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## Adolescents' multiple and individual risk behaviors: Examining the link with excessive sugar consumption across 26 industrialized countries

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### ABSTRACT

**Rationale:** Despite the public health importance and policy relevance, no cross-national studies using large representative samples of adolescents have examined the relationship between high sugar consumption and involvement in risk behaviors.

**Objective:** The current study examines the relationship between high sugar consumption, in the form of sweets and chocolates and non-diet soft drinks, and involvement in peer violence and substance use. It also examines whether any such relationship is moderated by low socio-economic status (SES) and psychological well-being.

**Method:** The study included representative samples of 11-, 13- and 15-year olds in 26 countries ( $N = 137,284$ ) using data from the Health Behaviors in School Aged Children (HBSC) 2013-14 study. The analysis involved multivariate logistic regression to predict involvement in both individual risk behaviors (physical fighting, bullying, cigarette use, alcohol use, and drunkenness) and multiple risk.

**Results:** This study showed strong and consistent relationships between high sugar consumption and multiple and individual risk behaviors across 26 countries. With the exception of few countries, this relationship did not vary by family SES and adolescents' psychological health measured through psychosomatic health and life satisfaction, which had strong independent associations with multiple and individual risk behaviors. In the majority of countries, the association between high sugar consumption and multiple risk behavior was driven to a greater extent by the sugary drinks rather than sweets.

**Conclusions:** Findings suggest that unhealthy nutrition such as the intake of large quantities of sugary drinks and sweets and chocolates could be seen as a "red flag" signaling potential involvement in multiple risk behaviors.

### 1. Introduction

In a pivotal research study in Boston, among 2725 students, frequent consumers of non-diet soft drinks reported being more likely to have carried a gun or a knife, and to have been violent with a sibling, person they were dating, or another young person than those who did not frequently drink soft drinks (Solnick and Hemenway, 2012). Yet, there are no large cross-country studies using representative samples of adolescents to examine the relationship between sugar intake and risk behaviors. Balanced nutrition is very important during all developmental stages of childhood, which is a period of vigorous growth, increased activity, and development of body functions and social cognitive ability (Benton, 2010); hence, an understanding of the correlates of high sugar consumption is an issue of public concern. The current study examined the relationship between high sugar consumption and involvement in substance use and violence among representative samples

of adolescents in 26 countries. The aim of this study was to map and understand a general pattern and consistency of this relationship across diverse contexts. This aim stems from the understanding that a more holistic perspective examining the interconnectedness between young peoples' physical health (i.e., nutrition) and behavioral tendencies can enable a more comprehensive understanding of young peoples' health; it can also promote richer interventions to address the multiple facets of young peoples' lives. In addition, building on evidence showing increased health risks of adolescents from less affluent families and overlapping vulnerabilities in poor health outcomes (Chzhen et al., 2018a), this study also examines whether low levels of socio-economic status (SES) and low psychological well-being may strengthen the relationship between sugar consumption and risk behaviors.

Research in the area of sugar consumption has focused on the impact of consumption of sugar-sweetened beverages ('non-diet soft drinks') as a proxy for sugar, in particular on the relationship between

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soft drink consumption and weight (Apovian, 2004). Among the few empirical studies examining risk behaviors, research among 5498 adolescents in Norway found high levels of soft drink consumption were related to higher levels of conduct problems, hyperactivity and mental distress (Lien et al., 2006). Similarly, soft drink consumption was associated with being involved in a physical fight, having suicidal thoughts (Solnick and Hemenway, 2014), lowered physical activity and current cigarette use (Park et al., 2012), peer violence (Park et al., 2013), and alcohol, cigarette, and drug use (Terry-McElrath et al., 2014). However, studies have also negated a relationship between sugar intake and aggression (Benton, 2007) and between sugar intake and children's cognitive and behavioral functioning (Wolraich et al., 1995).

Current understandings of the mechanism explaining the relationship between sugar consumption and risk behaviors are limited (Solnick and Hemenway, 2012). Consumption of energy drinks has been strongly related to marijuana use, sexual risk taking, fighting, smoking, and alcohol use (Miller, 2008); yet, energy drinks are notable for their high caffeine levels and other additives as well as sugar. It has also been suggested that mechanisms such as low blood sugar levels (hypoglycemia) (Benton, 2007), hyperactivity (Lien et al., 2006), or neurodevelopmental changes in mesolimbic regions following sugar intake among adolescents (Galvan, 2013) may explain the relationship between sugar consumption and risk behaviors. However, to date, the scarce empirical studies have tended to be single country studies and have focused on sugary beverages alone, many of which contain multiple ingredients.

In addition to examining the relationship between sugar intake and risk behaviors through a cross-national perspective, the current study investigates if this relationship is stronger for adolescents who report low psychosocial status (low family affluence and low psychological well-being). The importance of socio-economic drivers of adolescents' health behavior has been well established in the literature. Lower socio-economic position tends to be associated with poorer health status (Marmot, 2013). Socio-economic inequalities in health and well-being start at an early age and can already be observed among children and adolescents (Currie et al., 2012). Increased sugar intake and lower nutrition may reflect poorer socio-economic conditions (Hackman et al., 2010; Martin et al., 2015), with less access to (more expensive) "healthy foods." Socio-economic status is an important predictor of involvement in alcohol use (Goodman and Huang, 2002) and peer violence (Pickett et al., 2013). On a theoretical level, Wilkinson (1997) explained the relationship between lower SES and health disadvantage not only as a physiological effect of lower material standards but primarily as a result of direct and indirect psychosocial effects of stratification, in which a lower social position manifests in feelings of inferiority and insecurity (Elgar et al., 2016).

Unhealthy eating in general has consistently been found to be related to lower mental health among adolescents (O-Neil et al., 2014). Limited research specifically examining the relationship between sugar consumption and psychological well-being has found associations between sugar consumption and depression (Westover and Marangell, 2002) and ADHD (Johnson et al., 2011), but these associations were contested in a review from 1995 to 2006 (Ruxton et al., 2009). The relationship between sugar consumption and psychological well-being can be explained by poor eating habits as reflecting avoidant coping with negative emotions (Martyn-Nemeth et al., 2009). Low psychological well-being is related to involvement in risk behaviors in adolescents in what can be seen as a process of externalization ("acting out") (Overbeek et al., 2005) or "self-medication" (Virtanen et al., 2015) of psychological distress. Depressive symptoms are related to increased alcohol use and earlier onset of substance use (McCarty et al., 2012) among adolescents. In addition, adolescents involved in peer violence (bullying and physical fighting) exhibit lower psychological well-being and higher depressive, anxiety, and psychosomatic symptoms (Brooks et al., 2002). While the relationships between SES and psychological

well-being and risk behaviors have been examined in the literature, in the current study we also go a step further to examine whether these psychosocial variables may moderate the relationship between sugar intake and psychological well-being. Recent cross-national evidence on multiple overlapping deprivation among adolescent youth (Chzhen et al., 2018a) has suggested a particular vulnerability for children who are at low levels of SES, psychological well-being, and physical health. As such, we anticipated that for children with low SES and psychological well-being there would be a stronger relationship between excess sugar intake and involvement in risk behaviors. This is a first examination, through analysis of the moderation role of SES and psychological well-being, which could potentially point to a more targeted and multidimensional approach in policy responses.

The current study is a unique opportunity to explore the relationship between sugar intake, in the form of not only soft drinks but also sweets and chocolates, and the relationship with individual and multiple behavioral risks among adolescents. Multiple (as opposed to individual) risk may represent a level of exposure to different types of risk behaviors and may characterize the group of vulnerable young people at the highest risk for negative health outcomes (Harel-Fisch et al., 2012), who can be targeted by policy interventions. Adolescence is a critical developmental period (Erikson, 1968). Despite the importance of the family in the development of eating habits (Hammons and Fiese, 2011), the increased relevance of peer relationships, the lessening of parental influence, and the rise of independent decision making (Brown et al., 1993; Steinberg et al., 1994), mean that adolescents may be, for the first time, making their own choices around food consumption. Given the awareness of trajectories of health habits from adolescence to adulthood (Niemeier et al., 2006; Oesterle et al., 2004), understanding sugar consumption and its correlates at this age is important.

### 1.1. The present study

The current study examined the relationship between sugar consumption and peer violence and substance use. Moreover, it is a first study to examine whether this relationship may be moderated by the socio-economic status of the young person and/or his or her psychological well-being. As such the current study seeks to extend current knowledge in two ways: 1) to investigate in large representative samples of adolescents across diverse countries the relationship between high sugar consumption and involvement in substance use and peer violence; and 2) to examine whether the relationship between high sugar intake and adolescents' risk behavior is strengthened by low socio-economic status and psychological well-being. The main hypotheses of this paper are that high sugar consumption will be associated with both individual and multiple risk behaviors, and this relationship will be (partially) moderated by low socio-economic status and lower psychological well-being.

## 2. Method

### 2.1. Sample

This paper used 2013/2014 data from the Health Behavior in School-aged Children (HBSC) survey, a school-based survey focusing on adolescent health behaviors and their underlying determinants. The HBSC study includes nationally representative samples of school children aged 11, 13 and 15 and is carried out in over 40 participating countries in Europe and North America every four years using an international standardized methodological protocol (Currie et al., 2014). The questionnaires undergo an internationally supervised translation-back-translation process into national languages to ensure cross-country comparison and comprehensive validity studies ensure the cross-cultural applicability of measures. The sampling method is based on schools as the sampling unit: All students belonging to a sampled classroom are included. To ensure robustness and consistency of results,

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