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Examining Interaction of Constraints to Sport Participation among Adolescent Girls in Durham, Ontario: A Pilot Study

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Abstract

During adolescence, girls participate in sport less frequently than boys. Although research has examined this decline, a thorough understanding of how constraints interact to affect participation among girls is required. This study is an exploratory pilot of a previously developed survey designed to collect information on constraints to sport participation for adolescent girls. The objectives were to refine recruitment strategy, identify potential issues with administration, and to explore analytical techniques to examine interactions. Participants (n=97) were recruited using convenience sampling. Results found that the initial recruitment strategy requires a more direct approach, and that the online format of survey administration was effective. Recommendations for larger scale implementation include increasing sample size, and sampling from a wider range of geographical regions.

Keywords: Sports participation; Adolescent girls

Introduction

It is well documented that during adolescence, girls participate in sports less frequently compared to boys [1]. During this time, adolescents face vast developmental changes and the experience of early maturation comes with more friction in social contexts for girls than it does for boys [2]. Since sport participation has the potential to confer many health benefits such as reduce rates of depression, obesity, heart disease and diabetes, it is imperative to examine reasons behind this decreasing trend [3,4]. As a result, research has explored possible constraints that affect sport participation among girls.

Although focusing on constraints to participation has been the standard method of determining why adolescent girls do not participate in sport, it comes with two main limitations. Firstly, studies vary greatly with respect to which constraints have the greatest impact on sport participation. For example, research examining environmental constraints such as school intramural sport availability, the built environment, and weather patterns all demonstrate how certain aspects of the environment can affect participation among adolescents [5-8]. Similarly, research which emphasizes the importance of family support and individual factors such as lack of friends to participate with, the belief that sport is not fun, and dress code required for the sport have provided information on discrete constraints [9-12]. As a result, constraints to sport participation vary greatly, and most research alludes to the complex nature of constraint negotiation as a topic for further investigation [13].

The second gap in literature is the inconsistency of frameworks being used to classify constraints. There are two commonly used models in examining constraints to sport participation; which are the hierarchical and ecological models [14,15]. The nested nature of these models assume that constraints in each category are separate, which has led to the understanding that in the presence of a single 'main' constraint, the result is non-participation. However, much of the research on constraints to sport participation does not use a framework at all, which makes it difficult to conceptualize the findings in a practical setting. For example, in generating a comprehensive list of constraints to sport participation among adolescent girls in the literature Klicnik and colleagues found that approximately 31% of studies examining constraints to sport participation used a framework to classify them [16].

Though these models successfully aid in classification, they do not inform research on interactions of constraints. At the same time, no studies to date have examined interactions of constraints to sport participation, and a gap exists because intuitively the different layers do affect one another. The current research is an exploratory pilot study that administered a survey on a sample of adolescent girls from Durham Region, Ontario. The survey is designed to collect information on individual, environmental and task constraints to sport participation for the purpose of examining interactions of constraints. The first objective is to refine a sampling and recruitment strategy to best access the sample. The second objective is to identify any issues related to the administration of this online survey. The third objective is to explore and refine the analytical techniques to analyze interactions between constraints that emerge as most relevant among adolescent girls.

Framework

Examining interactions of constraints to sport participation can address the gap in knowledge about the complex nature of participation in sports. This study uses a combined model consisting of Newell's model of constraints and the 40 Developmental Assets Profile (DAP) to examine constraints to sport participation among adolescent girls [17-18]. Newell conceptualized optimal behavior and performance as a product of the interaction between three types of constraints: individual, environmental, and task (Figure 1).

Individual constraints include structural factors (e.g. height, weight, and the timing/tempo of maturation) and functional factors (e.g. psychological qualities of resilience, motivation, and personality). Environmental constraints refer to the broader social constructs that affect development, including geographical area, the physical environment, sociocultural environment, policies, and the influence of important actors in persons' lives, such as coaches, family, and friends. Finally, task constraints include the demands of the activity, such as strength, speed, agility, flexibility, or technical ability, as well as the goals, rules, and structure of an activity (e.g. individual *vs.* team sport).

Much like Newell's model, the DAP is based on the idea that there are many interacting parts to a whole person which cannot be addressed individually to stimulate behavior change. The DAP is made up of Internal and External assets. Internal assets are individual qualities which guide decision making and affect adolescents' confidence and self-efficacy. External assets are based on relationships and interactions with the society and environment in which one lives. The combined model is shown in Figure 2. Variables included in each index are listed in Table 1.

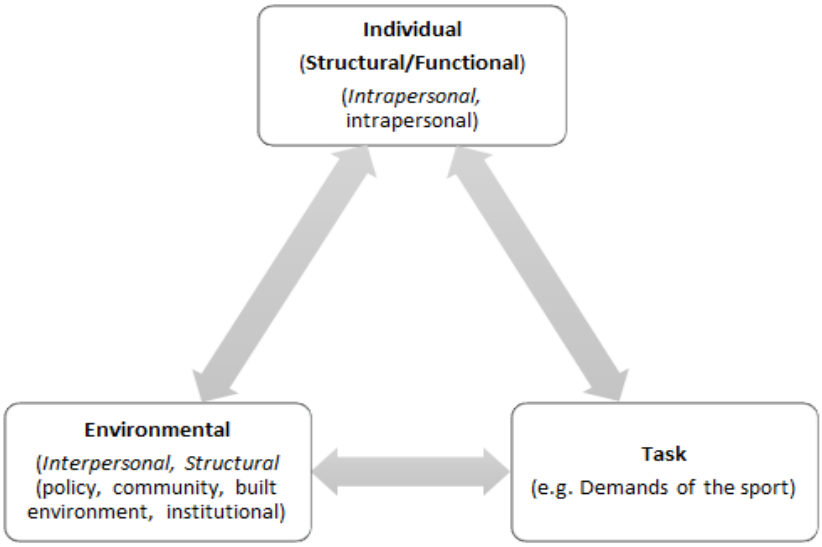

Figure 1: Newell's model (bolded) with the hierarchical (italics) and ecological models superimposed. Bidirectional arrows indicate interactions between constraint types (italics).

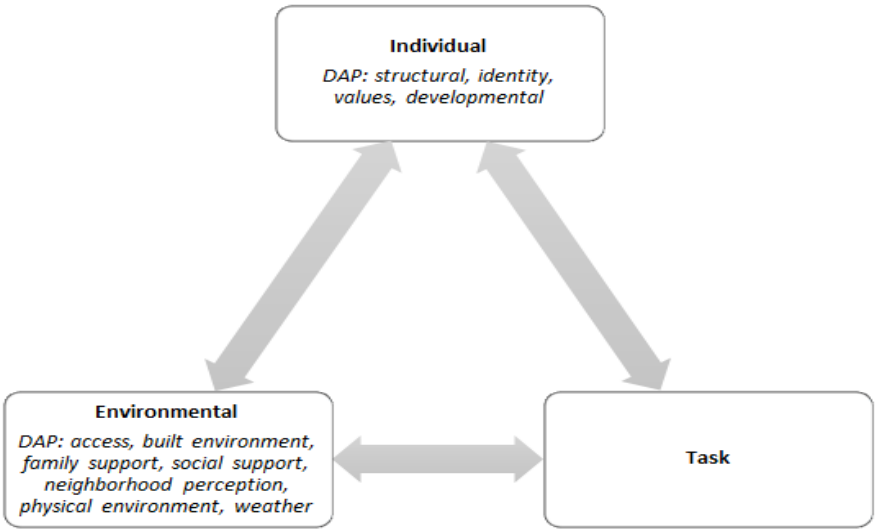

Figure 2: Newell's (1986) model of constraints (bolded) with indices based on the DAP (Scales, 1999).

Table 1: Variables sorted into 40 Developmental Assets framework.

	Constraint
Environmental Constraints (Indexed)	
Access[2] (5)	Accessible facility
	Opportunity in school
	Opportunity outside school
	Safe public transportation
	Availability of facilities
Built Environment[2] (5)	Greenspace
	Safe walking
	Options (for indoor/outdoor)
	Safe places close to home
	Clean facility
Support Family[1] (4)	Cultural
	Family participates in sport
	Family supports
	Financial
Support Social[1] (5)	Have friends (with whom to participate)
	Friends encourage
	Having friends makes me willing to participate
	Belief – Sport is important in society
	Peer Influence
Neighborhood Perception[2] (2)	Safe Neighborhood
	Pride in neighborhood
Physical Environment[2] (3)	Air Quality[3]
	Weather Allow
	Weather Prevent[3]
Weather[2] (5)	Cold[3]
	Hot[3]
	Humidity[3]
	Rain[3]
	Snow[3]
Environmental Constraints (Variables)	
Transportation	Mode of Transportation
Transportation	Duration of Transportation
Demographic	Immigrant status
Demographic	Immigrant status - parent
Demographic	Immigrant type - parent
Demographic	Presence of chronic condition[3] - family
Demographic	Postal Code
Use of TIME[1]	Hours Employed
Use of TIME[1]	Responsibilities
Individual Constraints (Indexed)	
Structural[2] (5)	Chronic condition
	Presence of Chronic Condition[3]
	BMI
	Body Type
	Overall Health
Identity[1] (3)	Body Type Satisfaction
	Have Energy
	Strive to excel
Values[1] (6)	Belief – Should participate
	Belief – Healthy Adult
	Belief - Important
	Have time
	Belief – Strong Women
Developmental[1] (13)	Enjoy Sport
	Perceived Competence
	Negative Experience
	Physical Strength
	Flexibility/Agility
	Energetic
	High Speed
	Confidence
	Belief – sport is fun
	Comfortable with dress code
	Sports not for girls
	Feel Positive
	Feel Gross[3]
Individual Constraints (Variables)	
Demographic	Ethnicity Type
Demographic	Age
Demographic	Immigrant type
Task Constraints (Variables)	
	Perseverance
	Competitive
	Recreational
	Physically intense
	Strict rules
	Coed
	Contact
	Long Game
[1]Taken from DAP framework [2]Developed by research team to complement DAP framework [3]Reverse scored	

Method

Study design

This pilot study administered an online survey to collect data on constraints to sport participation among adolescent girls and analyze the data for interactions among constraints using Statistical Package for Social Sciences (SPSS) 25. Klicnik et al. provide details related to the development of the survey [16].

Participants

Inclusion criteria to participate in the survey included girls between the ages of 13-19 who were attending high school in the Durham Region. Participants were recruited from three schools at one local area schoolboard, and one community organization. Convenience sampling was used to recruit participants, as parental consent and educator support was required to gain access to the participants.

Survey

The survey consisted of 81 questions and was delivered online via Google Forms. Web based delivery was selected due to the timeline and resources allotted for this study. The survey collected demographic information which was also used to ascertain the socioeconomic status of respondents.

Data analysis

To manage the large quantity of variables, constraints were indexed based on the 40 Developmental Assets framework with additions to further classify constraints that did not fit the framework.18 Variables of the same type (e.g. Likert scale) were grouped together, scored, added to generate a sum. Depending on the question, a high sum meant scoring 5 out of 5 on a Likert scale and indicated that participants chose the higher option. For example, for the statement "I have safe places to do sports" if 5 is strongly agree then a higher sum would demonstrate that participants were mostly selecting strongly agree. Categorical variables that fit with the DAP framework were included in the indices. Since demographic variables are not easily modifiable as is the case with socioeconomic status, chronic conditions, age, and ethnicity type, they were excluded from individual, environmental and task indices. After data cleaning, 73 constraint variables remained, including 29 individual constraints, 36 environmental constraints and 8 task constraints. Table 1 shows the breakdown of each index after data cleaning.

Univariate analyses consisted of assessing each variable (constraint) independently to evaluate the frequency of missing data. Items with fewer than 60% responses were not included. The acceptable limit for missing data varies within the literature from 5-10% [19,20]. For variables with less than 10% missing data, the values were replaced with the mean for that variable, so that they could be added together to create an index. Little's MCAR test was run in SPSS on the remaining variables to investigate whether data were missing at random. Variables which were not going to be included as part of an index were collapsed into either a dichotomous response (e.g. high/low, yes/no).

Variables used as part of an index were required to have no missing data because they would be added together. For variables not included in an index, categories were collapsed into binary responses (High/Low, Yes/No). Due to the large quantity of variables, the range of constraints included in the analysis was limited to constraints with a $p<0.10$ to ensure that interactions could be captured. Bivariate analysis of the indexed variables determined which variables would be used in interaction analysis. Constraints which came out as significant ($p<0.10$) were entered into a second binary logistic regression against the outcome and were used for interaction analysis.

Multivariate analysis was carried out to examine interactions between significant constraints in the form of a binary logistic regression. Constraints were entered in blocks based on constraint type using the enter method. New variables were computed by multiplying the existing significant variables together to carry out interaction analysis. Two constraints from different categories (e.g. Environmental and Individual) along with an interaction term (e.g. Environmental X Individual) were entered in the binary logistic regression to examine if the interaction was significant.

Results

Demographic data is shown in Table 2. Mean age of participants was 15.5 years, participants were primarily white (54.2%), with 86.6% reporting good, very good or excellent overall health. The majority (87.6%) were born in Canada, and 65.9% had parents who were born in Canada.

Objective 1: Refining recruitment strategy

The survey was completed by adolescent girls (n=97) who attend three high schools in Durham Region in 2017. The convenience sampling strategy resulted in a response rate of approximately 39%. Figure 3 illustrates the process of obtaining 97 eligible survey completions. This result indicates that a more direct and purposeful sampling is needed to reach a larger proportion of this sample.

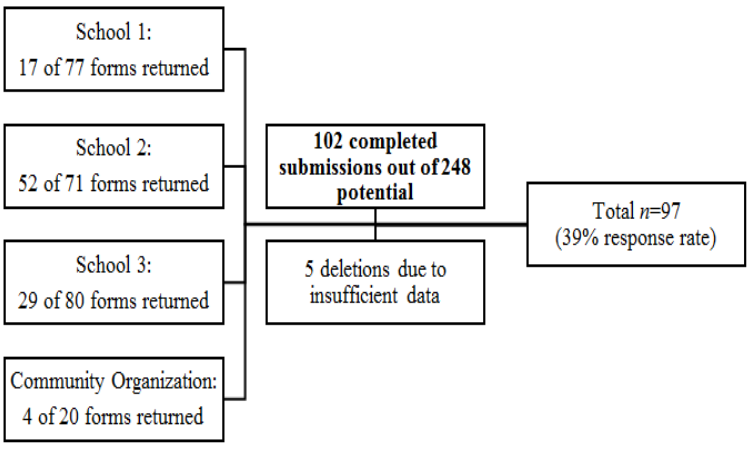

Figure 3: Recruitment process.

Table 2: Demographic information and characteristics of our sample.

	Participate in sport regularly				
	NO (%)	**YES (%)**	**Total (%)**		
	(*n*=49)	**(*n*=48)**	**(*n*=97)**	***X²***	***p***
Mean Age	15.52 +/- .98	15.47+/- 1.03	15.49 years +/- 1.00		
Mean BMI	21.89	21.08	21.49 *SD* 4.16		
Immigrant Status				0.67	0.72
Non-Immigrant	85.73	89.59	87.6		
Established Immigrant (>10years)	6.12	6.24	6.2		
Recent Immigrant (<10 years)	8.16	4.16	6.2		
Immigrant Status of Parents				1.37	0.5
Non-Immigrant	67.35	62.51	64.9		
Established Immigrant (>10years)	24.49	33.33	28.9		
Recent Immigrant (<10 years)	8.16	4.16	6.2		
Ethnicity				2.6	0.27
White	48.98	58.35	54.2		
Non White	40.82	25	33		
Multi Ethnic	10.2	14.59	12.5		
Presence of Chronic Conditions				0.95	0.81
None	69.39	60.43	64.9		
1 Chronic Condition	22.45	29.16	25.8		
2+ Chronic Conditions	4.08	4.16	4.1		
Overall Health				4.19	*0.04**
Good+	79.61	93.76	86.6		
Fair-	20.41	6.24	13.4		
Employment				4.62	*0.03**
Not Employed	67.31	81.24	74.2		
Employed	30.69	20.82	25.8		

*$\alpha<0.05$

Objective 2: Identifying issues with survey administration

The multi-step process of administering the survey (approval of school board REB, approval of principal, assistance of physical education teachers, parental consent) may have contributed to the low response rate. Additionally, out of 99 completed surveys, two were found to be exact duplicates which is an unexpected error attributable to either Google Forms or the computer or network being used. The survey also took approximately 20 minutes to complete, which may have deterred some participants from completing it.

Objective 3: Refining analytical technique

Univariate analysis: Eight Task Constraints remained unindexed as they did not logically fit together and could in some cases be considered mutually exclusive (e.g. competitive and recreational). There were 7 indices and 4 singular variables in the Environmental Constraints category, and 4 indices in the Individual Constraints category. Finally, there were 8 demographic variables.

Little's MCAR test was not significant ($X^2(1135) = 1127.12$, p=0.56) indicating that any missing data were missing completely at random. Each singular constraint and 9 out of 11 indices contained fewer than 5% missing data. The Weather and Developmental indices, the percentage of missing data was 5.2% and 6%, respectively, which is within the 10% outlined in the literature, so the mean for each variable and was imputed [20]. Table 3 shows descriptive statistics for indexed variables, and single variables not included in demographic analysis. Lower mean values indicate the presence of a constraint. In cases of missing data, the imputed mean sometimes contained decimal places, which resulted in decimal places in the index means, ranges and standard deviations. Most questions were on a 5-point Likert scale, and the number in brackets indicates how many questions were included in each index. For example, Access, made up of 5 variables had a maximum score of 25. Deviations from this pattern occur when responses are continuous, but not on a Likert Scale. Among the task variables, the constraint identified as the most likely to facilitate participation was recreational with the fewest participants who considered it a constraint (16.5%). The constraint identifies as most likely to reduce participation was *perseverance* with 36.5% of participants reporting it as a constraint.

Bivariate analysis: Independent samples t-tests were computed for each of the 11 indices to determine if a difference existed between those who participate in sports regularly, and those who do not. Table 4 shows the means and standard deviations for regular participants and non-participants within each index, as well as the t-test p-values. Only the *weather* index demonstrated a significant difference between participants and non-participants (p=0.014). *Physical environment and developmental* indices approached significance, with p values of 0.18 and 0.16. Among non-indexed variables, *contact between players and duration of transportation* were the only variables which demonstrated a significant difference between participants and non-participants, with p values of 0.03 and 0.05.

Table 3: Results of univariate analysis of variables and indices.

Index	Mean (SD)	Median	Range	Min-Max
Environmental Indices (variables contained in index)				
Access (5)	18.62(4.07)	19	19	6.0-25.0
Built Environment (5)	19.19(4.28)	19	17	8.0-25.0
Support Family (4)	14.41(3.24)	15	16	4.0-20.0
Support Social (5)	19.09(4.09)	19	19	6.0-25.0
Neighborhood Perception (2)	8.17(1.84)	8	7	3.0-10.0
Physical Environment (3)	11.38(2.00)	11	8	7.0-15.0
Weather (5)	16.25(4.05)	15	20	5.0-25.0
Environmental Variables				
Duration Transportation(mins)	15.62(17.95)	10	90	0.0-90.0
How many Responsibilities		1	4	0.0-4.0
Individual Indices (variables contained in index)				
Structural (5)	28.22(5.00)	27.69	32.91	16.9-49.8
Identity (3)	10.62(2.00)	11	12	3.0-15.0
Values (6)	25.03(4.35)	26	18	13.0-30.0
Developmental (13)	43.03(7.38)	43	31.94	24.0-55.9
Task Variables (% of respondents who considered it a constraint)				
Competitive			24.7	
Recreational			16.5	
Physically Intense			24.7	
Strict Rules			27.8	
Co-Ed			27.8	
Contact between players			25.8	
Games of Long Duration			24.7	
Perseverance			36.5	

Table 4: Results of bivariate analysis (independent t-test) of indices.

Index	Mean (SD)		*t*-test	*p*
	Participant (*n*=49)	Non-Participant (*n*=48)		
Environmental Indices				
Weather	15.26(3.97)	17.27(3.92)	-2.51	0.01**
Physical Environment	11.65(1.97)	11.10(2.02)	1.35	0.18
Family Support	14.05(3.57)	14.78(2.87)	-1.11	0.27
Neighborhood Perception	8.32(1.83)	8.02(1.86)	0.82	0.42
Access	18.54(4.45)	18.71(3.69)	-0.21	0.84
Built Environment	19.16(4.63)	19.20(3.94)	-0.05	0.96
Social Support	19.10(4.16)	19.08(4.05)	0.02	0.98
Individual Indices				
Developmental	41.99(7.17)	44.10(7.51)	-1.42	0.16
Identity	10.57(1.98)	10.67(2.06)	-0.23	0.82
Structural	28.13(5.02)	28.32(5.03)	-0.19	0.85
Values	25.06(4.53)	25.00(4.22)	0.07	0.95
Remaining Variables				
Contact between players	0.16(0.37)	0.35(0.48)	-2.18	0.03*
Duration of Transportation	12.04 12.4)	19.27(21.73)	-2.01	0.05*
Games of Long Duration	0.18(0.39)	0.31(0.46)	-1.47	0.14
Ethnicity Type	0.67(0.71)	0.49(0.69)	1.28	0.20
Hours Employed	0.20(0.40)	0.31(0.46)	-1.22	0.23
Strict Rules	0.22(0.42)	0.33(0.47)	-1.19	0.24
Competitive	0.20(0.40)	0.29(0.46)	-0.99	0.32
Immigrant type	0.14(0.45)	0.23(0.59)	-0.81	0.42
Co-Ed	0.24(0.43)	0.31(0.46)	-0.74	0.46
Presence of Chronic Conditions	1.30(0.71)	1.27(0.53)	0.28	0.78
Age	15.4(0.98)	15.52(1.03)	-0.25	0.80
Responsibilities	0.96(0.86)	0.98(0.91)	-0.11	0.92
Immigrant type – Parent	0.41(0.57)	0.42(0.65)	-0.07	0.94
Physically Intense	0.24(0.43)	0.25(0.43)	-0.06	0.95
Perseverance	0.63(0.49)	0.64(0.48)	-0.06	0.95
Recreational	0.16(0.37)	0.17(0.38)	-0.04	0.96
Presence of Chronic Conditions - Family	1.69(1.06)	1.69(1.01)	0.03	0.98
$^{**}p<0.05$				

Multivariate analysis: Four binary logistic regression analyses were computed with sport participation as the outcome. Specifically, each constraint type was entered in a block, with a fourth block of demographic variables. Odds ratios and 95% confidence intervals are shown in Table 5. There were no significant task constraints. There were three significant Environmental Constraints (weather $p<0.05$, OR = 0.83, 95% CI (0.72, 0.96), physical environment $p<0.05$, OR =1.3, 95%CI (1.03, 1.77) and duration of transportation $p<0.1$, OR 0.97, 95%CI (0.94, 1.00)). There was one significant Individual Constraint (developmental $p<0.05$, OR = 0.90, 95%CI (0.82, 0.99)) and one significant Demographic variable, which was classified as an Environmental constraint (presence of chronic condition in the family $p<0.1$, OR=0.66, 95%CI (0.43, 1.03)). These were used for interaction analysis which were entered into a second binary logistic regression as shown in Table 6. There were no significant constraints or interactions.

Table 5: Results of multivariate analysis: Binary logistic regression.

	Reference Category	**OR (95% CI)**	***p***
Demographic Variables			
Presence of Chronic Cond(Family)	No Chronic Condition	0.66(0.43,1.03)	0.07*
Ethnicity Type	White	1.58 (0.84, 2.99)	0.15
Immigrant Type	Non immigrant	0.53 (0.18, 1.53)	0.24
Presence of Chronic Condition	No Chronic Condition	1.19 (0.58, 2.43)	0.63
Parental Immigrant type	Non immigrant	1.21 (0.48, 3.08)	0.68
Birthdate		0.95 (0.62, 1.47)	0.82
Environmental Constraints			
Weather (i)	Low (Strongly Disagree)	0.83(0.72, 0.96)	0.01**
Physical Environment (i)	Low (Strongly Disagree)	1.35(1.03, 1.77)	0.03**
Duration of Transportation	Short (<10min)	0.97(0.94, 1.00)	0.07*
Hours Employed	Not Employed (0 hours)	0.50(0.16, 1.52)	0.22
Built Environment (i)	Low (Strongly Disagree)	0.89(0.73, 1.10)	0.29
Support: Social (i)	Low (Strongly Disagree)	1.07(0.93, 1.23)	0.36
Neighborhood Perception (i)	Low (Strongly Disagree)	1.16(0.81 1.67)	0.41
Support: Family (i)	Low (Strongly Disagree)	0.94(0.78, 1.13)	0.52
Access (i)	Low (Strongly Disagree)	1.03(0.85, 1.26)	0.74
Individual Constraints			
Developmental (i)	Low (Strongly Disagree)	0.90(0.82, 0.99)	0.03**
Values (i)	Low (Strongly Disagree)	1.11(0.96, 1.30)	0.17
Identity (i)	Low (Strongly Disagree)	1.11 (0.84, 1.48)	0.45
Structural (i)	Low (Strongly Disagree)	0.97(0.89, 1.06)	0.55
Task Constraints			
Contact	Not present	0.38(0.12, 1.25)	0.11
Physically Intense	Not present	1.78 (0.51, 6.26)	0.37
Long Games	Not present	0.66(0.24, 1.84)	0.43
Strict Rules	Not present	0.67(0.22, 2.04)	0.48
Competitive	Not present	0.68(0.19, 2.44)	0.55
Perseverance	Low (Strongly Disagree)	0.78 (0.31, 1.96)	0.59
Recreational	Not present	1.41(0.39, 5.08)	0.60
Co-Ed	Not present	1.08(0.37, 3.20)	0.88
(i)– index, *p<0.1, **p<0.05			

Table 6: Binary Logistic Regression 2.

	Reference Category	**OR (95% CI)**	***p***
Significant Constraints			
Developmental (i)	Low (Strongly Disagree)	1.42(0.91,2.21)	0.12
Weather (i)	Low (Strongly Disagree)	1.64(0.73,3.67)	0.23
Physical Environment (i)	No Chronic Condition	2.22(0.41,12.08)	0.36
Presence of Chronic Condition (Family) (PCCF)	Low (Strongly Disagree)	0.61(0.02, 16.68)	0.77
Duration of Transportation	Short (<10min)	0.98(0.77, 1.26)	0.90
Interaction terms			
Developmental x Weather		0.99(0.95,1.03)	0.09
Developmental x Physical Environment		1.00(0.99,1.01)	0.56
Developmental x PCCF		1.01(0.94,1.09)	0.80
Developmental x Duration of Transportation		0.985(0.97,1.01)	0.90
Note. (i)– index			

Discussion

Increasing sport participation is a targeted way of increasing overall physical activity, which research has shown to improve optimal well-being [21]. A thorough understanding of constraints to sport participation and how these interact to affect participation among girls is a key step in the development of future interventions. The goal of this study was to pilot a self-developed survey which collected information on constraints to sport participation for adolescent girls. The objectives were to refine the recruitment strategy, identify potential issues with survey administration, and to explore and refine analytical techniques to examine interactions.

This exploratory study found that the initial recruitment strategy requires a more direct approach to accessing the sample, and that the online format was effective. Binary logistic regression did not reveal any significant interactions of constraints, but identified weather ($p<0.01$, OR 0.82, 95% CI (0.72, 0.94)), the physical environment ($p<0.05$, OR 1.32 95% CI (1.03, 1.70)), duration of transportation ($p<0.10$, OR 0.970 95% CI (0.939, 1.001)), presence of chronic condition in the family ($p<0.10$, OR 0.662 95% CI (0.426,1.027)) and development ($p<0.05$, OR 0.90 95% CI (0.82,0.99) as constraints to sport participation for this sample. Some constraints, such as contact (in sport) were significant in bivariate but were not significant in multivariate. Weather was the only significant environmental index in the bivariate analysis, but five additional constraints became significant in multivariate analysis.

No significant interactions were found among the constraints examined in this study, and thus it is not possible to draw conclusions from this work about constraints to sport participation in the general population. However, there were two key themes in the data which highlight the importance of gender and environment. First, though many participants responded favorably to questions regarding beliefs about and attitudes toward sport participation, half of them (50.5%) still indicated that they do not participate in sport regularly, and 41.2% indicated that they had had a negative experience which caused them to stop participating in a certain sport. Further investigation into these types of negative experiences is necessary to understand drop-out from sport in addition to non-participation.

Second, it was clear that environmental constraints were the most frequently reported among our sample. This is consistent with previous research which shows that constraints external to the individual are more commonly generated through quantitative study than are individual or psychological factors [22]. The information collected from the survey was but a snapshot of the participants' stage of development but addresses the importance of acknowledging the multifaceted nature of constraints with respect to their stability over time. It also challenges the recent dialogue about changing the rules of sports (a task constraint) to facilitate girls' participation as task constraints were not found to be significant in our sample. This applies to sports like hockey, where checking is not permitted in girls' leagues but is in boys' and thus the tasks inherent to the sport are being modified. This highlights the utility of considering interactions between constraints in modifying the rules of sport by recognizing that it is probable that a task constraint would be moderated by an individual constraint. In addition, some environmental constraints are also modifiable. Though weather itself cannot be changed; safe, clean, and accessible indoor options in the neighborhood can reduce or eliminate this constraint altogether. However, for these options to be effective in increasing sport participation, it is equally important to address individual developmental constraints such as a lack of confidence or a belief that sports are not for girls. It is an appreciation of these interactions which can help create more comprehensive interventions to increase sport participation.

This study comes with several strengths which arise from meeting the three objectives. First, the study highlighted the importance of a more comprehensive sampling strategy to access a representative sample of adolescent girls. The response rate was low (39%) likely due to the population being "hard-to-reach". A potential bias is that most participants were in grade 10 at the time of participating in the survey. Since physical education classes are only mandatory in grade 9, it is not known whether the participants were enrolled in an elective physical education course because they are more likely to participate in sport or because they were not successful in completing the mandatory course. Expanding recruitment to classrooms outside of physical education may help to reduce this bias. Alternatively, respondent-driven sampling which is a chain-based recruitment method used to access hard-to-reach populations may be of use [23]. Though it can be more efficient in terms of duration of data collection and access to a representative sample, response-driven sampling requires intensive resources for monitoring recruitment logs [23]. In addition, informed consent from parents or guardians may continue to be a barrier [24].

The second objective was to resolve any issues related to survey administration. Feedback regarding the survey resulted in strengthening the instrument for future use. For example, the outcome variable was strengthened to removing any possibility of incorrect interpretation. The initial survey question read "*I participate in sport regularly (3x/week or more)*". The adjective 'regularly' was defined in parentheses based on General Social Survey data, but it was not clear if the sports being practiced were organized, in physical education class or a combination of both [25]. Also, the intensity at which the sport was pursued was not accounted for. Separating the question to account for both frequency and intensity, as well as differentiating between organized sport and physical education classes allows for a more accurate method of extracting the true level of sport participation for this population in larger scale implementation. The length of the survey may have also been a factor in survey administration. The present survey required approximately 20-25 minutes to complete thus future iterations may consider streamlining the question types or reducing the number of questions.

Finally, this work demonstrated the feasibility of examining interactions between constraints to sport participation using binary logistic regression analysis which has not been done previously. Many studies focus on isolating constraints but this approach fails to consider the complex nature of participation because it does not recognize that

modifying a constraint in one category can interact with a constraint in another category [26,27]. In this study, constraints which approached significance in bivariate analysis, such as the developmental and physical environment indices became significant in multivariate (logistic regression) analysis. This finding suggests that an interaction may exist between constraints which are non-significant when examined individually. More in-depth statistical analysis of indices which did not come out as significant, but which contained some significant components is warranted. However, in a larger scale application of this study, sample size will no longer be a limiting factor so single constraints will have enough statistical power to be meaningful without being part of an index.

This study also comes with limitations and recommendations for next steps. The first key limitation was the low response rate (39%) which can be increased with a more comprehensive sampling strategy. A second limitation was the potential for Type I error due to the large number of examined associations, specifically in the case of a large quantity of variables. As this was an exploratory pilot study with a small sample size, it is expected that this will be resolved in a larger scale study. Another potential limitation lies in how findings from this work could be interpreted. If an interaction is found between two constraints, it may not necessarily translate into an easily implemented intervention. There is no 'one size fits all' solution to the problem of non-participation, but it is also not reasonable to create an abundance of new possible interventions to increase participation in sports. This is why larger scale implementation is necessary, so that patterns of interactions can begin to emerge. It may also prove useful to include a sample of boys from the same schools to compare with the girls. In this way environmental constraints are essentially controlled for, and the true differences between boys and girls can be examined to bring attention to the gap in participation.

Conclusion

This study has two main implications for the study of constraints to sport participation among this sample; recruitment, and survey administration. Recruitment of adolescent girls must consider the many levels of consent required when accessing the sample through educational institutions, and more geographical locations should be considered to allow for comparison between rural and urban areas. Though interactions were not found to be significant in this study, further examination with larger sample sizes in different areas is warranted. The piloting of this online survey has also improved the instrument to decrease length of completion, clarify questions, and simplify future implementation.

Acknowledging the dynamic nature of constraints during adolescence and using a framework which allows for the conceptualization of constraints is an important step in understanding the unique combinations of constraints on adolescent girls. It has been shown that adolescent girls experience different socialization with respect to sport participation and are exposed to different barriers because of gender norms [28,29]. Future policies and programs to address the low levels of sport participation among girls should consider the female-specific individual factors related to sport participation, as well as environmental constraints.

Declaration

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Ethics Approval

This study received ethics approval from the University of Ontario Institute of Technology Research Ethics Board.

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