



**QUEEN'S
UNIVERSITY
BELFAST**

Mediators of behaviour change maintenance in physical activity interventions for young and middle aged adults: a systematic review

Murray, J. M., Brennan, S. F., French, D. P., Patterson, C. C., Kee, F., & Hunter, R. F. (2018). Mediators of behaviour change maintenance in physical activity interventions for young and middle aged adults: a systematic review. *Annals of Behavioral Medicine*, 52(6), 513-529. <https://doi.org/10.1093/abm/kay012>

Published in:

Annals of Behavioral Medicine

Queen's University Belfast - Research Portal:

[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights

Copyright 2018 Elsevier.

This supplementary file is distributed under a Creative Commons Attribution-NonCommercial-NoDerivatives License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits distribution and reproduction for non-commercial purposes, provided the author and source are cited.

General rights

Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

Open Access

This research has been made openly available by Queen's academics and its Open Research team. We would love to hear how access to this research benefits you. – Share your feedback with us: <http://go.qub.ac.uk/oa-feedback>

Supplementary file 4: Indirect effects' estimates in studies with formal mediation analysis

Study	Tested Mediators	Outcomes	Estimate (p-value)/[95% CI]	Mediation Analysis	Study powered to detect mediators?
Arrogi 2017 (n = 300)	Baseline-9m Autonomy Baseline-9m Competence Baseline-9m Relatedness Baseline-9m Total needs satisfaction	Baseline-9m Pedometer average day steps/day	195.68 [95% CI: 29.42, 510.41] 194.44 [95% CI: 25.47, 447.12] 7.08 [95% CI: -33.93, 134.05] 168.41 [95% CI: 15.44, 431.02]	Product-of-coefficients method with bias-corrected and accelerated bootstrapped CIs. Estimates are unstandardised regression coefficients.	Unclear.
	Baseline-9m Autonomy Baseline-9m Competence Baseline-9m Relatedness Baseline-9m Total needs satisfaction	Baseline-9m Pedometer weekday steps/day	151.43 [95% CI: 13.64, 419.73] 173.22 [95% CI: 20.86, 454.86] -7.53 [95% CI: -137.01, 38.26] 118.50 [95% CI: 9.61, 366.94]		
Friederichs 2016 (n = 1,415)	Baseline-3m Intrinsic motivation Baseline-3m Identified regulation Baseline-3m Competence Baseline-3m Perceived choice Multiple mediation model with all four mediators	Baseline-6m MVPA mins/week	9.85 [95% CI: -2.03, 27.34] 0.61 [95% CI: -9.28, 10.53] 8.17 [95% CI: -0.41, 20.82] -1.64 [95% CI: -8.90, 0.73] 16.98 [95% CI: 6.54, 33.11]	Product-of-coefficients method with bias-corrected bootstrapped CIs. Estimates are regression coefficients.	Unclear.
	Baseline-3m Intrinsic motivation Baseline-3m Identified regulation Baseline-3m Competence Baseline-3m Perceived choice Multiple mediation model with all four mediators	Baseline-6m weekly days with ≥30 mins PA	0.03 [95% CI: -0.00, 0.08] -0.00 [95% CI: -0.04, 0.02] 0.03 [95% CI: 0.01, 0.07] -0.00 [95% CI: -0.02, 0.00] 0.05 [95% CI: 0.02, 0.10]		

Hallam 2004 (n = 68)	<p>Baseline-12m Self-regulatory skill use for PA</p> <p>Baseline-12m PA self-efficacy</p> <p>Baseline-12m Outcome expectancies</p>	<p>Baseline-12m Total PA days/week</p>	<p>(1) -0.90 (p<0.01) (2) -0.73 (p<0.01) (3)(a) -0.24 (p=0.20) (3)(b) 0.55 (p<0.01)</p> <p>(1) -0.54 (p<0.01) (2) -0.73 (p<0.01) (3)(a) -0.63 (p<0.01) (3)(b) 0.05 (p=0.60)</p> <p>(1) 0.90 (p<0.01) (2) -0.73 (p<0.01) (3)(a) -0.87 (p<0.01) (3)(b) 0.19 (p=0.20)</p>	<p>Results of three linear equations: (1) Mediator regressed on group assignment; (2) PA regressed on group assignment; (3) PA regressed on group assignment (a) and mediator (b). Mediation was confirmed with significant coefficients for (1), (2) and (3)(b), and if (3)(a) was lower in total value than (2). Results refer to standardised regression coefficients and p-values from the equations.</p>	Unclear.
Lewis 2013 (n=448)	<p>Baseline-3m Behavioural processes of change Baseline-3m Experiential/Cognitive processes of change Baseline-3m PA self-efficacy Baseline-3m Decisional balance (pros/cons)</p> <p>Baseline-6m Behavioural processes of change Baseline-6m Experiential/Cognitive processes of change Baseline-6m PA self-efficacy Baseline-6m Decisional balance (pros/cons)</p>	<p>Baseline-6 month Total PA mins/week</p> <p>Baseline-12 month Total PA mins/week</p>	<p>27.29 [95% CI:13.32, 45.92] -4.28 [95% CI:-15.74, 5.61] 5.67 [95% CI:-2.89, 17.18] 0.71 [95% CI:-3.50, 5.45]</p> <p>34.89 [95% CI:9.49, 68.12] -15.10 [95% CI:-30.78, -0.56] 4.54 [95% CI:-7.29, 20.51] 1.47 [95% CI:-6.80, 10.30]</p>	<p>Product-of-coefficients method with bootstrapped SEs.</p> <p>Estimates are regression coefficients</p>	Yes.
Mailey 2014	Baseline-6m PA self-efficacy	Baseline-6 months	0.44 (p<0.01)	Linear regression	Unclear

(n=141)	<p>Baseline-6m Barrier self-efficacy Baseline-6m Planning (Action) Baseline-6m Goal setting</p>	<p>Self-report total weekly leisure PA score</p> <p>Baseline- 6 months Accelerometer: total CPM and MVPA mins/day.</p>	<p>Not stated (p=NS) 0.22 (p<0.05) Not stated (p=NS)</p> <p>Treatment group did not predict change in PA so no further testing was carried out.</p>	<p>analysis: 1. PA change on treatment group; 2. Mediator change on treatment group; 3. PA change on mediator change and group assignment. Mediation established when treatment group assignment was no longer a significant predictor of PA change when mediating variables were included.</p> <p>Estimates are regression coefficients.</p>	<p>(specifically powered to detect PA outcome).</p>
<p>Marcus 2013 (n = 266)</p>	<p>Baseline-6m Social support (family) Baseline-6m Social support (friends) Baseline-6m Social support (rewards and punishment)</p> <p>Baseline-6m Social support (family) Baseline-6m Social support (friends) Baseline-6m Social support (rewards and punishment)</p> <p>Baseline-12m Social support (family) Baseline-12m Social support (friends) Baseline-12m Social support (rewards and punishment)</p> <p>Baseline-12m Social support (family)</p>	<p>Baseline-6m 7-Day PAR MVPA mins/week</p> <p>Baseline-6m Accelerometer MVPA mins/week</p> <p>Baseline-12m 7-Day PAR MVPA mins/week</p> <p>Baseline-12m</p>	<p>7.39 [95% CI: -0.35, 21.78] 2.02 [95% CI: -3.46, 10.99] -4.51 [95% CI: -13.75, 0.58]</p> <p>5.21 [95% CI: 0.91, 14.11] 1.82 [95% CI: -1.52, 7.64] -0.53 [95% CI: -5.44, 3.92]</p> <p>3.25 [95% CI: -1.04, 15.21] 6.8 [95% CI: 0.16, 20.56] -5.99 [95% CI: -13.21, 2.02]</p> <p>1.73 [95% CI: -0.57, 6.89]</p>	<p>Product-of-coefficients method with bootstrapped SEs.</p> <p>Estimates are unstandardised regression coefficients.</p>	<p>Unclear (specifically powered to detect physical activity outcome).</p>

	Baseline-12m Social support (friends)	Accelerometer	1.23 [95% CI: -1.79, 6.11]		
	Baseline-12m Social support (rewards and punishment)	MVPA mins/week	1.79 [95% CI: -3.19, 7.91]		
Marcus, Napolitano, 2007 (n=239)	Baseline-6m (Print)-Behavioural processes of change	Baseline-6m MVPA mins/week	1.38 (p = 0.01)	Product-of-coefficients method SEs based on a first-order delta method. Estimates are standardised regression coefficients.	Unclear.
	Baseline-6m (Print)-Experiential/Cognitive Processes of change		-0.38 (p = 0.14)		
	Baseline-6m (Print)-PA self-efficacy		0.44 (p = 0.11)		
	Baseline-6m (Print)-Decisional balance (pros/cons)		-0.01 (p = 0.96)		
	Baseline-6m (Print)-Revitalisation		0.77 (p = 0.01)		
	Baseline-6m (Telephone)-Behavioural processes of change		1.57 (p = 0.01)		
	Baseline-6m (Telephone)-Experiential/Cognitive Processes of change		-0.38 (p = 0.14)		
	Baseline-6m (Telephone)-PA self-efficacy		0.52 (p = 0.10)		
	Baseline-6m (Telephone)-Decisional balance (pros/cons)		-0.01 (p = 0.96)		
	Baseline-6m (Telephone)-Revitalisation		0.74 (p = 0.01)		
	Baseline-12m (Print)-Behavioural processes of change	Baseline-12m MVPA mins/week	1.58 (p = 0.01)		
	Baseline-12m (Print)-Experiential/Cognitive Processes of change		-0.61 (p = 0.10)		
	Baseline-12m (Print)-PA self-efficacy		0.65 (p = 0.10)		
	Baseline-12m (Print)-Decisional balance (pros/cons)		-0.01 (p = 0.96)		
	Baseline-12m (Print)-Revitalisation		1.27 (p < 0.01)		
	Baseline-12m (Telephone)-Behavioural processes of change		1.31 (p = 0.01)		
	Baseline-12m (Telephone)-Experiential/Cognitive Processes of change		-0.46 (p = 0.12)		
	Baseline-12m (Telephone)-PA self-efficacy		0.51 (p = 0.11)		
	Baseline-12m (Telephone)-Decisional balance (pros/cons)		-0.01 (p = 0.96)		
	Baseline-12m (Telephone)-Revitalisation		1.12 (p < 0.01)		

<p>Martinson 2008 (n = 1,049)</p>	<p>PA self-efficacy Perceived barriers to PA PA integrated in the self-concept Social support (family) Social support (friends) PA self-efficacy and Perceived barriers to PA PA self-efficacy and PA integrated in the self-concept</p> <p>NB: Latent variables were composite measures of measures taken at 6, 12 and 24 months.</p>	<p>MVPA kcal/week</p> <p>NB: Latent variables were composite measures of measures taken at 6, 12 and 24 months.</p>	<p>0.012 (p = 0.09) -0.004 (p = 0.32) 0.01 (p = 0.08) 0.009 (p = 0.09) 0.006 (p = 0.16) 0.009 (p = 0.10) 0.009 (p = 0.05)</p>	<p>Structural equation modelling.</p> <p>Estimates are standardised coefficients</p>	<p>Unclear (specifically powered to detect physical activity outcome).</p>
<p>Opendacker 2008 (n = 169)</p>	<p>Baseline-6m Perceived benefits of PA Baseline-6m Perceived barriers to PA Baseline-6m PA self-efficacy Baseline-6m Experiential/Cognitive processes of change Baseline-6m Behavioral processes of change Baseline-6m Social support</p>	<p>Baseline-6m Total accelerometer counts/5 days</p>	<p>-278 [95% CI:-46,581, 23,547] -9,630 [95% CI:-81,449, 15,700] 28,520 [95% CI:-10,496, 11,6418] 6,801 [95% CI:-16,649, 92,376] -24,442 [95% CI:-119,863, 17,262] 16,913 [95% CI:-8,818, 87,906]</p>	<p>Product-of-coefficients method with bootstrapped SEs.</p> <p>Estimates are unstandardised regression coefficients</p>	<p>Yes.</p>
<p>Plotnikoff 2007 (n = 323)</p>	<p>Baseline-12m Decisional balance pros</p>	<p>Baseline-12m Leisure time PA MET mins/week</p>	<p>23.50 (p=0.15)</p>	<p>Baron and Kenny regression-based approach with test statistic based on first-order delta method.</p> <p>Estimates are the increase in change in PA MET minutes for the intervention group over and above the control group.</p>	<p>Yes.</p>

<p>van Stralen 2009 (n = 1,971)</p>	Baseline-3m (Intervention basic)-Awareness of PA level	Baseline-12 months total PA days/week	0.03 (p=NS)	<p>Product-of-coefficients method SEs based on a first-order delta method.</p> <p>Estimates are standardised regression coefficients</p>	No.
	Baseline-3m (Intervention basic)-Decisional balance pros		0.00 (p=NS)		
	Baseline-3m (Intervention basic)-Decisional balance cons		-0.01 (p=NS)		
	Baseline-3m (Intervention basic)-Social support		-0.00 (p=NS)		
	Baseline-3m (Intervention basic)-Social modelling		-0.01 (p=NS)		
	Baseline-3m (Intervention basic)-Sports partner		-0.01 (p=NS)		
	Baseline-3m (Intervention basic)-Intrinsic motivation for PA		-0.00 (p=NS)		
	Baseline-3m (Intervention basic)-PA self-efficacy		0.02 (p=NS)		
	Baseline-6m (Intervention basic)-Awareness of PA level	Baseline-12 months total PA days/week	0.04 (p<0.05)		
	Baseline-6m (Intervention basic)-Perceived environment		0.00 (p=NS)		
	Baseline-6m (Intervention basic)-Intention to change PA		0.07 (p<0.01)		
	Baseline-6m (Intervention basic)-Commitment		0.00 (p=NS)		
	Baseline-6m (Intervention basic)-Planning (Strategic)		0.01 (p=NS)		
	Baseline-6m (Intervention basic)-Planning (Action)		0.00 (p=NS)		
	Baseline-6m (Intervention basic)-Coping planning		0.00 (p=NS)		
	Baseline-3m (Environmental)-Awareness of PA level	Baseline-12 months total PA days/week	0.03 (p=NS)		
	Baseline-3m (Environmental)-Decisional balance pros		0.00(p=NS)		
	Baseline-3m (Environmental)-Decisional balance cons		-0.00 (p=NS)		
	Baseline-3m (Environmental)-Social support		-0.00 (p=NS)		
	Baseline-3m (Environmental)-Social modelling		-0.01 (p=NS)		
	Baseline-3m (Environmental)-Sports partner		0.01 (p=NS)		
	Baseline-3m (Environmental)-Intrinsic motivation for PA		0.00 (p=NS)		
	Baseline-3m (Environmental)-PA self-efficacy		0.00 (p=NS)		
	Baseline-6m (Environmental)-Awareness of PA level	Baseline-12 months total PA days/week	0.04 (p<0.05)		
	Baseline-6m (Environmental)-Perceived environment		0.03 (p=NS)		
	Baseline-6m (Environmental)-Intention to change PA		0.08 (p<0.01)		
	Baseline-6m (Environmental)-Commitment		-0.01 (p=NS)		
	Baseline-6m (Environmental)-Planning (Strategic)		0.00 (p=NS)		
Baseline-6m (Environmental)-Planning (Action)	-0.00 (p=NS)				
Baseline-6m (Environmental)-Coping planning	-0.01 (p=NS)				
Baseline-3m (Intervention basic)-Awareness of PA level	Baseline-12 months total PA mins/week	0.8 (p=NS)			
Baseline-3m (Intervention basic)-Decisional balance pros		-0.1 (p=NS)			

Baseline-3m (Intervention basic)-Decisional balance cons		-0.2 (p=NS)		
Baseline-3m (Intervention basic)-Social support		0.5 (p=NS)		
Baseline-3m (Intervention basic)-Social modelling		-5.3 (p=NS)		
Baseline-3m (Intervention basic)-Sports partner		-0.9 (p=NS)		
Baseline-3m (Intervention basic)-Intrinsic motivation for PA		-0.0 (p=NS)		
Baseline-3m (Intervention basic)-PA self-efficacy		5.6 (p=NS)		
Baseline-6m (Intervention basic)-Awareness of PA level	Baseline-12 months total PA mins/week	0.2 (p=NS)		
Baseline-6m (Intervention basic)-Perceived environment		0.5 (p=NS)		
Baseline-6m (Intervention basic)-Intention to change PA		5.0 (p=NS)		
Baseline-6m (Intervention basic)-Commitment		0.0 (p=NS)		
Baseline-6m (Intervention basic)-Planning (Strategic)		1.7 (p=NS)		
Baseline-6m (Intervention basic)-Planning (Action)		3.0 (p=NS)		
Baseline-6m (Intervention basic)-Coping planning		-0.3 (p=NS)		
Baseline-3m (Environmental)-Awareness of PA level	Baseline-12 months total PA mins/week	0.8 (p=NS)		
Baseline-3m (Environmental)-Decisional balance pros		-0.4 (p=NS)		
Baseline-3m (Environmental)-Decisional balance cons		-0.1 (p=NS)		
Baseline-3m (Environmental)-Social support		0.6 (p=NS)		
Baseline-3m (Environmental)-Social modelling		-4.4 (p=NS)		
Baseline-3m (Environmental)-Sports partner		0.9 (p=NS)		
Baseline-3m (Environmental)-Intrinsic motivation for PA		0.0 (p=NS)		
Baseline-3m (Environmental)-PA self-efficacy		0.2 (p=NS)		
Baseline-6m (Environmental)-Awareness of PA level	Baseline-12 months total PA mins/week	-0.2 (p=NS)		
Baseline-6m (Environmental)-Perceived environment		4.1 (p=NS)		
Baseline-6m (Environmental)-Intention to change PA		5.1 (p=NS)		
Baseline-6m (Environmental)-Commitment		-1.9 (p=NS)		
Baseline-6m (Environmental)-Planning (Strategic)		0.9 (p=NS)		
Baseline-6m (Environmental)-Planning (Action)		-1.2 (p=NS)		
Baseline-6m (Environmental)-Coping planning		1.0 (p=NS)		

Wilcox 2007 (n = 418)	Baseline-12m Social support (Institutional) Baseline-12m Social support (Instrumental) Baseline-12m Social support (Emotional) Baseline-12m PA self-efficacy Baseline-12m Enjoyment	Baseline-12m Meeting recommendations for 150 mins/week MVPA.	-0.05 [95% CI: -0.18, 0.04] 0.04 [95% CI: -0.07, 0.19] -0.05 [95% CI: -0.17, 0.03] -0.04 [95% CI: -0.13, 0.02] -0.02 [95% CI: -0.12, 0.05]	Product-of-coefficients method with asymmetric CIs based on the distribution of the product. Estimates are the product of a- and b-regression coefficients.	Unclear (specifically powered to detect physical activity outcome).
--------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------

CI: confidence interval; CPM: counts per minute; EFI: Exercise-Induce Feeling Inventory; PA: physical activity; m: months; MET: Metabolic equivalent task; MVPA: Moderate-vigorous physical activity; NS: non-significant; SE: standard error.