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

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Supplementary file 5: Risk of bias and quality assessment.

### **Cochrane risk of bias and quality assessment**

Nineteen studies had low risk of bias for randomisation, 16 had unclear risk and four had high risk. For allocation concealment, seven studies had low risk of bias, 29 had unclear risk and three had high risk. For blinding of outcome assessment, six studies had low risk of bias, 31 had unclear risk and two had high risk. For incomplete outcome data, 17 studies had low risk of bias and 22 had unclear risk (figure 5.1, below). In terms of quality rating, three studies were classified as 'high' quality, 25 were classified as 'moderate' quality and 11 were classified as 'low' quality (table 5.1, below). All twelve studies conducting formal mediation tests were classified as 'high' or 'moderate' quality.

### **Mediators of Physical Activity Maintenance in High and Moderate Quality Studies**

Tables 5.2 and 5.3 (below) show the number of studies testing mediators, number of times mediators were investigated and percentage of times a significant ( $P < 0.05$ ) effect was found for mediators measured before six months post-baseline, or six months and later in 'high' and 'moderate' quality studies. In the following paragraphs, information is presented on: the results of formal mediation tests (VII.a.), the results of tests of the association between mediators and physical activity (VII.b.), the results of tests of intervention effects on putative mediators (VII.c.).

### **Mediators Measured before Six Months Post-baseline in High and Moderate Quality Studies**

Fourteen studies examined mediators before six months post-baseline, three of which conducted formal mediation tests, four examined the association of mediators with physical activity outcomes, and 14 examined the mediator for significant intervention effects. In these studies, 28 variables (grouped in 10 categories) were examined with 14 variables being used in formal mediation tests, 18 being examined for an association with physical activity, and 28 being tested for whether the intervention significantly changed the variables.

#### **Results of formal mediation tests.**

All studies conducting formal mediation tests including mediators measured before six months post-baseline were classified as 'high' or 'moderate' quality. Therefore there are no changes to the results.

#### **Results of tests of the association between mediators and physical activity.**

All studies examining mediators measured before six months post-baseline for an association with physical activity were classified as 'high' or 'moderate' quality. Therefore there are no changes to the results.

### **Results of tests of intervention effects on putative mediators.**

Intrapersonal variables for which there was evidence of significant intervention effects before six months post-baseline included 'Behavioural processes of change' (n=4/4, 100%), 'Self-regulatory skill use for physical activity' (n=3/3, 100%), 'Competence' (n=2/2, 100%), 'Stage of change for physical activity/Motivational readiness for physical activity' (n=1/1, 100%), 'Identified regulation' (n=1/1, 100%), 'Self-determined behaviour beliefs' (n=1/1, 100%), 'Decisional balance (pros/cons)' (n=1/1, 100%), 'Total needs satisfaction' (n=1/1, 100%) and 'Experiential/Cognitive processes of Change' (n=3/4, 75%). Tests of 'Perceived benefits of physical activity/Response efficacy' (n=1/2, 50%), 'Enjoyment' (n=1/2, 50%), 'Autonomy/Perceived choice' (n=1/2, 50%) and 'Physical activity self-efficacy' (n=5/13, 38%) were inconclusive. There was no evidence for significant intervention effects of any of the other intrapersonal variables (significant in less than 34% of tests). The only socio-environmental variable for which there was evidence of having a significant intervention effect was 'Descriptive norms/Social modelling' (n=2/2, 100%). Tests of 'Social support (family)' (n=1/2, 50%) were inconclusive.

### **Mediators Measured at Six Months or Later in High and Moderate Quality Studies**

Twenty seven studies examined mediators at six months or later, 11 of which conducted formal mediation tests, 14 tested for an association with physical activity outcomes, and 26 examined the mediator for significant intervention effects. In these studies, 45 variables (grouped in 13 categories) were examined with 29 variables being used in formal mediation tests, 32 being examined for an association with physical activity, and 45 being tested for whether the intervention significantly changed the variables.

#### **Results of formal mediation tests.**

All studies conducting formal mediation tests including mediators measured at six months or later were classified as 'high' or 'moderate' quality. Therefore there are no changes to the results.

#### **Results of tests of the association between mediators and physical activity.**

Intrapersonal variables for which there was evidence of having an association with physical activity outcomes at six months or later included 'Competence' (n=2/2, 100%), 'Planning (Strategic)' (n=2/2, 100%), 'Self-regulatory skill use for physical activity' (n=1/1, 100%), 'Pros' (n=1/1, 100%), 'Revitalisation' (n=1/1, 100%), 'Goal setting' (n=3/4, 75%), 'Behavioural processes of change' (n=2/3, 67%) and 'Planning (Action)' (n=3/5, 60%). Tests of 'Awareness of physical activity level/benefits' (n=1/2, 50%), 'Physical activity integrated in the self-concept' (n=1/2, 50%), 'Enjoyment' (n=1/2, 50%), 'Autonomy/Perceived choice' (n=1/2, 50%), 'Total

needs satisfaction' (n=1/2, 50%) and 'Physical activity self-efficacy' (n=4/11, 36%) were inconclusive. There was no evidence that any of the other intrapersonal variables were associated with physical activity outcomes (significant in less than 34% of tests).

The only socio-environmental variable with evidence of having an association with physical activity outcomes included 'Perceived barriers to physical activity/Barrier self-efficacy' (n=4/5, 80%). Tests of 'Social support (family)' (n=4/8, 50%) and 'Social support (friends/community)' (n=4/9, 44%) were inconclusive.

#### **Results of tests of intervention effects on putative mediators.**

Intrapersonal variables for which there was evidence of having significant intervention effects at six months or later included 'Revitalisation' (n=4/4, 100%), 'Physical activity integrated in the self-concept' (n=3/3, 100%), 'Self-determined motivation/behaviour beliefs' (n=1/1, 100%), 'Competence' (n=1/1, 100%), 'Total needs satisfaction' (n=1/1, 100%), 'Self-regulatory skill use for physical activity' (n=3/4, 75%), 'Intention to change physical activity' (n=3/4, 75%) and 'Decisional balance (pros/cons)' (n=5/8, 63%). Tests of 'Tranquility' (n=2/4, 50%), 'Physical exhaustion' (n=2/4, 50%), 'Awareness of physical activity level/benefits' (n=1/2, 50%), 'Commitment' (n=1/2, 50%), 'Pros' (n=1/2, 50%), 'Experiential/Cognitive processes of change' (n=12/26, 46%), 'Behavioural processes of change' (n=10/26, 38%) and 'Physical activity self-efficacy' (n=11/32, 34%) were inconclusive. There was no evidence for significant intervention effects of any of the other intrapersonal variables (significant in less than 34% of tests).

The only socio-environmental variable for which there was some evidence of having a significant intervention effect included 'Social support (rewards and punishment)' (n=2/3, 67%). Tests of 'Social support (family)' (n=7/14, 50%), 'Social support (unspecified)/Social influences' (n=4/8, 50%), 'Perceived environment' (n=1/2, 50%) and 'Social support (friends/community)' (n=6/14, 43%) were inconclusive.





### *Quality of studies tool*

#### **Questions**

- 1) Did the study include a theoretical framework?
- 2) Were the methods designed to influence mediator variables?
- 3) Did the authors report conducting pilot studies to test mediation?
- 4) Was an objective measure of PA used?
- 5) Were the measures of PA reliable?
- 6) Were the mediator measures reliable (e.g., alpha)?
- 7) Was the study powered to detect mediation?
- 8) Was the design an RCT?
- 9) Was baseline PA considered in analyses?
- 10) Were statistically appropriate/acceptable methods of data analyses used?
- 11) Did the study ascertain whether changes in the mediator precede changes in the PA outcome?

**Table 5.1****Quality of studies tool**

| Study                   | Q1  | Q2  | Q3 | Q4  | Q5  | Q6  | Q7  | Q8  | Q9  | Q10 | Q11 | Score | Quality  |
|-------------------------|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-------|----------|
| Andersen 2012           | Yes | Yes | No | Yes | Yes | Yes | No  | Yes | Yes | Yes | Yes | 9     | High     |
| Arrogi, 2017            | Yes | Yes | No | Yes | Yes | Yes | No  | No  | Yes | Yes | No  | 7     | Moderate |
| Bennet 2008             | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 5     | Moderate |
| Buman 2011              | Yes | Yes | No | No  | Yes | Yes | Yes | Yes | No  | No  | No  | 6     | Moderate |
| Calfas 2000             | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | No  | No  | 6     | Moderate |
| Carroll 2010            | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | No  | No  | 6     | Moderate |
| Dallow, 2003            | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 5     | Moderate |
| Estabrooks 2011         | Yes | No  | No | No  | Yes | Yes | No  | Yes | Yes | No  | No  | 5     | Moderate |
| Friederichs, 2016       | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | Yes | Yes | 8     | Moderate |
| Graham-Clarke 1994      | Yes | Yes | No | No  | Yes | No  | No  | Yes | No  | No  | No  | 4     | Low      |
| Hallam 2004             | Yes | Yes | No | No  | Yes | Yes | No  | No  | Yes | Yes | No  | 6     | Moderate |
| Harris, 2017            | No  | Yes | No | Yes | Yes | Yes | No  | Yes | No  | No  | No  | 5     | Moderate |
| Hunter 2013             | Yes | Yes | No | No  | Yes | No  | No  | Yes | No  | No  | No  | 4     | Low      |
| Isaacs 2007             | Yes | No  | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 4     | Low      |
| Kamada 2013             | No  | No  | No | No  | Yes | No  | No  | Yes | Yes | No  | No  | 3     | Low      |
| Kinmonth 2008           | Yes | No  | No | Yes | Yes | No  | No  | Yes | Yes | No  | No  | 5     | Moderate |
| Lewis 2013              | Yes | Yes | No | No  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 9     | High     |
| Lilienthal 2014         | Yes | No  | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 4     | Low      |
| Mailey 2014             | Yes | Yes | No | Yes | Yes | Yes | No  | Yes | Yes | Yes | No  | 8     | Moderate |
| Marcus 1998             | No  | Yes | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 4     | Low      |
| Marcus, 2013            | Yes | Yes | No | Yes | Yes | Yes | No  | Yes | Yes | Yes | No  | 8     | Moderate |
| Marcus, 2016            | Yes | Yes | No | Yes | Yes | Yes | No  | Yes | No  | No  | No  | 6     | Moderate |
| Marcus, Napolitano 2007 | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | Yes | No  | 7     | Moderate |
| Martinson 2008          | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | Yes | No  | 6     | Moderate |
| Naylor 1999             | Yes | No  | No | No  | Yes | Yes | No  | No  | No  | No  | No  | 3     | Low      |
| Norris 2000             | Yes | Yes | No | No  | Yes | No  | No  | Yes | Yes | No  | No  | 5     | Moderate |
| Okazaki 2014            | Yes | No  | No | No  | Yes | No  | No  | Yes | No  | No  | No  | 3     | Low      |
| Opdenacker 2008         | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No  | 9     | High     |
| Pekmezi, 2009           | Yes | No  | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 4     | Low      |
| Plotnikoff 2009         | Yes | Yes | No | No  | Yes | Yes | Yes | Yes | Yes | Yes | No  | 8     | Moderate |
| Slootmaker 2009         | No  | No  | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 3     | Low      |
| Solomon 2014            | Yes | No  | No | No  | Yes | No  | No  | Yes | No  | No  | No  | 3     | Low      |
| Sriramatr 2014          | Yes | Yes | No | Yes | Yes | Yes | No  | Yes | No  | No  | No  | 6     | Moderate |
| van Stralen 2009        | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | Yes | Yes | 8     | Moderate |
| Wadsworth 2010          | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | Yes | No  | 6     | Moderate |
| Whitehead, 2007         | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 5     | Moderate |
| Wilcox 2007             | Yes | Yes | No | No  | Yes | Yes | No  | Yes | Yes | Yes | No  | 7     | Moderate |
| Williams 2011           | Yes | Yes | No | No  | Yes | Yes | No  | Yes | No  | No  | No  | 5     | Moderate |



|              |     |     |    |     |     |     |    |    |    |    |    |   |          |
|--------------|-----|-----|----|-----|-----|-----|----|----|----|----|----|---|----------|
| Wilson, 2015 | Yes | Yes | No | Yes | Yes | Yes | No | No | No | No | No | 5 | Moderate |
|--------------|-----|-----|----|-----|-----|-----|----|----|----|----|----|---|----------|



|   |   |   |    |   |   |    |   |   |     |
|---|---|---|----|---|---|----|---|---|-----|
| Decisional balance (pros/cons)                                | 1 | 1 | 0  | 1 | 1 | 0  | 1 | 1 | 100 |
| Pros  | 1 | 4 | 0  | 1 | 2 | 0  | 1 | 2 | 0   |
| Cons  | 1 | 4 | 0  | 1 | 2 | 0  | 1 | 2 | 0   |
| <b>Environmental context and resources</b>                    |   |   |    |   |   |    |   |   |     |
| Perceived barriers to physical activity/Barrier self-efficacy | - | - | -  | 1 | 1 | 0  | 2 | 3 | 33  |
| <b>Social influences</b>                                      |   |   |    |   |   |    |   |   |     |
| Social support (unspecified)/Social influences                | 1 | 4 | 0  | 1 | 2 | 0  | 1 | 2 | 0   |
| Social support (friends/community)                            | - | - | -  | 1 | 1 | 0  | 1 | 2 | 0   |
| Social support (family)                                       | - | - | -  | 1 | 1 | 0  | 1 | 2 | 50  |
| Social support (instrumental/institutional)                   | - | - | -  | - | - | -  | 1 | 1 | 0   |
| Sports partner  | 1 | 4 | 0  | 1 | 2 | 50 | 1 | 2 | 0   |
| Descriptive norms/Social modelling                            | 1 | 4 | 0  | 1 | 2 | 0  | 1 | 2 | 100 |
| <b>Emotion</b>  |   |   |    |   |   |    |   |   |     |
| Enjoyment   | - | - | -  | - | - | -  | 1 | 2 | 50  |
| Autonomy/Perceived choice                                     | 1 | 2 | 0  | 1 | 2 | 0  | 2 | 2 | 50  |
| Competence  | 1 | 2 | 50 | 1 | 2 | 50 | 2 | 2 | 100 |
| Relatedness   | - | - | -  | - | - | -  | 1 | 1 | 0   |
| Total needs satisfaction                                      | - | - | -  | - | - | -  | 1 | 1 | 100 |

A single study may contribute to more than one of the three columns in this table.





|                         |   |   |    |   |   |     |   |   |    |
|-------------------------|---|---|----|---|---|-----|---|---|----|
| Planning (Action)       | 2 | 5 | 20 | 2 | 5 | 60  | 3 | 5 | 20 |
| Planning (Strategic)    | 1 | 4 | 0  | 1 | 2 | 100 | 1 | 2 | 0  |
| Coping planning         | 1 | 4 | 0  | 1 | 2 | 0   | 1 | 2 | 0  |
| Physical activity habit | - | - | -  | - | - | -   | - | - | -  |

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A single study may contribute to more than one of the three columns in this table.