Water Consumption and Its Association with Suicide Attempts in Adolescents: A Multi-Model Analysis

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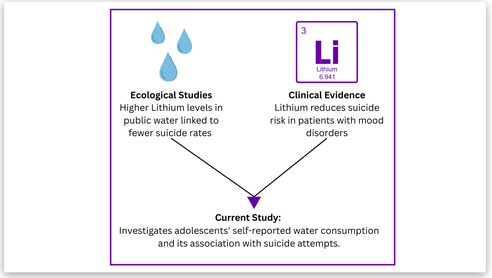
Introduction

Adolescent suicide attempts (SAs) remain a serious public health concern, with nearly **9%** of U.S. adolescents reporting a SA in the past year (**YRBSS, 2023**). Research has traditionally emphasized **individual-level risk factors** like trauma, substance use, and psychological symptoms (**Franklin et al., 2017; Bae et al., 2005; Baiden et al., 2020; Lee et al., 2021**), potentially overlooking **environmental influences**.

Ecological studies suggest that **higher lithium levels in public water** are linked to **lower suicide rates** (**Memon et al., 2020; Eyre-Watt et al., 2022; Liaugaudaite et al., 2017; Kugimiya et al., 2020**). Clinically, lithium is known to **reduce suicide risk** among patients with mood disorders (**Cipriani et al., 2017; Tondo et al., 2021**). Building on this evidence, our study **explores whether adolescents' self-reported water consumption is associated with suicide attempts**, using nationally representative data from the **2017, 2019, and 2021 YRBSS**.



Methods

- Data from the **2017, 2019, and 2021 YRBSS** were used.
- **Missing data** was assessed and determined to be **missing at random (MAR)**; therefore, **multiple imputation** methods were applied: **Polyreg** and **logreg** were used for categorical and binary variables, respectively. A total of **40 datasets** were imputed.

Additionally, **downsampling** was applied to the training set to address class imbalance in SAs, given that 11% of participants reported a suicide attempt. This technique reduced the number of majority class cases to better balance the data and improve model performance.

Finally,**five-fold cross-validation** was used to tune each model's penalty parameter.
All models were created in **R** using the **tidymodels** package.

Modeling Approach: We used Least Absolute Shrinkage and Selection Operator (LASSO) regression to identify predictors of SAs. Six domain-specific models were created based on established risk factors (see below), and a full model included all available predictors. All models adjusted for demographics (sex, race, grade, sexual orientation, Hispanic/Latino identity, and survey year) and included **self-reported water consumption** as the **outcome variable**.

- **Model Categories:**
  - Substance Use (12 variables)
  - Trauma & Victimization (7 variables)
  - Dietary Habits (11 variables)
  - Physical Activity & Sleep (7 variables)
  - Psychological Symptoms (5 variables)
  - Risk Behaviors (7 variables)
- Full Model: included all available predictors after preprocessing.

Results

Figure 1 presents the **penalized odds ratios** from the **domain-specific LASSO models** using **suicide attempts as the outcome**. All models were **adjusted for demographic** covariates.

The **x-axis** represents the penalized odds ratios, and the **y-axis** lists the retained predictors. The red indicator highlights the position of low water consumption among the selected predictors in each model**.

* Self-reported **low water consumption** was **retained as a predictor** of SAs **across ALL domain-specific LASSO models**

Figure 1. Domain-Specific LASSO Models Predicting Suicide Attempts: Pooled Odds Ratios

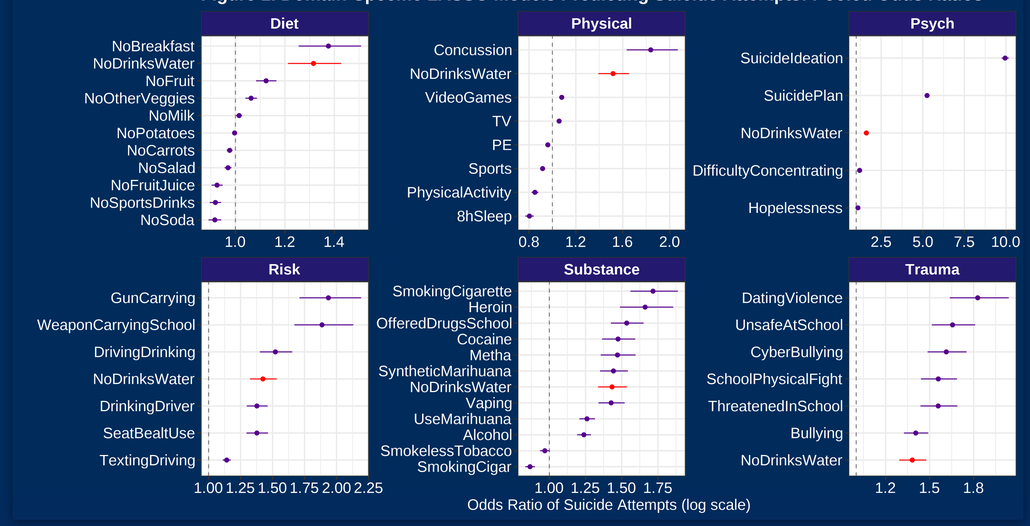


Figure 2 presents the **odds ratio estimates** for **low water consumption** across each of the multiply imputed datasets for all domain-specific models.

* In **all models** the median odds ratio for **low water consumption was greater than 1**, indicating consistent **retention as a predictor**.

* Only the **psychological model retained low water consumption** in all imputations **without elimination**.

Figure 2. Odds Ratios for Water-Related Terms Across Imputations

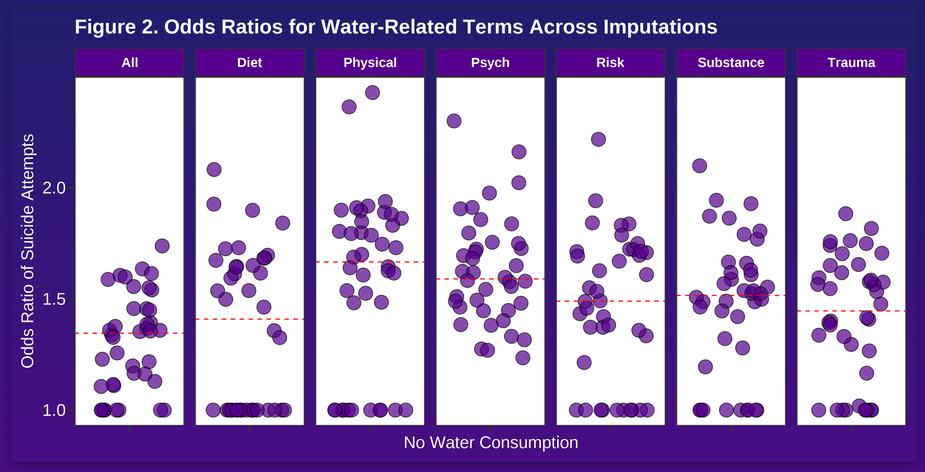


Table 1 presents the demographic characteristics of adolescents who reported SAs (n = 36,779).

Table 1, Sample Characteristics by Suicide Attempt (n=36,779)

	Yes N = 3,657[1]
Year	
2017	837 (7.8%)
2019	1,067 (10%)
2021	**1,753 (11%)**
Sex	
Female	**2,295 (12%)**
Male	1,255 (7.0%)
Race	
Am Indian/Alaska Native	**56 (18%)**
Multiple-Non-Hispanic	271 (13%)
Black or African American	646 (13%)
Multiple-Hispanic	589 (12%)
White	1,575 (8.4%)
Hispanic/Latino	239 (8.1%)
Asian	126 (7.1%)
Grade	
9	**1,073 (11%)**
10	1,030 (11%)
11	807 (9.0%)
12	685 (8.4%)
Sexual Orientation	
Bisexual	**865 (25%)**
Gay or Lesbian	216 (21%)
Not sure	294 (20%)
Heterosexual	1,962 (6.9%)

[1] n (%)

Discussion

Using **penalized regression models across multiple domains**, we found that **low water consumption was consistently retained as predictor of SAs**, suggesting a **robust correlation with suicidal behavior** even when accounting for well-established risk factors. These findings **align with prior ecological studies** demonstrating a relationship between water-related factors, such as **lithium concentrations in public water supplies**, and **reduced suicide rates** (Memon et al., 2020; Liaugaudaite et al., 2017; Kugimiya et al., 2020). While our study did not measure lithium levels, it **extends this literature** by showing that **adolescents' self-reported low water intake** itself is **associated with SA**, offering **preliminary evidence** of a **behavioral marker** linked to **suicide risk**. Furthermore, the results **reinforce existing evidence** regarding the **strong influence of psychological symptoms** on the likelihood of SA (Franklin et al., 2017; Eyre-Watt et al., 2022).

The **strong effects observed** in the **physical activity** and **dietary models** may reflect broader patterns of **poor health behaviors**. **Low water consumption** may co-occur with **insufficient physical activity** and **poor dietary habits**, which have been independently associated with **increased risk for suicidality** in adolescents (Fabiano et al., 2023; Jacob et al., 2020). In the **trauma model**, the **association between low water consumption and SAs** was the **weakest** among the domain-specific models. This may reflect the **strength of other trauma-related predictors**, such as **bullying**, **school violence**, and **dating violence**, which are known to account for a **substantial proportion of variance** in SAs (**Baiden et al., 2020; Howarth et al., 2020**). As a result, the **relative contribution of low water consumption** may be **attenuated** when **more proximal and severe risk factors** are present.

Several **limitations** should be noted. First, the **cross-sectional design** of the YRBSS data precludes any conclusions about **causal relationships** between **water consumption and SAs**. Although the **consistent retention of low water consumption** after adjusting for **demographic, psychological, substance use, risk behavior, trauma, and dietary factors** strengthens the case for a **meaningful association**, **longitudinal studies** are needed to establish **temporal precedence**. Second, **self-reported measures** may be subject to **recall or social desirability biases**, which could affect the accuracy of both **exposure (water intake)** and **outcome (SAs)** variables.

References