

Go Play Outside! A web-based and in-person risk reframing intervention to influence mothers' tolerance for, and parenting practices associated with, children's outdoor risky play: Results of a randomized controlled trial

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Abstract

Background: Outdoor risky play, such as climbing, racing and independent exploration, is an important part of childhood and is associated with various positive physical, mental and developmental outcomes for children. Parental attitudes and fears, particularly mothers', are a major deterrent to children's opportunities for outdoor risky play.

Objective: To evaluate the efficacy of two versions of an intervention to reframe mothers' perceptions of risk and change parenting behaviours: web-based intervention or an in-person workshop, compared to the control condition.

Methods: The Go Play Outside! randomized controlled trial was conducted in Canada in 2017 to 2018. Participants were recruited through social media, snowball sampling, and community notices. Mothers of children aged 6-12 years were self-assessed through eligibility questions, and those eligible and consented to participate in the study were randomized into a fully automated web-based intervention, the in-person workshop or the control condition. The intervention was underpinned by social cognitive theory, incorporating behaviour change techniques. Participants progressed through a series of self-reflection exercises and developed a goal for change. Control participants received the Position Statement on Active Outdoor Play. The primary outcome was increase in tolerance of risky play and the secondary outcome was goal attainment. Data were collected online via REDCap at baseline, 1-week and 3-months post-intervention.

Randomization was conducted using sealedenvelope.com. Allocations were concealed to researchers at assignment and data analysis. We conducted mediation analyses to examine whether the intervention influenced elements of social cognitive theory, as hypothesized.

Results: A total of 451 mothers were randomized and completed baseline socio-demographic assessments: 150 in the web-based intervention, 153 in the in-person workshop, and 148 in the

control condition; of which a total of 351 mothers completed the intervention. At 1-week post-intervention, 121, 85, and 135 mothers completed assessments for each condition, respectively, and at 3-months post-intervention, 105, 84 and 123 completed the assessments, respectively.

Compared to mothers in the control condition, mothers in the web-based intervention had significantly higher tolerance of risky play at 1-week, and 3-months post-intervention; and mothers in the in-person workshop had significantly higher tolerance of risky play at 1-week post-intervention. No other significant outcomes were found. None of the potential mediators were found to significantly mediate the outcomes.

Conclusions: The trial demonstrates that the web-based intervention was effective in increasing mothers' tolerance for risk in play.

Trial Registration: ClinicalTrials.gov, NCT03374683. Retrospectively registered on December 15, 2017.

Keywords: Outdoor play; Mothering; Independent mobility; Physical activity; Risk perception; Risky Play; Risk reframing

1 **Introduction**

2 Evidence is growing regarding the importance of outdoor play for children's health and
3 well-being, as are efforts to improve children's access to these opportunities [1]. Outdoor play
4 includes inherent risks, including those explicitly sought out by children as they explore their
5 bodies and environments. Risky play, such as climbing trees, building dens, or even walking
6 home from school without an adult, is an inherent and important part of outdoor play [2], and has
7 been associated with increases in physical activity, decreases in sedentary behaviour, and
8 positive influences on physical, social and cognitive development [3,4]. Parental attitudes and
9 fears, particularly mothers', are a primary barrier to children's outdoor risky play opportunities
10 [5–7]. They include fear of serious injury, traffic, abduction, or even the belief that time spent in
11 outdoor play has little value in contrast to academic or other pursuits. Efforts to shift parent
12 attitudes are a frequent focus of practitioners wanting to promote high quality play opportunities
13 [8], and policy makers wanting to improve rates of children walking to and from school [9,10].

14 Previous attempts to influence parent attitudes and practices toward risky play have been
15 limited to in-person workshops and have not been rigorously evaluated [11]. We sought to
16 develop and evaluate a risk reframing intervention for parents, particularly mothers as they may
17 be typically the more limiting parent [12,13], that would be accessible through either an in-
18 person workshop or on a web-based platform. A web-based intervention that was freely available
19 would facilitate parents' access, as well as the ease with which practitioners could incorporate
20 the intervention into their existing practice by, for example, encouraging the parents in their
21 network to complete the intervention prior to children's enrollment in activities.

22

23

24 This paper reports the results of a randomized controlled trial (RCT) evaluating the
25 efficacy of a risk reframing intervention to increase mothers' tolerance for risky play and attain a
26 behaviour change goal related to providing risky play opportunities for their 6-12-year-old
27 children. The intervention development, content, and theoretical framework were previously
28 published [14]. We tested two versions of the intervention: web-based and in-person workshop.
29 We hypothesized that either intervention condition would have significantly greater increase of
30 tolerance for risky play than those in the control condition at 1-week and 3-months post-
31 intervention. We also hypothesized that a greater proportion of participants in either intervention
32 condition would attain their behaviour change goal than those in the control condition.

33 We further examined whether social cognitive theory (SCT), the behaviour change model
34 that underpinned the development of the intervention, produced the hypothesized effect on the
35 outcome variables. Specifically, we hypothesized that self-efficacy, outcome expectations and
36 knowledge of risky play would mediate the relationship between the risk reframing intervention
37 and the outcomes: tolerance for risky play and goal attainment.

38

39 **Methods**

40 Study design

41 A description of the protocol for this study has been published [14]. Briefly, the study
42 was a single-blind (researchers and outcome assessors) three parallel condition RCT. The trial
43 was conducted between December 2017 to September 2018 in the Metro Vancouver area of
44 British Columbia, Canada. Measures were collected at baseline, 1-week and 3-months post-
45 intervention. The primary outcome was increase in tolerance of risk in play at either follow-up
46 time point. The secondary outcome was mothers' goal attainment at either follow-up time point.

47 The trial was registered with the United States National Institute of Health’s Protocol
48 Registration and Results System (NCT03374683) and approved by the University of British
49 Columbia/Children’s and Women’s Health Centre of British Columbia Research Ethics Board
50 (H15-03271). No change was made to methods after trial commencement. We followed the
51 CONSORT-EHEALTH guidelines in reporting this study [15]. The checklist can be seen in
52 Multimedia Appendix 1.

53

54 Participant Recruitment and Eligibility Criteria

55 Participants were recruited through advertising on online forums and social media,
56 distributing notices through our networks, snowball sampling and posting notices in community
57 centres. Interested participants visited the study homepage in the REDCap electronic data
58 capture tool hosted at British Columbia Children’s Hospital Research Institute [16]. There they
59 were provided with a description of study procedures and information that completing the survey
60 questions indicated consent. Potential participants were self-assessed through eligibility
61 questions establishing that they were a mother with primary custody of a child/children aged 6-
62 12 years; residing in the Metro Vancouver Regional District; and, able to speak, read and
63 understand English. Computer/internet access and literacy were implicit eligibility criteria since
64 accessing the study homepage and completing the eligibility questionnaire would be otherwise
65 impossible. Enrolled participants were emailed a unique link to the baseline questionnaire
66 package in REDCap.

67

68

69 Randomization and Blinding

70 Enrolled participants were automatically assigned to one of the three conditions by
71 REDCap: control; web-based; and in-person workshop. Participants had equal likelihood of
72 being assigned to each condition (33%). The randomization schedule was generated beforehand
73 via sealedenvelope.com using randomized permuted blocks of size 3, 6, and 9. The list was then
74 transferred to REDCap. Unbeknownst to participants, randomized allocation occurred in the
75 background before participants completed the baseline questionnaire. This had to be done
76 because REDCap limited capabilities for real-time, streamline randomized allocation. The nature
77 of the intervention did not permit participant blinding but they were informed of their allocated
78 treatment after completing the baseline questionnaires. The in-person workshop facilitator could
79 not be blinded to allocation as the other two arms did not have a facilitator. Likewise, research
80 staff who coordinated in-person workshop schedules could not be blinded to allocation of the in-
81 person workshop. In-person workshop participant information (name, email address) was only
82 used to coordinate the workshop. This information was encrypted, password protected, and
83 stored in a password protected folder in a secured network at the BC Children’s Hospital
84 Research. However, allocations were concealed to the researchers at participant assignment and
85 data analysis.

86

87 Risk Reframing Intervention

88 Participants in the web-based intervention were provided with a link to the fully
89 automated web-based intervention [17] to complete within one week. A reminder was sent via
90 email if participants did not complete the web-based intervention within 24 hours. The final
91 reminder was sent after 48 hours since their baseline entry via email. Contact information (i.e.,
92 email, phone) was provided for participants to contact the research coordinator if they had any

93 feedback or questions. Participants in the in-person workshop were scheduled to attend the in-
94 person workshop. Briefly, the risk reframing intervention was adapted from an in-person
95 workshop for parents and teachers developed by Bundy and colleagues [8,18] using SCT [19] to
96 incorporate health behaviour change techniques (BCT) as per Michie et al.'s taxonomy [20]. The
97 published study protocol outlines each intervention task with the corresponding SCT construct
98 and BCTs [14]. We sought to address common concerns about risky play and engage participants
99 in self-reflection tasks to consider how these concepts applied to their parenting approach. The
100 home page included a 2-minute video introduction by MB to the topic and the tool, text defining
101 outdoor and risky play and outlining why they are important, as well as a brief description of the
102 journey participants would follow in the tool. The logos of the British Columbia Children's
103 Hospital, the University of British Columbia, British Columbia Injury Research and Prevention
104 Unit, and the Digital Lab were prominently displayed on the home page. As per SCT, the home
105 page focused on building knowledge and influencing outcome expectations. BCTs included
106 credible source, and information about health, social, and emotional consequences. Participants
107 then proceeded through three chapters. Chapter 1, *Reflection*, involved considering the values
108 and traits they most desired for their child in adulthood, their child's favourite activities, their
109 own favourite play activities at the same age and what they got out of these childhood activities.
110 As above, this chapter also focused on knowledge and outcome expectations. BCTs included
111 framing/reframing, and incompatible beliefs. Chapter 2, *What Would You Do?*, presented
112 participants with three interactive video segments (climbing a tree, walking home from school,
113 building a den) and gave them the choice to allow or not allow the child to engage in the activity.
114 If the participant chose to allow the activity, the child displayed excitement at the opportunity
115 and a sense of achievement upon completion. If the participant chose to not allow the activity,

116 the child displayed disappointment and dejection. Once the choice was made, the rest of the
117 video played with the outcome of that choice. Participants were also asked to reflect on fears that
118 influenced their choice, and things that helped them let go. In addition to the above SCT
119 constructs (knowledge and outcome expectations), this chapter provided opportunities for
120 observational learning, building self-efficacy and identifying barriers and opportunities. BCTs
121 included information about health, social and environmental, and emotional consequences,
122 problem solving, demonstration of behaviour, comparative imagining of future outcomes,
123 framing/reframing, and focus on past success. Chapter 3, *Creating Your Plan*, allowed
124 participants to review their journey, set a realistic goal and the timeline and steps to attain it.
125 Participants could enter their own goal in a text box, or select from a list of suggested goals that
126 included steps to attain it; for example, “letting my child play out in the yard without
127 supervision” with the following steps: “Let your child play outside for a few minutes while you
128 watch from the window. Gradually extend this time. Then try not watching out the window.”
129 This chapter reinforced the above SCT constructs, and also encouraged building self-efficacy
130 and outlining intentions. BCTs included goal setting (behaviour and outcome), problem solving,
131 action planning, demonstration of behaviour, prompts/cues, graded tasks, comparative imagining
132 of future outcomes, framing/reframing, and incompatible beliefs.

133 The intervention was developed by the study authors. Development of the web-based
134 platform was led by JJ, assisted by his team at the Digital Lab at the University of British
135 Columbia and British Columbia Children’s Hospital. Once the web-based platform was
136 complete, the in-person workshop PowerPoint presentation and facilitator and participant
137 manuals were developed by CH and MB, using images from the web-based platform.
138 Intervention content was frozen during the trial. The web-based intervention is available online

139 [17]. Screenshot of the landing page can be seen in Figure 1 and the complete screenshots of the
140 web-based intervention can be accessed in Additional file 2. The in-person workshop materials
141 can also be accessed in Additional file 3.

142 Participants using the web-based intervention took between 15 and 45 minutes to
143 complete it, depending on their movement through each task. The in-person workshops lasted
144 approximately 45 minutes to 1.5 hours, depending on participant discussion. Participants in the
145 control condition took 15-20 minutes to complete.

146

147 Comparison Condition

148 Participants in the control condition were asked to review an online version of the
149 Position Statement on Active Outdoor Play, which includes information on research and
150 recommendations for action in addressing barriers to outdoor play [1,21].

151

152 Outcome Measures

153 Measurements were taken at baseline, 1-week and 3-months post-intervention.
154 Participants in all conditions received a \$30 honorarium at baseline and \$15 at each follow-up as
155 compensation for participation. Non-respondents received two email reminders to complete
156 survey data. Participants attending in-person workshops were provided with an additional \$30
157 honorarium to compensate for expenses incurred in attending, such as travel or childcare.

158 The primary outcome measure was increase in the total score on the Tolerance of Risk in
159 Play Scale (TRiPS), a 31-item measure examining adults' tolerance of risk during children's
160 play, based on Sandseter's six-category model of risky play [22]. An earlier version of the TRiPS
161 scale has been validated [23]. We obtained the scale from the author AB and assessed its

162 psychometric properties in our sample using Rasch analysis. This analysis was conducted using
163 mirt package in R software [24]. Rasch analysis of the baseline data (N=443 completed TRiPS,
164 Figure 3) resulted in dropping one item (“*Do you allow this child to play-fight, testing who is*
165 *strongest?*”) due to local dependence. The remaining 30 items resulted in the following model
166 fit: RMSEA = 0.051 (95% confidence interval: 0.047, 0.056), SRMSR = 0.089, TLI = 0.874, CFI
167 = 0.874, as well as empirical reliability = 0.789. Theta standardized scores from the Rasch
168 analysis of the final 30-item TRiPS scale ranged from -3.372 to 1.975, with a mean of 0.000 and
169 standard deviation of 0.974 (note: a higher standardized score indicates higher tolerance of risky
170 outdoor play).

171 The secondary outcome measure was self-reported behaviour change, measured by their
172 self-reported progress on attaining the goal they set for themselves within the risk reframing
173 intervention. At each follow-up, participants were reminded of their goal and asked: “Did you
174 accomplish your goal?” with “Yes” and “No” response options.

175

176 Behaviour Change Model

177 To assess whether the effect of the intervention was mediated by SCT as we had
178 theorized [14], we developed measures for self-efficacy, outcome expectations, and knowledge
179 of risky play. All measures were previously published [14]. Confirmatory factor analyses were
180 performed on the baseline data (N=441 completed all SCT construct measures, Figure 3) to test
181 the psychometric properties of the three measures, resulting at: (1) 4-item self-efficacy,
182 RMSEA=0.075 (90% CI=0.020, 0.139), CFI=0.987 and SRMR=0.023; (2) 7-item outcome
183 expectations, RMSEA=0.107 (90% CI=0.085, 0.129), CFI=0.975 and SRMR=0.023 (two items
184 were dropped: “*promote MY CHILD's self-confidence*” and “*help MY CHILD become more*

185 *imaginative*” due to high modification indices); and (3) 7-item knowledge of risky play:
186 RMSEA=0.129 (90% CI=0.108, 0.151), CFI=0.965 and SRMR=0.026 (two items were dropped:
187 “*promote A CHILD's self-confidence*” and “*help A CHILD become more imaginative*” due to
188 high modification indices). Average scores of all remaining items were calculated for each SCT
189 construct, respectively.

190

191 Statistical Analyses

192 All statistical analyses were conducted in Stata 15 [25].

193

194 Power

195 The TRiPS is scored on a logit scale and previous research indicated that scores on the
196 TRiPS for a sample of parents of children aged 5 to 13 range from 0.20 to about 1.95 with
197 standard deviations in the range of 1.78 to 1.82 [22]. With a sample size of at least 81 mothers in
198 each condition, a test that averaged the differences in TRiPS score from baseline to the first
199 assessment would have 80% power at a 0.05 level of significance to detect a difference of 0.75
200 with the control condition when the standard deviation is 1.82 and the correlation between
201 repeated observations is 0.75.

202

203 Descriptive analysis

204 To compare socio-demographic differences between conditions, for continuous variables, one-
205 way ANOVA was used, or Kruskal-Wallis H Test (if variance was not equal between
206 conditions). For categorical variables, chi-square test was used, or Fisher’s exact test if single

207 cell numbers were small. One-way ANOVA was used to compare TRiPs scores between
208 different conditions at different time points. Significance level: $p < 0.05$.

209

210

211

212 Treatment Effect of the Intervention

213 Linear and generalized linear mixed-effects models with random intercepts and
214 unstructured covariance were fit to analyze the effects of the intervention on TRiPS scores and
215 goal accomplishment, respectively. In other words, the mixed-effects regression analysis
216 examined: (1) whether TRiPS scores changed 1-week and 3-months post-intervention, and (2)
217 whether these changes were greater in either experimental condition (web-based intervention or
218 in-person workshop) compared to the control condition. Intent-to-treat analysis of TRiPS scores
219 used last-observation-carried forward as the method of imputation, because missing data were
220 primarily in the in-person workshop condition. Since these participants only completed baseline
221 measures and did not receive the intervention, it is reasonable to expect their scores to remain the
222 same throughout the study. Unstandardized (i.e. raw) beta coefficients (β) were reported,
223 which are interpreted as the change of TRiPS scores when comparing the experimental
224 conditions to the control groups at baseline.

225 Similar to the TRiPS analyses, we conducted a generalized mixed-effects regression
226 analysis to examine the effect of the intervention on goal accomplishment, when comparing the
227 control condition at 1-week to either of the experimental conditions at 3-months follow-up.
228 Intent-to-treat analysis of goal accomplishment was not performed due to the absence of baseline
229 data. To establish a goal, participants had to complete either intervention. As a result, there was

230 no basis to impute values of goal accomplishment. Odds ratios (ORs) were reported, which are
231 interpreted as the odds of attaining goals for the experimental conditions at 3-months follow-up,
232 when comparing to the control conditions at 1-week post-intervention.

233 All models were adjusted by parents' age, ethnicity, marital status, education,
234 employment, housing, household income; children's previous exposure to risky play, age,
235 gender, weekday/weekend outdoor time and chronic condition status.

236

237 Behaviour Change Model Testing

238 To test whether SCT produced the hypothesized effect on the outcomes, we tested
239 whether the effect of the intervention was mediated by self-efficacy, outcome expectations, and
240 knowledge of risky play, as outlined in Figure 2. We followed the steps of mediation analysis for
241 RCTs suggested by Whittle et al. [26]. First, univariable linear regression models were fitted to
242 the potential mediators to test whether there was an association between treatment and each
243 mediator, respectively. Second, since a variable can only be a mediator of treatment if there is a
244 significant effect ($p < 0.05$) of treatment on the mediator (path a), mediation analysis in the
245 second step was only fitted to variables that were significantly associated with treatment. In the
246 second step, the test of indirect (mediating) effect was performed by fitting regression models to
247 the outcome, with treatment and the significant mediator found in step 1 included as covariates
248 (path ab). This step of analysis controlled for baseline covariates, attempting to control for these
249 as potential confounders in order to add robustness to our analyses. These confounders included
250 mothers' age, ethnicity, marital status, education, employment, housing, household income;
251 children's previous exposure to risky play, children's age and gender, weekday/weekend outdoor

252 time and chronic condition status. Similar to the TRiPS analyses, intent-to-treat analysis was
253 conducted by using the last-observation-carried forward.

254

255

256 **Results**

257 Overview

258 Figure 3 shows the study flow diagram. Recruitment began on December 1, 2017 closed
259 on June 18, 2018, once we had a minimum of 81 participants in each condition with complete
260 data. A total of 510 mothers of a child between 6 and 12 years old residing in Metro Vancouver
261 were automatically allocated to one of the three conditions by REDCap. Of these, 351 completed
262 the intervention. While randomization produced roughly equal numbers of participants allocated
263 to each condition, the in-person workshop condition, experienced the most drop-outs (n=65).
264 This condition involved the most time commitment for the participant and produced scheduling
265 challenges. As such, despite the additional \$30 incentive to participate, it was most difficult to
266 maintain participants in this condition. However, of the mothers attending the workshop, only
267 one was lost to follow-up. We were able to ensure fidelity to the web-based intervention as we
268 received a summary of all responses when a participant completed the intervention. These were
269 reviewed to ensure full completion. Fidelity to the in-person workshop was established through
270 attendance to the workshop.

271

272 Participant Characteristics

273 Baseline socio-demographic data from 451 mothers were included in our analyses.
274 Participant demographics are displayed in **Table 1**. There were no statistically significant

275 differences between conditions with respect to demographic characteristics at baseline. There
 276 were statistically significant differences between conditions for child's disability/chronic
 277 condition at both 1-week ($p=0.034$) and 3-months ($p=0.033$) post-intervention, with the
 278 percentage of children having chronic conditions in the web-based intervention higher than the
 279 other two conditions, with $N=10$ (8.9%) for 1-week post-intervention, and $N=9$ (8.6%) for 3-
 280 month post-intervention, respectively. We also further compared the socio-demographic
 281 characteristics between those who completed the intervention ($N=351$) and those who did not
 282 complete the intervention ($N=100$), and found that employed mothers were more likely to
 283 complete the intervention (75.8% versus 65%, respectively, $p=0.031$). There were no statistical
 284 differences for other socio-demographic characteristics.

285

286 Table 1. Participant demographics at baseline, after randomization

		Control	Web-based intervention	In-person workshop	p-value
# of participants who completed the baseline socio-demographic assessment (N=451)		148	150	153	
Age (Mean, SD) (N=450) ^a		40.7 (5.3)	40.8 (5.5)	39.6 (5.0)	0.092
Ethnicity (N=451)	White	101 (68.2)	112 (74.7)	117 (76.5)	0.240
	Others	47 (31.8)	38 (25.3)	36 (23.5)	
Marital status (N=451)	Married/Common-law	118 (79.7)	125 (83.3)	131 (85.6)	0.393
	Others	30 (20.3)	25 (16.7)	22 (14.4)	
Education (n, %) (N=447) ^b	< University/college	36 (24.3)	36 (24.3)	33 (21.9)	0.323
	University/college	66 (44.6)	80 (54.1)	72 (47.7)	
	> University/college	46 (31.1)	32 (21.6)	46 (30.5)	
Employment (N=451)	Employed for wages/self-employed	115 (77.7)	107 (71.3)	44 (28.8)	0.351
	Unemployed	33 (22.3)	43 (28.7)	109 (71.2)	
	Single-detached	69 (46.6)	77 (51.3)	72 (47.1)	0.666

Home dwelling (N=451)	Others	79 (53.4)	73 (48.7)	81 (52.9)	
Income (N=451)	< \$63,300	36 (24.3)	40 (26.7)	33 (21.6)	0.809
	\$63,300-\$103,299	49 (33.1)	40 (26.7)	50 (32.7)	
	>= \$103,300	52 (35.1)	54 (36.0)	55 (36.0)	
	Prefer not to answer	11 (7.4)	16 (10.7)	15 (9.8)	
Exposure to risky play information (N=451)	No	22 (14.9)	28 (18.7)	36 (23.5)	0.159
	Yes	126 (85.1)	122 (81.3)	117 (76.7)	
Child age (Mean, SD) (N=451)		8.4 (1.7)	8.1 (1.7)	8.0 (1.9)	0.109
Child sex (n, %) (N=447)	Boy	85 (58.6)	82 (54.7)	85 (55.9)	0.783
	Girl	60 (41.4)	68 (45.3)	67 (44.1)	
Child's disability/chronic condition (n, %) (N=451) ^c	No	143 (96.6)	140 (93.3)	148 (96.7)	0.301
	Yes	5 (3.4)	10 (6.7)	5 (3.3)	
Outdoor time (hours) (Mean, SD) (N=451) ^d	Weekday	3.0 (3.6)	2.8 (3.2)	2.6 (2.8)	0.901
	Weekend	2.7 (2.2)	2.8 (2.0)	2.9 (2.8)	0.657

287 ^aOne parent reported age=7, which is not reasonable, so we treat that data as missing.

288 ^bprefer not to answer, n=4

289 ^cFisher's exact test due to small sample size in single cell

290 ^dKruskal-Wallis H Test due to non-equal variance between conditions

291

292

293 Primary Outcome, TRiPS

294 Table 2 presents the description of TRiPS scores by treatment conditions and times,

295 without accounting for treatment effects nor adjusting for socio-demographic characteristics.

296 There were no statistical differences in TRiPS scores between different conditions at each time

297 point. Table 3 describes findings of the mixed-effects regression analysis. Mothers who

298 completed the web-based intervention condition had significantly higher TRiPS scores than
 299 mothers who completed the control condition at 1-week ($\beta=0.26$, 95% CI=0.09, 0.43; $p=0.003$)
 300 and 3-months ($\beta=0.24$, 95% CI=0.06, 0.42; $p=0.010$) post-intervention, indicating sustained
 301 change. Mothers who completed the in-person workshop condition had significantly higher
 302 increases in TRiPS scores than the control condition at 1-week post-intervention ($\beta=0.19$, 95%
 303 CI=0.06, 0.38; $p=0.047$). No statistically significant differences were found when comparing
 304 mothers who completed the in-person workshop condition with those in the control condition at
 305 3-months post-intervention ($\beta=0.09$, 95% CI=-0.10, 0.29; $p=0.334$).

306 Results of the intention-to-treat analyses for the effects of the intervention on TRiPS
 307 score largely replicated the analyses described above, indicating that mothers in the web-based
 308 intervention condition were significantly more likely to increase their TRiPS scores at 1-week
 309 ($\beta=0.25$, 95% CI=0.08, 0.42; $p=0.004$) and 3-months ($\beta=0.24$, 95% CI=0.06, 0.42; $p=0.007$)
 310 post-intervention compared to the control condition. Mothers in the in-person workshop
 311 condition had significantly higher increases in TRiPS scores than the control condition at 1-week
 312 post-intervention ($\beta=0.22$, 95% CI=0.03, 0.40; $p=0.022$). No statistically significant differences
 313 were found when comparing mothers in the in-person workshop with the control condition at 3-
 314 months post-intervention ($\beta=0.13$, 95% CI=-0.06, 0.32; $p=0.176$).

315

316 Table 2. Description of TRiPS scores by treatment conditions and time points

Mean (SD)	Sample size	Control	Web-based intervention	In-person workshop	p-value for one-way ANOVA
Baseline	443	0.05 (1.03)	-0.11 (0.94)	0.06 (0.94)	0.243
Completed intervention	351	0.05 (1.03)	-0.14 (0.97)	0.18 (0.87)	0.059
1-week post-intervention	333	-0.09 (1.03)	-0.06 (1.05)	0.22 (0.80)	0.064

3-months post-intervention	312	-0.03 (0.92)	-0.09 (0.93)	0.15 (0.80)	0.192
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317

318 Table 3. Results of mixed effect regression analysis for change in TRiPS scores by treatment

319 condition and time

		Coefficients (95% confidence intervals)	p-value for coefficients	p-value for joint test of main effects
Raw TRiPS theta scores (N=351, for those who completed the intervention)^a				
Treatment effects	Web-based vs. Control	-0.14 (-0.36, 0.08)	0.211	0.219
	In-person vs. Control	0.09 (-0.15, 0.34)	0.462	
Time effects	1-week vs. Baseline	-0.16 (-0.27, -0.04)	0.007	0.860
	3-months vs. Baseline	-0.13 (-0.25, -0.01)	0.033	
Treatment by time effects	Web-based vs. Control by 1-week vs. Baseline	0.26 (0.09, 0.43)	0.003	0.021
	Web-based vs. Control by 3-months vs. Baseline	0.24 (0.06, 0.42)	0.010	
	In-person vs. Control by 1-week vs. Baseline	0.19 (0.06, 0.38)	0.047	
	In-person vs. Control by 3-months vs. Baseline	0.10 (0.00, 0.29)	0.334	
Intention-To-Treat analysis (imputed TRiPS theta scores) (N=443, for those who were randomized to a condition and completed baseline socio-demographic and TRiPs survey)^b				
Treatment effects	Web-based vs. Control	-0.13 (-0.34, 0.07)	0.203	0.476
	In-person vs. Control	0.00 (-0.21, 0.21)	0.986	
Time effects	1-week vs. Baseline	-0.16 (-0.27, -0.04)	0.008	0.901
	3-months vs. Baseline	-0.14 (-0.26, -0.02)	0.022	
Treatment by time effects	Web-based vs. Control by 1-week vs. Baseline	0.25 (0.08, 0.42)	0.004	0.017
	Web-based vs. Control by 3-months vs. Baseline	0.24 (0.06, 0.42)	0.007	
	In-person vs. Control by 1-week vs. Baseline	0.22 (0.03, 0.40)	0.022	
	In-person vs. Control by 3-months vs. Baseline	0.13 (-0.06, 0.32)	0.176	

320 ^aSignificant ($p < 0.10$) socio-demographic predictors include ethnicity, housing condition,

321 previous exposure to risky play information, child's age, child's disability/chronic conditions and

322 weekend outdoor time.

323 ^bSignificant ($p < 0.10$) socio-demographic predictors include ethnicity, parental employment
 324 status, housing condition, previous exposure to risky outdoor play information, child's age,
 325 child's disability/chronic conditions and weekend outdoor time.

326

327

328 Secondary Outcome, Goal Attainment

329 Table 4 describes the results of the generalized mixed-effects regression analysis. There
 330 was no statistical difference in goal attainment between mothers in the web-based intervention
 331 and control conditions at 3-months post-intervention as compared to 1-week post-intervention
 332 (OR=0.59, 95% CI=0.18, 1.91; $p=0.377$). There was also no statistical difference in goal
 333 attainment between mothers in the in-person workshop and control conditions at 3-months post-
 334 intervention as compared to 1-week post-intervention (OR=0.55, 95% CI=0.17, 1.76; $p=0.314$).

335

336 Table 4. Results of the mixed-effects regression analysis for goal attainment by treatment

337 condition and time^a

		Odds Ratios (95% confidence intervals)	p-value for coefficients	P-value for joint test of main effects
Treatment effects	Web-based vs. Control	3.36 (1.32, 8.54)	0.011	0.004
	In-person vs. Control	0.72 (0.28, 1.85)	0.493	
Time effects	3-months vs. 1-week	7.27 (3.11, 17.02)	0.000	0.000
Treatment by time effects	Web-based vs. Control by 3-months vs. 1-week	0.59 (0.18, 1.91)	0.377	0.532
	In-person vs. Control by 3-months vs. 1-week	0.55 (0.17, 1.76)	0.314	

338 ^aSignificant ($p < 0.05$) demographic predictors include ethnicity, child's disability/chronic
 339 conditions and weekend outdoor time.

340

341 Behaviour Change Model Mediation Analysis

342 Since only significant intervention effects were observed for TRiPs score and not goal
343 attainment, mediation analyses were only conducted for TRiPs data. With regards to the direct
344 effects of treatment conditions on the three SCT constructs, none of the three SCT constructs
345 (self-efficacy, $p=0.166$; outcome expectations, $p=0.240$; and knowledge of risky play, $p=0.122$)
346 was associated with treatment exposures in the unadjusted models, neither for those who
347 completed the intervention ($N=351$), nor the intention-to-treat analysis sample ($N=441$, for those
348 who completed baseline socio-demographic, TRiPs and SCT survey) (all p -values were greater
349 than 0.05). As there was no direct association between treatment and the SCT constructs (path a),
350 further mediation analyses were not conducted because it was not possible for the SCT
351 constructs to have an impact on the study outcome via mediation (i.e. path ab). Therefore, none
352 of the potential mediators were found to significantly mediate outcome.

353

354 **Discussion**

355 Principal Results

356 Our hypotheses were partially supported. Mothers receiving both the web-based
357 intervention and the in-person workshop intervention at 1-week post-intervention reported
358 significantly higher increases in their tolerance for risky play than mothers in the control
359 condition at baseline. These differences remained significant at 3-months post-intervention for
360 mothers receiving the web-based intervention but not mothers receiving the in-person workshop
361 intervention. There were no significant differences in goal attainment.

362 We did not have sufficient statistical power to test the difference in efficacy between the
363 two versions of the intervention. In any case, the significant results for the web-based

364 intervention and not the in-person workshop at 3-months post-intervention are unexpected, as the
365 in-person workshops provided arguably a higher intervention dose given the greater length
366 required in participation and the more social aspect of the experience that could influence
367 participant perceptions of social support, a construct of SCT [19]. Workshop participation
368 required fitting into a set schedule and demanded significantly more time commitment and effort
369 than the other conditions. Thus, it required a higher motivation level and had greater attrition.
370 Those who ended up attending the in-person workshop might have already been fully aware of
371 the benefits of children's outdoor play – which inadvertently left limited room for improvement.
372 However, this possibility is not supported by baseline scores on the TRiPS, which did not differ
373 between conditions. Another possible explanation could result from the fact that the number of
374 participants attending each workshop varied considerably (2-12 participants), which could
375 negatively impact the extent of discussion. Further, workshops were facilitated by a professional
376 facilitator, without content expertise in outdoor play and who was not a parent. SCT stresses the
377 importance of relatable peers modeling behaviour to encourage behaviour change [27]. Thus,
378 appropriate probing to foster discussion and participants' engagement with the topic may have
379 been hampered.

380 It is not readily apparent why there was a null finding for goal attainment. It is possible
381 that the binary yes/no outcome may have hampered participant responses in that participants may
382 not have indicated they had attained their goal unless they perceived that all aspects were
383 complete. In addition, goals may have been overly ambitious and difficult to define discrete
384 actionable steps to attain them, such as “give my child more independence to enjoy freedom.”
385 Future iterations of the intervention should encourage users to set a more realistic and actionable

386 goal. Sample actionable goals were provided in the tool but it is possible that these required
387 further details on actions.

388 In sum, our findings indicate the efficacy of both versions of the risk reframing
389 intervention for changing mothers' tolerance to risky play, with the web-based intervention
390 displaying longer term effects.

391

392 Behaviour Change Model

393 The hypothesized relationship between the constructs of SCT (self-efficacy, outcome
394 expectation and knowledge) and the intervention outcomes was not supported. We offer the
395 following explanations for these findings. First, the intervention may have been of insufficient
396 intensity or duration to influence these constructs. To reduce access and engagement barriers, we
397 sought to develop an intervention that was efficient, would require limited time commitment and
398 would not necessitate repeat visits [14]. Therefore, future iterations may attempt to increase the
399 intervention dose to determine whether this would impact the mediators as we hypothesized.
400 Second, it is possible that our SCT constructs were not sensitive enough to detect change over
401 time. While we evaluated the psychometric properties of our measures, we do not know whether
402 these measures are sensitive to change as they were developed for this study. Third, although we
403 hypothesized that both self-efficacy and outcomes expectations would increase as a result of the
404 intervention, it is possible that going through the intervention and attempting to change parenting
405 practices proved more difficult than anticipated for some parents and might explain why no
406 change was observed for the SCT constructs. We did not collect data on other potential factors
407 that could influence parents' success, such as self-efficacy in overcoming barriers, thus limiting
408 our insight on these results.

409

410 Strengths and Limitations

411 Our research is the first to use health behaviour change theory and behaviour change
412 techniques to develop an intervention to reframe mothers' perceptions and influence their
413 parenting behaviours related to outdoor risky play. As recommended by published guidelines
414 [28,29], we are also among the first to test the active ingredients of the intervention, examining
415 the hypothesized relationships between SCT constructs and the outcomes. In addition, our use of
416 RCT methods represents a gold-standard methodological evaluation technique. Previous research
417 reported on but did not evaluate an in-person workshop intervention separately from a loose parts
418 intervention in the playground [11]. Furthermore, our RCT evaluated two versions of the risk
419 reframing intervention, providing insight on the efficacy of alternative delivery methods with
420 important implications for practice.

421 There were several limitations to the study. Given the nature of the intervention, it was
422 not possible to blind participants to their allocation, thus potentially introducing sources of bias.
423 Furthermore, the intervention was developed based on research conducted in Western settings
424 and was only available in English. As such, it may not reflect the perspectives and needs of other
425 cultural and linguistic conditions and non-Western settings. Likewise, because one of our
426 conditions necessitated in-person participation, we were only able to recruit participants within a
427 limited geographic area, thus potentially limiting the applicability of our findings to other areas,
428 such as rural communities.

429

430 Conclusions

431 Our findings provide confidence in encouraging use and broad dissemination of the web-
432 based intervention. Given the ease of distribution, no cost to users, and low resource requirement
433 for ongoing maintenance of the web-based tool, it is encouraging that this was an effective model
434 and can provide the basis for further iterations and versions. Future research is necessary to
435 examine the risk perceptions of parents from other cultural conditions and settings to facilitate
436 the development of interventions that are applicable to their settings and realities.

437

438 Acknowledgements

439 This study was funded by the Lawson Foundation, Grant #GRT 2015-68 and #GRT 2016-72.

440 The Lawson Foundation was not involved in any aspect of study design or writing of the

441 manuscript. MB and LCM are supported by salary awards from the British Columbia Children's

442 Hospital Research Institute. GF is supported by a Canadian Institutes of Health Research-Public
443 Health Agency of Canada Chair in Applied Public Health.

444 We thank Juan Tellez, Kevin Quach and Fahad Hasany from the Digital Lab at the University of

445 British Columbia Department of Pediatrics for providing partnership and technical support in

446 development and programming of the web-based tool. We thank Dr. Anita Niehues for her ideas

447 and contributions to the development of the web-based intervention. We also thank Pam Fuselli,

448 Heidi Campbell, Pierre Harrison, Brandy Tannenbaum, and Dr. Guylaine Chabot for their review

449 of and comments on an earlier version of the in-person workshop materials. We are further

450 grateful to the Lawson Foundation for funding tool development and evaluation and to Christine

451 Alden for her personal engagement in the project.

452

453 Authors' contributions

454 MB conceived of the study. AB and IP assisted MB with adaptation of the original risk
455 reframing workshop for the purposes of the study. MB and LM led development of the study
456 design, with contribution from GF, CH and the remaining authors. MB wrote the first and
457 subsequent drafts of this manuscript. LM and YL advised on statistical analysis. All authors read
458 and approved the final manuscript.

459

460 Conflicts of Interest

461 The authors declare that they are both the developers and evaluators of the intervention.

462

463 Abbreviations

464 BCT: behaviour change technique

465 CONSORT-EHEALTH: Consolidated Standards of Reporting Trials-Electronic Health

466 OR: odds ratios

467 RCT: randomized controlled trial

468 SCT: social cognitive theory.

469 TRiPS: Tolerance of Risk in Play Scale

470

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566

567

568 **Figures**

569 **Figure 1.** The web-based intervention landing page at <https://OutsidePlay.ca>

570 **Figure 2.** Mediation analysis to test effect of SCT constructs on outcomes, adapted from Whittle

571 et al. [23]

572 **Figure 3.** CONSORT flow diagram for Go Play Outside! RCT

573