

## Aberystwyth University

### *Motivational processes and well-being in cardiac rehabilitation*

Rahman, Rachel; Thatcher, Joanne; Thøgersen-Ntoumani, Cecilie; Doust, J. H.

*Published in:*

Psychology, Health and Medicine

*DOI:*

[10.1080/13548506.2015.1017509](https://doi.org/10.1080/13548506.2015.1017509)

*Publication date:*

2015

*Citation for published version (APA):*

Rahman, R., Thatcher, J., Thøgersen-Ntoumani, C., & Doust, J. H. (2015). Motivational processes and well-being in cardiac rehabilitation: A self-determination theory perspective. *Psychology, Health and Medicine*, 20(5), 518-529. <https://doi.org/10.1080/13548506.2015.1017509>

#### **General rights**

Copyright and moral rights for the publications made accessible in the Aberystwyth Research Portal (the Institutional Repository) are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the Aberystwyth Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the Aberystwyth Research Portal

#### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

tel: +44 1970 62 2400  
email: [is@aber.ac.uk](mailto:is@aber.ac.uk)

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23

Motivational processes and well-being in cardiac rehabilitation: A Self-Determination Theory  
perspective

**Rachel Jane Rahman**, Department of Psychology, Aberystwyth University, Penbryn 5,  
Penglais Campus, Aberystwyth, Ceredigion, SY23 3UX; Tel: 01970 621749; Fax: 01970  
628781; email: [rjr@aber.ac.uk](mailto:rjr@aber.ac.uk)

**Joanne Hudson**, School of Sport, Carnegie Faculty, Leeds Beckett University, Headingley  
Campus, Leeds, West Yorkshire, LS6 3QS e-mail: [Joanne.Hudson@leedsbeckett.ac.uk](mailto:Joanne.Hudson@leedsbeckett.ac.uk)

**Cecilie Thøgersen-Ntoumani**, School of Psychology & Speech Pathology, Faculty of Health  
Sciences, Curtin University, GPO Box U1987, Perth, Western Australia 6845, Australia; **Tel:**  
+61 8 9266 5171; Fax: +61 8 9266 2464 email: [C.Thogersen@curtin.edu.au](mailto:C.Thogersen@curtin.edu.au)

**Jonathan H. Doust**, Chelsea School, Brighton University, Hillbrow, Gaudick Road,  
Eastbourne, BN20 7SR. Tel: 01273 643700; email: [J.H.Doust@brighton.ac.uk](mailto:J.H.Doust@brighton.ac.uk)

*"This is an Accepted Manuscript of an article published by Taylor & Francis Group in Psychology,  
Health and Medicine on 07/02/2015, available online:  
<http://www.tandfonline.com/doi/full/10.1080/13548506.2015.1017509#abstract>.*

## 1 **Abstract**

2 This research examined the processes underpinning changes in psychological well-being and  
3 behavioural regulation in Cardiac Rehabilitation (CR) patients using Self-Determination  
4 Theory (SDT; Deci & Ryan, 1985). A repeated measures design was used to identify the  
5 longitudinal relationships between SDT variables, psychological well-being and exercise  
6 behaviour during and following a structured CR programme. Participants were 389 cardiac  
7 patients (aged 36-84 years;  $M_{\text{age}} = 64 \pm 9$  years; 34.3% female) referred to a 12 week  
8 supervised CR programme. Psychological need satisfaction, behavioural regulation, health-  
9 related quality of life, physical self-worth, anxiety and depression were measured at  
10 programme entry, exit and 6 month post-programme. During the programme, increases in  
11 autonomy satisfaction predicted positive changes in behavioural regulation, and  
12 improvements in competence and relatedness satisfaction predicted improvements in  
13 behavioural regulation and well-being. Competence satisfaction also positively predicted  
14 habitual physical activity. Decreases in external regulation and, increases in intrinsic  
15 motivation, predicted improvements in physical self-worth and physical well-being  
16 respectively. Significant longitudinal relationships were identified whereby changes during  
17 the programme predicted changes in habitual physical activity and the mental quality of life  
18 from exit to 6 month follow-up. Findings provide insight into the factors explaining  
19 psychological changes seen during CR. They highlight the importance of increasing patients'  
20 perceptions of psychological need satisfaction and self-determined motivation to improve  
21 well-being during the structured component of a CR programme and longer-term physical  
22 activity.

23

24

1 **Key words**

2 Self-Determination Theory; Cardiac rehabilitation; well-being; psychological need  
3 satisfaction; behavioural regulation.

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

1           Cardiac Rehabilitation (CR) programmes are an essential component of care for  
2 patients who have experienced MI, cardiovascular disease and pre/post cardiac surgery  
3 (National Institute of Clinical Excellence; NICE, 2013). Typically, programmes involve a  
4 multidisciplinary team offering exercise training, education and counselling, with the aim of  
5 improving physical functioning, symptoms and quality of life (NICE, 2013).

6           CR programmes have been found to reduce deaths in cardiac patients by 27% (British  
7 Heart Foundation; 2010), improve exercise capacity, lipid, lipoprotein and blood glucose  
8 levels, and, reduce body weight, systolic and diastolic blood pressure (Balady, Fletcher, &  
9 Froelicher, 1994; Bjarnason-Wehrens et al., 2007). Research has also revealed psychological  
10 benefits in the form of improved anxiety, depression and quality of life (Yohannes, Doherty,  
11 Bundy, & Yalfani, 2010). This is important given that cardiac patients report elevated levels  
12 of anxiety and depression and poor quality of life, contributing to increased risks of  
13 secondary cardiac events (Frasure-Smith & Lespérance, 2005, 2008). Despite this, only 40%  
14 of MI patients participate in CR programmes, highlighting the need to understand exercise  
15 motivation in CR patients (BHF, 2010).

16           Studies have drawn on psychological theory to understand motivations underpinning  
17 exercise behaviour and participation in CR. One theory demonstrating relevant application is  
18 Self-Determination Theory (SDT; Deci & Ryan, 1985). SDT is concerned with the processes  
19 involved in behavioural regulation and their associated cognitive, affective and behavioural  
20 outcomes. According to SDT, individuals' self-determined regulation lies along a continuum  
21 of five increasingly internalised regulations. Amotivation signifies a lack of motivation,  
22 external regulation refers to a drive as a result of pressure from an external source, introjected  
23 regulation refers to feeling moved to engage in a behaviour but not truly accepting its value,  
24 and identified regulation refers to feeling motivated through accepting the values of the  
25 behaviour in question. Finally, intrinsic motivation signifies the most self-determined form of

1 regulation where individuals engage in behaviour for the inherent pleasure of doing so.  
2 According to SDT, self-determined regulation leads to increased persistence, well-being and  
3 likelihood to maintain behaviour (Deci & Ryan, 2002).

4 SDT further proposes that self-determined regulation and well-being result from the  
5 satisfaction of three innate psychological needs: autonomy (the need to feel volitional in  
6 one's actions), competence (the need to feel able to affect outcomes) and relatedness (the  
7 need to have supportive relationships; Wilson, Rodgers, Blanchard, & Gessell, 2003).

8 SDT has demonstrated relevance in exercise and health care contexts. As such, self-  
9 determined regulations lead to better mental health and stronger physical activity intentions  
10 (Rouse, Ntoumanis, Duda, Jolly, & Williams, 2011) and improvements in psychological  
11 outcomes in exercise referral patients (Rahman, Thøgersen-Ntoumani, Thatcher, & Doust,  
12 2011). These associations have been confirmed by meta-analysis (Ng et al., 2012).

13 More specifically, in CR, Russell and Bray (2009) used SDT to predict exercise  
14 behaviour in a cross-sectional and prospective study of CR outpatients ( $N = 68$ ,  $M_{\text{age}} = 64.9$   
15 years) with competence satisfaction demonstrating a key role as a predictor of self-  
16 determined regulation and exercise behaviour up to 6 weeks following CR. Extending these  
17 findings, Sweet, Tulloch, Fortier, Pipe, and Reid (2011) demonstrated that self-determined  
18 individuals were more likely to maintain exercise behaviour up to 24 months following CR  
19 ( $N = 251$ , 79% male,  $M_{\text{age}} = 61.4$  years).

20 These studies illustrate the applicability of SDT for predicting short and long term  
21 exercise behaviour; however, they did not examine relationships between SDT variables and  
22 psychological outcomes in a CR context. The aim of this research was therefore to use SDT  
23 to explore if changes in psychological need satisfaction predicted changes in behavioural  
24 regulation over the duration of the programme, and, if changes in psychological need

1 satisfaction and behavioural regulation during the programme predicted changes in  
2 psychological well-being during the programme, and, from exit to 6-month follow-up.

3 It was hypothesised that increases in psychological need satisfaction would predict  
4 improvements in self-determined regulation and decreases in more controlled regulations  
5 during the programme (entry to exit), and, that increases in psychological need satisfaction  
6 and self-determined regulation and decreases in controlled forms of regulation during the  
7 programme (entry to exit) would predict improvements in psychological well-being and  
8 habitual physical activity during the programme (entry to exit) and beyond (exit to 6 month  
9 follow-up).

10

## 11 **Methods**

### 12 *Participants*

13 577 participants were referred to the CR scheme over 3 years (age range 18-87 years;  
14  $M_{\text{age}} = 64 \pm 10$  years; 35.3% female). 484 were invited to start classes during the research  
15 period and 389 consented (age range 36-84 years;  $M_{\text{age}} = 64 \pm 9$  years; 34.3% female). No  
16 significant differences in age ( $t(721) = .78, p > .05$ ) or gender ( $Z(1) = -.44, p > .05$ ) were  
17 identified between the total referral group and the research participants. Figure 1 presents a  
18 flow diagram of participation which illustrates that not all of the 389 consenting participants  
19 returned each questionnaire at each time point. 243 completed the programme during the  
20 research period. Many did not provide a reason for drop-out (48%), four died during the  
21 programme (non-programme related), other reasons included ill-health, family or work  
22 commitments, moving and lack of time. Comparisons of programme completers and non-  
23 completers using a Mann-Whitney Test demonstrated a significant difference in anxiety  
24 ( $U(248)=5392.5, p<.05$ ), depression ( $U(248)=5294.0, p<.05$ ) and MCS of the SF-36v2 (see

1 below;  $U(245)=5645.0, p<.05$ ) with completers reporting significantly higher levels of well-  
2 being.

3 [Insert Figure 1 here]

#### 4 *Measures*

5 *Behavioural Regulation in Exercise Questionnaire-2* (BREQ-2; Markland & Tobin,  
6 2004a) measured participants' exercise regulation and comprised 19 items [5-point scale  
7 ranging from 0 (*Not true for me*) to 4 (*Very true for me*)] with 5 subscales representing the  
8 motivational regulations. Reliability analyses show high Cronbach's alphas ranging from .73-  
9 .86 for subscales (Markland & Tobin, 2004a).

10 *Psychological Need Satisfaction Scale* (PNSS; Markland & Tobin, 2004b) comprises  
11 9 items (3 for each need) measuring psychological need satisfaction in an exercise class  
12 context. The response scale matches that of the BREQ-2. Cronbach's alphas range between  
13 .59 and .72 (Markland & Tobin, 2004b).

14 *Hospital Anxiety and Depression Scale* (HADS; Zigmond & Snaith, 1983) is a 14-  
15 item questionnaire [4-point scale; scores ranging from 0-21] consisting of subscales for  
16 anxiety and depression. Both subscales report alpha values exceeding .90 (Moorey et al.,  
17 1991).

18 *Short Form-36version2* (SF-36v2; Wade, Snow, Kosinski, & Gandek, 1993, 2002)  
19 measured health-related quality of life. The 36 items measure physical and social functioning,  
20 role limitations due to physical and emotional problems, mental health, vitality, pain and  
21 general health. Response scales vary by question. Scores form 2 summaries: the physical  
22 component summary (PCS) and the mental component summary (MCS). Cronbach's alphas  
23 for the subscales range from .80-.95 (Jenkinson, Stewart-Brown, Petersen, & Paice, 1999).



1            *Baecke's Questionnaire of Habitual Physical Activity* (BeackeHPA ; Baecke, Burema,  
2 & Frijters, 1982) comprises 16 items that constitute three subscales: activity at work, sport  
3 and leisure. Response format varies by question and responses are combined, producing an  
4 overall habitual activity score. Cronbach's alphas for the total score are reported as .77  
5 (Florindo, do Rosario Dias, & Latorre, 2003).

6            *Physical Self-Perception Profile* (PSPP; Fox & Corbin, 1989) comprises 5 subscales.  
7 The physical self-worth subscale used in this study assesses an individual's general feelings  
8 about their physical self. The question format employs a four point forced choice scale in  
9 which two alternative statements are provided and individuals select the most representative  
10 statement before indicating the degree to which the statement is true for them. Coefficient  
11 alphas for the subscale exceed .80 (Fox & Corbin, 1989).

#### 12            *The Cardiac Rehabilitation programme*

13 A 12 week supervised Phase III (structured exercise training and education) and IV  
14 (maintenance) CR programme was held in 6 council owned leisure centres across Mid Wales.  
15 Adult participants with any heart condition were referred by health professionals, or, could  
16 self-refer. They included those who had suffered an MI, were awaiting/recovering from heart  
17 surgery, those with heart disease, heart failure, stable angina, or controlled arrhythmias.  
18 Anyone with uncontrolled hypertension, unstable angina or uncontrolled arrhythmias was not  
19 eligible.

20            Patients were invited to a consultation where a cardiac nurse assessed their medical  
21 history, they were briefed about the research and their participation was requested.  
22 Participants provided informed consent and were invited to attend an induction followed by  
23 twice weekly 60 minute exercise classes: one gym based and one circuit session. Qualified  
24 exercise professionals taught participants how to exercise safely and gradually increase

1 exercise intensity. Both exercise sessions included cardiovascular and strength based exercise  
2 with warm up/warm down protocols of approximately 10 minutes within the hour.  
3 Participants wore heart rate monitors and were encouraged to work between 60-75% of their  
4 maximum heart rate, as determined by the exercise professionals. On completion of the  
5 programme participants were offered a 6 month maintenance package, which entitled them to  
6 access exercise facilities at reduced cost.

### 7 *Procedures*

8 Ethical approval for the study was obtained from an NHS ethics Committee. The SF-  
9 36v2, PSPP and the HADS were posted for completion prior to commencing classes.  
10 Participants met with a researcher during their first class and completed the BaeckeHPA. The  
11 BREQ-2, the PNSS, a covering letter and a pre-paid return envelope were sent to participants  
12 following their first class. Following their final class, participants met with the researcher to  
13 complete the BaeckeHPA and were asked to complete all other measures independently.  
14 Those who completed the programme were also contacted 6 months later and asked to  
15 complete all measures again.

### 16 **Data analysis**

17 Assumptions for multicollinearity, independence of outcome variables, independent  
18 errors homoscedasticity, normally distributed errors and linearity were tested. Data were not  
19 normally distributed and remained so following log and root transformations. Thus original  
20 raw data were retained. An intent to treat analysis was utilised where baseline data was  
21 carried forward to missing time points to provide a conservative effect of changes seen during  
22 the programme. Wilcoxon signed rank and Friedman tests were used to examine whether  
23 there were significant differences in variables across time points.

1           In the longitudinal analysis, all variable scores at entry were force entered into a simple  
2 linear regression model and used to predict scores of the same variable at exit; standardised  
3 residual scores were retained. The same procedure was used when examining if exit predicted  
4 6 month follow-up. Residual scores were used as indicators of change in each variable and  
5 were used in subsequent analyses. Change scores (residuals) were force entered into linear  
6 regression analyses to explore: 1) change in psychological needs predicting change in  
7 behavioural regulations (entry to exit), and, 2) change in psychological needs and behavioural  
8 regulations (entry to exit) predicting change in psychological outcomes and habitual activity  
9 (entry to exit and exit to follow-up).

## 10 **Results**

### 11 *Descriptive statistics*

12           Table 1 shows how competence and relatedness satisfaction both significantly  
13 increased from entry to exit with levels of competence remaining significantly higher at 6  
14 months than at entry. In contrast, relatedness satisfaction significantly decreased from exit to  
15 6 month follow-up, resulting in significantly lower relatedness satisfaction at 6 months post  
16 programme than at entry. No changes were observed in autonomy satisfaction. External  
17 regulation significantly decreased from entry to exit and remained significantly different from  
18 entry to 6 months; however intrinsic motivation remained unchanged during the programme  
19 but then significantly decreased from baseline to 6 months.

20           All psychological outcomes improved significantly from entry to exit, with  
21 improvements in physical self-worth and the PCS of the SF-36v2 maintained at 6 months.  
22 Significant increases in habitual physical activity were seen at programme exit and were  
23 maintained at 6 month follow-up.

1 [Insert Table 1 here]

2 *Inferential statistics*

3 Table 2 shows the correlation matrix between all residual scores used in subsequent  
4 regression models. Table 3 shows how changes in psychological needs predicted changes in  
5 outcome variables during the programme. Increases in autonomy satisfaction significantly  
6 predicted decreases in amotivation and external regulation, and, increases in intrinsic  
7 motivation. Increases in competence satisfaction predicted an increase in intrinsic motivation,  
8 physical well-being and habitual physical activity and a decrease in depression. Finally  
9 increases in relatedness satisfaction predicted increases in identified regulation and mental  
10 well-being.

11  
12 [Insert Tables 2 and 3 here]

13  
14 Table 4 shows how changes in behavioural regulation (entry to exit) predicted  
15 changes seen in psychological well-being (entry to exit). A decrease in external regulation  
16 predicted an increase in physical self-worth whilst increases in intrinsic motivation predicted  
17 increases in SF-36v2-PCS.

18 [Insert Table 4 here]

19  
20 The results of analyses exploring whether changes in psychological needs and  
21 behavioural regulation that were experienced during the programme predicted psychological  
22 well-being and habitual physical activity from exit to follow-up, demonstrated that changes in  
23 autonomy satisfaction from entry to exit negatively predicted changes in the mental  
24 component of quality of life ( $\text{Adj } R^2 = .068, F(128)=4.122, p < .01$ ; standardised  $\beta = -.244, p$   
25  $< .01$ ) whilst changes in intrinsic motivation from entry to exit positively predicted changes

1 in habitual physical activity from exit to 6 months ( $\text{Adj } R^2 = .075$ ,  $F(170)=3.774$ ,  $p < .01$ ;  
2 standardised  $\beta = -.219$ ,  $p < .05$ ).

3

#### 4 **Discussion**

5 This research employed SDT as a framework to explore how psychological need  
6 satisfaction and behavioural regulation relate to change in CR patients' psychological well-  
7 being and physical activity following an exercise based CR programme. The hypothesis was  
8 supported. Specifically, increased autonomy satisfaction during the programme predicted  
9 decreased amotivation and external regulation, and, increased intrinsic motivation. It appears  
10 that autonomy was central to internalising behavioural regulations for exercise. However,  
11 satisfaction of this psychological need had no direct benefit for psychological well-being.

12 Both competence and relatedness satisfaction predicted behavioural regulation and  
13 psychological and behavioural outcomes in the expected direction. Competence satisfaction  
14 predicted an increase in intrinsic motivation, physical quality of life and habitual physical  
15 activity, as well as a decrease in depression during the supervised CR exercise programme. It  
16 appears that following the potential disruption to physical ability and daily functioning  
17 resulting from a cardiac event or disease (Hobbs et al., 2002), whether an individual  
18 subsequently feels competent to exercise contributes to their enjoyment of CR, their  
19 perception of their physical well-being and depression level. It also makes intuitive sense that  
20 an individual's perceived ability to exercise is likely to positively influence their levels of  
21 activity (Rhodes & Nigg, 2011).

22 This lends support to findings by Russell and Bray (2009) who identified competence  
23 satisfaction as a key predictor of self-determined motivation in CR. Given that competence  
24 satisfaction is modifiable, for instance, by providing positive feedback (Ryan, Patrick, Deci,  
25 & Williams, 2008) this finding identifies a potential mechanism for reducing depression,

1 considered to be a key contributor to secondary cardiac events (Frasure-Smith & Lespérance,  
2 2005, 2008), as well as encouraging self-determined motivation to engage in CR and physical  
3 activity.

4           Increases in relatedness satisfaction significantly predicted increased identified  
5 regulation and mental well-being. Thus, feeling connected to the exercise environment may  
6 contribute to the internalisation process whereby individuals begin to identify with the values  
7 of exercise. This sense of support is key to enhancing psychological aspects of quality of life.

8           Becoming less externally regulated from entry to exit predicted increases in physical  
9 self-worth. This may stem from increased pride in physical achievements given the  
10 opportunity to regain ownership of one's behaviour, feeling less controlled by external  
11 sources and actively participating in risk factor modification. This relationship between  
12 external regulation and physical self-worth therefore suggests the importance of encouraging  
13 CR participants to be more self-determined during programme delivery.

14           Finally, increasing intrinsic motivation from entry to exit predicted improvements in  
15 the quality of life-PCS over this period, supporting the SDT proposal that self-determined  
16 motivation is necessary for increased well-being (Deci & Ryan, 2002). A possible  
17 explanation for this relationship is that participants who became more self-determined during  
18 the programme adhered more and benefitted from the exercise, thus they perceived an  
19 improvement in their physical well-being. Alternatively individuals who enjoyed the exercise  
20 might have been more likely to acknowledge the benefits accrued.

21           There were no associations between changes in behavioural regulation from entry to  
22 exit and changes in well-being at 6 month follow-up. However, increased intrinsic motivation  
23 during the programme predicted subsequent increases in habitual physical activity at 6 month  
24 follow-up. As the aim of CR is to encourage long-term behaviour change this finding

1 indicates the importance of helping patients to feel self-determined and enjoy their exercise  
2 sessions in achieving this aim. Increased autonomy satisfaction significantly predicted  
3 decreases in the mental aspects of quality of life from exit to 6 months. This is an unexpected  
4 finding and suggests that those who became more autonomous during the programme were  
5 less likely to adapt well psychologically in the sixth months following the structured  
6 programme. It may be that those individuals with higher levels of autonomy satisfaction, and  
7 who were therefore participating through volitional choice felt despondent when the formal  
8 element of the programme ended thus having a negative impact on their mental well-being.

9         The lack of other significant longitudinal relationships between changes in need  
10 satisfaction and psychological outcomes in the 6 months post programme suggests that  
11 effects might be context specific. Thus changes experienced could well have little impact  
12 after formal delivery of the programme where structured support of need satisfaction is  
13 available for participants. In this case, social and environmental factors such as access to  
14 facilities and social support from family and friends might better explain subsequent changes  
15 in psychological need satisfaction.

16         However, limitations of the current study could also contribute to these non-  
17 significant effects. Some variables were not normally distributed which should be considered  
18 when interpreting regression analyses. Although attributable to the clinical sample including  
19 a higher proportion of participants with low well-being scores compared with those typically  
20 seen in a non-clinical sample (Vickers, 2007) this is likely to have resulted in reduced power.

21         Despite this, this study has advanced the current literature by demonstrating how  
22 changes in components of SDT might help to explain changes in psychological well-being  
23 during a CR programme and in physical activity following the programme. Competence  
24 satisfaction and self-determined regulation appear to contribute significantly to improved  
25 well-being and activity within this context, lending support to previous research in CR.

1 Although the study demonstrated that the CR programme was effective in improving  
2 individuals' psychological need satisfaction, the programme was not designed with this  
3 explicit goal in mind. Therefore future research would benefit from examining the effects of  
4 an SDT based exercise intervention on psychological and behavioural outcomes in similar  
5 clinical populations.

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22



## 1 **References**

- 2 Baecke, J.A.H., Burema, J., & Frijters, J.E.R. (1982). A short questionnaire for the  
3 measurement of habitual physical activity in epidemiological studies. *American Journal*  
4 *of Clinical Nutrition*, *36*, 936-942.
- 5 Balady, G. Fletcher, B., & Froelicher, E. (1994). Cardiac rehabilitation programs: A  
6 statement for health care professionals from the American Heart Association.  
7 *Circulation*, *90*, 1602-1610.
- 8 Bjarnason-Wehrens, B., Bott, D., Benesch, L., Bischoff, K.O., Buran-Kilian, B., & Gysan,  
9 D. *et al.* (2007). Long-term results of a three-week intensive cardiac out-patient  
10 rehabilitation program in motivated patients with low social status. *Clinical Research*  
11 *in Cardiology*, *96*, 77-85. doi:10.1007/s00392-007-04610-0.
- 12 British Heart Foundation (2010). The national audit of cardiac rehabilitation; Annual  
13 statistics report 2010. British Heart Foundation: Northampton.
- 14 Deci, E.L., & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human*  
15 *behavior*. New York: Plenum.
- 16 Deci, E.L., & Ryan, R.M. (2002). An overview of self-determination theory: An organismic-  
17 dialectical perspective. In E. L. Deci & R.M. Ryan (Eds.), *Handbook of self-*  
18 *determination research* (pp. 3-33). Rochester NY: University of Rochester Press.
- 19 Florindo, A.A., do Rosario Dias, M., & Latorre, O. (2003). Validation and reliability of the  
20 Baecke questionnaire for the evaluation of habitual physical activity in adult men.  
21 *Revista Brasileira de Medicina do Esporte*, *9*, 1517-8692. doi:10.1590/s1517-  
22 86922003000300002.
- 23 Fox, K.R., & Corbin, C.B. (1989). The Physical Self-Perception Profile: Development and  
24 preliminary validation. *Journal of Sport and Exercise Psychology*, *11*, 408-430.
- 25 Frasure-Smith, N., & Lespérance, F. (2005). Reflections on depression as a cardiac risk

1 factor. *Psychosomatic Medicine, Supplement 1*, S19-S25.  
2 doi:10.1097/01.psy.0000162253.07959.db.

3 Frasura-Smith, N., & Lespérance, F. (2008). Depression and anxiety as predictors of 2-year  
4 cardiac events in patients with stable coronary artery disease. *Archives of General*  
5 *Psychiatry, 65*, 62-71. doi:10.1001/archgenpsychiatry.2007.4

6 Hobbs, F.D.R., Kenkre, J.E., Roalfe, A.K., Davis, R.C., Hare, R., & Davies, M.K. (2002).  
7 Impact of heart failure and left ventricular systolic dysfunction on quality of life. A  
8 cross-sectional study comparing common chronic cardiac and medical disorders and a  
9 representative adult population. *European Heart Journal, 23*, 1867-1876.  
10 doi:10.1053/euhj.2002.3255.

11 Jenkinson, C., Stewart-Brown, S., Petersen, S., & Paice, C. (1999). Assessment of  
12 the SF-36 version 2 in the United Kingdom. *Journal of Epidemiology and Community*  
13 *Health, 53*, 46-50. doi:10.1136/jech.53.1.46.

14 Markland, D., & Tobin, V. (2004a). A modification to the Behavioural Regulation in  
15 Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and*  
16 *Exercise Psychology, 26*, 191-196.

17 Markland, D., & Tobin, V. (2004b). On the relationships among perceived  
18 environmental supportiveness, psychological need satisfaction and intrinsic  
19 motivation: A comparison of alternative models. International Self-Determination  
20 Theory Conference II. Ottawa, Canada.

21 Moorey, S., Greer, S., Watson, M., Gorman, C., Rowden, L., & Tunmore, R. *et al.* (1991).  
22 The factor structure and factor stability of the Hospital Anxiety and Depression Scale in  
23 patients with cancer. *British Journal of Psychiatry, 158*, 255-259.  
24 doi:10.1192/bjp.1582.255.

25 National Institute for Clinical Excellence (2013). MI: secondary prevention in primary and

- 1 secondary care for patients following a myocardial infarction. (NICE Clinical  
2 guidance 172): London.
- 3 Ng, J.Y.Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E.L., Ryan, R.M., & Duda, J.L. et  
4 al., (2012). Self-determination theory applied to health contexts: A meta-analysis.  
5 *Perspectives on Psychological Science*, 7(4), 325-340.
- 6 Rahman, R.J., Thøgersen-Ntoumani, C., Thatcher, J., & Doust, J. (2011). Changes in need  
7 satisfaction and motivation orientation as predictors of psychological and behavioural  
8 outcomes in exercise referral. *Psychology and Health*, 26, 1521-1539.  
9 doi:10.1080/08870446.2010.538849.
- 10 Rhodes, R.E., & Nigg, C.R. (2011). Advancing physical activity theory: a review and future  
11 directions. *Exercise & Sport Sciences Reviews*, 39(3), 113-119.
- 12 Rouse, P.C., Ntoumanis, N., Duda, J.L., Jolly, K., & Williams, G.C. (2011). In the  
13 beginning: Role of autonomy support on the motivation, mental health and intentions  
14 of participants entering an exercise referral scheme. *Psychology and Health*, 26, 729-  
15 749. doi:10.1080/08870446.2010.492454.
- 16 Russell, K.L., & Bray, S.R. (2009). Self-determined motivation predicts independent, home  
17 based, exercise following cardiac rehabilitation. *Rehabilitation Psychology*, 54, 150-  
18 156. doi:10.1037/a0015595.
- 19 Russell, K.L., & Bray, S.R. (2010). Promoting self-determined motivation for  
20 exercise in cardiac rehabilitation: The role of autonomy support. *Rehabilitation  
21 Psychology*, 55, 74-80. doi:10.1037/a0018416.
- 22 Ryan, R.M., Patrick, H., Deci, E.L., & Williams, G.C. (2008). Facilitating health behaviour

1 change and its maintenance. Interventions based on self-determination theory. *The*  
2 *European Health Psychologist*, 10, 2-5.

3 Sweet, S.N., Tulloch, H., Fortier, M.S., Pipe, A.L., & Reid, R.D. (2011). Patterns of  
4 motivation and ongoing exercise activity in cardiac rehabilitation settings: A 24-  
5 month exploration from the TEACH study. *Annals of Behavioral Medicine*, 42, 55-63.

6 Vickers, A. J. (2007). *If the normal distribution is so normal, how come my data never are?*  
7 Medscape Business of Medicine at <http://www.medscape.com/viewarticle/556012>. Last  
8 viewed 15<sup>th</sup> May 2007.

9 Wade, J.E., Snow, K.K., Kosinski, M., & Gandek, B. (1993). *SF-36® Health Survey: Manual*  
10 *& Interpretation Guide*. Lincoln, RI: QualityMetric Incorporated.

11 Wade, J.E., Snow, K.K., Kosinski, M., & Gandek, B. (2002). *SF-36® Health Survey: Manual*  
12 *& Interpretation Guide*. Lincoln, RI: QualityMetric Incorporated.

13 Williams, G.C., McGregor, H.A., Sharp, D., Kouides, R.W., Levesque, C.S., & Ryan, R.M.  
14 et al. (2006). A self-determination multiple risk intervention trial to improve smokers'  
15 health. *Journal of General Internal Medicine*, 21, 1288-1294. doi:10.1111/j.1525-  
16 1497.2006.00621.x.

17 Wilson, P.M., Rodgers, W.M., Blanchard, C.M., & Gessell, J.G. (2003). The relationship  
18 between psychological needs, self-determined motivation, exercise attitudes, and  
19 physical fitness. *Journal of Applied Social Psychology*, 33, 2373-2392.  
20 doi:10.1111/j.1559-1816.2003.tb01890.x.

21 Yohannes, A.M., Doherty, P., Bundy, C., & Yalfani, A. (2010). The long term benefits of  
22 cardiac rehabilitation on depression, anxiety, physical activity and quality of life.  
23 *Journal of Clinical Nursing*, 19, 2806-2813. doi:10.1111/j.1365-2702.2010.03313.x.

24 Zigmond, A.S., & Snaith, R.P. (1983). The Hospital Anxiety and Depression Scale. *Acta*  
25 *Psychiatrica Scandinavia*, 67, 361–370. doi:10.1111/j/1600-0447.1983.tb09716.x.

26

1 Figure 1: Flow diagram of participant involvement in research.

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

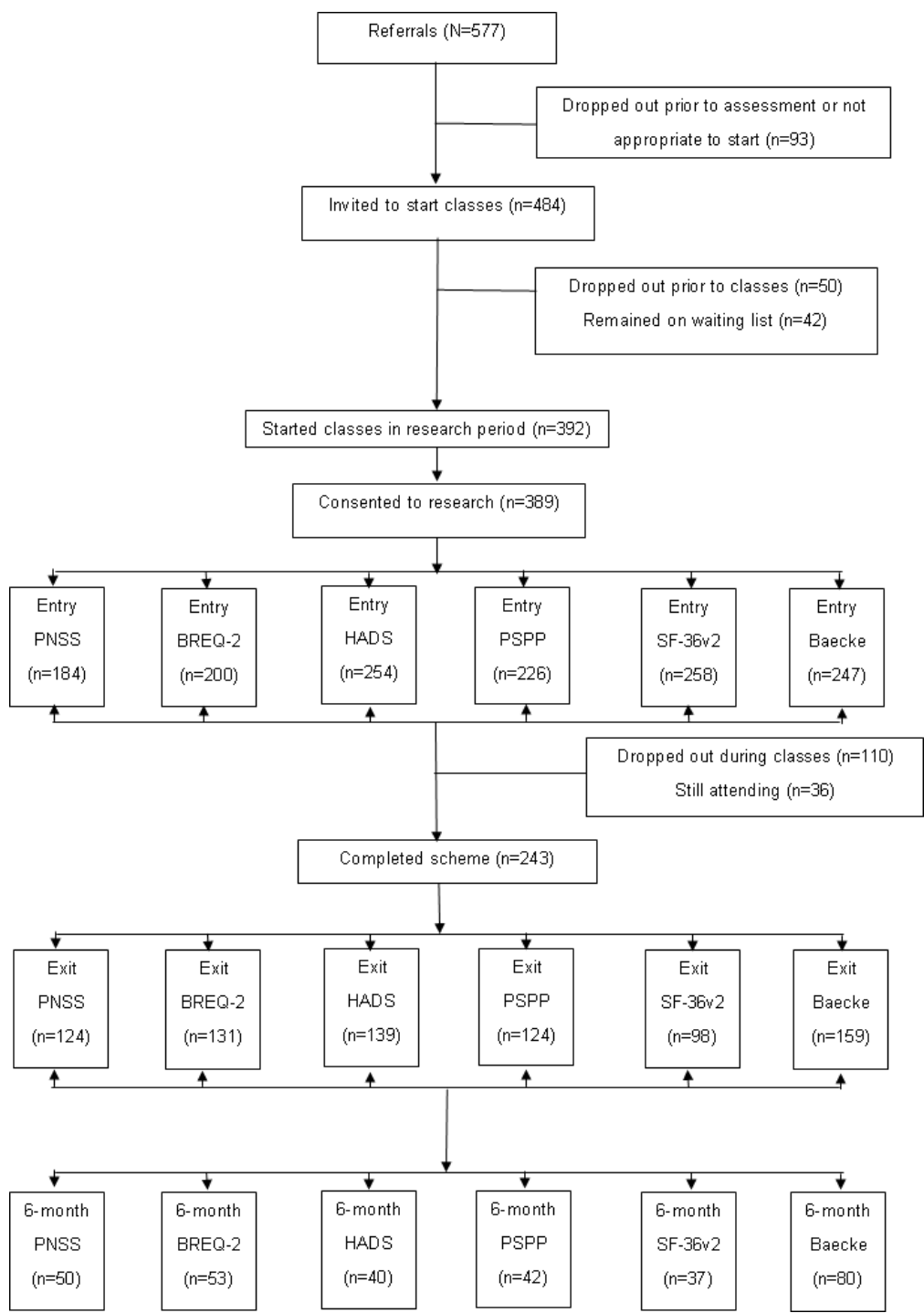
21

22

23

24

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25



1 Table 1: Entry, exit and 6 month scores for psychological need satisfaction, behavioural  
 2 regulation and psychological well-being.

	Score Range	N	Entry Mean $\pm$ SD	Exit Mean $\pm$ SD	6-month Mean $\pm$ SD
Autonomy	0-12	184	8.24 $\pm$ 2.66	8.43 $\pm$ 2.61	8.23 $\pm$ 2.70
Competence	0-12	184	8.90 $\pm$ 2.40	9.58 <sup>a</sup> $\pm$ 2.25	9.09 <sup>ab</sup> $\pm$ 2.41
Relatedness	0-12	184	10.81 $\pm$ 1.81	11.01 <sup>a</sup> $\pm$ 1.87	10.54 <sup>ab</sup> $\pm$ 2.07
Amotivation	0-4	200	0.20 $\pm$ 0.54	0.18 $\pm$ 0.47	0.21 $\pm$ 0.55
External regulation	0-4	200	0.71 $\pm$ 0.94	0.58 <sup>a</sup> $\pm$ 0.86	0.62 <sup>a</sup> $\pm$ 0.91
Introjected regulation	0-4	200	1.56 $\pm$ 1.10	1.62 $\pm$ 1.11	1.55 $\pm$ 1.11
Identified regulation	0-4	200	3.06 $\pm$ 0.75	3.08 $\pm$ 0.70	3.06 $\pm$ 0.75
Intrinsic motivation	0-4	200	3.02 $\pm$ 0.85	3.09 $\pm$ 0.82	2.97 <sup>b</sup> $\pm$ 0.91
Habitual physical activity	2-12	247	5.42 $\pm$ 1.51	5.80 <sup>a</sup> $\pm$ 1.50	5.58 <sup>ab</sup> $\pm$ 1.56
Anxiety	0-21	255	6.91 $\pm$ 4.65	6.45 <sup>a</sup> $\pm$ 4.39	6.80 <sup>b</sup> $\pm$ 4.60
Depression	0-21	254	4.93 $\pm$ 3.67	4.61 <sup>a</sup> $\pm$ 3.53	4.78 <sup>a</sup> $\pm$ 3.71
Physical self-worth	6-24	226	13.58 $\pm$ 3.94	14.23 <sup>a</sup> $\pm$ 3.77	13.83 <sup>ab</sup> $\pm$ 3.84
PCS of SF-36v2	0-100	258	38.67 $\pm$ 10.13	40.22 <sup>a</sup> $\pm$ 10.34	39.11 <sup>ab</sup> $\pm$ 10.24
MCS of SF-36v2	0-100	258	44.74 $\pm$ 12.50	46.39 <sup>a</sup> $\pm$ 12.41	44.94 <sup>b</sup> $\pm$ 12.79

<sup>a</sup> significant difference from entry  $p < .05$ ; <sup>b</sup> significant difference from exit  $p < .05$

3  
 4  
 5  
 6  
 7  
 8  
 9

1 Table 2: Correlation matrix of residual scores.

2

		Change scores (residuals) from entry-exit programme							
		Autonomy	Competence	Relatedness	Amotivation	External	Introjected regulation	Identified regulation	Intrinsic motivation
Change scores (residuals) from entry – exit of programme	Amotivation	-.235**	.150*	.017					
	External	-.185*	-.139	.075					
	Introjected	.087	.096	.168*					
	Identified	.085	.142	.204**					
	Intrinsic	.259**	.312**	.154*					
	Anxiety	-.137	-.177*	-.091*	.132	.078	-.187*	-.078	-.008
	Depression	-.017	-.224**	-.166	.067	-.021	-.111	-.128	-.092
	Physical SW	-.025	.160	.104	-.009	-.246**	-.005	.156	.191*
	PCS of SF-36v2	.151	.269**	.138	-.041	-.190*	.149	.110	.272**
	MCS of SF-36v2	.208*	.199**	.218**	-.023	-.013	.134	.094	-.094
	Habitual PA	-.001	-.264**	.085**	-.052	-.116	.159*	.113	.122
Change scores (residuals) from exit-6 months post programme	Anxiety	.161*	.095	-.004	-.104	.029	.178*	.046	.011
	Depression	.039	.126	.048	-.053	.047	.053	.116	.120
	Physical SW	-.032	-.032	-.047	-.144	-.050	.105	-.042	-.073
	MCS of SF-36v2	-.261**	-.066	-.167	.027	.029	.135	.057	-.120
	PCS of SF-36v2	-.067	-.138	-.088	-.035	-.045	-.128	-.110	-.154
	Habitual PA	.073	-.023	.048	-.033	.017	.095	.256**	.256**

3 \*  $p < .05$ ; \*\*  $p < .01$  Habitual PA = Habitual physical activity; Physical SW = Physical self-worth

4

5

6

7

8

9

10

11



1 Table 3: Changes in psychological need satisfaction from entry to exit predicting changes in  
 2 behavioural regulation, well-being and habitual physical activity from entry to exit.

	N	Adj. R <sup>2</sup>	F	B	SE	β
Amotivation	176	.061	4.777*			
Autonomy				-.212	.070	-.226**
Competence				-.131	.073	-.139
Relatedness				.099	.072	.106
External regulation	175	.049	4.019**			
Autonomy				-.172	.071	-.181*
Competence				-.143	.074	-.151
Relatedness				.141	.073	.149
Introjected regulation	175	.017	1.992			
Identified regulation	175	.034	3.041*			
Autonomy				.042	.074	.044
Competence				.081	.077	.083
Relatedness				.167	.076	.172*
Intrinsic motivation	175	.123	9.098**			
Autonomy				.175	.065	.195**
Competence				.237	.067	.263**
Relatedness				.041	.067	.045
Anxiety	155	.025	2.341			
Depression	155	.033	2.771*			
Autonomy				.044	.078	.046
Competence				-.223	.081	-.230**
Relatedness				.001	.077	.001
Physical self-worth	147	.027	2.365			
PCS of SF-36V2	129	.079	4.641**			
Autonomy				.109	.086	.108
Competence				.259	.086	.249**
Relatedness				.143	.111	.110
MCS of SF-36V2	129	.088	5.127**			
Autonomy				.192	.099	.166
Competence				.188	.099	.163
Relatedness				.286	.128	.190*
Habitual physical activity	154	.054	3.886*			
Autonomy				-.041	.070	-.047
Competence				.225	.069	.269**
Relatedness				.009	.068	.011

<sup>a</sup> $p < .05$ ; <sup>b</sup> $p < .01$

3  
4

1 Table 4: Changes in behavioural regulation from entry to exit predicting changes in well-  
 2 being and habitual physical activity from entry to exit.

	N	Adj. R <sup>2</sup>	F	B	SE	β
Anxiety	174	.035	2.256			
Depression	173	-.003	0.903			
Physical self-worth	159	.059	2.972*			
Amotivation				.101	.082	.102
External regulation				-.247	.089	-.230**
Introjected regulation				-.027	.085	-.027
Identified regulation				-.031	.102	-.031
Intrinsic motivation				.193	.105	.181
PCS of SF-36v2	133	.085	3.459**			
Amotivation				.140	.100	.133
External regulation				-.197	.110	-.157
Introjected regulation				.020	.088	.119
Identified regulation				-.092	.117	-.084
Intrinsic motivation				.398	.139	.319**
MCS of SF-36v2	133	.025	1.670			
Habitual physical activity	171	.034	2.180			

\*  $p < .05$ ; \*\*  $p < .01$

3  
 4  
 5  
 6  
 7  
 8  
 9