

1 **Abstract**

2 **Background:** To suppress the transmission of coronavirus, many governments,
3 including that of the island of Ireland, implemented a societal lockdown which included
4 school closures, limits on social gatherings and time outdoors. This study aimed to
5 evaluate changes in physical activity (PA), mental health, sleep and social media use
6 among adolescent girls during lockdown.

7 **Methods:** 281 female pupils (12-14 years) taking part in the ongoing Walking In
8 Schools (WISH) Study on the island of Ireland self-reported PA, mental health, sleep
9 and social media use before (Sept-Oct 2019), and during lockdown (May-June 2020),
10 via questionnaires. These were supplemented with open-ended structured interviews
11 conducted with 16 girls during lockdown.

12 **Results:** During the period of lockdown and school closures, pupils tried new forms of
13 PA and undertook PA with family but there was no significant change in self-reported
14 PA. There was a decline in health-related quality of life and motivation for exercise;
15 however, self-efficacy for walking and happiness with appearance increased. There
16 was no change in sleep quality or social media usage.

17 **Conclusions:** Despite the many challenges that schools face as they reopen, there
18 is a need to continue to prioritise PA and motivation for exercise to support health and
19 wellbeing in adolescent girls.

20 **Background**

21 On the 11th of March 2020, the World Health Organisation (WHO) announced a global
22 pandemic caused by the coronavirus (COVID-19).¹ COVID-19 is an infectious disease
23 caused by a newly discovered coronavirus which is transmitted primarily through
24 droplets of saliva or discharge from the nose when an infected person coughs or
25 sneezes.² Recent figures indicate that worldwide by mid-September 2020,
26 approximately 31 million people have contracted the virus and 950,000 people have
27 died.³ Globally, many countries have imposed a period of 'lockdown' through public
28 health legislation, which included the closure of non-essential businesses, social
29 distancing, travel restrictions and limits on social gatherings. Based on data from
30 previous influenza outbreaks that showed school closures reduce social contacts and
31 therefore virus transmission^{4,5}, schools in both the Republic of Ireland (RoI) and
32 Northern Ireland (NI) closed during the period of March to August 2020.

33 Extended school closures may not only adversely affect educational attainment but
34 also the physical and mental health of children and adolescents.⁶ Although the decline
35 in PA during school holidays is well established^{7,8}, it is not yet known how lockdown
36 will have affected the PA levels of adolescents and in particular adolescent girls. It is
37 recognised that adolescent females typically have lower levels of PA than their male
38 counterparts⁹⁻¹¹ and prior to the pandemic, only 7.2% of adolescent girls in NI were
39 meeting PA guidelines¹².

40 Previous research has shown that school closures and separation from friends can
41 cause stress and anxiety in children and adolescents¹³. Social media and technology
42 can help maintain social contact and during the pandemic increases in recreational
43 screen-based activities, and time spent on social media have been reported¹⁴.

44 However, there is evidence of an association between mobile screen use and adverse
45 mental health and wellbeing outcomes in young people^{15,16}. Frequent mobile phone
46 use has also been associated with sleep problems¹⁶ and in particular, the use of digital
47 media near bedtime could negatively affect sleep¹⁷. In addition, sleep quality is lower
48 during school holiday closures¹⁸, which may exacerbate feelings of low mood, stress
49 and anxiety¹⁹ during periods of lockdown.

50 The future of COVID-19 is unknown, further outbreaks and new lockdowns are
51 possible, and measures such as social distancing may be in place for some time²⁰.
52 Prior to the pandemic, the mental health of adolescent girls on the island of Ireland
53 was of concern^{21,22} and it is important that we understand how the restrictions
54 implemented to control the transmission of COVID-19 affected their health and
55 wellbeing. The findings of this study may inform future public health strategies and
56 indicate the support measures required for adolescent girls impacted by societal
57 lockdowns and school closures.

58 This paper draws on data collected from a mixed-method study to: a) understand how
59 the PA levels of adolescent girls were affected by lockdown, social distancing and
60 school closures which were enforced as part of the governments' (Northern Ireland
61 Executive and the Government of Ireland) response to COVID-19; and b) evaluate
62 changes in mental health, sleep and social media usage among adolescent girls
63 before and during lockdown.

64

65 **Methods**

66 *Sample and recruitment*

67 Participants were those who took part in Phase 1 (September 2019) of the Walking In
68 ScHools (WISH) Study. The recruitment methods used within the WISH Study have
69 been outlined previously.²³ In brief, all post-primary schools in Co Donegal (RoI) with
70 an enrolment of >240 girls and all post-primary schools Co Derry/Londonderry (NI)
71 with ≥80 girls across years 9-10 were invited to participate in the study. Female pupils
72 aged 12-14 years were invited to take part in the study and all potential pupils (and
73 parents/guardians) were provided with a copy of the participant information sheet.
74 Parents/guardians were asked to provide written consent. Written assent was obtained
75 from pupils. The present study was conducted according to the guidelines laid down
76 in the Declaration of Helsinki, and all procedures were approved by Ulster University
77 Research Ethics Committee (Ref: REC/19/0020).

78 **Quantitative Data Collection**

79 At baseline (September – October 2019; before lockdown), pupils (12-14 years) were
80 asked to complete a series of questionnaires within the school premises on electronic
81 devices (Apple iPad®) using Qualtrics (Provo, Utah, USA). At follow-up (May to June
82 2020; during lockdown), the key contact in each school was asked to circulate the
83 Qualtrics link to pupils via email or online learning platforms. The questionnaires were
84 piloted and modified to ensure there was no ambiguity in the questions and to identify
85 any potential problems the participant might experience. Questionnaires were
86 estimated to take no longer than 30 minutes to complete.

87 *PA:* The PACE+ questionnaire^{24,25} was adapted to capture levels of PA before school
88 closures and the implementation of government restrictions. At the beginning of the
89 questionnaire, pupils were asked to self-report their PA levels before school closures
90 and lockdown, 1) “Thinking back to your last week at school, before coronavirus and

91 lockdown, on how many days were you physically active for a total of at least 60
92 minutes per day?” and 2) “When you were at school, over a typical or usual week, on
93 how many days were you physically active for a total of at least 60 minutes per day?”.
94 From these two questions, the average number of days per week that pupils
95 accumulated 60 minutes of moderate-to-vigorous PA (MVPA) was calculated.
96 Compliance with PA recommendations was assessed by creating a binary variable for
97 those achieving/not achieving ≥ 5 days with at least 60 mins of MVPA.²⁴ At the end of
98 the questionnaire, pupils were then asked to self-report their current levels of PA
99 (during lockdown) and the average number of days that pupils accumulated 60 mins
100 of MVPA per week and compliance with PA recommendations was assessed.^{24,25}

101 *Health Related Quality of Life:* Self-reported wellbeing was assessed using the
102 KIDSCREEN-10 instrument.²⁶ Total scores were calculated, and a higher score
103 indicated a better health-related quality of life.²⁶

104 *Emotion regulation:* The Emotion Regulation Questionnaire for Children and
105 Adolescents (ERQ-CA) was used to assess cognitive reappraisal (changing the way
106 one thinks about potentially emotion-eliciting events) and expressive suppression
107 (changing the way one behaviourally responds to emotion-eliciting events).^{27,28} Scores
108 were calculated for cognitive reappraisal and expression suppression, where higher
109 scores on each subscale represented a greater use of that emotion regulation
110 strategy.

111 *Body weight and appearance satisfaction:* Using the questions adopted for the UK
112 Millennium Cohort Study,²⁹ body weight satisfaction was assessed using three
113 questions. Responses were combined to generate a body satisfaction variable;

114 satisfied or dissatisfied. Happiness with appearance was measured by asking “How
115 happy do you feel about the way you look?”.²⁹

116 *Social Media:* There were three questions included in the questionnaire to assess
117 social media usage 1) Do you use social media?; 2) How often do you use social
118 media?; 3) How many hours do you use social media on a typical day?. Pupils were
119 advised that by social media we meant Facebook, Twitter, Instagram, Snapchat etc.

120 Emotional investment in social media was assessed using the Social Media Use
121 Integration Scale.³⁰ Similar to the methodology used by Woods & Scott, 2016³¹ the
122 term “social media” replaced “Facebook” in six of the questions. A higher overall score
123 indicated a greater level of emotional investment in social media. Questions 1-6
124 assessed social integration and emotional connection to social media while questions
125 7-10 assessed integration into social routines.³⁰

126 *Sleep Quality:* The Pittsburgh Sleep Index³² is composed of 19 questions which
127 assesses seven components (subjective sleep quality; sleep latency; sleep duration;
128 sleep efficiency; sleep disturbance; use of sleep medication; daytime dysfunction) and
129 was used to measure sleep quality. Each question was scored 0 (no difficulty) to 3
130 (severe difficulty) and a global score was then calculated (0-21). A higher score
131 indicated poorer sleep quality, and pupils with a score of greater than 5 were classified
132 as “poor sleepers”.³²

133 *Self-efficacy:* Self-efficacy for PA was measured using the Children’s PA Self-Efficacy
134 Survey.³³ A higher score indicated greater self-efficacy. To assess self-efficacy for
135 walking, the Children’s PA Self-Efficacy Survey³³ was adapted and the term “walk”
136 replaced “exercise”.³⁴ A higher score indicated greater self-efficacy for walking.

137 *Reasons for engaging in PA: The Behavioral Regulation in Exercise Questionnaire-3*
138 (BREQ3)^{35,36} was administered to assess exercise motivation. The BREQ-3
139 questionnaire consists of 23-items and includes subscales that assess amotivation,
140 intrinsic, integrated, identified, interjected, and external regulation. Participant
141 responses were scored using an item aggregation approach³⁶ whereby six unique
142 scores were derived by averaging the items of each individual subscale.

143 *Data Analysis:*

144 We explored the missing data patterns by comparing descriptive statistics of pupils
145 with missing data versus those without missing data and by visualising the pattern of
146 missing data via heat maps, lollipop plots, and upset plots (our missing data analysis
147 can be found here: <https://osf.io/6xjku/>). We did not impute missing data because the
148 level of missing data exceeded 15% for most variables. Categorical data were
149 presented as frequencies and percentages and before and during lockdown
150 comparisons for dichotomous variables were made via exact McNemar's tests.
151 Resulting p-values of below 0.05 were interpreted as 'surprising if we assume the null
152 hypothesis is true' and those above 0.05 were interpreted as 'unsurprising if we
153 assume the null hypothesis is true'.

154 For continuous variables, because of the exploratory nature of the study and the level
155 of missing data, we summarised the data via a five-number summary consisting of the
156 minimum value, maximum value, median, and upper and lower quartiles and
157 visualisation via box plots with paired lines, violin plots, and scatterplots. To compare
158 continuous normally-distributed variables before and during lockdown comparisons
159 we computed mean differences and 95% confidence intervals, whereas for non-
160 normally distributed we calculated nonparametric continuity-corrected 95% confidence

161 intervals and the median of the difference between a sample from before and a
162 sample from during lockdown.³⁷

163 All statistical analyses were performed with RStudio version 1.2.5033 (release name:
164 "Orange Blossom"). Our data, code, and full analysis can be found at:
165 <https://osf.io/6xjku/>.

166 **Qualitative Data Collection:**

167 Parent/guardian contact details were obtained at the end of the questionnaire and
168 were used to explain the procedure for pupils who indicated they were willing to take
169 part in the semi-structured interview. Following parental verbal informed consent, a
170 suitable date and time was arranged for the interview. At the start of each interview,
171 the researcher confirmed consent and advised the participant that they could stop the
172 interview at any time without giving reason.

173 *Data Analysis:*

174 Data were collected from individual open-ended semi-structured interviews lasting
175 approximately 15 minutes which were conducted via Zoom© (version 5.2.1) or
176 telephone. The interview guide (Table 1) was used to initiate conversation and ensure
177 consistency between interviews, but the researcher could probe using additional
178 follow-up questions. All interviews were recorded using a digital recorder (Sony ICD-
179 PX370) and transcribed verbatim. Following familiarisation with the data (listening to
180 the audio-recordings and re-reading transcripts), all transcripts were uploaded to
181 NVivo 12 (QSR International Pty Ltd., Doncaster, VIC, Australia), and analysed
182 thematically, following a six phase deductive approach³⁸ (1. Data familiarisation; 2.
183 Generating initial codes; 3. Searching for themes; 4. Reviewing themes; 5. Defining
184 and naming themes; 6. Producing the report). Initially, each meaningful quote or key

185 example was assigned a code. Codes were then grouped together to develop themes
186 that were representative of the coded excerpts. Once coding had been completed for
187 all transcriptions, definitions and names were then assigned to each theme. For
188 example, codes including lack of motivation, maintenance of skills or fitness, PA for
189 mental health, PA as a coping strategy, PA as a priority or not during lockdown, were
190 grouped together to develop the “changing priorities” theme. Quotes from pupils were
191 used to highlight key themes identified during the interviews.

192

193 **Results**

194 Participants were recruited from five NI schools, three of which were grammar, one
195 secondary and one grant maintained integrated (mean 25.5% entitled to free school
196 meals). Of the four participating ROI schools, two were community, one secondary
197 and one comprehensive (three were participating in the Delivering Equality of
198 Opportunity in Schools (DEIS) programme). At baseline (pre-lockdown), n=281
199 adolescent girls completed the questionnaire and at follow up (during lockdown), n=94
200 girls completed the questionnaire in full. When comparing pupils who had missing data
201 at follow up with those who did not, there was no difference in terms of age, body mass
202 index (BMI), waist:hip ratio (WHR), or any psychological or social media variable
203 assessed. Sample characteristics of pupils at baseline are provided in Table 2.

204

205 *Physical Activity:* Most of the pupils not meeting PA guidelines at baseline were also
206 not meeting guidelines during lockdown (n=46; 58%), while 16 (20%) were meeting
207 the guidelines at both timepoints. However, 12 (15%) pupils not meeting guidelines at
208 baseline were meeting them during lockdown, whereas 6 (8%) pupils meeting

209 guidelines at baseline did not during lockdown. These changes from pre to during
210 lockdown were unsurprising if we assume there is no difference between the two
211 timepoints (Exact McNemar test, $p = .24$). In addition, the average number of days
212 active (≥ 60 mins MVPA) pre-lockdown compared to during lockdown were almost
213 identical [median (IQR): 4.0 (2) vs. 3.5 (3.5) days].

214 *Sleep Quality:* Overall, sleep quality was similar before and during lockdown (Table
215 3). Before lockdown, 38% of pupils were classed as “poor sleepers” (score greater
216 than 5)³² compared to 41% during lockdown.

217 *Wellbeing:* For all the wellbeing outcomes, only 31% of pupils provided lockdown
218 assessment data, therefore, caution is advised when interpreting differences between
219 these timepoints. As outlined in Table 3, there was a small decrease in health-related
220 quality of life scores from before and during lockdown. There was no change in the
221 use of expressive suppression strategies from before and during lockdown; however,
222 there was a slight reduction in the use of cognitive reappraisal strategies (Table 3).

223 Before lockdown, 20% of pupils reported being unhappy with their appearance, this
224 decreased to 12% during lockdown. Most ($n=71$, 74%) pupils with complete data
225 reported that they were satisfied with their appearance at both timepoints. There was
226 no change in the proportion of pupils dissatisfied with their body weight before (21%)
227 or during lockdown (18%). Most ($n=70$, 73%) pupils were satisfied with their body
228 weight at both timepoints, six (6%) pupils who were satisfied pre-lockdown were
229 dissatisfied during lockdown, whereas, nine (9%) who were dissatisfied pre-lockdown
230 were satisfied during lockdown. Eleven (11%) pupils were dissatisfied with their body
231 weight at both timepoints.

232 There was a slight increase in self-efficacy for walking during lockdown, but no change
233 in scores for exercise self-efficacy (Table 3). Compared to pre-lockdown, pupils' score
234 for all six subscales (amotivation, external regulation, introjected regulation, identified
235 regulation, integrated regulation and intrinsic regulation) were average one point lower
236 (on 0 to 5 scale) during lockdown.

237 *Social media usage:* Only 37% of pupils provided information on social media use
238 during lockdown therefore, caution is advised when interpreting differences between
239 timepoints. Pupils reported spending a similar number of hours on social media during
240 lockdown as before lockdown [median (IQR): 2 (2) vs. 2 (2) h/day]. Social media
241 integration scores were similar pre-lockdown versus during (Table 3). Pre-lockdown
242 integration of social media into social routine scores were slightly lower than during
243 lockdown scores, while there was a small increase in social integration and emotional
244 connection scores from pre-lockdown to during.

245

246 **Qualitative Interviews**

247 In total, 16 pupils from six schools were interviewed. The mean (SD) age of pupils was
248 13.8 (0.8) years. The interviews generated discussion on the effects of the COVID-19
249 restrictions on PA and the main themes are outlined below, (1. The changing
250 landscape of PA during lockdown; 2. Increased discussion about PA; 3. Changing
251 priorities; 4. PA with family). Further illustrative quotes are provided in Table 4.

252 1. The changing landscape of PA during lockdown

253 *Changes in physical activity levels:* Many pupils explained that their level of PA had
254 increased during lockdown: "I think I'm actually doing more cos I'm going on walks
255 during the day cos I'm getting bored, and then I'm going on walks in the evening and

256 then I'm outside playing with my dog" (School_09). However, for some pupils,
257 particularly those involved in team sports, their PA levels had decreased: "I think it's
258 went down because I'm not doing as much training as I would have. Like I do try and
259 go out a walk every day and I do the home workouts, but it would have gone down"
260 (School_09).

261 *Choice of activity:* A common theme to emerge was the idea of "swapping" activities:
262 "It has cut Irish dancing out but I am still trying to get on a walk everyday" (School_01).
263 During lockdown many pupils tried new activities: "I've been out with my football, I've
264 been practicing that, that's something I wouldn't be doing before" (School_09). Pupils
265 explained how they were able to access different forms of PA online during lockdown:
266 "I've never done Zumba before cos there's not one round here but I can do it virtual
267 now" (School_06). Many indoor recreational facilities were closed during lockdown and
268 pupils reported how they made use of outdoor facilities: "We would have went to the
269 beach a lot" (School_01).

270 *Physical distancing:* Social distancing regulations were not a barrier to PA for most
271 pupils: "I'm not very at risk and no one in my house is at risk so I was a wee bit like it's
272 ok to go outside but I know for other people that would be more scary" (School_06).
273 Pupils were able to adapt their activities and plans to adhere to social distancing
274 regulations: "Me and my friend go out for a walk once a week, social distancing and
275 stuff" (School_09).

276 2. Increased discussion about PA

277 *PA resources and information:* Pupils noted how there had been increased discussion
278 about PA during lockdown: "On the news and stuff, it seems to be more of a thing"
279 (School_09). Pupils discussed that there were many resources available to encourage

280 people to be physically active during lockdown: “There were more people on the TV
281 like providing like workouts and stuff...they were doing stuff on their stories on
282 Instagram and stuff like workouts” (School_09).

283 *Sources of information:* It was also apparent that there had been a change in who
284 provided information on PA: “Before it was on a low scale, it would have been people
285 like the PE teachers and the swimming club coaches, it would have been just them
286 people talking about PA, like none of my friends, but now it’s like all these people are
287 talking about it” (School_09). Pupils discussed several other information sources on
288 PA during lockdown including the news, television and social media: “Well there’s like
289 these things on YouTube and Instagram” (School_01).

290 3. Changing priorities

291 *Benefits of PA:* PA was a priority for many during the lockdown period: “It is more
292 important cos before the lockdown, I wouldn’t really care if I went on walks after school
293 as I had already been doing exercise anyway without knowing it, but now...I know it’s
294 really going to affect me, so I started doing a bit more” (School_08).

295 *Lack of motivation:* However, for some pupils, particularly those involved in team
296 sports, it was difficult to get motivated: “I think it’s [PA] probably less [important]
297 because my life involves around being in camogie and football teams, so I was doing
298 a lot and being part of that but now I’m not doing anything really” (School_09).

299 *PA as a coping strategy:* For other pupils PA helped them cope during the lockdown:
300 “I think it helped me cope, because I could just go outside and be on my own for a
301 while” (School_09). Pupils were aware of the benefits of PA, particularly in terms of
302 mental wellbeing: “I think it [PA] became a lot more important, it’s sort of like with your
303 mental health its very good, like it makes you feel happy and stuff” (School_09).

304 *Maintenance of skills and fitness:* For other pupils, PA was a priority during lockdown
305 as they wanted to maintain their fitness levels and skills: “I don’t want to go back and
306 not be able to swim, the things that I was used to be able to swim, so I kind of want to
307 keep my PA up” (School_09).

308 *Time:* During the interviews, pupils outlined that while schools were closed, they had
309 time available which enabled them to make PA a priority: “I feel I have more time to
310 go out for walks more often and for longer periods of time” (School_09). PA was also
311 a way of passing time for pupils and was used as a strategy to combat boredom: “I
312 thought it was good cos then it keeps you entertained instead of doing nothing, I like
313 going on a cycle or something” (School_09).

314 4. PA with family

315 *Social interaction:* It was evident that undertaking PA without their friends was
316 challenging and pupils missed the social interaction with their friends and teammates:
317 “Being with your friends makes it really fun, but when you’re not with your friends you
318 don’t chat or anything” (School_09). Pupils found it difficult to exercise on their own
319 and to motivate themselves: “It’s a bit more challenging without them [friends] because
320 they would sometimes push you on and be like you can do it” (School_01).

321 *PA with family:* For many young people, PA with friends was replaced with PA with
322 members of their family: “I do beach walks with my family” (School_03). In many cases,
323 this was relatively new and something that they had only started since lockdown: “I
324 would have went out walks or went running with my dad...that would have been quite
325 new doing it together” (School_07).

326

327 **Discussion**

328 The purpose of this study was to examine changes in PA, mental health, sleep and
329 social media usage in adolescent girls during the COVID-19 lockdown. During
330 lockdown, pupils had increased free time, tried new forms of PA and many undertook
331 PA with their families but there was no significant change in PA levels. There were no
332 changes in sleep quality and social media usage was unchanged. There was a decline
333 in health-related quality of life and motivation for exercise decreased during lockdown,
334 however, self-efficacy for walking and happiness with appearance increased in this
335 cohort.

336 During lockdown, PA has been one of a few reasons people were permitted to leave
337 their homes³⁹ and there was much positive messaging about PA from sporting
338 organisations and government particularly across social media.⁴⁰ Messaging is just
339 one approach that can be used to reach large numbers of people at a relatively low
340 cost⁴¹ and using mass media, websites and smartphones apps to deliver PA
341 messages to young people may be most effective^{42,43}. The positive messaging during
342 lockdown, may have increased awareness of the importance of PA and prevented a
343 decline in levels of PA among adolescent girls.

344 In addition, changed circumstances may interrupt 'automatic' behaviour patterns
345 through 'habit discontinuity' leading to formation of new health habits.⁴⁴ During
346 lockdown adolescents reported having more time available for PA as commuting to
347 and from school had ceased and it was estimated that pupils were spending
348 approximately 2.5 hours a day doing schoolwork.⁴⁵ In the absence of a structured
349 school day and homework during lockdown, adolescents may have had additional
350 opportunities to be physically active⁴⁶ as previous evidence has reported homework
351 to be a barrier to PA in this population⁴⁷. Many adolescents had taken up new activities
352 during lockdown including online workouts, virtual dance classes and cycling and for

353 many families, exercising together was new. This trend has been observed in other
354 studies^{14,48} and it has been reported that 71% of children were taking part in PA with
355 their parent/carer compared to 17% that were exercising online with their friends⁴⁸.
356 Whether these changes are likely to be sustained post-lockdown is currently unknown;
357 however, it is recognised that family-based interventions to increase PA in children are
358 effective⁴⁹ and efforts should be made to sustain this increase in family-based PA to
359 support a long-term improvement in adolescent PA.

360 Although children and adolescents appear to be less vulnerable than adults to COVID-
361 19⁵⁰, some reports suggest that adolescents may have experienced higher rates of
362 mental ill-health during lockdown^{51,52}. During adolescence, social relationships form
363 and develop where adolescents have increased motivation, enthusiasm and are
364 attuned to peer group, and relationships.⁵³ Social distancing and lockdown measures
365 can result in social isolation⁵⁴ and adolescents may feel frustrated, nervous,
366 disconnected, and bored.¹³ Therefore, there is a need to continually monitor the mental
367 health of adolescents in the longer term to determine how extended school closures,
368 lockdown and social distancing measures affect adolescents.⁵⁵ The data presented in
369 the current manuscript shows that while there was no change in sleep quality and time
370 spent on social media, there was a decrease in health-related quality of life scores.
371 Health-related quality of life may have been negatively influenced by the rapid
372 implementation of social distancing measures and school closures and associated
373 increases in feelings of loneliness, isolation, uncertainty and anxiety⁵¹. As government
374 restrictions are eased, adolescents should be supported to reconnect with friends and
375 access appropriate support.

376 This study provides insight into the changes in PA, sleep, mental health and social
377 media use of adolescent girls during lockdown. Participating schools varied by type

378 and socio-economic status and were largely reflective of the demographic
379 characteristics of schools on the island of Ireland. A robust methodology using
380 validated instruments and supplemented by semi-structured interviews generated rich
381 data on the changes in PA during lockdown. Accelerometer data is recognised as an
382 objective method of collecting PA data⁵² and while it was possible to collect
383 accelerometer data for pupils at baseline, this was not possible during lockdown due
384 to school closures and travel restrictions. Therefore, we were reliant on self-reported
385 PA data which the authors acknowledge is dependent on pupils' recall ability⁵⁶ and
386 subject to social desirability bias.⁵⁷ It is also important to acknowledge that while the
387 follow up questionnaire was only completed by 33% of pupils, remote data collection
388 is challenging and was largely dependent on pupil engagement with home learning.
389 As such, the rate of missing data was lower when data collection took place on school
390 premises.

391 In conclusion, the present study adds to the knowledge base on the impact of
392 restrictive measures implemented to reduce the transmission of COVID-19 on PA,
393 sleep and psychological wellbeing of adolescent girls. While the restrictive measures
394 and school closures were necessary to prevent the spread of disease^{4,5}, we observed
395 a decline in health-related quality of life and motivation for exercise during lockdown.
396 Previous studies have reported declines in the mental health of adolescents during the
397 pandemic^{58,59} and careful monitoring is required in the event of future lockdowns.
398 Schools provide key opportunities for PA⁶⁰, however while they were closed, young
399 people participated in alternative activities. Adolescents should be encouraged to
400 continue with the activities they have enjoyed during lockdown and the principles of
401 habit formation applied to sustain changes in behaviour. As restrictions are eased and
402 schools reopen, there will be many challenges for schools, however; PA should be a

403 continued priority to optimise the health and wellbeing of adolescents. In the event of
404 future lockdowns, a collective effort involving parents and policy makers is required to
405 promote PA, health and wellbeing⁶¹ particularly among adolescent girls. Furthermore,
406 positive PA messaging should continue, and family-based PA encouraged to prevent
407 any decline in PA.

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421 The WISH trial is registered with ISRCTN, protocol number ISRCTN 12847782.

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1.	Before coronavirus, school closures and lockdown did you take part in much PA?
2.	Do you think coronavirus restrictions have affected your PA levels?
3.	Did you try any new activities during the coronavirus lockdown?
4.	How have you found it being unable to take part in PA with your friends?
5.	Did you take part in PA with your family during the lockdown or did you exercise on your own?
6.	Did you notice there was more information and discussion about PA during the lockdown?
7.	Did you find that PA helped you cope during the lockdown or did you find that it was hard to get motivated for exercise while the lockdown was ongoing?
8.	Would you say PA was more or less important / a priority to you during the lockdown than normal?
9.	Did the rules around social distancing put you off going outside your house to exercise?
10.	Is there anything about PA and coronavirus that we haven't chatted about that you would like to mention?

Table 1: Interview schedule

	Mean (SD)
Age (years)	12.8 (0.8)
Height (m)	1.6 (0.1)
Body mass (kg)	54.3 (11.5)
BMI (kg/m ²)	21.4 (4.3)
BMI Category, N (%) ^{55,56}	
Underweight	7 (9%)
Healthy weight	210 (75%)
Overweight	33 (12%)
Obese	12 (4%)
Waist:Hip ratio	0.8 (0.1)

Table 2: Sample characteristics of pupils ($n=281$) at baseline

SD = Standard Deviation; BMI = Body Mass Index

	Pre-lockdown			During lockdown			Pre-during lockdown
	N (%)	Median (IQR)	Min-max	N (%)	Median (IQR)	Min-max	MDiff (95% CI)*
Health related quality of life	281 (100)	39 (6)	24-50	104 (37)	36 (6)	23-49	-3.4 (-4.5, -2.5)
Expressive suppression	281 (100)	16 (6)	4-27	96 (34)	15 (6)	5-26	-5.6 (-1.5, 1.0)
Cognitive reappraisal	281 (100)	29 (6)	9-42	96 (34)	26 (7)	10-40	-3 (-4.5, -1.5)
Sleep quality	266 (95)	4 (3.8)	0-16	87 (31)	5 (4.0)	0-17	0.5 (-0.0, 1.0)
Exercise self-efficacy	281 (100)	23 (6)	12-32	94 (33)	24 (6)	10-32	1.0 (0.0, 2.0)
Walking self-efficacy	281 (100)	25 (7)	13-32	94 (33)	27 (6)	12-32	2.0 (1.0, 2.5)
Amotivation	281 (100)	0.8 (2.0)	1-4	94 (33)	0.5 (1.2)	0-4	-1.0 (-1.1, -0.6)
External regulation	281 (100)	2 (2.3)	1-5	94 (33)	1 (1.9)	0-4	-0.9 (-1.1, -0.6)
Introjected regulation	281 (100)	3.3 (1.5)	1-5	94 (33)	2.0 (1.6)	0-4	-1.4 (-1.6, -1.1)
Identified regulation	281 (100)	3.8 (1.0)	1-5	94 (33)	2.5 (1.0)	0-4	-1.3 (-1.5, -1.1)
Integrated regulation	281 (100)	3.5 (1.8)	1-5	94 (33)	1.6 (1.8)	0-4	-1.5 (-1.7, -1.3)
Intrinsic regulation	281 (100)	4.0 (1.0)	1-5	94 (33)	2.8 (1.4)	0-4	-1.2 (-1.4, -1.0)
Social media use integration	269 (96)	37 (15)	11-60	90 (32)	36 (11)	13-53	-0.5 (-2.5, 1.5)
Integration into social routines	269 (96)	18.0 (6.0)	6-36	90 (32)	15.5 (4.0)	6-34	-2.5 (-3.5, -2.0)
Social integration & emotional connection	269 (96)	19.0 (9.0)	5-24	90 (32)	21.0 (8.0)	6-20	2.0 (0.5, 3.5)

Table 3: Changes in psychological variables and social media usage from before to during lockdown

Key: MDiff = median of the difference between a sample from before and a sample from after.

* continuity-corrected nonparametric 95% confidence intervals

Theme	Quote
1. The changing landscape of PA during lockdown	<p>“It [lockdown] has cut Irish dancing out but I am still trying to get on a walk every day.”</p> <p>“All those things I did are now cancelled so all the activities I have to do now would be on my own.”</p> <p>“I’m not walking to school and back so that affects that physical activity and we are at home, so we don’t really get that much just walking upstairs and downstairs.”</p> <p>“If you’re meeting up with somebody...the footpaths aren’t wide enough but it wouldn’t put me off [walking] that much.”</p>
2. Increased discussion about PA	<p>“There is stuff on the news, you can do this like Joe Wicks and all that and you sort of talk about it as well.”</p> <p>“On like social media there would be a lot of ads, the perfect time to get your summer body or keep active at home, a lot more workouts that I didn’t know personally about becoming more popular and I would hear about them lot over social media.”</p> <p>“There was a lot of like social media influencers that I would have followed, and this would have been the time to get active and all these different apps and trainers.”</p> <p>“You sort of see a whole bunch of people on social media saying this is a good time to do it [physical activity] so you’re like yeah so if they’re doing it, I’m doing it.”</p>
3. Changing priorities	<p>“Well I thought it [physical activity] was good cos then it keeps you entertained instead of doing nothing, I like going on a cycle or something.”</p> <p>“It makes you feel better when you have done exercise otherwise if you don’t do it you feel lazy because you’re just sitting in the house all day. If everyone is annoying you in the house, you can just go and be away from them.”</p> <p>“[Physical activity] was probably less important because it wasn’t like a team, it wasn’t like trying to win a competition or anything, you know it wasn’t as fun.”</p> <p>“It is more important because before the lockdown, I wouldn’t really care if I went on walks after school as I had already been doing exercise anyway without knowing it, but now with technology I notice I barely do anything.”</p>
4. PA with family	<p>“Most of it [physical activity] was with my family, I would have went out walks or went running with my dad.”</p> <p>“Because I was at clubs, I wouldn’t have walked with her [mum], but now because I’m not at the clubs I walk with her”</p>

“I would walk the dog with my parents...I would have rarely like gone for a walk because I would have been too busy with school-work and training but yeah it probably would have been something new that I’m just doing now.”

“At the start of lockdown I was doing the workout app, but then at the minute I’m just going out for walks and cycles with my family and stuff...we’ve went on a couple of walks every few evenings every week for the past couple of years now, so we’ve been doing that like normally anyway but, like walking a bit more since lockdown started.”

Table 4: Emerging themes and key quotes from the semi-structured interviews