

1 **Behavior change theory, content and delivery of interventions to enhance adherence in chronic**  
2 **respiratory disease: a systematic review**

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26 The authors declare that they have no competing interests.

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28 **ABBREVIATIONS LIST**

29 BCT: behavior change technique

30 COPD: chronic obstructive pulmonary disease

31 CF: cystic fibrosis

32 IQR: interquartile range

33 MRC: medical research council

34 mRCT: metaregister of controlled trials

35 OSA: obstructive sleep apnea

36 Psych: psychologist

37 RT/PT: respiratory therapist/physical therapist

38 SD: standard deviation

39 SDM: shared decision making

40 SEM: standard error of the mean

41 TIDiER: template for intervention description and replication

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46 **ABSTRACT**

47 **Background:** We sought to describe the theory used to design treatment adherence interventions, the  
48 content delivered, and the mode of delivery of these interventions in chronic respiratory disease.

49 **Methods:** We included randomized controlled trials of adherence interventions (compared to another  
50 intervention or control) in adults with chronic respiratory disease (8 databases searched; inception until  
51 March 2015). Two reviewers screened and extracted data: post-intervention adherence (measured  
52 objectively); behavior change theory, content (grouped into psychological, education and self-  
53 management/supportive, telemonitoring, shared decision-making); and delivery. "Effective" studies  
54 were those with  $p < 0.05$  for adherence rate between groups. We conducted a narrative synthesis and  
55 assessed risk of bias.

56 **Results:** 12,488 articles screened; 46 included studies ( $n=42,91\%$  in OSA or asthma) testing 58  
57 interventions ( $n=27, 47\%$  were effective). Nineteen (33%) interventions (15 studies) used 12 different  
58 behavior change theories. Use of theory ( $n=11,41\%$ ) was more common amongst effective interventions.  
59 Interventions were mainly educational, self-management or supportive interventions ( $n=27,47\%$ ). They  
60 were commonly delivered by a doctor ( $n=20,23\%$ ), in face-to-face ( $n=48,70\%$ ), one-to-one ( $n=45,78\%$ )  
61 outpatient settings ( $n=46,79\%$ ) across 2-5 sessions ( $n=26,45\%$ ) for 1-3 months ( $n=26,45\%$ ). Doctors  
62 delivered a lower proportion ( $n=7,18\%$  vs  $n=13,28\%$ ) and pharmacists ( $n=6,15\%$  vs  $n=1,2\%$ ) a higher  
63 proportion of effective than ineffective interventions. Risk of bias was high in  $>1$  domain ( $n=43, 93\%$ ) in  
64 most studies.

65 **Conclusions:** Behavior change theory was more commonly used to design effective interventions. Few  
66 adherence interventions have been developed using theory, representing a gap between intervention  
67 design recommendations and research practice.

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## 70 INTRODUCTION

71 Adherence, the extent to which patients' behaviors follow a recommended treatment path<sup>1</sup>, is widely  
72 reported as being sub-optimal.<sup>2</sup> Chronic respiratory disease is no different – it is reported that between  
73 30-50% of patients take treatment as prescribed.<sup>3-5</sup> This lack of adherence is not inconsequential; low  
74 adherence is associated with treatment failure and poor health outcomes.<sup>5-7</sup>

75 Many researchers have attempted to change adherence to prescribed treatments in chronic respiratory  
76 disease by developing behavior change interventions.<sup>8-11</sup> Medical Research Council (MRC) guidance  
77 states that these interventions should be developed systematically and involve the use of behavior  
78 change theories.<sup>12</sup> Yet studies of other complex interventions demonstrate that behavior change  
79 theories are rarely used.<sup>12,13</sup> The TIDieR reporting guidelines also recommend that the behavior change  
80 theory used to design the intervention should be reported alongside a detailed description of what was  
81 actually delivered (content) and how this was delivered (who provided the intervention, what was the  
82 mode of delivery, where was it delivered, in what frequency and over what duration).<sup>14</sup>

83 Systematic reviews of interventions to change adherence behavior in chronic respiratory disease have  
84 synthesised the evidence for the effectiveness of these interventions.<sup>2,15</sup> But they have not focused  
85 specifically on synthesising data on whether behavior change theories were used in their development,  
86 nor have they explored the content or the delivery of these interventions. These data are needed to  
87 inform the development of new interventions and to allow implementation of effective interventions  
88 into clinical practice. This systematic review describes the behavior change theories used to develop  
89 adherence interventions (compared to another intervention or usual care) in adults with chronic  
90 respiratory disease, the content that was delivered, along with who provided it, its mode of delivery,  
91 where it was delivered, in what frequency and over what duration.

## 92 MATERIALS AND METHODS

### 93 Inclusion and exclusion criteria for studies

94 We included randomized controlled trials (RCTs) of adults  $\geq 18$  years old, with a clinical diagnosis of  
95 chronic respiratory disease (asthma, bronchiectasis, chronic obstructive pulmonary disease [COPD],  
96 allergic bronchopulmonary aspergillosis, interstitial lung disease, obstructive sleep apnea [OSA]<sup>16</sup> or  
97 cystic fibrosis [CF]) who received an adherence to treatment (any treatment with the exception of  
98 exercise) intervention compared to another intervention or usual care, where adherence was objectively

99 measured (e.g. electronic monitoring, pill counts or medication possession data). Only objective  
100 measures of adherence were included because subjective adherence measurements (e.g. self-report  
101 questionnaire) are known to over-estimate adherence.<sup>17</sup> Studies measuring adherence to exercise or  
102 those available in abstract form only, were excluded. No attempt was made to identify unpublished  
103 studies. This review was not registered on PROSPERO but the protocol can be obtained from the authors.  
104 No ethical approval was required for this study.

#### 105 **Search strategy**

106 We searched the Cochrane Central Register of Controlled Trials (CENTRAL), Medline, EMBASE, CINAHL,  
107 International Pharmaceutical Abstracts, PsycINFO, Sociological abstracts and PEDro from inception until  
108 March 2015 using the search strategy outlined in the online supplement. Language was restricted to  
109 English. We searched the metaRegister of controlled trials (mRCT), ClinicalTrials.gov and the WHO trials  
110 portal using the keywords ‘adherence’, ‘compliance’ and ‘concordance.’

#### 111 **Study selection**

112 Pairs of reviewers screened titles, abstracts and subsequent full texts (AMcC, CR, NY, CM, BON, JB, CH  
113 plus three research assistants. All screeners received written instructions on screening from AMcC to  
114 ensure consistency in approach (available on request from AMcC). Conflicts were resolved between  
115 pairs and disagreements were resolved by a third reviewer (AMcC or CH).

#### 116 **Data extraction**

117 Pairs of reviewers (AMcC and CR, NY and CM) extracted data on study design, participants and the  
118 number of interventions tested (e.g. a three-arm study where two interventions were tested against  
119 usual care would have two intervention arms). For each intervention, we extracted (from the abstract,  
120 introduction, methods, results or discussion sections) the name of any behavior change theory used, the  
121 content delivered, who provided the intervention, the mode of delivery, where it was delivered, in what  
122 frequency and over what duration (items 2-8 of the TiDieR checklist<sup>14</sup>). Reviewers also extracted mean  
123 ( $\pm$ SD, 95% CI or SEM) or median (IQR or range) and p values for objective adherence to treatment in  
124 intervention and control groups at the end of study follow-up. If no other measures were reported,  
125 mean change, mean difference ( $\pm$ SD) or the number of participants (%) categorized as adherent were  
126 extracted. Pairs of reviewers (AMcC and CR, NY and CM) assessed each study’s risk of bias (as high,  
127 unclear or low, using the Cochrane Collaboration’s tool for assessing risk of bias) across six domains:

128 random sequence generation, allocation concealment, blinding of participants and personnel, blinding  
129 of outcome assessment, incomplete outcome data, and selective reporting.

### 130 **Synthesis of results and summary measures**

131 Included studies could not be meta-analysed due to heterogeneity in the outcome measures used and  
132 the interventions tested. Without meta-analysis, we could not determine the statistical importance of  
133 theory, content and delivery using meta-regression. Consequently, we narratively described the  
134 behavior change theories used in intervention development, and provided descriptive statistics of what  
135 content was delivered, who provided the intervention, what the mode of delivery was, where it was  
136 delivered, in what frequency and over what duration. Classification of the content of complex  
137 interventions is difficult, due to overlap in content between different interventions. However, we  
138 grouped interventions by content (psychological; education and supportive or self-management;  
139 telemonitoring; and shared decision-making interventions) by consensus within the research team.  
140 More than one clinician may have delivered a single intervention; each profession is counted separately.  
141 We categorized interventions into “effective” ( $p < 0.05$  for adherence rate between groups), or  
142 “ineffective” ( $p > 0.05$ ) by whether they were associated with statistically significant improvements in  
143 objective adherence.

## 144 **RESULTS**

### 145 **Summary of studies**

146 Screening resulted in the inclusion of 46 studies (Figure 1) testing 58 interventions in 12,415 participants  
147 (median 100 per study, range 12-6431) (e-Table 1-3). Most studies included patients with OSA or asthma  
148 (Figure 1). Twenty-seven interventions (47%) were shown to be effective (e-Table 4-6).

### 149 **Behavior change theory used in intervention development**

150 Most ( $n=39$ , 67%) interventions were not based on behavior change theory (Figure 2). Nineteen  
151 interventions (33%) (from 15 studies) were designed using 12 different behavior change theories (Table  
152 1). A higher proportion of effective interventions ( $n=11$ , 41%) used behavior change theory to design  
153 their intervention than ineffective interventions ( $n=8$ , 26%) (Figure 3).

### 154 **Content**

155 Most (n=27, 47%) interventions delivered educational, self-management or supportive content (Figure  
156 2). Educational, self-management or supportive content was more common for ineffective interventions  
157 (n=17, 55%) than effective interventions (n=10, 37%) (Figure 3). Detailed descriptions of intervention  
158 content are provided in eTable 1-3.

### 159 **Delivery**

160 The majority of interventions were delivered by doctors or nurses, on a face-to-face, one-to-one, out-  
161 patient basis across two to five visits, at various frequencies over the course of one to three months  
162 (Figure 2). Doctors delivered a lower proportion of effective interventions (n=7, 18%) compared to  
163 ineffective (n=13, 28%). Pharmacists delivered a higher proportion of effective (n=6, 15%) compared to  
164 ineffective interventions (n=1, 2%). No other differences could be identified in who provided the  
165 intervention, the mode of delivery, where was it delivered, in what frequency and over what duration.

### 166 **Risk of Bias**

167 Three studies had a low risk of bias. We rated the remaining studies as having an unclear or high risk of  
168 bias in one or more domains (high risk in  $\geq 1$  domains, n=28; unclear risk in  $\geq 1$  domains, n=43) (Figure 4,  
169 e-Figure 1).

170

## 171 **DISCUSSION**

172 Most adherence interventions did not use behavior change theories in their development. Of those that  
173 did, they used 12 different behavior change theories. Use of behavior change theory was more common  
174 amongst effective interventions. Most adherence interventions used educational and self-management  
175 or supportive interventions delivered on a face-to-face, one-to-one out-patient basis (up to five visits,  
176 one to three months). Interventions with educational, self-management or supportive content  
177 constituted over half of ineffective interventions. Doctors delivered a lower proportion of the effective  
178 interventions, and pharmacists a higher proportion of effective interventions (compared to ineffective  
179 interventions).

180 One third of studies reported using behavior change theories in their development and more studies in  
181 the effective interventions group used behavior change theory, adding weight to the recommendations  
182 to use behavior change theory to design interventions.<sup>12</sup> Our findings are limited by the small number of



183 studies that reported using theory, and the extent to which these theories were used to inform the  
184 intervention is not known. Given the poor reporting noted in behavior change interventions, it is also  
185 possible that more studies used theory but did not report it.<sup>16</sup> Only self-efficacy theory and social  
186 cognitive theory were used in more than one study. This is not surprising, given the range of behavior  
187 change theories that exist. At the time that many of these interventions were designed, there was no  
188 clear cut way of defining which theories to use and how to use them. Michie and colleagues have  
189 attempted to remedy this issue by creating the Theoretical Domains Framework, in which they have  
190 combined 128 explanatory constructs from 33 behavior change theories into a single framework of 14  
191 domains.<sup>13,20</sup>

192 Interventions using education, self-management or supportive approaches were more common  
193 amongst ineffective interventions. The categories which were used to group content were broad and  
194 the educational content varied greatly between studies, from group education<sup>21</sup> to patient advocates.<sup>22</sup>  
195 Defining intervention content and grouping similar interventions is a common challenge when reviewing  
196 behavior change interventions and is a limitation of this review. This is due to the variety of  
197 interventions used and is, in part, due to poor reporting of the exact content of interventions.<sup>23</sup> The  
198 Behavior Change Technique (BCT) Taxonomy (published after this review commenced) attempts to  
199 overcome this issue by defining the individual components of behavior change interventions in a  
200 reproducible way by providing definitions and examples.<sup>24</sup> It has been used in other systematic reviews  
201 to extract the components of existing interventions.<sup>25</sup> The main challenge with using this approach is  
202 that the original intervention content was not designed to be defined by behavior change techniques  
203 and is so poorly reported that it makes it nearly impossible to use this approach.<sup>25</sup> Future adherence  
204 intervention studies should describe their interventions using the BCT Taxonomy<sup>24</sup> and report them  
205 using reporting checklists such as TIDiER and CONSORT.<sup>14,26</sup> Many studies in this review reported study  
206 designs and outcomes poorly; the use of these checklists would also address these issues. An adherence  
207 intervention for bronchiectasis has been developed using this approach, and is currently under further  
208 development prior to feasibility and pilot testing.<sup>27</sup>

209 Findings from this review demonstrated that a higher proportion of effective interventions were  
210 delivered by pharmacists, and a lower proportion by doctors. It is possible that pharmacists have more  
211 time, and receive more training on how to monitor and change adherence behaviour, or that those  
212 interventions led by pharmacists contained components that specifically targeted the underlying  
213 barriers and facilitators to adherence. No other differences in delivery were identified. It is likely that

214 there is no 'one-size fits all' approach to intervention delivery and will depend on the healthcare context  
215 in which the intervention is likely to be effective.<sup>28</sup> As an example, in cystic fibrosis, a group-based  
216 primary care intervention delivered by a general practitioner and/or practice nurse is unlikely to be  
217 effective given that most care is delivered by specialists in secondary care and patients are treated in  
218 isolation of one another. In contrast, for COPD, this approach might be appropriate given that they  
219 already receive annual reviews and have contact with their general practitioner and practice nurse (if in  
220 the United Kingdom). Thus, researchers should involve stakeholders in intervention design to identify  
221 the most appropriate delivery method for their patient population and healthcare context.<sup>29</sup>

222 Most studies in this review included those with OSA or asthma, making the findings more generalizable  
223 to those populations. Clear gaps exist for patients with COPD, bronchiectasis and CF, who are known to  
224 have low adherence.<sup>5-7</sup> Research is beginning to focus on developing adherence interventions for these  
225 groups<sup>27,30,31</sup> and this is an area for further development.

226 Our data show that the education, self-management and supportive approaches that may be commonly  
227 used in clinical practice may not always be effective at improving adherence, and that using theory-  
228 based interventions may be more useful for clinicians to implement with patients.

229 Strengths of this review include: its broad scope, incorporating all adherence interventions across any  
230 chronic respiratory disease or clinical setting, and the inclusion of studies reporting objective measures  
231 of adherence. Comparisons between the use behavior change theory, content and delivery were  
232 descriptive and based on small numbers of studies and should be interpreted with caution. The  
233 heterogeneity of included interventions made categorization of intervention content problematic. We  
234 only extracted data on adherence from final study visits, meaning any interim effects have not been  
235 captured. Our search was restricted to English language and we did not contact authors to identify  
236 unpublished studies, meaning the results presented could be affected by publication bias. We did not  
237 extract any data on recruitment rates for individual studies which may affect the generalisability of the  
238 findings presented.

## 239 **Conclusion**

240 Behavior change theory use was more common amongst effective interventions, providing evidence  
241 that this is an important consideration for future adherence interventions. Few adherence interventions

242 have been developed using theory, representing a gap between medical research guidance and research  
243 practice.

244

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252 **Author’s contributions**

253 All authors made substantial contributions to the conception or design of the work and interpretation of  
254 the data. AMcC, CR, CH, JB, B’ON, NY, CM screened abstracts. AMcC, CR, NY and CM screened full text  
255 and extracted data. AMcC, NY and CM analysed data. All authors contributed to the drafting and  
256 revision of the manuscript for important intellectual content, and gave final of the version to be  
257 published. All authors agree to be accountable for all aspects of the work in ensuring that questions  
258 related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.  
259 AMcC had full access to all of the data in the study and takes responsibility for the integrity of the data  
260 and the accuracy of the data analysis.

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264 **REFERENCES**

265

266 1. World Health Organisation. Adherence to long-term therapies: evidence for action [Internet].  
267 2003. Available from: [http://www.who.int/chp/knowledge/publications/adherence\\_report/en/](http://www.who.int/chp/knowledge/publications/adherence_report/en/)  
268

269 2. Niewlaat R, Wilczynski N, Navarro T, et al. Interventions for enhancing medication adherence.  
270 *Cochrane Database Syst Rev* 2014;(11):CD000011.  
271

272 3. Latchford G, Duff A, Quinn J, Conway S, Conner M. Adherence to nebulised antibiotics in cystic  
273 fibrosis. *Patient Educ Couns* 2009;75:141–144.  
274

275 4. Gamble J, Stevenson M, McClean E, Heaney L. The prevalence of nonadherence in difficult  
276 asthma. *Am J Respir Crit Care Med* 2009;180:817–822.  
277

278 5. McCullough A, Tunney M, Quittner A, Elborn J, Bradley J, Hughes C. Treatment adherence and  
279 health outcomes in patients with bronchiectasis. *BMC Pulm Med* 2014;14(107).  
280

281 6. Quittner AL, Zhang J, Marynchenko M, et al. Pulmonary medication adherence and healthcare  
282 utilization in cystic fibrosis. *Chest* 2014;146(1):142–151.  
283

284 7. Boven JFM van, Chavannes NH, Molen T van der, Rutten-van Mólken MPMH, Postma MJ, Vegter  
285 S. Clinical and economic impact of non-adherence in COPD: A systematic review. *Respir Med*  
286 2014;108(1):103–13.  
287

288 8. Gallefoss F. The effects of patient education in COPD in a 1-year follow-up randomised,  
289 controlled trial. *Patient Educ Couns* 2004;52(3):259–66.  
290

291 9. Leiva-Fernandez F, Barnestein-Fonseca P, Leiva- Fernandez J, Vidal-España F, García-Ruiz A,  
292 Prados-Torres D. Effectiveness Of a Multifactorial Intervention to Improve Adherence in Patients  
293 with Chronic Obstructive Pulmonary Disease (COPD) Icepoc Study. *Value Heal* 2011;14(7):A487–  
294 A488.  
295

296 10. Gamble J, Stevenson M, Heaney LG. A study of a multi-level intervention to improve non-  
297 adherence in difficult to control asthma. *Respir Med* 2011;105(9):1308–1315.  
298

299 11. Wilson SR, Strub P, Buist AS, et al. Shared treatment decision making improves adherence and  
300 outcomes in poorly controlled asthma. *Am J Respir Crit Care Med* 2010;181:566–77.  
301

- 302 12. Medical Research Council. Developing and evaluating complex interventions: new guidance  
303 [Internet]. 2008. Available from:  
304 <http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC004871>  
305
- 306 13. Michie S, Johnston M, Abraham C, et al. Making psychological theory useful for implementing  
307 evidence based practice: a consensus approach. *Qual Saf Health Care* 2005;14(1):26–33.  
308
- 309 14. Hoffmann TC, Glasziou PP, Barbour V, Macdonald H. Better reporting of interventions: template  
310 for intervention description and replication (TIDieR) checklist and guide. *Br Med J*  
311 2014;348:g1687.  
312
- 313 15. Wozniak D, Lasserson TJ, Smith I. Educational, supportive and behavioural interventions to  
314 improve usage of continuous positive airway pressure machines for adults with obstructive sleep  
315 apnoea. *Cochrane Database Syst Rev* 2014;(1):CD007736.  
316
- 317 16. Cochrane Airways Group. Scope of our work [Internet]. 2011 [cited 2012 Oct 29];Available from:  
318 <http://airways.cochrane.org/scope-our-work-0>  
319
- 320 17. Horne R, Weinman J. Self-regulation and self-management in asthma: exploring the role of illness  
321 perceptions and treatment beliefs in explaining non-adherence to preventer medication. *Psychol*  
322 *Health* 2002;17(1):17–32.  
323
- 324 18. Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions [Internet].  
325 2011;Available from: <http://www.cochrane-handbook.org/>  
326
- 327 19. Bartlett D, Wong K, Richards D, et al. Increasing adherence to obstructive sleep apnea treatment  
328 with a group social cognitive therapy treatment intervention: a randomized trial. *Sleep*  
329 2013;36(11):1647–1654.  
330
- 331 20. Cane J, O’Connor D, Michie S. Validation of the theoretical domains framework for use in  
332 behaviour change and implementation research. *Implement Sci* 2012;7:37.  
333
- 334 21. Soares Pires F, Drummond M, Marinho A, et al. Effectiveness of a group education session on  
335 adherence with APAP in obstructive sleep apnea—a randomized controlled study. *Sleep Breath*  
336 2013;17(3):993–1001.  
337
- 338 22. Apter AJ, Wan F, Reisine S, et al. Feasibility, acceptability and preliminary effectiveness of patient  
339 advocates for improving asthma outcomes in adults. *J Asthma* 2013;50(8):850–860.  
340
- 341 23. Hoffmann TC, Eructi C, Glasziou PP. Poor description of non-pharmacological interventions :

- 342 analysis of consecutive sample of randomised trials. *Br Med J*  
343 2013;347(f3755):10.1136/bmj.f3755.  
344
- 345 24. Michie S, Richardson M, Johnston M, et al. Behavior Change Technique Taxonomy. *Ann Behav*  
346 *Med* 2013;46(1):81–95.  
347
- 348 25. Davey P, Peden C, Charani E, Marwick C, Michie S. Time for action—Improving the design and  
349 reporting of behaviour change interventions for antimicrobial stewardship in hospitals: Early  
350 findings from a systematic review. *Int J Antimicrob Agents* 2015;45(3):203–212.  
351
- 352 26. Schulz K, Altman D, Moher D, for the CONSORT Group. CONSORT 2010 Statement: updated  
353 guidelines for reporting parallel group randomised trials. *BMJ* 2010;340:c332.  
354
- 355 27. McCullough AR, Ryan C, O’Neill B, Bradley JM, Elborn JS, Hughes CM. Defining the content and  
356 delivery of an intervention to Change AdhereNce to treatment in BonchiEctasis (CAN-BE): a  
357 qualitative approach incorporating the Theoretical Domains Framework, behavioural change  
358 techniques and stakeholder expert panels. *BMC Health Serv Res* 2015;15(1):342.  
359
- 360 28. Bate P. Context is everything. In Perspectives on Context. *Heal Found* [Internet] 2014;Available  
361 from:  
362 <http://www.health.org.uk/sites/default/files/PerspectivesOnContextBateContextIsEverything.pdf>  
363
- 364 29. Glidewell L, Boocock S, Pine K, et al. Using behavioural theories to optimise shared haemodialysis  
365 care: a qualitative intervention development study of patient and professional experience.  
366 *Implement Sci* 2013;8(1):118.  
367
- 368 30. Quittner AL. I change adherence and raise expectations [Internet]. 2012 [cited 2012 Oct  
369 29];Available from: <http://uhealthsystem.com/clinical-trials/study/details/6284>  
370
- 371 31. Clarke T. Problem solving therapy for people with major depression and chronic obstructive  
372 pulmonary disease [Internet]. Available from:  
373 <https://clinicaltrials.gov/ct2/show/NCT00601055?term=COPD+AND+adherence&rank=2>  
374
- 375 32. Aloia MS, Dio L Di, Ilniczky N, Perlis M, Greenblatt D, Giles DE. Improving compliance with nasal  
376 CPAP and vigilance in older adults with OSAHS. *Sleep breathingSleep Breath* 2001;5(1):13–21.  
377
- 378 33. Olsen S, Smith SS, Oei TPS, Douglas J. Motivational interviewing (MINT) improves continuous  
379 positive airway pressure (CPAP) acceptance and adherence: a randomized controlled trial. *J*  
380 *Consult Clin Psychol* 2012;80(1):151–63.  
381

- 382 34. Bender BG, Apter A, Bogen DK, et al. Test of an interactive voice response intervention to  
383 improve adherence to controller medications in adults with asthma. *J Am Board Fam Med*  
384 2010;23(2):159–65.  
385
- 386 35. Trupp RJ, Corwin EJ, Ahijevych KL, Nygren T. The impact of educational message framing on  
387 adherence to continuous positive airway pressure therapy. *Behav Sleep Med* 2011;9(1):38–52.  
388
- 389 36. Schaffer SD, Tian L. Promoting adherence: effects of theory-based asthma education. *Clin Nurs*  
390 *Res* 2004;13(1):69–89.  
391
- 392 37. Berg J, Dunbar-jacob J, Sereika SM. An evaluation of a self-management program for adults with  
393 asthma. *Clin Nurs Res* 1997;6(3):225–238.  
394
- 395 38. Aloia MS, Arnedt JT, Strand M, Millman RP, Borrelli B. Motivational enhancement to improve  
396 adherence to positive airway pressure in patients with obstructive sleep apnea: a randomized  
397 controlled trial. *Sleep* 2013;36(11):1655–1662.  
398
- 399 39. Richards D, Bartlett DJ, Wong K, Malouff J, Grunstein R. Increased adherence to CPAP with a  
400 group cognitive behavioural treatment intervention: a randomized trial. *Sleep* 2007;30(5):635–  
401 640.  
402
- 403 40. Sparrow D, Aloia M, Demolles D a, Gottlieb DJ. A telemedicine intervention to improve  
404 adherence to continuous positive airway pressure: a randomised controlled trial. *Thorax*  
405 2010;65(12):1061–6.  
406
- 407 41. Smith CE, Daus E, Clements F, Werkowitch M, Whitman R. Patient education combined in a music  
408 and habit-forming intervention for adherence to continuous positive airway (CPAP) prescribed  
409 for sleep apnea. *Patient Educ Couns* 2009;74(2):184–190.  
410
- 411 42. Janson SL, McGrath KW, Covington JK, Cheng S-C, Boushey H a. Individualized asthma self-  
412 management improves medication adherence and markers of asthma control. *J Allergy Clin*  
413 *Immunol* 2009;123(4):840–6. Available from:  
414
- 415 43. Roecklein K a, Schumacher J a, Gabriele JM, Fagan C, Baran AS, Richert AC. Personalized feedback  
416 to improve CPAP adherence in obstructive sleep apnea. *Behav Sleep Med* 2010;8(2):105–12.  
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## FIGURE LEGENDS

Figure 1. PRISMA chart of review process

Figure 2. Summary of behavior change theory, content, and delivery of all interventions

SDM: shared decision making

RT/PT: respiratory therapist/physiotherapist

Psych: psychologist

Unknown: not reported in the manuscript

Numbers in bars denote percentage with each characteristic

Figure 3. Summary of behavior change theory, content, and delivery of effective and ineffective interventions

SDM: shared decision making

RT/PT: respiratory therapist/physiotherapist

Psych: psychologist

Unknown: not reported in the manuscript

Numbers in bars denote percentage with each characteristic

Figure 4. Summary of risk of bias of included studies

**Table 1. Psychological theories used in the design of adherence interventions for OSA, asthma and COPD**

<b>Psychological theories used</b>
Compliance therapy model <sup>10</sup>
Decisional balance <sup>32</sup>
Health Belief Model <sup>33</sup>
Horne and Weinman's Benefit-risk model <sup>34</sup>
Patient navigator model <sup>22</sup>
Prospect theory <sup>35</sup>
Protection motivation theory <sup>36</sup>
Self-efficacy theory <sup>32,37</sup>
Social cognitive theory <sup>35,38,19,39,40</sup>
Transtheoretical model <sup>38</sup>
Triandis theory of behavior <sup>41</sup>
"Theory-based" but specific theory not reported <sup>42,43</sup>