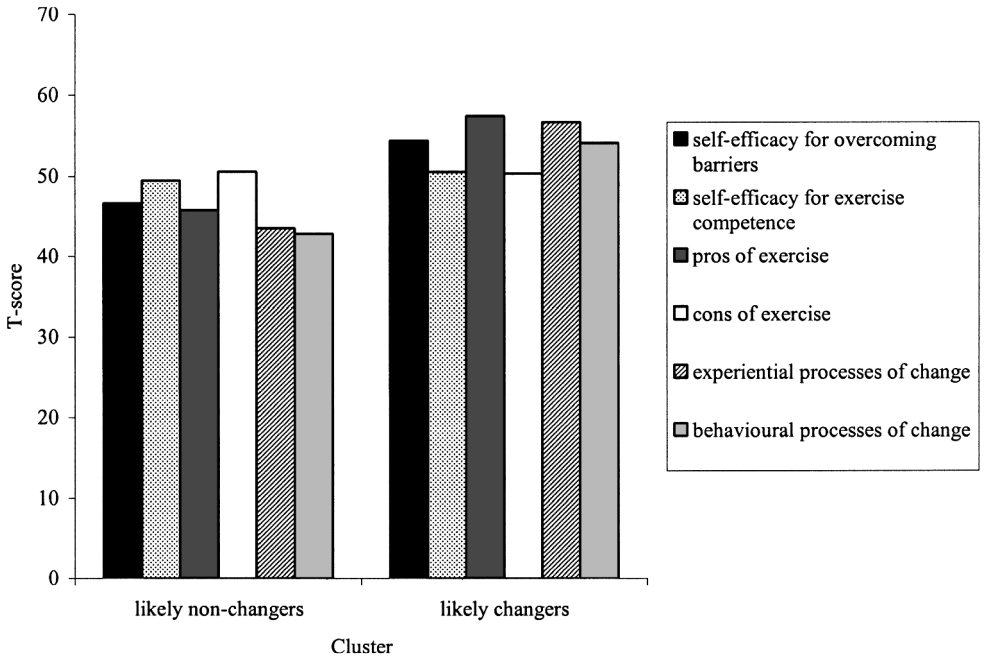

Figure 1. Clusters within the contemplation stage.

change, stage membership at six months was examined within each cluster. For the 'likely non-changers' cluster, 91.7% had progressed to action, 2.1% to preparation and 6.3% remained in contemplation. For the 'likely changers', 89.5% had progressed to action, 5.3% to preparation and 5.3% remained in contemplation. Chi-square analysis revealed that there was no significant difference in stage membership at six months between the clusters, $\chi^2(2) = .662$, $p > .05$.

Participants who were in action at six months were selected for inclusion in the second cluster analysis which examined whether there were meaningful subgroups within the action stage. Clusters were again formed on the basis of self-efficacy for overcoming barriers, self-efficacy for exercise competence, pros and cons of exercise, and use of experiential and behavioural processes of change. Visual inspection of the dendogram produced by the hierarchical cluster analysis suggested that a two- or three-cluster solution may be appropriate. The agglomeration schedule showed a smaller increase from three clusters merging to two, compared to four clusters merging to three, indicating the two-cluster solution may be more suitable. This was supported by the application of the stopping rule identified by Milligan and Cooper (1985). The two-cluster solution was confirmed by the K-means analysis and the profile of the clusters is presented in Figure 2. Cluster 1 ($n = 35$, 53.03%) contained individuals who were below average in self-efficacy for overcoming barriers, pros of exercise, and use of both behavioural and experiential processes of change. They were above average in self-efficacy for exercise competence and cons of exercise. This cluster was labelled 'likely relapsers', as the profile suggests the individuals may be at risk of relapse. Cluster 2 ($n = 31$, 46.97%) contained individuals who were above average in self-efficacy for overcoming barriers and self-efficacy for exercise competence, pros of exercise, and use of the behavioural and experiential processes of change. They were about average in

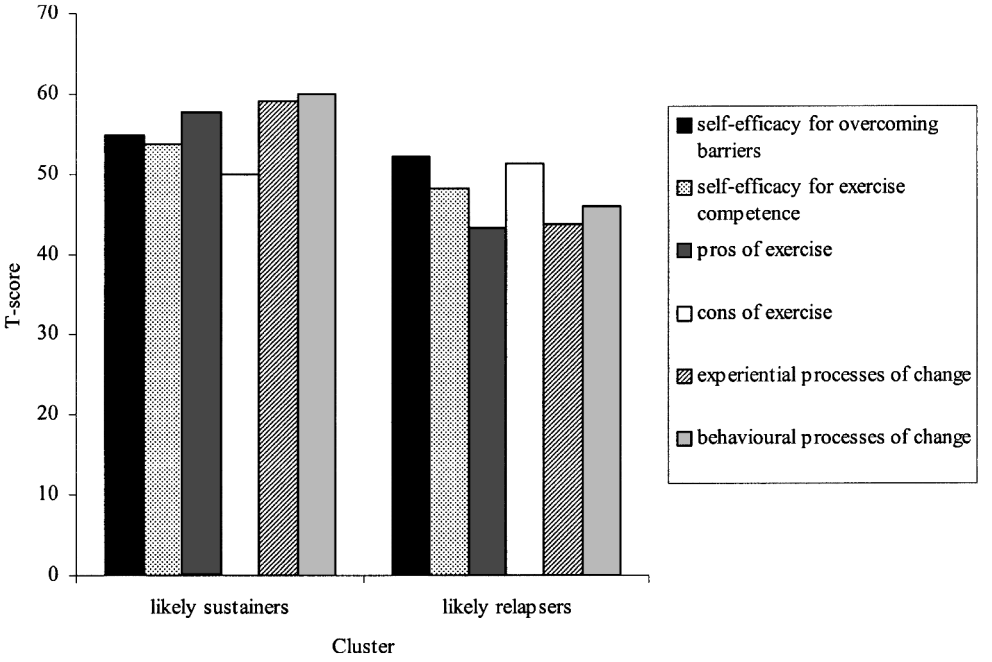

Figure 2. Clusters within the action stage.

cons of exercise. This cluster was labelled 'likely sustainers', as the profile suggests the individuals are ready to sustain change. Chi-square analysis showed no differences between the clusters in exercise location or intensity ($p > .05$). To ascertain whether cluster membership influenced behaviour change, stage membership at 12 months was examined within each cluster. For the 'likely relapsers' cluster, 77.4% had progressed to maintenance, 6.5% had regressed to preparation, 12.9% to contemplation and 3.2% to precontemplation. For the 'likely sustainers', 88.9% had progressed to maintenance, 3.7% remained in action, 3.7% had regressed to preparation, and 3.7% to contemplation. Chi-square analysis revealed that there was no significant difference in stage membership at 12 months between the clusters, $\chi^2(2) = 3.876$, $p > .005$.

Based on the patterns described in Table 1, the group of participants who successfully made the transition from contemplation to action to maintenance and continued maintenance were selected to examine the question, 'Did the core constructs of the TTM change in the predicted manner as individuals adopted a physically active lifestyle?' Separate 2 × 2 × 4 (exercise group × exercise intensity × time) MANOVA with repeated measures on the last factor were conducted for each independent variable. In analyses where sphericity was compromised (Greenhouse-Geisser <.75; Tabachnick & Fidell, 1996) the correct value is reported.

For self-efficacy for overcoming barriers, a significant time effect was observed, $F(3, 117) = 9.202$, $p < .05$, $\eta^2 = .19$. *Post hoc* analysis (Tukey's) showed that self-efficacy for overcoming barriers at contemplation ($M = 15.21$) was significantly lower than at action or the two maintenance time points (Ms = 18.02, 17.37 and 17.19, respectively). For self-efficacy for exercise competence, a significant time × exercise group interaction was observed, $F(1.62, 63.18) = 3.937$, $p < .05$, $\eta^2 = .09$. Examination of this interaction (see Fig. 3) showed that while self-efficacy for exercise competence

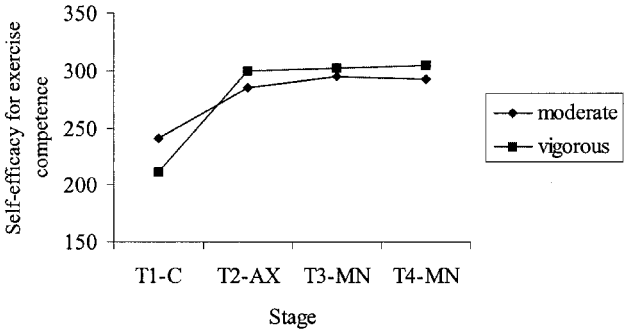

Figure 3. Time × exercise group interaction for self-efficacy for exercise competence.

increased for both groups from contemplation to action and then plateaued, this increase was greater in the vigorous exercise group. For the decisional balance variables, a significant multivariate three-way interaction was observed, $F(6, 31) = 2.594$, $p < .05$, $\eta^2 = .33$. However, in univariate follow-up, no three-way interaction was observed for pros or cons. For the behavioural processes of change there was a significant multivariate effect for time, $F(15, 27) = 7.422$, $p < .05$, $\eta^2 = .80$). Univariate follow-up demonstrated a significant time effect for each of the five behavioural processes (see Table 2). *Post hoc* analysis (Tukey's) showed that for all behavioural processes there was significantly lower use at contemplation (baseline) compared with action (six months) or maintenance (12 and 18 months). There were no significant differences at any level for the experiential processes of change.

Table 2. Univariate results for the Behavioural Processes of Change

	Stage						
Process of change	C	AX	MN_1	MN_2	F**	η^2	Tukey's ($p < .05$)
Self-liberation	11.7	15.6	15.5	15.6	29.39*	.41	$C < AX, MN_1, MN_2$
Reinforcement management	9.4	11.4	11.2	11.3	8.56*	.17	$C < AX, MN_1, MN_2$
Counterconditioning	7.8	13.2	12.9	13.0	61.08*	.60	$C < AX, MN_1, MN_2$
Stimulus control	6.4	7.8	8.1	8.0	6.54*	.14	$C < AX, MN_1, MN_2$
Helping relationships	6.7	8.8	7.9	8.3	6.87*	.14	$C < AX_1, MN_2$

*Significant, $p < .001$; **$F(3, 123)$, except for reinforcement management which is corrected for sphericity and $F(2, 83)$.
Note: C = contemplation at baseline; AX = action at six months; MN_1 = maintenance at 12 months; MN_2 = maintenance at 18 months.

Discussion

The importance of participation in regular exercise for health is well established and the ongoing challenge to health promoters is to facilitate the adoption of active lifestyles among the many individuals who are sedentary. The purpose of this study was, first, to examine the tenets of the TTM within a prospective, longitudinal design in which a stage-based exercise intervention was provided. Specifically, this research examined the

patterns of behaviour change for this group of older women as they were supported to adopt a physically active lifestyle. Secondly, this research examined whether there are identifiable subgroups who are more or less ready to adopt or maintain exercise. Finally, this research examined whether the core constructs of the TTM change in the predicted manner as individuals adopt a physically active lifestyle.

Although the majority of participants who completed the 18 months had progressed to a more active lifestyle (i.e. were in preparation, action or maintenance), during the study the patterns of change were varied. The dominant pattern was one of linear change from contemplation to action to maintenance, with the remaining patterns providing evidence of the periods of stagnation, progression and regression hypothesized to occur during behaviour change. The majority of reasons for drop-out from the study were incidental to the study and were not systematically associated with either exercise group of intensity. That only 6.1% of the original sample and 11% of those completing the project remained sedentary provides support for the efficacy of the intervention. Furthermore, there was no difference between the exercise intervention groups in terms of the patterns of change, suggesting that the intervention was effective regardless of the setting in which exercise is undertaken, or intensity. This latter observation has been made before with respect to exercise setting. Dunn *et al.* (1999) reported similar changes in physical activity, fitness and other health measures in sedentary men and women with a lifestyle physical activity intervention and a structured exercise programme after 24 months.

The role of exercise intensity on retention and adherence has not been systematically studied, although Sallis *et al.* (1986) report that the intensity of exercise is inversely associated with the adoption and maintenance of exercise programmes. Cox *et al.* (2003) have previously reported that the moderate exercise intervention retained more participants at 18 months. The reason for this not being apparent at six and 12 months could have been due to the tendency for both groups to regress towards a common or preferred intensity, with the moderate group exercising at the higher end of the moderate range (mean intensity: 55% heart rate reserve) and the vigorous group at the lower end of vigorous (mean intensity: 65% heart rate reserve). This effect has been observed by others (Dishman, Farquhar, & Cureton, 1994; King *et al.*, 1991). Furthermore, it took some time for participants to reach the more vigorous level whereas the moderate group reached their prescribed level by about eight weeks. In addition, due to soreness and injuries starting to be reported when some exercised at the upper end of the vigorous range, they were told to decrease their intensity to the lower end of the range. The cumulative effects of these variations may explain why intensity did not influence early retention levels. The influence of intensity on retention is discussed more fully in Cox *et al.* (2003).

Another reason why the patterns of change were not different between groups may have been that the underlying model was applied to both intervention groups with strategies that could be utilized in either condition depending on the perceived need of the participant. A further explanation is that the participants were part of a randomized trial as 'healthy volunteers' and may therefore have been more compliant to the exercise intervention then community exercisers (Martin & Sinden, 2001). Overall the results support the practice of providing moderate intensity programmes to improve long-term retention of participants, although giving participants a choice of both setting and exercise intensity may enhance retention and adherence further.

The possible existence of substages within contemplation was confirmed with the emergence of two clusters that were readily interpretable, had intuitive appeal, and

were similar in nature to those reported in an earlier study (Gorely & Bruce, 2000). That only two clusters (substages) were found in the present study is perhaps due to the fundamental difference between the two projects. In the current project, sedentary individuals were recruited to take part in an exercise intervention, while in the Gorely and Bruce study participants were recruited to take part in a monitoring study where no intervention was provided. It is possible that the provision of an intervention meant that individuals who were more ready to change signed up, whereas less ready individuals did not. Hence one of the substages (early contemplation) identified by Gorely and Bruce was not represented.

The most important difference, however, is the finding in the present study that the contemplation substages were not related to actual behaviour change. That is, those with a profile suggesting less readiness to change were just as likely to adopt exercise. A similar result was found for substages within the action stage, with interpretable and intuitively appealing substages seemingly identifying a group of individuals at higher risk of relapse, but there being no difference in relapse between the two action substages. There are at least two possible explanations for this finding. First, as the outcome of the cluster analysis procedure must be homogenous groups, the clusters (substages) that emerge may simply be a result of employing this statistic and therefore not be meaningful in the real world. Alternatively, the provision of stage-based intervention material may have been sufficient to assist those who were less ready to adopt or at greater risk of relapse to achieve their goals. From a practitioner's standpoint, this explanation would suggest that a single stage-appropriate and appealing intervention is sufficient to facilitate behaviour change even in those who appear less ready to change. That is, although substages may exist, practitioners do not need to increase the specificity of interventions to match these substages. Taking the present results in combination with the work of Gorely and Bruce (2000), it is suggested that substages reflecting a true temporal order of change do exist; however, these substages have limited practical utility where an intervention is provided, but perhaps help to explain the slow nature of self-change (i.e. where no intervention is supplied). In addition, it further highlights the need for more research examining the temporal links between independent constructs, stages and actual behaviour change.

The results of cross-sectional work have suggested that as sedentary individuals adopt regular exercise, there is an increase in self-efficacy, the pros of exercise, and the use of both experiential and behavioural processes of change. A decrease in the cons of exercise has also been shown to be associated with this transition in cross-sectional work (Marcus, Rakowski, & Rossi, 1992; Marcus, Rossi *et al.*, 1992). In a longitudinal study, Gorely and Bruce (2000) demonstrated support for positive changes in self-efficacy and pros of exercise within individuals as they adopted exercise. However, these authors reported no change in cons during the transition. The current results offer partial support for this finding. Self-efficacy for overcoming barriers was again shown to be important in the adoption of exercise with significant increases between contemplation and action regardless of intervention condition. Self-efficacy for exercise competence also increased from contemplation to action but was greatest in the vigorous exercise group, perhaps indicating that successful completion of 'harder' exercises results in greater increases in exercise-specific self-efficacy. Regardless of the reason for this differential increase, the self-efficacy findings as a whole highlight once again the importance of targeting self-efficacy in behaviour change.

The findings for the decisional balance construct are difficult to interpret, as the three-way interaction was only evidenced at the multivariate level. This suggests a

degree of complexity that cannot be identified within the current study and is an area for future research. Some of the ambiguity in the findings for cons of exercise may result from the DBQ not reflecting pros, and particularly cons, that the women participants in this study identify with, or it may not reflect the complexity of how pros and cons are utilized within an individual during decision making. These are measurement issues worthy of further research exploration.

The findings for the behavioural processes of change generally support those reported in previous literature (Gorely & Gordon, 1995; Marcus, Rossi *et al.*, 1992; Marcus *et al.*, 1996). That is, individuals made greater use of all the behavioural processes as they adopted exercise. The finding that there is no change in any of the experiential processes is counter to most previous work (Gorely & Gordon, 1995; Marcus, Rossi *et al.*, 1992; Marcus *et al.*, 1996). However, Jue and Cunningham (1998) also reported no differences between stages or processes in a cross-sectional study and Marshall and Biddle (2001) have reported experiential processes increase between precontemplation and contemplation (a transition not covered in this research). The findings suggest that practical behavioural strategies are important during the transition from contemplation to action and interventions that target these should be most successful (Calfas *et al.*, 1997; Marcus *et al.*, 1996). However, it should be noted that although there were significant changes in each of the behavioural processes over time, the actual use of each process remained low except for self-liberation and counter-conditioning. For example, in action the score for stimulus control was 7.8/20, for helping relationships it was 8.8/20 and for reinforcement management it was 11.4/20. On the metric used in the PCQ, these scores reflect less than occasional use of the given process. When you add to this the argument that self-liberation and counterconditioning must increase as behaviour changes because of the inherent logic of the model definitions (Smedslund, 1997), then serious consideration must be given to whether or not the processes of change as they are currently defined and represented have utility within exercise behaviour (Marshall & Biddle, 2001).

No difference was found between action and maintenance for any of the independent constructs within the TTM. This is perhaps not surprising as the major effort in developing an active lifestyle is the first step: the adoption of exercise—hence the significant changes observed between contemplation and action. However, once active, remaining active requires effort and the present results suggest that the strategies used to become active may also be useful in promoting adherence.

In terms of the TTM, except for the uninterpretable interaction observed for the decisional balance construct and the exercise × time interaction for self-efficacy for exercise competence, no differences were found between the four intervention groups (home-moderate, home-vigorous, centre-moderate, centre-vigorous). From the practitioner's point of view this implies that the same intervention principles and strategies are likely to be effective regardless of setting or intensity of prescribed exercise—although it should be remembered that there were some retention and adherence differences between the groups, suggesting that setting and intensity may impact other aspects of behaviour change as discussed more fully in Cox *et al.* (2003).

One of the strengths of the current study is that it examines all independent constructs of the TTM across four time points. However, several limitations should be noted. First, the participants self-selected to be included in the research and the selection criteria applied may mean that the participants are not representative of the majority of individuals in contemplation. A second limitation is that only change from contemplation was investigated, so comment about the entire behaviour change cycle is

not possible. A third limitation is that stage was self-reported. However, although not overcoming this limitation entirely, the participants' weekly logs of completed exercise sessions provide some supporting evidence for their exercise stage. Finally, this study was limited to women and it is possible that men may respond to the intervention material in a different way.

The results of this study suggest that the idea of individuals changing their behaviour through a series of interdependent stages remains a useful heuristic for considering behaviour change. In line with this, designing stage-based interventions appears to efficiently facilitate behaviour change (Marcus, Bock *et al.*, 1998) and in this study the stage-based intervention was efficacious regardless of prescribed exercise intensity or location. Of the constructs suggested to facilitate forward movement through the stages, self-efficacy is the most consistently supported and increases in self-efficacy would appear to be critical to behaviour change. Behavioural strategies for change are likely to be effective in both assisting exercise adoption and then maintaining participation. Having said that, issues with the relevance of current definitions and representations of processes suggest this result should be treated with caution (Marshall & Biddle, 2001). Further longitudinal investigation of the role of the processes of change and the decisional balance construct in exercise adoption and maintenance is required, along with further exploration of the measurement of these constructs.

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Appendix: Definitions of the 10 processes of change (adapted from Marcus, Rossi *et al.*, 1992)

Process	Definition
Experiential	
Consciousness raising	Seeking new information, understanding & feedback about physical activity.
Dramatic relief	Using affective experiences associated with change.
Environmental re-evaluation	Consideration of how inactivity affects the social & physical environment.
Self re-evaluation	Emotional & cognitive reappraisal of values with respect to physical inactivity.
Social liberation	Awareness, availability & acceptance of being physically active.
Behavioural	
Self-liberation	Making a choice & commitment to change including the belief that one can change.
Reinforcement management	Changing the contingencies that control or maintain an inactive lifestyle.
Counterconditioning	Substitution of active behaviour for inactive behaviour.
Stimulus control	Control of situations that trigger inactivity.
Helping relationships	Trusting, accepting & utilizing support from others during attempts to change.