

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

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## Introduction

Adolescent suicide attempts (SA) remain a major public health concern in the United States. According to the 2023 Youth Risk Behavior Surveillance System (YRBSS), approximately **9% of adolescents reported attempting suicide in the past year**. Given that SAs are one of the strongest predictors of death by suicide, there is an urgent need to deepen our understanding of contributing factors. However, most research focuses on **individual-level predictors** (Franklin et al., 2017) such as such as trauma, substance use, psychological symptoms, and risky behaviors (Bae et al., 2005; Baiden et al., 2020; Lee et al., 2021). While these factors are critical, the heavy reliance on them may **limit our understanding of other potential influences—particularly those rooted in adolescents’ everyday environments**.

Ecological studies, including meta-analyses (Memon et al., 2020; Eyre-Watt et al., 2022), have shown a **protective association between lithium concentrations in public water supplies and suicide rates** (Liaugaudaite et al., 2017; Kugimiya et al. , 2020). As a psychiatric medication, lithium is well-established in reducing self-harm and suicide risk in patients with bipolar and unipolar depression (Cipriani et al., 2017; Tondo et al., 2021). Therefore, building on this literature, the current study takes a **preliminary step in evaluating whether adolescents’ reported water consumption is associated with suicide attempts**, using data from the 2017, 2019 and 2021 YRBSS cycle. We created multiple models using Least Absolute Shrinkage and Selection Operator (LASSO) regression, a variable selection technique designed to identify the most relevant predictors from a large set of potentially correlated factors. These models included established risk factors for suicide attempts as well as water consumption, allowing us to assess whether water intake remains a relevant predictor when considered alongside other known variables.

## 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 suicide attempts, and **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 LASSO regression to identify predictors of suicide attempts. 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.

- **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, ordered by effect size within each domain. 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 suicide attempts across all domain-specific LASSO models
- Low water consumption was among the strongest predictors of suicide attempts in the dietary, physical activity, and psychological symptoms models, ranking second or third in magnitude.
- In the substance use and risk behavior models, its association was moderate relative to other selected variables, while in the trauma model, it represented the smallest retained effect.
- The association between low water consumption and suicide attempts was strongest in the psychological symptoms model, with a penalized odds ratio of 1.60 (95% CI: 1.53–1.68)

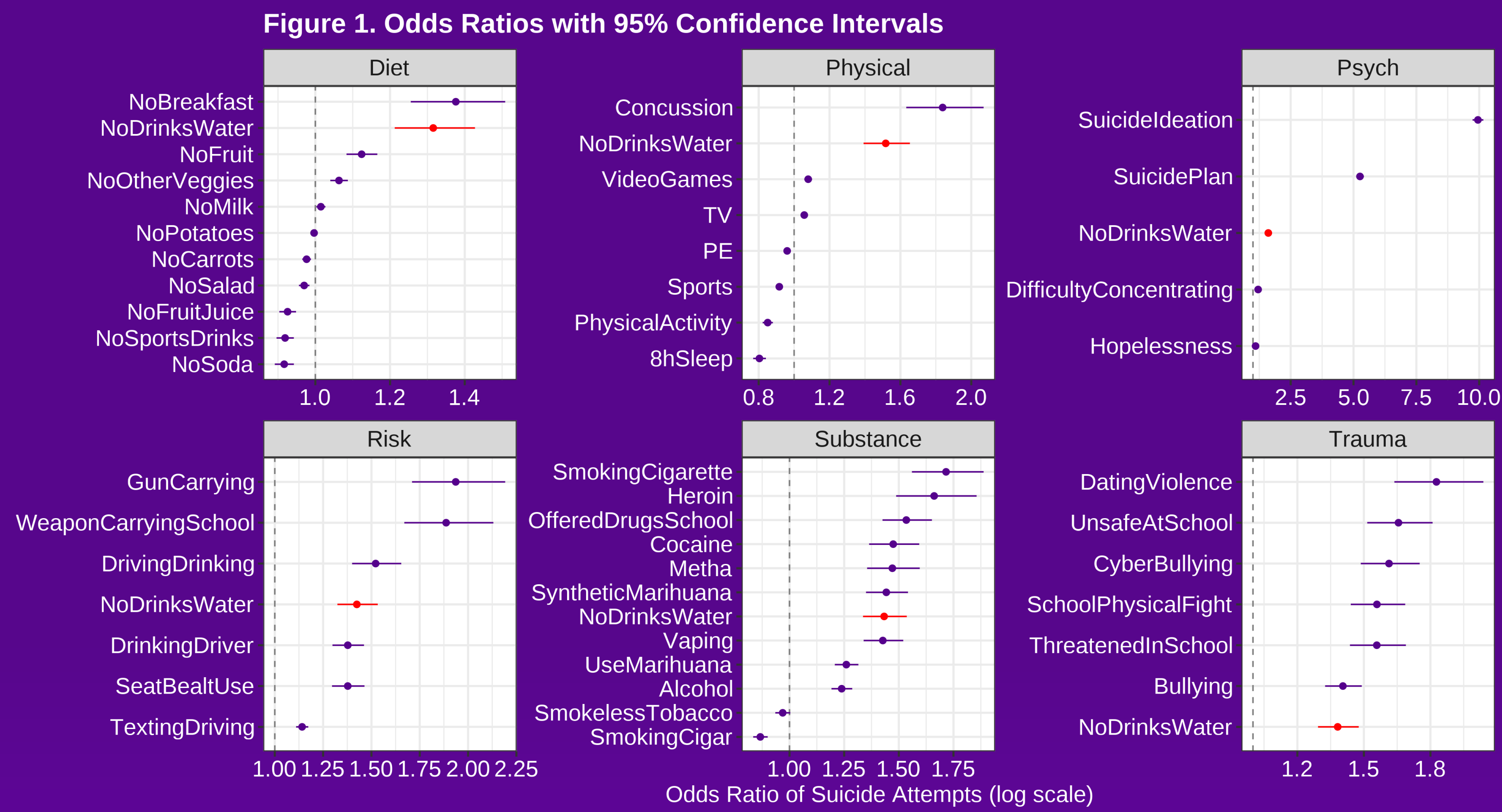


Figure 2 presents the odds ratio estimates for low water consumption across each of the 40 multiply imputed datasets for all domain-specific models. Each point represents an estimate from one imputation. The dotted line indicates the median odds ratio for each model.

- In all models across 40 imputations, the median odds ratio for low water consumption exceeded 1, indicating consistent retention as a predictor.
- The highest median odds ratio was observed in the physical activity model; the lowest in the full model including all predictors.
- Only the psychological model retained low water consumption in all 40 imputations without elimination.

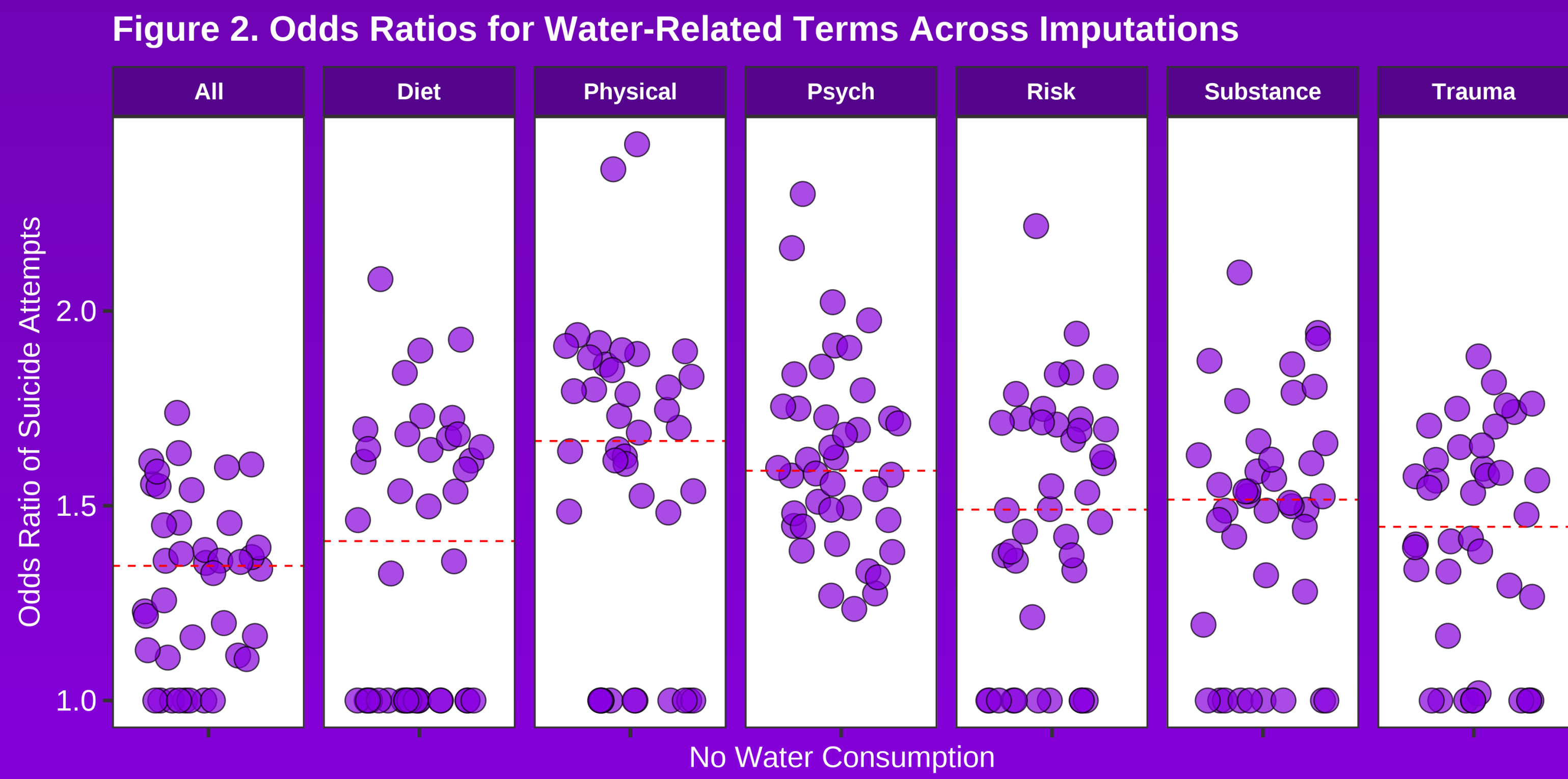


Table 1 presents the demographic characteristics of adolescents who reported suicide attempts (n = 3,657).

Table 1. Sample Characteristics by Suicide Attempt (n=36,779)	
	Yes N = 3,657 <sup>†</sup>
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%)
Asian	126 (7.1%)
Black/African American	646 (13%)
Hispanic/Latino	239 (8.1%)
Multiple-Hispanic	589 (12%)
Multiple-Non-Hispanic	271 (13%)
White	1,575 (8.4%)
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%)

## Discussion

Using penalized regression models across multiple domains, we found that low water consumption was consistently retained as a predictor of suicide attempts, 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 suicide attempts, 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 suicide attempts (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 suicide attempts was the weakest among the domain-specific models. This may reflect the strength of the other trauma-related predictors, such as bullying, school violence, and dating violence, which are known to account for a substantial proportion of variance in suicide attempts (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 suicide attempts. 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 (suicide attempts) variables. ## References