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Paper:

Con, W., Ka, M., Wtb, E., G, S., Am, W., Jy, R., Ijm, D., Ma, M. & Ga, D. (2017). Perceptions of asthma and exercise in adolescents with and without asthma. *Journal of Asthma*, 00-00.

<http://dx.doi.org/10.1080/02770903.2017.1369992>

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1 **Perceptions of asthma and exercise in adolescents with and without asthma**

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9

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11

12 **Abstract**

13 **Objective:** To elicit the views of adolescents, with and without asthma, about exercise and
14 asthma, and the perceived benefits of and barriers to participation. The adolescent views
15 elicited would subsequently inform the design of a high-intensity exercise intervention to
16 improve asthma control.

17 **Methods:** Fifty-four adolescents (age 13.1±0.9years; 26 with asthma) participated in twelve
18 semi-structured group interviews. Questions were structured around knowledge, attitudes and
19 beliefs towards asthma and its impact on exercise participation and lifestyle. The interviews
20 were transcribed verbatim, thematically analysed and presented via diagrams of emergent
21 themes. Ethical approval was granted by the institutional research ethics committee.

22 **Results:** Fear of an asthma attack emerged as the main barrier to exercise, with many
23 adolescents with asthma withdrawing from exercise as a coping strategy; many healthy

24 adolescents perceived this withdrawal as laziness or an excuse. Despite this, the majority
25 (81%) of adolescents with asthma reported exercise to be their most enjoyable activity.
26 Adolescents suggested incorporating mixed activities, such as team games (e.g., rounders,
27 football, netball), for future interventions to ensure adherence.

28 **Conclusions:** Whilst exercise is important in the management of asthma, the tendency of
29 those with asthma to withdraw from exercise to avoid adverse events could be addressed
30 through a games-based high-intensity exercise intervention. Furthermore, educating all
31 adolescents on asthma could simultaneously reduce stigmatisation and enhance exercise
32 engagement.

33

34 **Introduction**

35 Asthma is one of the most common chronic diseases in the UK, affecting 1 in 11 children [1].
36 The benefits associated with exercise are well-recognised for healthy children, with
37 additional benefits, such as reduced symptoms and severity [2], for those with asthma.
38 However, whilst some children with asthma recognise that regular exercise is associated with
39 improved control of their asthma and enhanced physical self-perceptions [3], exercise
40 participation is typically lower in those with asthma compared to their healthy peers [4, 5].
41 Indeed, the attribution of normal symptoms of physical exertion to symptoms of asthma is a
42 common misconception [6, 7], which, when exacerbated by a lack of fitness [8], leads to a
43 greater manifestation of the apparent symptoms of asthma, resulting in further avoidance of
44 exercise and a vicious negative cycle.

45 Commonly cited barriers to exercise for adolescents include time constraints, school
46 work and lack of interest [9]; with additional barriers, such as fear of asthma symptoms, in
47 those with asthma [10]. Despite no differences in fitness levels [11], there is a perception that
48 children with asthma are less physically able than their healthy peers [12], potentially
49 reflecting a lack of understanding rather than true disease-related physiological limitation.
50 Teachers report that they have limited confidence when engaging children with asthma in
51 exercise and encourage them towards musical instruments rather than physical pursuits [13].
52 This perception is frequently reinforced by parents who restrict their children's activities to
53 minimise potential detrimental risks of asthma [14, 15]. These actions are likely to contribute
54 to the feelings of ostracization often cited by those with asthma, with some children
55 deliberately "struggling through" exercises with their healthy peers to avoid social isolation
56 [16] and being identified as different [17].

57 Although numerous studies have described the perceptions of those with asthma
58 regarding their ability to exercise and their perceived barriers and facilitators [18, 19], there is
59 little information on the perceptions of their healthy peers, which may impact participation.
60 Furthering our understanding of the perceptions of those with and without asthma is
61 fundamental to the design of interventions to increase exercise in adolescents with asthma,
62 thus breaking the vicious negative cycle of exercise avoidance [20]. Frequently reported
63 barriers to exercise interventions revolve around poor adherence due to monotony and
64 sustainability, for continuous aerobic exercise [21], and high-intensity exercise interventions,
65 respectively [22]. It is noteworthy that no studies to date have sought input from adolescents
66 with asthma themselves with regards to the intervention design and implementation.

67 The primary aim of this study was therefore to elicit views of adolescents, with and
68 without asthma, about exercise and asthma, and the perceived benefits of and barriers to
69 participation. The secondary aim was to inform the design of a future high-intensity exercise
70 intervention to improve asthma control.

71 **Methods**

72 **Participants**

73 Fifteen secondary schools in the UK were invited, as part of a wider randomised control trial
74 (the X4A trial: eXercise for Asthma with Commando Joe's), to participate in an exercise
75 intervention with the aim of improving asthma symptoms and quality of life. Subsequently,
76 one school was randomised to the intervention arm and four schools to the control arm of the
77 study. The current manuscript describes a qualitative study that was conducted using semi-
78 structured group interviews of adolescents with and without asthma. Ethical approval was
79 granted by the institutional research ethics committee (ref: PG/2014/29).

80 Five hundred and eighty five adolescents from the intervention school were eligible
81 to participate (aged 11-14 years) in the exercise intervention, of which 223 (48 with asthma;
82 24 boys) provided written parental consent and child assent. Using stratified randomisation, a
83 subsample of 60 adolescents, split by age, sex and asthma, were selected to participate in
84 formative group interviews. Three school year groups were used (11-12 years, 12-13 years
85 and 13-14 years) with ten adolescents with and ten without asthma from each, with an even
86 split of sex (n=60). From the 60 selected participants, six were absent on the day, and
87 therefore 26 and 28 participants with and without asthma, respectively, attended the
88 interviews (13.1 ± 0.9 years). Of the 26 with asthma, severity was classified as intermittent
89 and mild persistent (88%) and moderate and severe (12%) according to GINA criteria [23].

90 **Procedures**

91 Thirteen semi-structured group interviews consisting of 3-5 adolescents were conducted
92 separately grouped by age and condition. The group interviews were performed in a quiet
93 area of the school to avoid interruption; the interviews lasted 30.9±3.2 minutes. **Interviewers**
94 **were all conducted by WTBE for consistency, who** was known by the participants, providing
95 an interview environment in which the adolescents could speak honestly and freely about
96 their perceptions [24]. Group interviews with adolescents have been found to be a viable
97 method for exploring perspectives provided the groups are small (i.e., 3-5 participants) [25,
98 26]. Questions were structured around adolescents' knowledge, attitudes and beliefs towards
99 asthma and its impact on exercise participation and life. The questions were designed to elicit
100 the adolescents' perceptions of asthma and exercise, with questions in the asthma groups
101 relating to themselves and others with asthma, and questions in the groups without asthma
102 relating to their perceptions of those with asthma. Each group were also asked questions
103 relating to the design of a high-intensity exercise intervention in which they might participate.

104 Sample interview questions are presented in Table 1. All interviews were recorded using a
105 digital recorder (Galaxy S7 Edge, Samsung) and were transcribed verbatim.

106 **Data analysis**

107 The transcribed data were thematically analysed in a deductive manner and presented via
108 diagrams of key emergent themes (pen profiles), which are considered appropriate for
109 representing findings from large data sets in a manner understandable to both qualitative and
110 quantitative researchers [27, 28]. **The pen profiles were independently constructed by both
111 CONW and KAM prior to discussion on key themes, issues and findings [29]. Following
112 initial analyses, both authors presented the pen profiles to MAM for co-operative
113 triangulation, whereby the data was cross-examined in reverse from pen profile to transcripts
114 until a general consensus was reached. This process was repeated, allowing all authors to
115 offer alternative interpretations of the data, until a final acceptable consensus had been
116 reached.**

117 **Results**

118 Participants quotes are labelled in text by sex (B=boy, G=girl).

119 **Participants with asthma**

120 Key emergent themes have been structured around control, impact, perceptions and exercise
121 (Figure 1). The group interviews revealed that the majority of adolescents with asthma
122 controlled their condition using an inhaler (78%). Other participants, and indeed those who
123 could not access their inhaler during asthmatic symptoms, suggested altering their breathing
124 pattern as a mechanism to control their asthma. Only one person highlighted taking their
125 inhaler prior to an activity as a control strategy.

126 Asthma was found to impact adolescents during school and/or in a social context.
127 For example, participants felt that their asthma restricted them whilst they were with their
128 friends,

129 *“I just want to keep up but then I can't” B4,*

130 or resulted in them being left out altogether. Furthermore, some adolescents even reported
131 struggling when laughing with their friends,

132 *“I can't laugh a lot, it's really hard” G1.*

133 Symptoms of asthma experienced at night resulted in poor sleep quality and consequently
134 impacted on social aspects and a lack of concentration in school.

135 Poor school attendance due to asthma symptoms and doctors' appointments was
136 reported, with particular focus on reducing their involvement, or participation, in physical
137 education (PE) lessons. The majority of the participants alluded to their healthy peers having
138 a lack of understanding of their condition and often misinterpreting situations. Specifically,
139 those with asthma felt that they were often perceived as lazy or that they used their condition
140 as an excuse,

141 *“they think it might just be like an excuse” B3.*

142 Some participants reported being told to:

143 *“get on with it” B3*

144 by their healthy peers. Finally, some reported that healthy peers failed to appreciate when it
145 was their asthma symptoms limiting them,

146 *“they just misjudge everything, they think that you can do it when you can't” B2.*

147 Whilst some adolescents with asthma did acknowledge that they sometimes used
148 their asthma as an excuse,

149 *“When I don’t want to do something I use it as an excuse” G4,*

150 a more common perception was one of fear of exercise inducing an asthma attack leading to
151 decreased participation,

152 *“I do prevent myself from doing activity because I feel that I’m scared to have an*
153 *asthma attack” G3.*

154 In contrast, some reported that having asthma actually acted as a facilitator to exercise by
155 increasing their competitiveness to show that they are not affected by their condition,

156 *“I just want to do as much as everyone else” G2.*

157 Moreover, six of the participants found that being ‘fitter’ reduced their asthma symptoms and
158 therefore used exercise as a way to improve their health.

159 **Participants without asthma**

160 Similar to participants with asthma (Figure 1), key emergent themes have been
161 structured around control, impact, perceptions and exercise (Figure 2). Those without asthma
162 were less sure about how asthma is controlled; 39% demonstrated knowledge of the use of
163 inhalers and 11% suggested altering breathing as a form of asthma control. Similarly, healthy
164 counterparts were also less clear on the impact of asthma on school and social life, only
165 recognising the burden of carrying an inhaler and factors such as worrying about having an
166 asthma attack. Eight adolescents without asthma (29%) believed that asthma had no effect on
167 social or school life,

168 *“they’ve got their pump, it shouldn’t really affect anything” G12.*

169 Despite some thinking there was no effect, others noticed the issues during PE,

170 *“they slow down, take their pumps and then get going again” B23.*

171 School attendance was also noted as a potential issue for upcoming exams,

172 *“they have to leave the class ... they can't afford to miss out on work” B16.*

173 Two of the group had a complete lack of understanding of the condition, with five more not
174 providing an answer to ‘what is asthma?’ Adolescents who had some understanding outlined
175 breathing difficulties (68%) and reduced lung function (14%) as characteristics of asthma.
176 Indeed, breathing difficulties were outlined as one of the main barriers to exercise for
177 adolescents with asthma,

178 *“they can't breathe properly” G16.*

179 along with stopping often to take breaks (46%). These breaks were perceived by others as
180 laziness, using asthma as an excuse to avoid certain activities, especially in girls,

181 *“many girls use it as an excuse because they don't want to have PE” G12*

182 and as an excuse to avoid trouble, such as forgetting their kit. Other cited potential barriers
183 included fear of asthma attacks (14%) and not being able to participate in as much exercise
184 (21%). Participants without asthma perceived there to be relatively few facilitators of
185 exercise in comparison to their peers with asthma, citing only health benefits (18%).

186 **Views on an exercise intervention**

187 In response to the icebreaker question (‘what is your favourite thing to do?’), 77% of
188 participants referred to some form of exercise, irrespective of asthma status (81% of those
189 with asthma). Emergent themes are structured around activity type, high-intensity interval
190 training (HIIT), logistics and barriers (Figure 3).

191 All of the adolescents participated in some form of exercise; 38 in individual sports,
192 37 in team sports and 7 in dance. The participants identified five main categories of activity
193 type as enjoyable, with team games widely stated as the most enjoyable (76%). Due to its
194 popularity, running was categorised separately to other individual sports, with suggestions
195 that this activity type, particularly sprinting, was good to include given its simplicity.
196 Obstacle courses and circuits were both mentioned as a way of implementing many different
197 activities within the same session,

198 *'because it's a range of things. People might find some easier than others and others*
199 *might find it hard' G8.*

200 Some of the participants with asthma (n=4) raised the need for breaks within the exercise in
201 order for them to catch their breath or,

202 *"take your pump if you need to" B1.*

203 High-intensity interval training was described by the majority as being hard work.
204 Interestingly, the perceptions of HIIT difficulty were vastly different between those with and
205 without asthma; only three of those with asthma thought that the difficulty would vary, with
206 thirteen of those without asthma thinking that,

207 *"it depends on what sort of exercise you do" B26.*

208 In contrast to participants with asthma who perceived HIIT to be difficult
209 specifically due to their asthma, their healthy counterparts attributed difficulty to a type of
210 training their bodies are not used to,

211 *"so like you're just instantly in something and it will be difficult" B20.*

212 Due to the structure of the school day, the adolescents were only able to participate
213 in the exercise intervention out of school hours, resulting in a split for delivering the
214 intervention before or after school, citing barriers such as after school activities. The majority
215 of the participants would have preferred if the sessions were run outdoors (61%), with 22% of
216 participants asking for a combination of both indoor and outdoor activities, dependent on type
217 of activity and weather.

218 A range of barriers to future exercise interventions were reported, such as illness or
219 injury, or clashes with other activities, such as homework or paid work. The data revealed
220 that 35% of the participants believed that those with asthma did not participate in as much
221 exercise as their healthy peers, 48% perceived them to participate in the same amount and the
222 remaining 17% believed that it was dependent on the activity in question. Lack of enjoyment
223 of both team and individual sports was alluded to as one of the main barriers, contradicting
224 previous activity choices. Running was specifically highlighted as a form of exercise that
225 some participants without asthma found to be boring, and those with asthma reported
226 difficulty breathing when running. In contrast to sprints, which were mentioned as an
227 enjoyable activity type, long distance type running was cited as a barrier which the majority
228 of asthma sufferers said they would find difficult. Being pushed too hard in the sessions was
229 also mentioned as a barrier as it would decrease adherence to the intervention.

230 **Discussion**

231 The primary aim of this study was to elicit perceptions about asthma and exercise from
232 adolescents with and without the condition and to compare their perceived benefits and
233 barriers to participation. Data were analysed thematically and presented using pen profiles,
234 facilitating more accessible qualitative data for quantitative researchers and reducing the
235 likelihood of skewed themes through dominating individuals in the interviews [27]. The

236 second aim of the study was to inform the design, the content and delivery of a school-based,
237 high-intensity exercise intervention, the X4A trial: eXercise for Asthma with Commando
238 Joe's, which was achieved using a representative sample across the ages within the planned
239 intervention.

240 There are many known benefits of exercise for those who suffer from asthma [11,
241 30]; however, only 23% of participants with asthma and 18% of those without asthma were
242 aware of the potential health benefits of exercise in asthma. Previous research documents the
243 lack of knowledge of the benefits of exercise [31] and therefore further education is required.
244 Asthma guidelines highlight physical training as part of asthma management, with
245 appropriate precautions for exercise-induced asthma [32]. Exercise reduces the symptoms
246 and severity of asthma [2] and, as lung function and wheeze in those with asthma are not
247 adversely affected by exercise with appropriate treatment, there is no reason why they should
248 not participate regularly [20].

249 Adolescents with asthma perceived that their healthy peers lacked understanding
250 about the limiting effect of their condition on exercise, and that they use their condition as an
251 excuse to be lazy. This perception of laziness and lack of understanding about asthma was
252 confirmed by those without asthma. A minority of adolescents with asthma admitted to using
253 their condition as an excuse, in contrast to previous research [16]. These perceptions and
254 misconceptions must be addressed through improved education about asthma and its
255 implications for daily life and exercise. Indeed, two adolescents with asthma misjudged
256 others with asthma, demonstrating a lack of understanding of their own condition. Only one
257 person highlighted taking their inhaler prior to an activity as a control strategy suggesting a
258 need for improved education to manage exercise-induced symptoms.

259 Exercise participation rates of those with and without asthma are considered to be
260 conflicting, with suggestions that adolescents with asthma participate in more [33, 34], less
261 [4, 35] or equivalent levels of exercise to their healthy counterparts [36-38]. While our study
262 did not specifically address levels of exercise participation, adolescents with asthma were not
263 perceived to engage in higher levels of exercise in comparison to their healthy peers, with
264 most (48%) stating that participation was similar or reduced (35%). In an attempt to
265 demonstrate that their condition does not negatively affect them, competitive motivation to
266 outperform their healthy peers, was found to be a facilitator to 15% of adolescents with
267 asthma, albeit more in terms of the intensity rather than volume of exercise [17]. Participants
268 without asthma discussed a wide range of barriers of asthma to exercise with relatively few
269 facilitators, with fear of having an asthma attack identified as the main barrier by participants,
270 irrespective of their asthma [7]. Despite fear of asthma attacks, 81% of those with asthma
271 stated that their favourite activity was exercise [39], demonstrating that these individuals
272 overcome their fear in order to exercise.

273 Asthma has been previously found to impact on social [40] and academic life [41],
274 often resulting in isolation [17]. In contrast to previous studies where those with asthma
275 reported being bullied or ignored due to their perceived limited physical capabilities [42],
276 adolescents with asthma in the present study did not report any form of bullying. However, it
277 is possible bullying would not have been raised in a group situation. School attendance was
278 only discussed by two participants with asthma, although this may be due to the participants
279 not perceiving absence from school as a negative factor [42]; participants without asthma
280 thought that poor school attendance may affect their upcoming exams [40]. As with previous
281 research [43], a lack of sleep due to asthma symptoms at night negatively impacted on
282 subsequent social situations and concentration in school.

283 The adolescents reported participating in a variety of physical activities; the vast
284 majority (76%) liked the idea of team games, such as rounders, football or netball, which
285 were commonly suggested by the participants, being incorporated into future interventions.
286 Interestingly, there were no differences in type of activities suggested by those with and
287 without asthma, with the exception of running, which was recommended by more adolescents
288 without asthma. Almost half suggested obstacle courses or circuits to ensure a variety of
289 different activities in each session, which might prevent burnout and boredom, and increase
290 enjoyment during the sessions [44]. Indeed, this variation was suggested as a tool to divert
291 attention away from the fear of an asthma attack and increase adherence to the exercise
292 programme. Intermittent activities were suggested by four adolescents with asthma in order
293 to catch their breath or take their medication. Given that it takes approximately 7.75 minutes
294 of continuous exercise to elicit bronchoconstriction [45], intermittent activities may
295 potentially reduce symptoms.

296 Participants with asthma generally thought that HIIT was difficult; this may be due
297 to past experiences and potentially poor asthma control. Whilst asthma should not interfere
298 with exercise if well controlled [46], congruent with previous research [42], adolescents with
299 asthma highlighted that their running ability was limited, impeding participation in the
300 majority of sports. The current study, however, revealed that it was not running per se, but
301 specifically long distance running that was difficult for those with asthma and therefore
302 sprints could still be used within intervention sessions, also facilitating regular breaks.

303 Whilst the present findings significantly advance our understanding of the
304 perceptions of those with and without asthma regarding exercise participation, and the ideal
305 constituents for future interventions, it is perhaps pertinent to note the potential influence of
306 self-selection bias on our findings. **Such a self-selection bias would, however, be anticipated**
307 **in any voluntary exercise intervention. Further work is required that focusses on the**

308 engagement of those with particularly low levels of physical activity. Furthermore, the
309 positive outcomes of the present study may be under-represented as the participants in each
310 group often tried to give answers that had not already been expressed. It is also important to
311 highlight that the interviews were conducted in the summer and therefore answers to the
312 preferred location of an intervention, time of day and types of sport may have reflected this.
313 Contrary to previous research, parent interviews were not used in the present study as it was
314 believed that it is the adolescents' engagement that is required for the sustainability of an
315 intervention. Moreover, parents' perceptions of exercise and asthma have been found to be
316 less accurate than their children with the condition [47].

317 **Conclusion**

318 Educating adolescents about asthma could simultaneously aid in reducing stigmatisation and
319 increasing the awareness of exercise-related health benefits, including better asthma control.
320 Whilst participants with asthma reported a fear of undertaking exercise, it was still
321 highlighted as their favourite activity, demonstrating promise for future exercise
322 interventions. Employing an inclusive exercise approach appears feasible given the similarity
323 in activity choices between those with and without asthma. High-intensity, intermittent,
324 varied exercise was highlighted as potentially effective at avoiding bronchoconstriction,
325 distracting those with asthma from their preconceptions regarding exercise, yet ensuring
326 enjoyment.

327 **Acknowledgments**

328 The authors would like to thank the pupils and staff at the school involved with the planning
329 and execution of the interviews. This work is funded by the Asthma UK Centre for Applied
330 Research [AUK-AC-2012-01] and Swansea University Medical School. Commando Joe's
331 also assisted in funding for WTBE who conducted the group interviews.

332 **Declaration of interest**

333 The authors report no conflicts of interest. The authors alone are responsible for the content

334 and writing of the paper.

335

336 **References**

- 337 1. Wanrooij VHM, Willeboordse M, Dompeling E, van de Kant KDG. Exercise
338 training in children with asthma: a systematic review. *Br J Sports Med.*
339 2014;48(13):1024-1031.
- 340 2. Andrade LB, Britto MC, Lucena-Silva N, Gomes RG, Figueroa JN. The efficacy of
341 aerobic training in improving the inflammatory component of asthmatic children.
342 Randomized trial. *Respir Med.* 2014;108(10):1438-445.
- 343 3. Chiang LC, Huang JL, Fu LS. Physical activity and physical self-concept:
344 comparison between children with and without asthma. *J Adv Nurs.* 2006;54(6):653-
345 662.
- 346 4. Lang DM, Butz AM, Duggan AK, Serwint JR. Physical activity in urban school-
347 aged children with asthma. *Pediatrics.* 2004;113(4):341-346.
- 348 5. Glazebrook C, McPherson AC, Macdonald IA, Swift JA, Ramsay C, Newbould R,
349 Smyth A. Asthma as a barrier to children's physical activity: implications for body
350 mass index and mental health. *Pediatrics.* 2006;118(6):2443-2449.
- 351 6. Rietveld S, Prins PJM, Colland VT. Accuracy of Symptom Perception in Asthma
352 and Illness Severity. *Children's Health Care.* 2010;30(1):27-41.
- 353 7. Williams B, Hoskins G, Pow J, Neville R, Mukhopadhyay S, Coyle J. Low exercise
354 among children with asthma: a culture of over protection? A qualitative study of
355 experiences and beliefs. *Br J Gen Pract.* 2010;60(577):e319-326.
- 356 8. McNarry MA, Boddy LM, Stratton GS. The relationship between body mass index,
357 aerobic performance and asthma in a pre-pubertal, population-level cohort. *Eur J*
358 *Appl Physiol.* 2014;114(2):243-249.
- 359 9. Tappe MK, Duda JL, Ehrnwald PM. Perceived Barriers To Exercise Among
360 Adolescents. *J Sch Health.* 1989;59(4):153-155.

- 361 10. Rudell K, Hareendran A, Bonner N, Arbuckle R, Burbridge C, Abetz L. Patients'
362 experience of asthma control and clinical guidelines: perspectives from a qualitative
363 study. *Respir Med.* 2012;106(6):909-911.
- 364 11. Philpott J, Houghton K, Luke A. Physical activity recommendations for children
365 with specific chronic health conditions: Juvenile idiopathic arthritis, hemophilia,
366 asthma and cystic fibrosis. *Paediatr Child Health.* 2010;15(4):213-218.
- 367 12. Sawyer SM, Fardy HJ. Bridging the gap between doctors' and patients' expectations
368 of asthma management. *J Asthma.* 2003;40(2):131-138.
- 369 13. Thornton J. Overcoming 'protected child syndrome': kids, exercise, and chronic
370 illness. *Phys Sportsmed.* 1997;25(11):97-100.
- 371 14. Callery P, Milnes L, Verduyn C, Couriel J. Qualitative study of young people's and
372 parents' beliefs about childhood asthma. *Br J Gen Pract.* 2003;53(488):185-190.
- 373 15. Dantas FM, Correia MA, Jr., Silva AR, Peixoto DM, Sarinho ES, Rizzo JA. Mothers
374 impose physical activity restrictions on their asthmatic children and adolescents: an
375 analytical cross-sectional study. *BMC Public Health.* 2014;14:287.
- 376 16. Protudjer JL, McGavock JM, Ramsey CD, Sevenhuysen GP, Kozyrskyj AL, Becker
377 AB. "Asthma isn't an excuse, it's just a condition": youths' perceptions of physical
378 activity and screen time. *J Asthma.* 2012;49(5):496-501.
- 379 17. Trollvik A, Nordbach R, Silen C, Ringsberg KC. Children's experiences of living
380 with asthma: fear of exacerbations and being ostracized. *J Pediatr Nurs.*
381 2011;26(4):295-303.
- 382 18. Jonsson M, Egmar AC, Hallner E, Kull I. Experiences of living with asthma - a
383 focus group study with adolescents and parents of children with asthma. *J Asthma.*
384 2014;51(2):185-192.

- 385 19. Walker TJ, Reznik M. In-school asthma management and physical activity:
386 children's perspectives. *J Asthma*. 2014;51(8):808-813.
- 387 20. Ram FS, Robinson SM, Black PN, Picot J. Physical training for asthma. *Cochrane*
388 *Database Syst Rev*. 2005(4):Cd001116.
- 389 21. Coquart JB, Lemaire C, Dubart AE, Luttembacher DP, Douillard C, Garcin M.
390 Intermittent versus continuous exercise: effects of perceptually lower exercise in
391 obese women. *Med Sci Sports Exerc*. 2008;40(8):1546-1553.
- 392 22. Logan GR, Harris N, Duncan S, Schofield G. A review of adolescent high-intensity
393 interval training. *Sports Med*. 2014;44(8):1071-1085.
- 394 23. Global Initiative for Asthma. Global strategy for asthma management and
395 prevention 2017 [cited 2017 Apr 27]. Available from: [http://ginasthma.org/2017-](http://ginasthma.org/2017-gina-report-global-strategy-for-asthma-management-and-prevention/)
396 [gina-report-global-strategy-for-asthma-management-and-prevention/](http://ginasthma.org/2017-gina-report-global-strategy-for-asthma-management-and-prevention/)
- 397 24. Hennessy E, Heary C. Exploring children's views through focus groups. In: Greene
398 S, Hogan DM, editors. *Researching children's experiences: Approaches and*
399 *methods*. London: Sage; 2005. p. 236-252.
- 400 25. Horner SD. Using focus group methods with middle school children. *Res Nurs*
401 *Health*. 2000;23(6):510-517.
- 402 26. Gibson F. Conducting focus groups with children and young people: strategies for
403 success. *J Res Nurs*. 2007;12(5):473-483.
- 404 27. Mackintosh KA, Knowles ZR, Ridgers ND, Fairclough SJ. Using formative research
405 to develop CHANGE! : a curriculum-based physical activity promoting intervention.
406 *BMC Public Health*. 2011;11(1):831.
- 407 28. Ridgers ND, Knowles ZR, Sayers J. Encouraging play in the natural environment: a
408 child-focused case study of Forest School. *Children's Geographies*. 2012;10(1):49-
409 65.

- 410 29. O'Dea JA. Why do kids eat healthful food? Perceived benefits of and barriers to
411 healthful eating and physical activity among children and adolescents. *J Am Diet*
412 *Assoc.* 2003;103(4):497-501.
- 413 30. Mancuso CA, Choi TN, Westermann H, Wenderoth S, Wells MT, Charlson ME.
414 Improvement in asthma quality of life in patients enrolled in a prospective study to
415 increase lifestyle physical activity. *J Asthma.* 2013;50(1):103-107.
- 416 31. Haughney J, Barnes G, Partridge M, Cleland J. The Living & Breathing Study: a
417 study of patients' views of asthma and its treatment. *Prim Care Respir J.*
418 2004;13(1):28-35.
- 419 32. British Guideline on the Management of Asthma. *Thorax.* 2008;63 Suppl 4:iv1-121.
- 420 33. Ownby DR, Peterson EL, Nelson D, Joseph CC, Williams LK, Johnson CC. The
421 relationship of physical activity and percentage of body fat to the risk of asthma in
422 8- to 10-year-old children. *J Asthma.* 2007;44(10):885-889.
- 423 34. Weston AR, Macfarlane DJ, Hopkins WG. Physical activity of asthmatic and
424 nonasthmatic children. *J Asthma.* 1989;26(5):279-286.
- 425 35. Taylor WR, Newacheck PW. Impact of childhood asthma on health. *Pediatrics.*
426 1992;90(5):657-62.
- 427 36. Nystad W. The physical activity level in children with asthma based on a survey
428 among 7–16-year-old school children. *Scand J Med Sci Sports.* 1997;7(6):331-335.
- 429 37. van Gent R, van der Ent CK, van Essen-Zandvliet LE, Rovers MM, Kimpfen JL, de
430 Meer G, Klijn PH. No differences in physical activity in (un)diagnosed asthma and
431 healthy controls. *Pediatr Pulmonol.* 2007;42(11):1018-1023.
- 432 38. Walders-Abramson N, Wamboldt FS, Curran-Everett D, Zhang L. Encouraging
433 Physical Activity in Pediatric Asthma: A Case–Control Study of the Wonders of
434 Walking (WOW) Program. *Pediatr Pulmonol.* 2009;44(9):909-916.

- 435 39. Fereday J, MacDougall C, Spizzo M, Darbyshire P, Schiller W. "There's nothing I
436 can't do – I just put my mind to anything and I can do it": a qualitative analysis of
437 how children with chronic disease and their parents account for and manage physical
438 activity. *BMC Pediatrics*. 2009;9(1):1.
- 439 40. Nocon A. Social and emotional impact of childhood asthma. *Arch Dis Child*.
440 1991;66(4):458-460.
- 441 41. Tsakiris A, Iordanidou M, Paraskakis E, Tsalkidis A, Rigas A, Zimeras S, Katsardis
442 C, Chatzimichael A. The presence of asthma, the use of inhaled steroids, and
443 parental education level affect school performance in children. *Biomed Res Int*.
444 2013;2013:762805.
- 445 42. van den Bemt L, Kooijman S, Linssen V, Lucassen P, Muris J, Slabbers G,
446 Schermer T. How does asthma influence the daily life of children? Results of focus
447 group interviews. *Health Qual Life Outcomes*. 2010;8(5).
- 448 43. Turner-Warwick M. Nocturnal asthma: a study in general practice. *J R Coll Gen
449 Pract*. 1989;39(323):239-243.
- 450 44. Wilson DK, Williams J, Evans A, Mixon G, Rheume C. Brief report: a qualitative
451 study of gender preferences and motivational factors for physical activity in
452 underserved adolescents. *J Pediatr Psychol*. 2005;30(3):293-297.
- 453 45. van Leeuwen JC, Driessen JM, de Jongh FH, van Aalderen WM, Thio BJ.
454 Monitoring pulmonary function during exercise in children with asthma. *Arch Dis
455 Child*. 2011;96(7):664-668.
- 456 46. Lucas SR, Platts-Mills TA. Physical activity and exercise in asthma: relevance to
457 etiology and treatment. *J Allergy Clin Immunol*. 2005;115(5):928-934.
- 458 47. Panditi S, Silverman M. Perception of exercise induced asthma by children and their
459 parents. *Arch Dis Child*. 2003;88(9):807-811.

460 **Table 1. Example interview questions**

Group interview	Example questions
Asthma	<ul style="list-style-type: none"> • What do you think people without asthma get wrong or don't understand? • How does your asthma affect you when participating in exercise?
Without asthma	<ul style="list-style-type: none"> • What is asthma? • How do you think exercise affects people with asthma?
Intervention – Both with and without asthma	<ul style="list-style-type: none"> • What type of activities do you think would get your heart rate up high but be enjoyable? • Where do you like to participate in exercise and what time of the school day would you like to participate?

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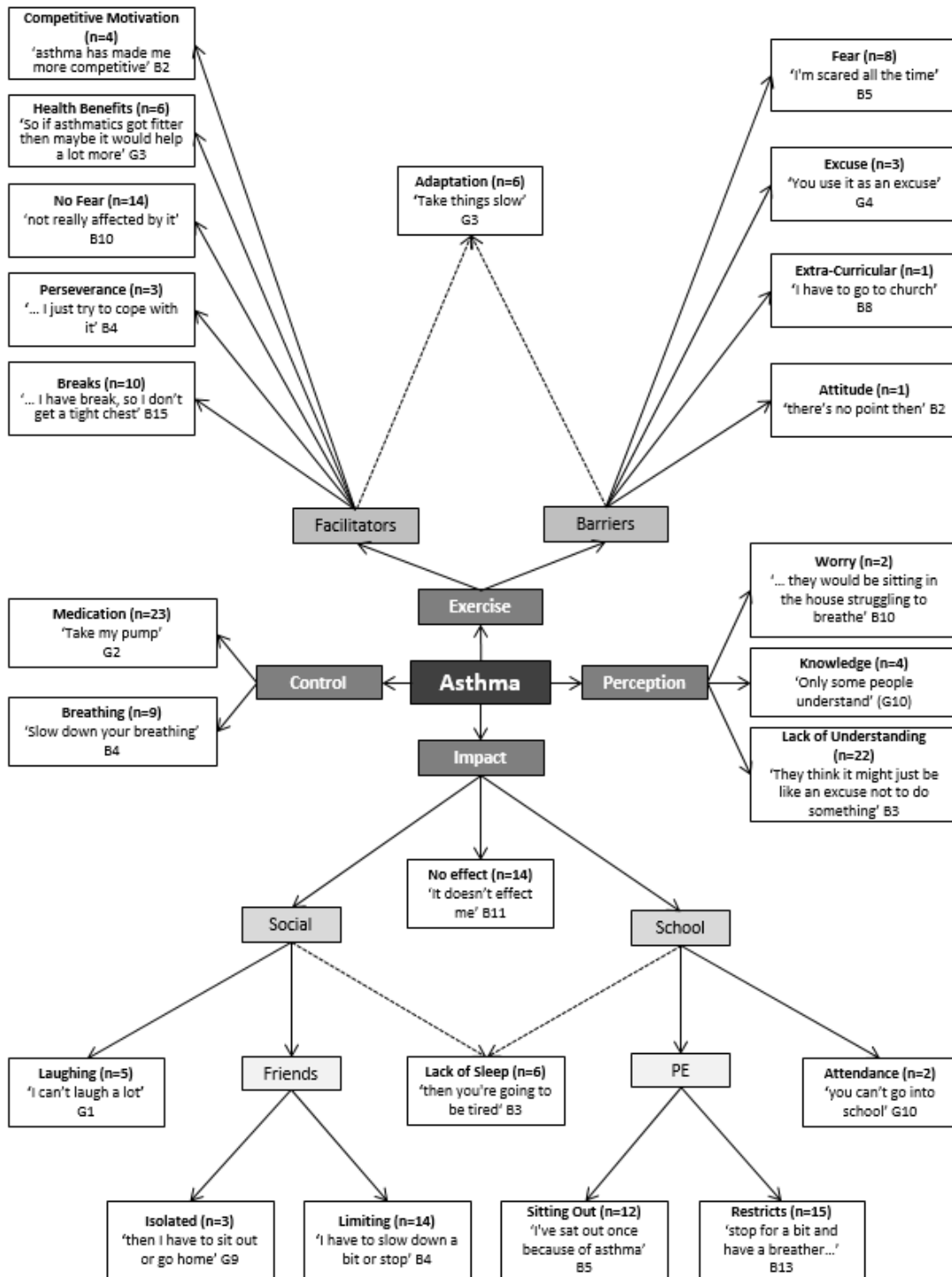
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475 Figure 1

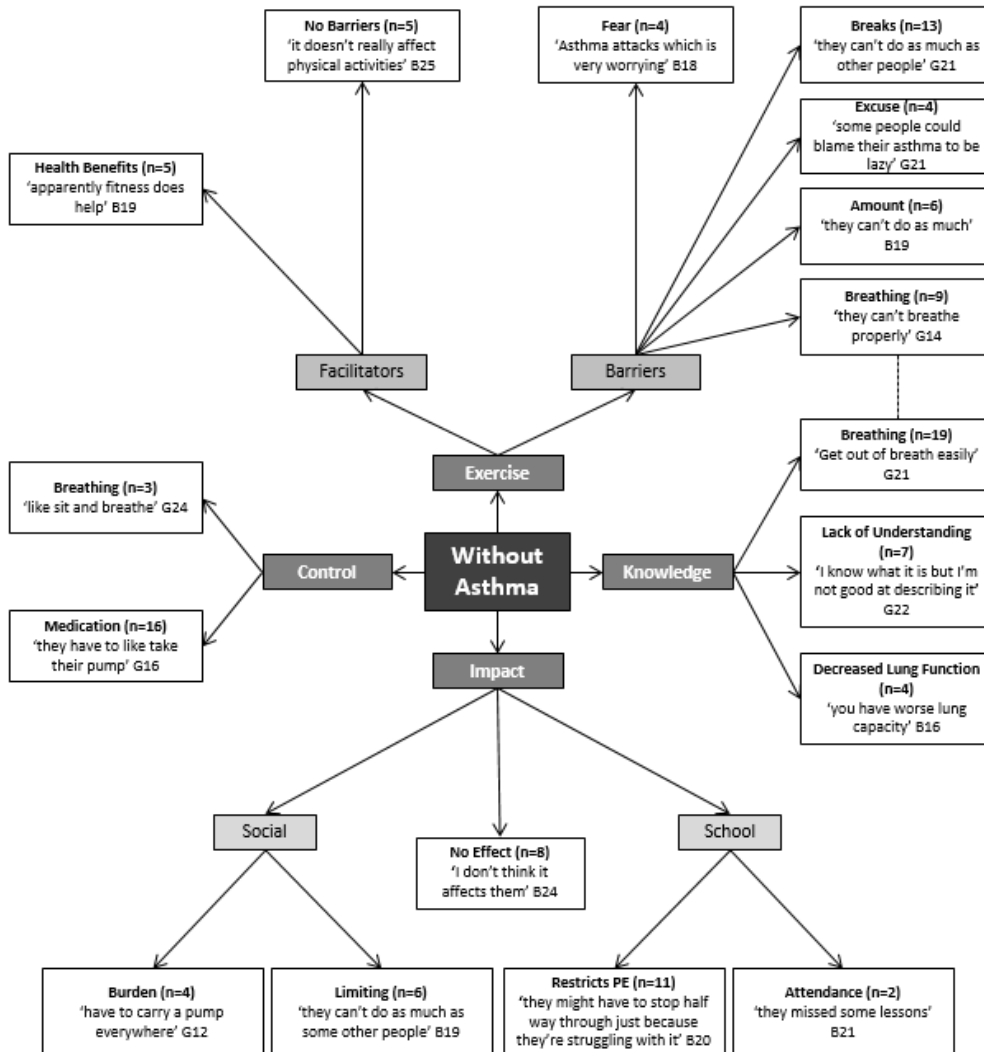


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479 Figure 2



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