Use of green spaces, self-satisfaction and social contacts in adolescents: A population-based CASPIAN-V study

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ABSTRACT

Background: A growing body of evidence has associated contact with green spaces with improved mental health and wellbeing in adults. Social contacts has been postulated as a potential mechanism underlying such effects. However, the available evidence on the association between green spaces and self-satisfaction and also the mediatory role of social contacts in health benefits of green spaces in adolescents is still very scarce. We aimed to evaluate the association of time spent in different types of green spaces with self-satisfaction and social contacts in adolescents. We also investigated the mediatory role of social contacts in the association of green space use and self-satisfaction.

Methods: This cross-sectional study was based on a population-representative sample of 10,856 adolescents (10–18 years old) living in urban and rural districts across 30 provinces of Iran (2015). Data on the time spent in green spaces (separately for parks, forests and private gardens), self-satisfaction, social contacts (number of friends and time spent with friends), and socio-demographic characteristics were obtained through questionnaires from parents and children. Logistic mixed effects models with recruitment centre as the random effect were developed to estimate associations adjusted for relevant covariates.

Results: More time spent in green spaces was associated with improved self-satisfaction and social contacts. While for the self-satisfaction, there was no indication for effect modification by sex, socioeconomic status (SES), and urbanity, we observed stronger associations for older adolescents (> 14 years old). For social contacts, we found indications for stronger associations for boys, older adolescents, those residing in rural areas, and those from lowest and highest SES groups. Social contacts could explain more than half of the association between green spaces use and self-satisfaction.

Conclusions: Our observed enhanced self-satisfaction and social contacts associated with more time spent in green spaces could provide policymakers with measures to improve mental wellbeing of adolescents. Further studies are required to replicate our findings in other populations with different climates, cultures and lifestyles.

1. Introduction

During the past few decades, there has been an increased number of people residing in urban areas (UN Department of Economic and Social Affairs, 2015). By 2050, it is projected that urban population will grow by 2.5 billion people, increasing the proportion of population living in cities to two-third of global population (UN Department of Economic and Social Affairs, 2015). Such a large-scale urbanization is continuing to increase the number of children and adolescents living in urban areas where residents often have limited access to natural environments.

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Green spaces have been associated with improved mental health and wellbeing in adults (Gascon et al., 2015). A limited but emerging body of evidence is also suggestive for such an association in children (Amoly et al., 2014; Markevych et al., 2014; McCormick, 2017; Richardson et al., 2017). For this age group, contact with green spaces has been associated with improved cognitive development (Dadvand et al., 2015, 2017), reduced risk of behavioural and emotional problems (Aggio et al., 2015; Amoly et al., 2014; Feng and Astell-Burt, 2017; Markevych et al., 2018, 2014; Younan et al., 2017; Zach et al., 2016), and improved self-discipline (Taylor et al., 2002) as well as academic performance (Hodson and Sander, 2017; Sivarajah et al., 2018; Wu et al., 2014). Stress reduction, attention restoration, increased social cohesion and physical activity and reduced exposure to environmental hazards such as air pollution, heat, and noise have been suggested to underlie such health benefits (Markevych et al., 2017). Although, through some of these mechanisms, green spaces could also influence self-satisfaction, to our knowledge, there is no available evidence on such an influence in children. Self-satisfaction, which is a function of accord between actual and ideal self, has been associated with reduced risk of depression and improved mental health (Higgins, 1987, 1989; Marsella et al., 1973), hence can have an important role in mental wellbeing.

A limited body of evidence is suggestive for an association between green spaces and social cohesion/contact (Dadvand et al., 2016b; De Vries et al., 2013; Dzhambov et al., 2018a; Maas et al., 2009b; Sugiyama et al., 2008), which in turn is associated with improved physical and mental health (Leigh-Hunt et al., 2017) in adults. Accordingly, social contacts has been suggested as a potential mechanism underlying the health benefits of green spaces (Markevych et al., 2017; Weinstein et al., 2015). In children, social contacts during outdoor play may be beneficial to socio-emotional development and can help to establish stronger social cohesion which feeds into perception of safety in the neighbourhood (Markevych et al., 2017). However, to date, the available evidence on the association of social contacts with green spaces or the mediatory role of social contacts in health effects of green spaces in children and adolescents remains very scarce (Dzhambov et al., 2018b).

So far, studies of the health effects of green spaces have mainly used proximity to green spaces as a proxy for access, and hence the use of these spaces by the study participants. However, in real life, proximity to green spaces would not necessarily translate into use of these spaces. Such a disagreement between residential proximity to green spaces and use of these spaces can have important implications for studying the association between green spaces and health, particularly for those associations for which physical activity or social interaction are key mediators (Markevych et al., 2017). Therefore, studies of health effects of green spaces could benefit from information on the use of green spaces by study participants. Moreover, the vast majority of studies evaluating health effects of green spaces, to date, have been conducted in high-income countries. As ethnicity and lifestyle habits might influence such effects, the generalizability of studies in these countries to the rest of the world could be limited (Markevych et al., 2017). There is therefore a need for more evidence on these effects from low- and middle-income countries where much of urbanization is currently occurring (UN Department of Economic and Social Affairs, 2015).

Emotional problems in adolescence has been shown to be a predictor for early old age mental wellbeing (Nishida et al., 2016). Thus, Adolescence could be considered as a window of opportunity; as prevention and interventions for emotional stress during development could have a major role in person's future mental health (Nishida et al., 2016). This study aimed to test the hypothesis that more use of green spaces is associated with improved self-satisfaction and enhanced social interaction in adolescents. We also hypothesized that social contacts could act as a mediator for this association, if any. Towards this aim, this study disentangled the associations for different types of green spaces and the variation of these associations by age, socioeconomic status (SES), level of urbanity, and sex. It also investigated the mediator role of social contacts in the association between use of green spaces and self-satisfaction.

2. Methods

2.1. Study area

Iran is located in Middle East Region with a total land area of about 1,628,000 km^2, including 31 provinces (Supplementary Fig. S1). This country has a population of about 79.9 million people (2016 census); of whom about 74% are living in urban areas (Iran, 2018). The average annual precipitation of Iran is 228 mm and approximately 90% of the country is arid or semi-arid (FAO, 2008). Iran is covered by approximately 55% rangeland, 21% desert, 7.5% forest, 11% cropland, and 6% residential areas and infrastructure (Badripour, 2004).

2.2. Study setting

This nationwide study was conducted in the context of the fifth survey of the Childhood and Adolescence Surveillance and PreventIon of Adult Non-communicable disease study (CASPIAN-IV). CASPIAN surveys started in 2003 and have been repeated every two to three years (Kelishadi et al., 2013, 2012; Motlagh et al., 2009, 2017). The CASPIAN-V survey was conducted in 2015 in urban and rural areas of thirty provinces of Iran. It applied a multistage stratified cluster sampling method to recruit a population-based sample of 14,400 schoolchildren aged 7–18 years. Detailed description of CASPIAN-V sampling and data collection methods have been published elsewhere (Motlagh et al., 2017). Briefly, from each province, 480 students were recruited. Sampling within each province was conducted according to the student's place of residence (urban or rural) and the level of education (primary or secondary school) using the proportional to size method with equal sex ratio. Consequently, the ratio of participants in urban and rural areas and in each grade in each province was proportional to the number of schoolchildren studying in urban and rural areas and in each grade in that province. A cluster sampling method was then used to enrol the required sample size from rural and urban areas and each grade in each province. Clusters were determined at school levels with ten schoolchildren (and their parents) in each cluster, resulting in 48 clusters in each province. Since this study was aimed to evaluate the association between green spaces use and self-satisfaction and social contacts in adolescents, we limited our analyses to those participants aged 10 years old or more at the time of interview.

Study protocols were reviewed and approved by the Research and Ethics Council of Isfahan University of Medical Sciences approved the study (Project Number: 194049). After complete explanation of the study objectives and protocols, written informed consent and verbal consent were obtained from the parents/legal guardians and schoolchildren, respectively.

2.3. Questionnaire data

Two sets of questionnaires were implemented for schoolchildren and their parents through face-to-face interviews by trained fieldworkers. Data on use of green spaces, self-satisfaction, and social contacts were obtained through the schoolchildren's questionnaire, while data on covariates were obtained from parents. The description of questionnaires applied in CASPIAN-V and conditions under which the interviews were conducted have been detailed elsewhere (Motlagh et al., 2017).

2.3.1. Green spaces use

Schoolchildren were instructed to report the average hours per week they spent in green spaces during working and non-working days separately for each season (spring, summer, autumn, and winter) and each type of green spaces (parks, forests/other natural green spaces,

and private gardens/agricultural field) for a 12-month period preceding the interview (see Green Spaces Questionnaire in Supplementary materials, page 2). For each green spaces type, the weekly average of time spent in that space was calculated by first adding up the reported hours for working and non-working days for each season and then averaging the resulting seasonal values. Those categories for which no time was reported were assumed to be zero (Amoly et al., 2014). The total weekly hours of time spending in green spaces was estimated by averaging the values for all the three green spaces types.

2.3.2. Self-satisfaction

The children answered a question on self-satisfaction: "How satisfied are you with yourself?" with possible responses being: completely dissatisfied, dissatisfied, often dissatisfied, not dissatisfied nor satisfied, often satisfied, satisfied, and completely satisfied. The description of participants' answers to this question is presented in Supplementary Table S1. The answers were dichotomized with cut-off at "satisfied" to generate a comparable number of participants in each category. We considered less than satisfied answers as the reference category, therefore a positive association between green spaces use and this variable could be interpreted as improved self-satisfaction.

2.3.3. Social contacts

Data on social contacts were obtained through two questions answered by children: (i) "How many close friends do you have?" with possible answers being none, one, two, and three or more; and (ii) "How many days per week do you spend time with your friends after school?" with the following answers: none, one day, two days, three days, four days, five days, and six days. The participants' answers to these questions are described in Supplementary Tables S2 and S3. We dichotomized the answers to the first question by considering two and less friends as the reference category to achieve a balanced number of participants in each category. Consistently, we dichotomized answers to the second questions by defining none as reference category. Therefore, a positive association of green spaces use with these variables could indicate stronger social contacts.

2.3.4. Covariate data

Data on socio-demographic characteristics such as maternal and paternal educational attainment, employment, marital status, and home ownership, and the number of people living in the household were obtained from parents through questionnaires. Data on other relevant covariates such as perceived stress from school homework, feelings towards school, experiencing bullying (during the three months prior to the interview), and having been injured leading the child seeking medical attention (during the 12 months prior to the interview) were obtained through questionnaires from children.

2.4. Main analyses

We conducted complete case analyses, including only participants with available data on outcomes, exposure, and all covariates.

2.4.1. Self-satisfaction

We developed logistic mixed effects models with self-satisfaction as the outcome variable, time spent in green spaces as fixed effect predictor, and recruitment centre as the random effect to account for the potential clustering of individuals in centres. The analyses were adjusted for a number of covariates identified *a priori*: child's age, sex and self-reported perceived stress from school homework (none/little/some/much), feelings towards school (like it very much/like it much/almost like it/don't like it), experiencing bullying during the three months prior to the interview (never/1–2 times/2–3 times/more than 3 times), having been injured during the 12 months prior to the interview (yes/no), number of individual living in the child's household, urbanity (urban/rural), and indicators of socioeconomic status (SES) including

parental educational attainment (highest degree attained by either parents: No or primary school/secondary school/university), parental employment (employment status by either parents: unemployed/employee/self-employed), and home ownership (owning the home: yes/no).

2.4.2. Social contacts

We developed logistic mixed effects models using indicators of social contacts (one at a time) as outcome together with identical set of random effect and fixed effect exposure and covariates to the aforementioned analyses for self-satisfaction.

2.5. Sensitivity analyses

The main analyses were conducted using recruitment centre as the random effect. To evaluate the potential influence of sampling clusters on our analyses, we added cluster as another random effect to the models (i.e. two random effects: recruitment centre and cluster). We also further adjusted our analyses for school type (private/public), parental marital status (single parent: yes/no), feeling comfortable to discuss problems with at least one parent (yes/no), and feeling comfortable to discuss problems with siblings (yes/no).

2.6. Further analyses

2.6.1. Green spaces type-specific analyses

We repeated the main analyses, using time spent at (i) parks, (ii) forests/other natural green spaces, and (iii) private gardens/agricultural field as the exposure (one at a time) to disentangle the association of different types of green spaces with self-satisfaction and social contacts.

2.6.2. Variation of associations by urbanity, SES, and sex

To explore potential variations in the association between use of green spaces and self-satisfaction and indicators of social contacts (one at a time) across strata of urbanity, SES, and sex, we stratified the aforementioned main analyses by urbanity (urban and rural), parental education (primary, secondary, and university), sex (girls and boys), and age (≤ 14 years and > 14 years). We also checked the statistical significance of the multiplicative interaction term between time spent in green spaces and each of these potential effect modifiers using likelihood ratio test, comparing models with and without interaction terms.

2.6.3. Quantifying the mediatory role of social contacts

Following the method applied in our previous similar study (Dadvand et al., 2016b), we quantified the mediatory role of social contacts variables in the association between green spaces use and self-satisfaction as the proportion of the total effect that was mediated by the mediator. We used the STATA "binary mediation" command that implements the Baron and Kenny's framework for mediation by fitting separately a model for the mediator as a function of exposure and a model for the outcome given the mediator and the exposure (Baron and Kenny, 1986). This allows the calculation of the direct, indirect and total effects of exposure as well as the proportion of effect mediated. We conducted the analyses by including both indicators of social contacts in the same model to account for interrelations between these indicators (Dadvand et al., 2016b). We used bootstrap to obtain percentile-based 95% confidence interval for the contribution of each mediator.

3. Results

3.1. Sample characteristics

Of 14,440 children selected for the study, 14,274 (98.9%) children

Table 1
Description[a] of self-satisfaction, social contacts, and sociodemographic characteristics of study participants.

Variable	Description[a]
Age (years)	13 (5)
Family (number)	5 (2)
Sex	
Female	5220 (48.1%)
Male	5636 (51.9%)
Parental education[b]	
No or primary school	3039 (28%)
Secondary school	5781 (53.2%)
University	1897 (17.5%)
Missing	139 (1.3%)
Parental employment[c] status	
Unemployed	893 (8.2%)
Employee	6064 (55.9%)
Self-employed	3803 (35%)
Missing	96 (0.9%)
Urbanity	
Urban	7861 (72.4%)
Rural	2995 (27.6%)
Home ownership	
Owing home	8919 (82.2%)
Not owning home	1828 (16.8%)
Missing	109 (1%)
Feelings towards school	
Like it very much	7230 (66.6%)
Like it much	2735 (25.2%)
Almost like it	522 (4.8%)
Don't like it	362 (3.3%)
Missing	7 (0.1%)
Perceived stress from school homework	
None	4159 (38.3%)
Little	3594 (33.1%)
Some	2212 (20.4%)
Much	888 (8.2%)
Missing	3 (0.03%)
Experiencing bullying[d]	
Never	8578 (79%)
1–2 times	1663 (15.3%)
2–3 times	204 (1.9%)
More than 3 times	372 (3.4%)
Missing	39 (0.4%)
Having been injured[e]	
No	9157 (84.4%)
Yes	1650 (15.2%)
Missing	49 (0.4%)
Self-satisfaction	
Dissatisfied	4237 (39%)
Satisfied	6619 (61%)
Number of friends	
None/1/2	5286 (48.7%)
3 or more	5550 (51.1%)
Missing	20 (0.2%)
Time spent with friends	
None	6199 (57.1%)
1–6 days per week	4657 (42.9%)

[a] Results are presented as count (%) for categorical variables and as median (interquartile range) for continuous variables.
[b] Highest educational attainment by either parent.
[c] Highest employment level by either parent.
[d] During the three months prior to the interview.
[e] During the 12 months prior to the interview.

and one of their parents completed the survey. From these children, 10,881 were 10 years old or more at the time of survey of whom 10,856 (99.8%) had data available on green spaces use, self-satisfaction, and social contacts that were included in our study. The description of study outcomes and sociodemographic characteristics of these participants are presented in Table 1. The median (IQR) of the total time spent in green spaces was 1.33 (1.75) hours per week.

3.2. Self-satisfaction

As presented in Table 2, longer time spent in green spaces was associated with enhanced self-satisfaction. Adding cluster as another random effect to the models or further adjustment of our analyses for school type, parental marital status, feeling comfortable to discuss problems with parents or older siblings did not change our findings notably (Data not shown). With regards to different types of green spaces, time spent in all green space types was positively associated with self-satisfaction and social contacts. The only exception was the time spent in forests/other natural green spaces that showed inverse association with self-satisfaction (Table 2). We did not observe any statistically significant interaction for urbanity, parental education, and sex or any notable variation in the direction and strengths of green spaces use and self-satisfaction associations across the strata of these factors (Table 3) However, for age, we observed a statistically significant interaction (interaction p-value < 0.01) with indications of stronger association for older adolescents.

3.3. Social contacts

More total time spent in green spaces as well as more time spent in each type of green spaces were associated with higher likelihood of having three to more close friends (Table 2). We also observed similar associations for spending time with friends after school at least once a week (Table 2). These findings were robust to adding cluster as another random effect to the models or further adjustment of our analyses for school type, parental marital status, feeling comfortable to discuss problems with parents or older siblings (Data now shown). As presented in Table 3, we observed indications for the modification of the association for the number of friends by parental education (interaction p-value < 0.01), sex (interaction p-value: 0.04), and age (interaction p-value: 0.02) and the association for the time spent with friends by urbanity (interaction p-value: 0.03), parental education (interaction p-value: 0.07), and age (interaction p-value: 0.06). We did not observe any consistent pattern across the strata of parental education for neither indicators of social contacts; however, the associations were slightly stronger for the adolescents with the most and the least educated parents (no or primary school education/university education) (Table 3). The association between time spent in green spaces and number of friends was stronger for boys compared to girls (Table 3). Moreover, the association between time spent in green spaces and time spent with friends was stronger for adolescents in rural areas (Table 3). Finally, we observed stronger associations for older adolescents for both outcomes (Table 3).

3.4. Mediation analyses

The two indicators of social contacts (i.e. number of friends and time spent with them after school) together could explain 59.9% (95% confidence intervals: 27.0%, 208.9%) of the association between green spaces use and self-satisfaction.

4. Discussion

To our knowledge, this study is the first to evaluate the association between contact with green spaces and self-satisfaction in children. It also adds to the very limited available evidence on the health effects of green spaces in low and middle-income countries, on the association of green spaces and social contacts in children, and on disentangling the health effects of different types of green spaces. We observed positive associations between time spent in green spaces and self-satisfaction and social contacts. We also observed some suggestions for the modification of the associations of social contacts by urbanity, SES, age, and sex. About half of the association between time spent in green spaces and self-satisfaction could be explained by improved social contacts.

Table 2

Adjusted[a] odds ratio (95% confidence intervals) of better self-satisfaction, having three or more close friends, and spending time with friends after school at least once a week associated with one interquartile range (IQR) increase in time spent in green spaces, in total and in each green space type.

Time spent in green spaces	IQR[b]	Self-satisfaction		Number of friends		Time spent with friends	
		Odds ratio (95% CIs)	p-value	Odds ratio (95% CIs)	p-value	Odds ratio (95% CIs)	p-value
Total	1.8	1.06 (1.01, 1.10)	< 0.01	1.13 (1.08,1.17)	< 0.01	1.26 (1.21,1.32)	< 0.01
Urban parks	2.3	1.07 (1.03, 1.12)	< 0.01	1.08 (1.03,1.12)	< 0.01	1.12 (1.07,1.17)	< 0.01
Forests	1.5	0.96 (0.93, 0.99)	< 0.01	1.12 (1.09,1.15)	< 0.01	1.15 (1.12,1.19)	< 0.01
Private gardens	3.3	1.13 (1.08, 1.19)	< 0.01	1.09 (1.04,1.14)	< 0.01	1.30 (1.24,1.37)	< 0.01

[a] Adjusted for age, sex, urbanity, parental educational attainment, employment, home ownership, household size, perceived stress from school homework, feelings towards school, experiencing bullying and having been injured.

[b] Hours per week.

Table 3

Adjusted[a] odds ratio (95% confidence intervals) of better self-satisfaction, having three or more close friends, and spending time with friends after school at least once a week associated with one interquartile range (IQR) increase in time spent in green spaces, stratified by urbanity, parental education, and sex.

	Self-satisfaction		Number of friends		Time spent with friends	
	OR (95% CIs)	Interaction p-value	OR (95% CIs)	Interaction p-value	OR (95% CIs)	Interaction p-value
Urbanity		0.39		0.59		0.03
Urban	1.07 (1.02, 1.13)*		1.14 (1.08, 1.19)		1.25 (1.19, 1.31)*	
Rural	1.04 (0.96, 1.12)		1.11 (1.03, 1.20)		1.32 (1.20, 1.44)*	
Parental education[b]		0.94		< 0.01		0.07
No or primary school	1.06 (0.98, 1.15)		1.27 (1.17, 1.37)*		1.38 (1.26, 1.50)*	
Secondary school	1.07 (1.01, 1.13)*		1.04 (0.99, 1.09)		1.23 (1.17, 1.30)*	
University	1.08 (0.97, 1.20)		1.24 (1.12, 1.38)*		1.30 (1.17, 1.45)*	
Sex		0.84		0.04		0.30
Female	1.06 (1.00, 1.12)		1.08 (1.03, 1.14)*		1.24 (1.17, 1.32)*	
Male	1.05 (0.99, 1.11)		1.17 (1.10, 1.23)*		1.27 (1.20, 1.35)*	
Age		< 0.01		0.02		0.06
≤14 years	1.02 (0.97, 1.08)		1.11 (1.05, 1.17)*		1.26 (1.19, 1.34)*	
> 14 years	1.14 (1.05, 1.24)*		1.19 (1.10, 1.28)*		1.37 (1.27, 1.50)*	

* p-value < 0.05

[a] Adjusted for age, sex, urbanity, parental educational attainment, employment, home ownership, household size, perceived stress from school homework, feelings towards school, experiencing bullying and having been injured.

[b] Highest educational attainment by either parent.

4.1. Interpretation of results in the context of available evidence

We are only aware of few studies on our investigated associations in adolescents; therefore, it is hard to compare our findings with those of others. However, our findings are consistent with a number of previous observations: Studies have suggested that contact with green spaces has beneficial impacts on mental health and well-being in adults (Gascon et al., 2015). A study of over 10,000 European adults showed that living in areas with more green spaces was associated with lower mental distress and higher life satisfaction (White et al., 2013). A limited body of evidence has also associated green spaces with improved self-discipline and better academic performance in children (Hodson and Sander, 2017; Sivarajah et al., 2018; Taylor et al., 2002; Wu et al., 2014). However, it should be noted that adolescents compared to adults and children spend more time in the vicinity of their house, therefore neighbourhood greenness may be more beneficial for mental health and well-being in adolescents (Roe et al., 2017).

A large cross-sectional study of more than 10,000 participants in the Netherlands revealed that less neighbourhood greenness was associated with weaker perceived social support and stronger feelings of loneliness; however, the study did not report estimates separately for adolescents (Maas et al., 2009a). Another study of 437 pupils from 10 to 17 years of age in Germany suggested that public urban green spaces may have an important role in social inclusion of adolescents (Seeland et al., 2009). Nevertheless, the mediatory role of social contacts in health benefits of green spaces was not investigated in this study (Seeland et al., 2009). Although De Vires et al. reported that in adults, social cohesion partly accounts for the relationship between greenness and mental health (De Vries et al., 2013), a recent study of 399 participants aged 15–25 in Bulgaria showed that social cohesion was not a significant mediator for mental health benefits of objectively measured green spaces in single and parallel mediation models (Dzhambov et al., 2018a). However, in the latter study adolescents and adults were not separated and they were considered as a single group.

The available studies comparing the health benefits of different types of green spaces are still very scarce (Richardson et al., 2017). For the associations with the number of friends, we did not observe any clear variation among different green spaces types; however, there were some suggestions for stronger associations for private gardens in relation with self-satisfaction and time spent with friends. This latter observation was in line with the findings of a recent longitudinal study of 2909 Scottish children showing that access to private gardens was more strongly related to improved mental health compared to access to natural spaces (Richardson et al., 2017). This could be due to the potential that parents may feel more secure to allow their children playing unsupervised in a private garden compared to forests and urban parks, which may lead to independent play and more beneficial nature exposure in private settings. We observed an inverse association between time spent in natural green spaces and self-satisfaction. We do not have any clear explanation for this counterintuitive finding which could be a chance finding, given its inconsistency with other findings of this study.

While for the association between green spaces use and self-satisfaction, we did not observe any indication of effect modification by the sex, socioeconomic status, and degree of urbanity, for social contacts, there were some indications for such modifications for the associations with indicators of social contacts. The body of evidence on

mental health benefit differences between both sexes is not consistent. Studies that show such variation differ on whether the associations are stronger for girls (Annerstedt et al., 2012; Roe et al., 2013) or boys (Astell-Burt et al., 2014; Currie et al., 2016; Markevych et al., 2014; Richardson et al., 2017), while some other are not supportive for this variation (Barton and Pretty, 2010; Ruijsbroek et al., 2017). Our findings were suggestive for stronger associations for indicators of social contacts for boys compared to girls. The reason could be that in this age group, Iranian boys might have more liberty to spend time with their friends outdoors and establish new relationships (Sadoughianzadeh, 2008). Socializing in urban green spaces independently of adults could increase the use of these places among adolescents. However, many of the Iranian girls who prefer to spend time with their friends in public green spaces are dependent on their families (Mahdiar and Dali, 2016). They often accompanied by at least one of their parents because of perceived safety concerns, which could lead to a restriction in the number and duration of social interactions (Mahdiar and Dali, 2016). The presence of drug addicts, homeless people and some undesirable groups of adolescents are suggested to spread a sense of insecurity in some parks, which could discourage girls from initiating social interactions with strangers (Mahdiar and Dali, 2016). These concerns are partly why the women-only parks were established in the recent decade in Iran.

The available evidence on variation of the health benefits of green spaces between urban and rural areas is also inconsistent (De Vries et al., 2003; Maas et al., 2009c, 2006; Markevych et al., 2014; Mitchell and Popham, 2007; Triguero-Mas et al., 2015). Our findings were suggestive for stronger associations between use of green spaces and time spent with friends for those residing in rural areas. A possible explanation could be that in rural areas of Iran, adolescents are less likely to have access to modern forms of indoor entertainment (e.g. videogames, computer games, internet, etc.) making them more prone to spend time outdoors with their friends. We also observed stronger associations between use of green spaces and social contacts in adolescents with the most and the least parental educational level. Our finding is consistent with a number of previous studies suggesting that people from lower SES groups are more likely to benefit from green spaces (Amoly et al., 2014; Dadvand et al., 2014; De Vries et al., 2003; Maas et al., 2009b; van den Berg et al., 2016; Zach et al., 2016). Similar to adolescents residing in rural areas, this pattern could be in part explained by the less access of adolescents from lower socioeconomic groups to indoor entertainment potentials, making them more likely to spend time outdoors with friends.

4.2. Potential mechanisms

We observed that social contacts could mediate the association between green spaces and self-satisfaction which was in line with findings of a number of previous studies:

A few studies showed that social cohesion was one of the key mediators of the association between green spaces and perceived general and mental health in adults (Dadvand et al., 2016a; De Vries et al., 2013; Maas et al., 2009a). However, a recent study did not support such a significant mediatory role for social contacts (Dzhambov et al., 2018a). This could be due to the fact that different approaches to testing social cohesion as a mediator could yield different conclusions (Dzhambov et al., 2018a). Dzhambov et al. also found that perceived measures of green spaces (i.e. time in green space) is associated with beneficial effects on mental health through increased restorative quality of the living environment as well as increased physical activity (Dzhambov et al., 2018b). Moreover, increased social interactions could improve the sense of respect and perceived safety that in turn could result in increased green space use for different purposes such as physical activity (Lee and Maheswaran, 2011; Markevych et al., 2017). Another possible mechanism could be that strong social cohesion could predict better work performance in adults as well as academic performance in children (Hodson and Sander, 2017; Weinstein et al., 2015), which ultimately could lead to improved self-satisfaction.

4.3. Strengths and limitations

One of the major strengths of this study was the large national representative sample of adolescents. Focusing on adolescents who one of the understudied age groups with regard to health benefits of green spaces and the selection of self-satisfaction, which is a novel outcome, could be the other strengths. Moreover, this study adds to the limited available body of evidence on the health benefits of green spaces in low and middle-income countries.

Our study, given its cross-sectional design, had a limited capability for establishing a causal relationship, given that it could not rule out reverse causation or establish the precedence of the exposure to the outcome. Moreover, because of this cross-sectional design and limitation in our available data, we were not able to more sophisticated mediation analytical approaches. Also, we did not have data on some potentially important mediators such as physical activity which could work together with social contacts and should have been included in our mediation analyses. Therefore, the results of our mediation analyses should be interpreted with caution. The generalizability of our findings might have been affected by selection bias in sampling only students, overlooking those who did not go to school. Also, given that we collected data retrospectively, our results might have been influenced by recall bias. Furthermore, our characterization of self-satisfaction was crude and could have resulted in outcome misclassification. Ideally, the studies of the health effects of green spaces should be controlled for indicators of SES at both household and neighbourhood levels to minimize the likelihood of residual SES confounding (Markevych et al., 2017). We did not have access to indicators of neighbourhood SES; however, our findings were robust to adjustment for a wide range of household SES indicators. Moreover, we did not have data on puberty to evaluate its influence on our investigated associations. Another main limitation of this study was the lack of objective greenspace data.

5. Conclusions

We found that longer time spent in green spaces, was associated with enhanced self-satisfaction and improved social contacts in a population-based sample of Iranian adolescents. We also observed that the association between time spent in green spaces and self-satisfaction can be mediated by improved social contacts. Our findings, if established by future studies, could offer policymakers a practical mitigating measure to improve mental wellbeing of adolescents. Further studies are required to replicate our findings in other populations with different climates, cultures, and lifestyles.

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Conflict of interest

None.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envres.2018.09.033.

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