

## Abstract

**Background:** Loneliness during adolescence is a growing public health concern associated with adverse mental and physical health outcomes. While exposure to greenspace has been identified as a potential environmental determinant of social wellbeing, evidence of its putative impact on adolescent loneliness remains limited. This study investigated the prospective association between childhood greenspace exposure (age 5 months-10 years) and loneliness in early adolescence (ages 10-13), accounting for a range of confounding factors, and explored effect modification by sex and family socio-economic status. **Methods:** Data were drawn from the Quebec Longitudinal Study of Child Development (n = 1481), a population-based prospective cohort of individuals born in 1997/98 in the Canadian province of Quebec. Average residential greenspace exposure from 5 months to 10 years was measured using annual mean Normalized Difference Vegetation Index (NDVI) across buffer zones around residential postal codes (100m, 250m, 500m, 1000m) and values were expressed in interquartile units. Loneliness was assessed at ages 10, 12, and 13 using the UCLA Three-Item Loneliness Scale. A two-part hurdle model with a random intercept examined associations between greenspace and (1) presence of any loneliness and (2) severity of loneliness among those with non-zero scores. Models adjusted for sex, proportion of years in the study period lived in an urban area, family socioeconomic status, and neighborhood social/material deprivation. **Results:** Part 1 of the fully adjusted hurdle model showed that greenspace exposure was not associated with presence or absence of loneliness in early adolescence. In Part 2 of the fully adjusted model among early adolescents reporting loneliness, higher greenspace exposure was linked to lower severity of loneliness at 100m and 250m buffer distances (at 250m, mean ratio (MR): 0.95, 95% CI: 0.91, 1.00), but no association was found at 500m or 1000m buffers. Testing for effect modification revealed that neither sex or

family SES moderated the relationship between childhood greenspace exposure and early adolescent loneliness. **Conclusions:** Childhood greenspace may buffer the severity of loneliness in early adolescence. Future research should explore mechanistic pathways of the putative effect of greenspace on loneliness and social connection and the integration of greenspace into broader strategies to support adolescent mental health.