Associations of only-child status with health outcomes and risky behaviors in Korean middle- and high-school students: An outcome-wide analysis

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ABSTRACT

The proportion of children who are the only child in the family are increasing. Several associations between only-child status and health outcomes or risky behaviors have been identified, but no study has explored associations across a wide range of outcomes in a single study. We used the 2019 Korea Youth Risk Behavior Survey, a nationwide cross-sectional survey of 57,303 middle and high school students, to perform an outcome-wide analysis on six health outcomes and risky behaviors, i.e. alcohol use, asthma, body mass index, sexual activity, smoking, and suicide attempt. Individual multivariable logistic regression models examined associations between single-child status and each outcome or behavior. Of the eligible 38,211 students, 5,334 students (14.0 %) were the only child in their family, while 32,877 students (86.0 %) had siblings. Of the six selected outcomes and behaviors, alcohol use (aOR 0.88, 95 % CI 0.82–0.94), asthma (aOR 1.22, 95 % CI 1.10–1.35) and sexual activity (aOR 1.16, 95 % CI 1.02–1.31) were significantly associated with only-child status. Thus, being the only child among South Korean adolescents is both a potential protective factor and risk factor for different health outcomes and behaviors. Future research is warranted to corroborate these findings and identify mechanisms, which could provide evidence for reducing adverse outcomes and behaviors in adolescents.

1. Introduction

Only child refers to children who have no siblings. The proportion of families having only one child is increasing; for example, in the United States, the number of women giving birth to only one child has doubled from 11 % to 22 % between 1976 and 2014 (Parker and Horowitz, 2015). Many researchers have explored whether being an only child affects a child's health outcomes, such as obesity, hypertension, and depression (Deng et al., 2022).

South Korea in particular has experienced a dramatic decrease in its birth rate over the past 20 years, and currently has the lowest birth rate in the world. Accordingly, the number of single-child families in South Korea are on the rise; in 2020, 24.9 % of married women aged 40 to 49 had only one child, compared to 9.5 % of married women aged 60 or older (Statistics Korea, 2020). However to our knowledge, the association between only-child status and health outcomes has not been explored in South Korea.

Given the increasing prevalence of only-child status in South Korea and other parts of the world, it is important to identify which health outcomes are associated with being an only child. Since being an only child can impact a wide range of outcomes that could be either beneficial or harmful, an outcome-wide analysis can provide evidence for more nuanced public health recommendations for each outcome

(VanderWeele, 2017). Also, outcome-wide analyses are subject to less bias compared to exposure-wide analyses, in which an exposure can mediate the effects of other exposures (VanderWeele, 2017), Thus, we performed an outcome-wide analysis of the association between only-child status and various health outcomes in South Korean middle and high school students.

2. Methods

2.1. Study population and data collection

Korea Youth Risk Behavior Survey (KYRBS) is a web-based cross-sectional survey conducted by the Korean Center for Disease Control (KCDC) that assesses health outcomes and health-risk behaviors of middle- and high-school students in South Korea. (Kim et al., 2016) It uses a multi-stage cluster sampling design to capture a nationally representative sample of students. In June and July of each year, students from one classroom per grade are selected to complete an online anonymous survey that lasts around 40 min at the school's computer laboratory. We used the data from the 2019 survey in which 57,303 students out of 60,100 eligible students (95.3 %) participated. Of these students, 38,211 students provided information regarding family members, including sibling status; this subpopulation was used for our

final analysis. The survey was approved by the KCDC Institutional Review Board. As the KYRBS is a publicly available anonymized database, it was exempt from ethical compliance.

2.2. Study population sociodemographic covariates

The following covariates were included in this analysis: sex (male vs female), age (years), and city size (metropolitan city vs city vs county). For socioeconomic status, or SES, students were asked for their subjective household economic status (high vs middle-high vs middle vs middle-low vs low). For stress, students were asked how stressed they are usually (extremely vs quite vs little vs hardly vs not at all). For feeling of despair or sadness, students were asked whether in the past 12 months, they had felt feeling of despair or sadness that would halt their daily activities for 2 weeks (yes vs no). For violence, students were asked in the past 12 months, how many times they had been treated at a hospital for violence (physical assault, blackmail, bullying) from friends, school seniors, or adults; if they responded at least once, they were categorized as a victim of violence. If a student had ever had at least one drink of alcohol (except during ancestral rites or religious ceremonies), he or she was classified as an ever drinker. Also, a binary variable was created to determine whether students were living with both biological parents or not, as this can influence health outcomes (Weitoft et al., 2003).

2.3. Exposure assessment

Students who consented to provide family information were asked who composed their household (even those currently not living with the student). Students who did not indicate that their household included a brother or a sister were categorized as an "only child", and the rest were categorized in the "sibling" group.

2.4. Outcome assessment

We selected six variables as outcomes: alcohol use, asthma, body mass index (BMI), sexual activity, smoking, and suicide attempt. These outcomes were selected based on their high burden of disease during teenage years and beyond, as well as data availability (Gore et al., 2011). Sexual activity was also included given the South Korean context, as its culture is conservative and stigmatizing towards sexual activity among adolescents, which could in turn be associated with worse mental health outcomes and hesitancy to seek medical care related to sexual activity (Kim, 2016). For alcohol use, students were asked "have you ever had a drink of alcohol (except for traditional or religious ceremonies)?" and replied either "yes" or "no." For asthma, students were asked "have you ever been diagnosed with asthma by a physician?" and replied either "yes" or "no". BMI was a continuous variable that was calculated using the height and weight reported by each student. For sexual activity, students were asked "have you ever had sexual intercourse?" and replied either "yes" or "no." For smoking, students were asked "have you ever smoked one or two puffs from a cigarette?" and replied either "yes" or "no." For suicide attempt, students were asked "have you attempted suicide in the past 12 months?" and replied either "yes" or "no.".

For each outcome, individual models were created to adjust for potential confounders. All six models were adjusted for SES, since SES is associated with the number of children in a family and also is a predictor of diverse health outcomes (Levesque et al., 2021). All six models were also adjusted for living with both biological parents, as we found in our exploratory analysis that only children were much more likely to not live with both biological parents, and this can impact diverse health outcomes (Crosnoe et al., 2014). In addition to these common confounders, alcohol use was adjusted for smoking, asthma was adjusted for sex (Yung et al., 2018) and residence (Wong and Chow, 2008), BMI adjusted for age, sex, and physical activity (Chung et al., 2012), sexual activity adjusted for residence (Guo et al., 2012), smoking adjusted for alcohol

use (Koopmans et al., 1997), and suicide attempt adjusted for feelings of sadness/despair (Lewinsohn et al., 1994), victim of violence (Waldrop et al., Oct 2007), and stress (Kim et al., 2015).

2.5. Data analysis

All statistical analysis was performed on R version 1.4.1106. The "survey" package was used to perform the weighted survey analysis; the variables for stratification, clustering, and weighting were provided in the KYRBS dataset. (Lumley, 2020) Bivariate analysis between only-child status and other characteristics or confounders included in the study was done to calculate measures of association; odds ratio was calculated for binary, nominal, or ordinal variables, and beta-coefficient was calculated for continuous variables. Multivariate logistic regressions were performed to explore the associations between only-child status and six outcomes, i.e. alcohol use, asthma, BMI, sexual activity, smoking, and suicide attempt, adjusting for different confounders for each outcome model. To account for potential unmeasured confounders, we performed sensitivity analyses by calculating the E-value for adjusted ORs as was previously done in a weighted sample survey; E-value is the minimum strength of association that an unmeasured confounder needs to have with both exposure and outcome to fully explain away the association between exposure and outcome (VanderWeele and Ding, 2017; Lian et al., 2021). A P-value of 0.05 was used to indicate statistical significance.

3. Results

Of the 57,303 participants in the study, 38,211 (66.7 %) students consented to provide information regarding family members and was eligible for our study (Supplementary Table 1). Of this study population, 20,193 (52.8 %) were female, and 17,187 (44.8 %) were high school students (Table 1). 5,334 students (14.0 %) responded that they were an only child, while 32,877 students (86.0 %) said they had siblings. There were significant differences between children with and without siblings for covariates such as residence, subjective SES, victim of violence, and living with both biological parents. Higher proportion of only children lived in metropolitan cities compared to children with siblings (46.7 % vs 41.6 %), while the opposite was true for smaller cities (48.6 % vs 52.5 %). Proportions of only children and children with siblings differed for high (12.2 % vs 10.7 %), middle (44.1 % vs 47.7 %), middle-low (12.8 % vs 10.2 %), and low (2.7 % vs 1.9 %) SES, but there was no clear trend. 3.1 % of only children were victims of violence compared to 1.6 % of children with siblings. Only 69.3 % of only children lived with both biological parents compared to 86.5 % of children with siblings. Table 2 shows the results of bivariate analyses between only-child status and all other variables included in the current study.

After adjusting for confounders, asthma (aOR 1.22, 95 % CI 1,10–1.35) and sexual activity (aOR 1.16, 95 % CI 1.02–1.31) were positively associated with only-child status, while alcohol (OR 0.88, 95 % CI 0.82–0.94) was negative associated (Table 3). Suicide attempt approached borderline significance (aOR 1.18, 95 % CI 1.00–1.39), while BMI (aOR 1.08, 95 % CI 0.98–1.20) and smoking (aOR 1.07, 95 % CI 0.97–1.18) were not significantly associated with only-child status. On sensitivity analysis, the E-value for alcohol, asthma and sexual activity were 0.94, 1.74 and 1.59, respectively.

4. Discussion

This is the first outcome-wide analysis of the associations between only-child status and health outcomes or behaviors among Korean teenagers. After adjusting for confounders, only alcohol use, asthma and sexual activity were statistically significant, and suicide attempt approached borderline significance. While the association between only-child status and asthma has been observed in previous studies, that between only-child status and alcohol use or sexual activity is a novel

Table 1
Baseline characteristics of study population.

Characteristic	N or mean (percentage)		
	Have sibling (N = 32877)	Only child (N = 5334)	P-value
Female sex	17,599 (53.8)	2634 (49.7)	
Age (years)	14.9	14.9	
Residence			
Metropolitan city	14,186 (41.6)	2551 (46.7)	<0.05
City	15,951 (52.5)	2412 (48.6)	<0.05
County	2740 (5.9)	371 (4.8)	
Height (cm)	164.7	165.1	
Weight (kg)	58.1	58.9	
Physical activity (days)			
0	11,621 (36.2)	1864 (35.4)	
1	5025 (15.4)	814 (15.3)	
2	4944 (15.1)	777 (14.7)	
3	4233 (12.7)	709 (13.4)	
4	2195 (6.5)	371 (6.9)	
5	2092 (6.2)	342 (6.2)	
6	775 (2.2)	111 (1.8)	
7	1992 (5.7)	346 (6.4)	
Subjective socioeconomic status			
High	3499 (10.7)	652 (12.2)	<0.05
Middle-high	9557 (29.5)	1502 (28.2)	
Middle	15,727 (47.7)	2347 (44.1)	<0.05
Middle-low	3440 (10.2)	685 (12.8)	<0.05
Low	654 (1.9)	148 (2.7)	<0.05
Subjective stress			
Extremely	3731 (11.3)	676 (12.3)	
Quite	9459 (28.9)	1487 (28.4)	
Little	13,465 (41.1)	2159 (40.5)	
Hardly	5119 (15.4)	797 (14.8)	
Not at all	1103 (3.2)	215 (3.9)	
Feeling of sadness or despair	9291 (28.5)	1563 (29.1)	
Victim of violence	554 (1.6)	161 (3.1)	<0.05
Living with both biological parents	28,183 (86.5)	3620 (69.3)	<0.05

Table 2
Bivariate analysis between only-child status and other variables.

Characteristics/confounders	Variable type	Measure of association	Effect size	95 % CI
Female sex	Binary	Odds ratio	0.85	0.80–0.90
Age (years)	Continuous	β-coefficient	−0.02	−0.08–0.04
Residence	Nominal	Odds ratio		
Metropolitan city vs city			0.82	0.78–0.88
Metropolitan city vs county			0.72	0.62–0.84
Height (cm)	Continuous	β-coefficient	0.37	0.11–0.63
Weight (kg)	Continuous	β-coefficient	0.72	0.33–1.12
Physical activity (days)	Ordinal	Odds ratio		
0 vs 1			1.02	0.93–1.12
0 vs 2			0.99	0.90–1.09
0 vs 3			1.07	0.97–1.18
0 vs 4			1.08	0.95–1.22
0 vs 5			1.02	0.89–1.17
0 vs 6			0.83	0.67–1.02
0 vs 7			1.14	1.00–1.30
Subjective socioeconomic status	Ordinal	Odds ratio		
High vs Middle-high			0.84	0.76–0.92
High vs Middle			0.81	0.74–0.89
High vs Middle-low			1.09	0.97–1.22
High vs Low			1.23	1.01–1.50
Subjective stress	Ordinal	Odds ratio		
Not at all vs Hardly			0.78	0.66–0.92
Not at all vs Little			0.80	0.69–0.92
Not at all vs Quite			0.80	0.68–0.94
Not at all vs Extremely			0.88	0.74–1.04
Living with both biological parents	Binary	Odds ratio	0.35	0.33–0.37

Table 3
Logistic regression for only child status and six outcomes or behaviors.

Outcomes or behaviors	Unadjusted OR (95 % CI)	Adjusted OR (95 % CI) [a]
Alcohol use	0.97 (0.92–1.03)	0.88 (0.82–0.94)
Asthma	1.25 (1.13–1.38)	1.22 (1.10–1.35)
Body mass index	1.16 (1.05–1.30)	1.08 (0.98–1.20)
Sexual activity	1.37 (1.21–1.54)	1.16 (1.02–1.31)
Smoking	1.13 (1.03–1.23)	1.07 (0.97–1.18)
Suicide attempt	1.34 (1.15–1.56)	1.18 (1.00–1.39)

[a] All six outcomes or behaviors were adjusted for socioeconomic status and living with both biological parents. In addition, each outcome was adjusted for the following variables:
Alcohol use: smoking
Asthma: sex, residence
BMI: age, sex, physical activity
Sexual activity: residence
Smoking: alcohol use
Suicide attempt: feelings of sadness/despair, victim of violence, stress
CI: confidence interval; OR: odds ratio

finding.

We hypothesize that the association between only-child status and various outcomes or behaviors could each be explained by different mechanisms. For instance, biological mechanisms (hygiene hypothesis, in utero programming, endocrine effects, etc.) were put forward by previous studies to explain the increased prevalence of asthma in only-children (Karmaus and Botezan, 2002). However, health outcomes can be influenced by parental behaviors as well; families with only one child may have different healthcare seeking behaviors compared to families with multiple children resulting in variations in disease diagnosis and management (Almqvist et al., 2016). This highlights the complex pathways by which being an only child can impact health outcome measures.

Given such complex mechanisms, there is a likelihood that associations identified in our analysis is confounded by unmeasured variables. Our sensitivity analyses using E-values provide a sense of how likely this is. For example, second-hand smoking could be an unmeasured confounder between only child status and asthma. The E-value for this association was 1.74, compared to the OR of 1.24 between second-hand smoke and asthma reported in a *meta*-analysis. This suggests that second hand smoke would not fully explain away the association between only-child status and asthma reported in our analysis (He et al., 2020).

We identified that only children were much less likely to live with both biological parents than children with siblings. We hypothesized that this is because parents who undergo divorce early in their marriage will have done so before they have time to have a second child. Children whose parents have divorced experience significant increases in morbidity and mortality, which can be explained by stress from family conflict, inconsistent parental oversight, and economic distress (Weitoft et al., 2003). Thus, we believe that living with both biological parents

could confound the association between only-child status and outcomes or behaviors, and adjusted for this in all of our six models. Future studies are warranted to explore the importance of living with both parents when studying the relationship between only-child status and health outcomes.

Sexual activity during adolescence, despite being very prevalent in high-income countries, is concerning for its association with adverse health outcomes and behaviors, such as suicide attempt (Hallfors et al., 2004). Our research findings suggest that being an only child could be a risk factor for sexual activity during adolescence. This is an unexpected finding since, assuming that single children would be subject to increased parental monitoring, previous studies suggest that increased monitoring leads to delayed sexual initiation (Huang et al., 2011). Other

unmeasured factors, such as parental values towards sexual activity and teenagers' popularity self-concept, could influence sexual initiation during adolescence (Manning et al., 2005).

Being the only child is protective of alcohol use. This is in contrast to sexual activity, for which being an only child was shown to be a risk factor. This adds a layer a complexity to understanding the association between only-child status and risk behaviors, since it was traditionally thought that risk behaviors such as sexual activity and alcohol use were strongly correlated (Fergusson and Lynskey, 1996). Our results challenge the traditional notion of clustering adolescent risk behaviors together, and highlight the need for identifying risk factors that are not common to sexual activity and alcohol use.

We did not find significant associations for suicide attempt, BMI, and smoking. However, we found that the direction of all these associations except for alcohol use was positive, suggesting that being an only-child could be more often a risk factor for health outcomes rather than a protective one. Future studies with bigger sample sizes may discover significant associations among these outcomes. Indeed, suicide attempt had a bigger effect size than sexual activity in our study, suggesting that statistical significance was not achieved for suicide attempt due to small sample size of attempted suicide.

Our research provides unresolved questions for future research. For instance, is birth order important when studying children with siblings? Future research could make more nuanced comparisons between only-children and children with either older or younger siblings. Also, while we have showed that only-child status and alcohol use or sexual activity in adolescence is associated for the first time, the mechanism by which this occurs is not known, and remains an important topic for future research.

Our study has several limitations. This is a cross-sectional survey and thus it is difficult to infer causality between being an only child and health outcomes. The study population did not include the full cohort of students who participated in the KYRBS, since some students did not consent to providing information on sibling status; thus, there is selection bias against students who are not comfortable with sharing information. Lastly, the 2019 KYRBS did not collect information on potential mediators and effect modifiers, such as internet use and bullying.

In conclusion, this study explored the relationship between being an only child with various health outcomes or risk behaviors. We identified alcohol use, asthma and sexual activity to have statistically significant associations with only-child status – future research on only-child status with bigger and more diverse populations could validate these findings and provide evidence for enacting public health interventions that could reduce adverse outcomes and behaviors in adolescents.

CRediT authorship contribution statement

Jewel Park: Conceptualization, Data curation, Formal analysis, Investigation, Project administration, Software, Validation, Visualization, Writing – original draft. **Aruna Chandran:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.102101.

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