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Sport participation and loneliness in adolescents:

The mediating role of perceived social competence

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Abstract

Young people perceive loneliness as a distressing emotional experience associated with sadness and boredom. Also, feelings of loneliness may be associated with psychosocial and emotional problems during adolescence. The aim of this study was to investigate whether perceived social competence mediated the cross-sectional relationship between sport participation and loneliness in young people when controlling for age, sex, shyness, and non-organized physical activity. This cross-sectional study consisted of 2,055 pupils (995 boys and 1,060 girls) from 38 schools in Norway, with a mean age of 15.3 years. In addition to normal theory regression procedures, bootstrapping techniques were used to test the hypothesized indirect effect.

Findings revealed that sport participation was inversely associated with loneliness mediated by perceived social competence. This indirect effect was evident when controlling for age, sex, non-organized physical activity and shyness. Findings suggest that sport participation during adolescence is indirectly associated with lower level of loneliness through higher level of perceived social competence. One may argue that sport participation during adolescence can contain important social components that help meet young peoples' social needs and expectations, which in turn may prevent feelings of loneliness.

Keywords: sport participation; loneliness; perceived social competence; non-organized physical activity; shyness.

Introduction

Loneliness is thought to be a common experience, especially during adolescence (Heinrich and Gullone 2006; Perlman and Landolt 1999). Loneliness may be defined as a negative emotional response to a mismatch between desired and actual level of social contact (Perlman and Peplau 1981). Young people perceive loneliness as a distressing experience associated with sadness and boredom (Hymel et al. 1999). Moreover, feelings of loneliness have been shown to correlate with anxiety, depression, and lower levels of life-satisfaction (Moore and Schultz 1983). Indeed, loneliness is proposed to have a major influence on psychosocial problems and personal well-being (see Heinrich and Gullone (2006) for a review). Hence, alleviating loneliness in the adolescent period would seem a pertinent undertaking.

Whereas research has shown physical activity participation in general and sport participation in particular to be associated with a variety of positive psychosocial outcomes during adolescence, the role of loneliness in this age period has been less well studied. With respect to positive outcomes, sport and physical activity involvement have been linked to higher level of psychological well-being (Callaghan 2004; Fox 1999; Saxena et al. 2005) and lower level of psychological distress (Calfas and Taylor 1994; Tomson et al. 2003). The few studies that have examined the link between physical activity and/or sport participation and loneliness generally report an inverse relationship (Page et al. 1992; Page and Page 1994; Page and Zarco 2001; Poulsen et al. 2008; Taliaferro et al. 2010).

Despite that research report an inverse relationship between physical activity participation and feelings of loneliness during adolescence, the mechanisms underlying this relationship is not well understood. Potential third variables may elucidate the relation between participation and loneliness, and subsequently contribute to a further understanding of why they are related. Indeed, Cerin (2010) stated that mediation analyses of both cross-sectional data and longitudinal data are

vital for clarifying how personal well-being may be enhanced through participation in physical activity.

Aspects of the social context of sport participation may be particularly important when investigating loneliness because one of the key components of loneliness is a lack of connectedness with others (Goosens and Beyers 2002). Hence, while one may argue that enhanced personal well-being attached to sport participation emanates from the physical activity per se, social characteristics embedded in the organizational context in which the activity takes place may also play a role. Indeed, studies have shown sport participation to be related to both positive and negative outcomes (e.g. Larson et al. 2006). Sport activities that foster affiliation, good peer relations, and friendship opportunities (Fletcher et al. 2003) may be seen as favorable in the development of social self-perception (Harter 1999) and reduced feelings of loneliness (Page et al. 1992). Hence, opportunities of positive social relationships with peers may be reflected in satisfaction in the social domain of life, whereas the opposite may lead to feelings of loneliness and negatively impact social development (Hymel et al. 1990; Parker and Asher 1987).

While there may be several mechanisms through which peer relations may degenerate and lead to peer rejection and even loneliness during adolescence (Kupersmidt and DeRosier 2004), research has pointed towards perceived social competence as being important for maintaining good peer relations and thus protecting against loneliness (Riggio et al. 1993; Sandstrom and Zakriski 2004). Indeed, the development of enhanced social skills may be one building block for enhanced perceptions of social competence. Both social skills training and enhancement of self-esteem have been suggested as strategies for remediation and/or prevention of young people's subjective feelings of loneliness (Galanaki and Vassilopoulou 2007).

Studies have shown that an individual's perceived social competence is not necessarily equal to actual social skills, as rated by his/her significant others (Adams et al. 2000). Furthermore, there is

evidence that feelings of loneliness have less to do with the actual number of social relationships than with the quality and perceived meaningfulness of those relationships (Stokes 1985; Wheeler 1983). Although actual social skills would be a key component in succeeding in social domains during adolescence, cognitive dimensions such as perceived social competence may be of particular importance for prevention of loneliness. For example, Hymel and colleagues (1990) found that perceived social competence inversely predicted feelings of loneliness three years later in a sample of children / pre-adolescents. The way in which individuals perceive their ability to meet with others in social interactions may affect their actual interactions with peers (Leary et al. 1995; Crick and Ladd 1993). Expectations about future social contact and also perceptions of possible or likely social relations may help to prevent or minimize feelings of loneliness (Perlman and Peplau 1981). By affecting the expectations, goals, and plans to deal with social situations, perceived social competence may influence the extent of loneliness a person experiences.

In light of this, one may hypothesize that under conditions in which sport participation relates positively to perceptions of social competence, participation may buffer against feelings of loneliness while taking part.

Covariates

In general terms regarding model selection, variables that are being controlled for should be determined by theory or a reason for believing that bias is introduced into the estimation of the paths of the model if one fails to account for competing causal influences.

Backhouse and co-workers (2007) pointed out that the identification of the sources of variability in the response patterns of individuals or subgroups is an obvious challenge for future research when examining personal well-being outcomes of sport participation. Therefore, one must also take into account that the representatives of such factors would seem important when examining health gains from participation in sport. Age and sex may be considered important sociodemographic

factors to address. In terms of other individual factors, personality characteristics may consist of coping resources which may add to positive personal well-being outcomes from sport participation. In contrast, such characteristics may well represent risk factors that may detract from otherwise positive outcomes.

Shyness is often regarded as a heritable dimension of one's personality, although researchers have struggled to develop a consensual definition. Cheek and Buss (1981) defined shyness as social anxiety or discomfort in the presence of others, particularly among strangers. Shyness has also been argued to be a precursor of loneliness (Dill and Anderson 1999), and may represent a risk factor that could detract from or reduce otherwise positive outcomes of sport participation as well as influencing the role of mediating cognitions such as perceived social competence. During adolescence, much emphasis is placed on peer groups and social activities, especially physical activity (Page and Zarco 2001). Shy individuals may feel anxious or discouraged in social contexts such as sport, which may further facilitate exclusion from the peer group (Miller and Coll 2007). Hence, it would seem important to control for shyness when investigating the association between sport participation and loneliness through perceived social competence.

Spink and colleagues (2006) encourage researchers to focus on measuring relevant variables salient to participation in specific types of physical activities. In the present study, one distinction that may be important is the difference between organized sport participation and non-organized physical activity (i.e. unorganized, self-initiated by the young people themselves). Non-organized activity has traditionally been seen as a risk factor for antisocial and deviant behavior (Mahoney et al. 2005). However, it is worth noting that non-organized leisure activity is not in itself antisocial or deviant. Indeed, developmental research argues that at least a moderate amount of time spent outside organized contexts is useful for the development of social skills and peer relations (Osgood et al. 2005). Furthermore, Spink and co-workers (2006) found social correlates to be equally (friends'

support) or more important (friends' participation) when comparing unstructured physical activity to structured physical activity. In accordance with this reasoning, it seems relevant to include non-organized physical activity as a covariate in the hypothesized model.

According to the issues raised so far, the aim of this study was to investigate the potential indirect effect of sport participation on feelings of loneliness through perceived social competence when controlling for age, sex, shyness, and non-organized physical activity in a cross-sectional sample of Norwegian adolescents.

The research model is presented in Figure 1.

Insert figure 1 about here

Methods

Sampling and participants

This cross-sectional study was conducted as a part of the "Goodness of Fit in Norwegian Youth Sport Study". A total of 2,971 pupils from 38 different Norwegian schools were invited, and 2,055 (71%) adolescents (995 boys and 1060 girls) from age 13 to 18 (mean age 15.3 years) completed the self-report questionnaire during school hours. The amount of missing values varied across variables. The Norwegian Social Science Data Service (NSD) approved the study, and parents and children signed a written informed consent before participating in the study.

Measures

Loneliness. Loneliness was assessed using a brief version of the Revised UCLA Loneliness Scale (Russell et al. 1980) which measured perceived negative affections, unhappiness and dissatisfaction with social relationships. The brief version (Skarabø et al. 2006) consists of items 1, 13, 15 and 18 from the original 20 items. Two of the items are positively phrased and two are negatively phrased. The items were answered on a four-point scale ranging from 1 (absolutely not) to

4 (absolutely). Typical items are “*I feel in tune with the people around me*” and “*No one really knows me well*”. The average score on the four items indicates the level of perceived loneliness, with a high score indicating a higher level of loneliness. Subsequent studies reveal satisfactory estimates of validity and reliability for the scale (Russell et al. 1980; Skarbø et al. 2006).

Sport participation and non-organized physical activity. The instrument used to measure sport participation and non-organized physical activity was taken from Sagatun and co-workers (2007). In this study, however, the same question was asked twice and specified to two different contexts. The first one consisted of club led organized sport participation and the second included non-organized physical activity outside of club/school in the format of self-initiated physical activity including games play, and exercise activities taking place alone or with others. Sport participation is usually considered an organized activity given that club led sport is usually characterized by regular time schedules, specified locations, coach supervision and a group setting, and usually includes goals for performance and/or skill development.

Non-organized physical activity in contrast, has no set schedule or regimen and does not involve coach led or supervised activities. With regard to the two contexts (sport participation and non-organized physical activity, respectively), participants were asked the question: “*How many hours per week do you play or exercise enough to make you sweat or breathe hard?*”: 0, 1-2, 3-4, 5-7, 8-10 or 11 hours or more per week. The original six-category ordinal scales were coded as participation (1-2 and upwards) or non-participation (0) in both sport and non-organized context, thereby providing mutually exclusive groups. Sagatun (2010) reported that this question correlated fairly well with other measures of physical activity, and was the one that best predicted physical activity measured by accelerometer.

Perceived Social Competence. The Social Competence Subscale from the revised Norwegian version (Wichstrøm 1995) of Harter’s Self-Perception Profile for Adolescents (Harter

1988) was included to determine individuals' perceptions of their social competence. The scale consisted of five descriptions (e.g. *"I find it quite difficult making friends"*), and the participants indicated their degree of agreement: (1) Describes me very poorly, (2) Describes me fairly poorly, (3) Describes me fairly well, and (4) Describes me very well. Two of the items were reversed. The mean score was derived from the item scores, with higher score indicating higher level of overall perceived social competence. Psychometric support for the measure is derived from Wichstrøm's (1995) analyses.

Shyness. Shyness was measured using a Norwegian translation of the Revised Cheek and Buss Shyness Scale (Cheek and Buss 1981). The Shyness Scale consists of 13 items that measure degrees of discomfort and inhibition that occur in the presence of others. Typical items are: *"I do not find it difficult to ask other people for information"*, *"I am often uncomfortable at parties and other social functions"*. The average score on the 13 items represents level of shyness, ranging from 1 (low) to 4 (high). Calculations of validity and reliability of the shyness scale have been demonstrated in previous studies (Jones et al. 1986).

The indexes were regarded continuous data. Other measured variables such as age and biological sex were also collected in the questionnaire.

Data Analysis

All statistics were calculated using IBM SPSS version 19.0. Only participants with complete data were included in the analyses. Means and standard deviations were used when presenting central tendencies and dispersion, and independent t-tests were used when testing major study variables for potential sex-differences and differences between participants / non-participants in sport and non-organized physical activity, respectively (Table 2). Cronbach's alpha was used when calculating internal consistency in the indexes measured. When examining correlations between major study variables and within indexes (Table 1), a Pearson's r coefficient was used.

In order to test for indirect effects when also controlling for covariates, we used the Preacher and Hayes' (2004; 2008) bootstrapping technique for mediation analysis. Bootstrapping is a non-parametric resampling procedure that can be used to test the null hypothesis for an indirect effect. Bootstrapping involves repeated extractions with replacement of samples from the data set (in this case 10,000 samples were drawn), and the estimation of the indirect effect in each resample data set.

In comparison to other procedures, the method used does not rely on the assumption that the total and indirect effects are normally distributed (Preacher and Hayes 2004). In extensive sets of simulations, MacKinnon and co-workers (2002) examined the performance of different methods for testing mediation in order to assess their Type I error rates and power. They recommended the use of the distribution of the product approach or bootstrapping over the Sobel test or causal steps approach, on the grounds that the former have higher power while maintaining reasonable control over the Type I error rate. The Indirect-macro (Preacher and Hayes 2008) for SPSS was used for investigating the proposed indirect effect when also including covariates. In addition to normal theory regression procedures, this technique produces point estimates and bias-corrected (BC) confidence intervals for the indirect effect. A 95 % BC confidence interval that does not include zero indicates a statistically significant mediation.

Because this study consisted of individuals from 38 different schools in Norway, the possibility of clustering effect on school-level existed. The variables investigated in the model were hypothesized to be student-level constructs, and therefore the possibility of school-level variance was assumed to be low (Martins et al. 2011). However, in order to take into account the possible non-independence produced by school variation in levels of the variables, analyses were performed with the school-variable included as 37 dummy variables and treated as covariates.

Results

Insert table 1 about here

As can be seen in Table 1, all indexes showed an acceptable internal consistency (Cortina 1993). Social competence and loneliness had the strongest correlation (-.71). Both sexes were equally represented within participants/non-participants in both sport and non-organized contexts. As can be seen from the descriptive statistics in Table 2, males scored higher than females on loneliness. When comparing the sport participants with the non-participants, results revealed that sport participants were scoring lower on loneliness (Cohen's $d = 0.33$, appx nonoverlap = 23%), higher on social competence (Cohen's $d = 0.36$, appx nonoverlap = 25%) and lower on shyness (Cohen's $d = 0.19$, appx nonoverlap = 13%) compared to the non-participants. According to Cohen (1988) the two former may indicate medium to low effect size. Similar results occurred when comparing the participants in non-organized activities to the individuals not participating in non-organized activities.

Insert table 2 about here

Insert table 3 about here

The proposed model explained 54% of the variation in feelings of loneliness (adjusted $R^2 = .54$, $F = 265.70$, $p < .01$). When examining the partial effects of the covariates, both sex and shyness individually predicted loneliness. More specifically, boys reported higher levels of loneliness than girls, and higher levels of self-reported shyness predicted a higher perceived loneliness. In addition, participation in non-organized physical activity predicted lower levels of loneliness in the total model.

As can be seen in table 3, sport participation was positively related to perceived social competence (a path). Social competence was inversely related to loneliness (b path). The total effect

(c path) of sport participation on loneliness was also significant, albeit marginally ($p = .042$). When investigating the indirect effect of sport participation on feelings of loneliness through social competence, the results revealed a significant indirect effect (BC 95% CI not including zero), thereby supporting the hypothesized model. Sport participation had an indirectly inverse association to perceived loneliness through higher perception of social competence. This indirect effect was evident when controlling for age, sex, shyness and non-organized physical activity participation.

Discussion

To the best of our knowledge, no study has examined the relationship between sport participation and loneliness through social competence in adolescents. The aim of this study was to investigate the cross-sectional relationship between sport participation and feelings of loneliness mediated by social competence, when controlling for age, sex, shyness, and non-organized physical activity participation. The indirect sport participation– loneliness link through social competence observed suggests that sport participation may indirectly affect loneliness by elevating young people’s sense of social competence. These findings run parallel to those reported in Taliaferro et al. (2010), in which social support mediated the relationship between sport participation and loneliness.

While the current study did not include measurements of social skills, social recognition and the quality of peer relations, research on organized leisure activities often highlights these factors as building blocks for heightened psychosocial competencies as a consequence of participation (Mahoney et al. 2005). Hence, sport participation may play a role in preventing or reducing feelings of loneliness by enhancing perceptions of social competence elicited by positive peer relations, social recognition, feelings of connectedness and social skills learning. It may well be that sport participation positively affect the way in which individuals perceive their abilities in social interactions. These perceptions may in turn help to prevent or minimize feelings of loneliness (Perlman and Peplau 1981).

Indeed, previous findings suggest that individuals may experience sense of belonging, intimate friendships, fellowship and positive peer relationships through participation in organized activities (Bohnert et al. 2007). Additionally, McGee and colleagues (2006) pointed out that the effect of participation (in sport clubs among others) during adolescence is to widen the “social convoy” as well as strengthening relationships within that convoy. Baumeister and Leary (1995) highlight the importance of “belonging”. The need to belong is thought to be most important in terms of buffering against perceptions of loneliness. Positive social contact within the context of valued relationships with people other than strangers is seen as essential for satisfying the need to belong.

Perlman and Peplau (1981) argue that the most obvious way of overcoming loneliness is to establish or improve social relationships. If a person has difficulty with peer relationships it may be hard to rectify that without changing peer groups altogether, something often not practical because of the expense of moving, challenges of accommodating to a new school, etc. One angle of argument could be that engaging in or switching sport groups may be relatively less difficult for the average youth participant. In other words, sport may offer young people a context that provides opportunities for positive social interactions with peers.

While individual characteristics may constrain positive outcomes of sport participation (Miller and Coll 2007), the link in this study observed between sport participation and loneliness through social competence is evident, even when controlling for age, sex, non-organized physical activity and shyness. Regarding shyness, the findings are encouraging by suggesting that it is possible even for shy or socially anxious adolescents (boys and girls) to benefit from positive peer relations and close friendships as a buffer against perceptions of loneliness. Indeed, Findlay and Coplan (2008) suggest that sport participation may play a unique protective role for shy individuals. Regrettably, shy individuals may retreat to the fringes of social interaction and may be more unwilling to risk initiating participation even if participation would be beneficial (Weiss 1973).

In addition, non-organized physical activity participation individually predicts lower levels of loneliness in this study. This activity may include some of the same characteristics as sport participation in a self-organized informally structured arena that may or may not be carried out in the company of peers or adults. This type of leisure activity may also work as an environment that provides adequate resources to meet individuals' social provisions (Ernst and Cacioppo 1999).

Limitations & Future Directions

This study must be seen in light of its strengths and limitations. Research on associations between sport participation and loneliness is scarce, and this study attempts to meet the call for a better understanding of mechanisms that may explain the association between sport participation and personal well-being outcomes (Cerin 2010).

However, perceived social competence is only one of several potential ways in which sport participation may affect loneliness (e.g. actual social skills, athletic competence). A limitation of this study is the absence of other alternative mediators. Furthermore, participation in alternative pursuits with peers, such as choir, after-school programs, art and politics, could also strengthen social competence and thus counteract feelings of loneliness.

Detailed information of the social and structural characteristics of the sport context was not recorded in this study. For example, it has been shown that social outcomes of sport participation are associated with young peoples' perception of the motivational climate of the activity (Ommundsen et al. 2005). Also, this study includes all types of organized sport, and the relationship shown in this study may differ from one sport to another. It should be emphasized that positive peer relations, social recognition, feelings of connectedness and perceived social competence should not be seen as something immediate and embedded in any sport context. Consequently, future research would do well to also expand on the notion of contextual specificities when examining the role of sport participation in relation to personal well-being.

Due to its cross-sectional design, no conclusions can be drawn regarding causality.

Loneliness may predispose adolescents toward lower levels of physical activity participation (Page and Page 1994). Indeed, both perceived social competence and feelings of loneliness may be a precursor of sport participation, or perhaps most likely, the associations may be reciprocal. It is possible that sport participation constitutes the endpoint rather than the antecedent in this model. Smith's (1999) work, for example, supported a model whereby peer relationship variables (including perceived social acceptance/competence) predict physical activity motivation and behavior by way of affect. A perceived social competence --> loneliness --> sport participation pathway is analogous to this conceptual chain of events.

By contrast, interpretations should be done with caution because self-selection may play a role. Sport participation during adolescence is largely voluntary. One may very well argue that self-selection and preexisting differences can explain the psychological differences between adolescents who decide to spend time in different activities and those who do not. The need for longitudinal studies and well-designed experimental research is warranted.

Moreover, even though the factors of interest in this study are hypothesized to be student-level constructs, the sample in this study is multilevel (students are nested within different schools). The usual assumption for causal inference from regression models is that individual observations are independent. With nested structures like these, this may not be the case. The correlation between observations within a common unit may be higher than the average correlation of observations between units. A consequence might well be that we underestimate the uncertainty of effects from pooled estimates. Even though the hypothesized model includes schools as covariates and thus taking the possible school-clustering into account, the fact that the sample is drawn at school-level and not student-level should be considered when interpreting the results of this study.

Conclusions

Our findings attest to the value of investigating mechanisms through which sport participation may contribute to enhanced personal well-being during adolescence. In conclusion, our findings provide empirical support for the hypothesized model linking sport participation to reduced loneliness mediated by enhanced social competence. The findings suggest that sport participation during adolescence contains important social components that help meet young peoples' social needs and expectations, which in turn may prevent feelings of loneliness.

These findings, together with those of other studies in this field, may help inform public youth health policy and planning. Health professionals should advocate for increased opportunities to involve young people in sport and other physical activities, while also seeing to it that conditions for constructive social interactions and competence building while taking part are met with. Practitioners working specifically with young people with social skill deficits should consider the finding that sport may be an arena for development of social competence. These findings suggest an intervention opportunity for practitioners to use sport and physical activity as a tool for preventing and possibly reducing feelings of loneliness during adolescence.

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Figure and legend

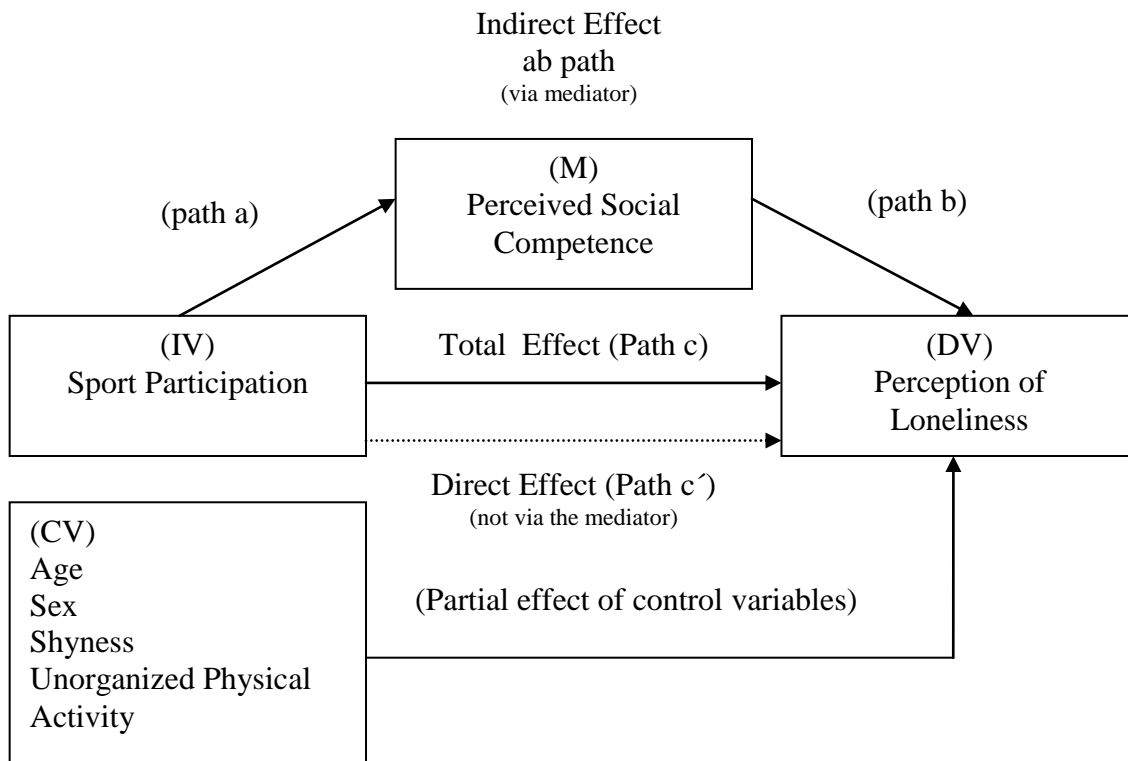


Fig 1 The hypothesized mediation model, including covariates.

Note. The lines represent the paths of interest. IV = Independent variable; M = Mediator; DV = Dependent variable; CV = Covariate(s).

Tables

Table 1 Internal Consistency and Inter-Item Correlation in Major Study Indexes

	1	2	3	4
1 Age	-			
2 Shyness	-.06*	-		
3 Social Competence	-.03	-.59**	-	
4 Loneliness	.04	.55**	-.71**	-
Cronbach's alpha	-	.84**	.80**	.73**
Inter-item correlation	-	.05 - .46	.29 - .72	.32 - .53

Note. Pearson product-moment correlation coefficient, * $p < .05$; ** $p < .01$. Cronbach's alpha and inter-item correlations shown for indexes.

Table 2 Descriptive Data for Major Study Variables According to Sex, Sport Participation, and Non-organized Physical Activity

	Males	Females	Sport	No Sport	Non-org	No Non-org
N (valid %)	995 (48)	1060 (52)	1214 (67.5)	584 (32.5)	1328 (77.8)	379 (22.2)
Age	15.3 (1.51)	15.3 (1.51)	15.1 (1.47)	15.7* (1.49)	15.2 (1.52)	15.6* (1.49)
Shyness	2.1 (0.50)	2.1 (0.52)	2.1 (0.54)	2.2* (0.50)	2.1 (0.50)	2.2* (0.53)
Social Comp.	3.2 (0.55)	3.1 (0.57)	3.2* (0.59)	3.0 (0.53)	3.2* (0.53)	3.0 (0.59)
Loneliness	1.9* (0.60)	1.7 (0.59)	1.7 (0.58)	1.9* (0.63)	1.7 (0.58)	1.9* (0.63)

Note. Values are reported as mean and standard deviation; M (SD). Sport = Individuals reporting participation in sport; No Sport = Individuals that do not participate in sport; Non-org = Individuals reporting participation in non-organized physical activity; No Non-org = Individuals that do not participate in non-organized physical activity.

* Statistically significant higher values compared to opposite group; independent sample t-test ($p < .01$).

Table 3 Mediation analysis of Sport Participation on Loneliness through Perceived Social Competence

	Coeff	SE	NT Sig	BC 95% CI	
				Lower	Upper
Sport Participation (IV)					
IV to Mediator (a path)	.103	.023	<.001		
Total effect (c path)	-.052	.030	.042		
Direct effect (c' path)	.012	.025	.634		
Social Competence (M)					
Direct effect (b path)	-.622	.025	<.001		
Indirect effect (ab path)	-.064	.017		-.099	-.031
Partial effect of CV					
Age	.009	.008	.237		
Sex	-.152	.022	<.001		
Shyness	.250	.027	<.001		
Non-organized PA	-.058	.028	.036		
Model summary (R ²)			.54 (p <.001)		

Note. Dependent variable in the model: Loneliness. IV = Independent variable; M = Mediator; CV = Covariate(s); PA = Physical activity; Coeff = Point estimate of effects; SE = standard error of the point estimate; NT sig = normal theory p-value; BC 95% CI = bias corrected 95% confidence interval. School included in the analysis as dummy-variables (not shown in the figure, for clarity purposes).