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**JULY  
2020**

**LEADING IN RESEARCH &  
INNOVATION  
FOR PLASTIC WATER BOTTLE  
REDUCTION  
AND A BRIGHTER WORLD**

RESEARCH REPORT BY STUDENTS OF SUSTAIN 2SS3

# INTRODUCTION

Single-use plastics are used by consumers worldwide due to their convenience factor and ability to be mass-produced. Single-use plastic water bottles, in particular, are a popular choice for those who are looking for water on-the-go or have negative perceptions about tap water (Daniels, 2013). In 2016 alone, **480 billion plastic bottles were produced worldwide**, however less than half of these bottles were recycled (Laville and Taylor, 2017). The lack of recycling is just one part of growing environmental problems related to the consumption of single-use plastic water bottles. Local water resources are being negatively impacted by their production, and ecosystems such as the world's oceans are being polluted by plastic to no avail (Laville and Taylor, 2017). In addition, single-use plastic water bottles require energy-intensive processes to be manufactured and transported (Choate et al., 2018), which results in a large carbon footprint for both producers and consumers. In order to combat these adverse environmental impacts and reduce their carbon footprint, many post-secondary institutions have banned the sale of single-use plastic water bottles (Daniels, 2013).



The ideal outcome of a ban on single-use plastic water bottles is to reduce waste by encouraging students, faculty, staff, and visitors to opt for reusable water bottles or water fountains instead. However, there is also the possibility that people on campus could instead opt for sugary drinks such as pop and juice that are still packaged in single-use plastic bottles. This would not only have poor impacts on the health of the campus population and continue to generate plastic waste, thus creating more problems than before the ban. To avoid implementing a policy with unintended or harmful outcomes at McMaster University, more information is required as to whether or not banning the sale of plastic water bottles reduces waste, and if there are any adverse public health effects. For simplicity, we will hereafter be also referring to 'single-use plastic water bottles' as 'plastic water bottles'.

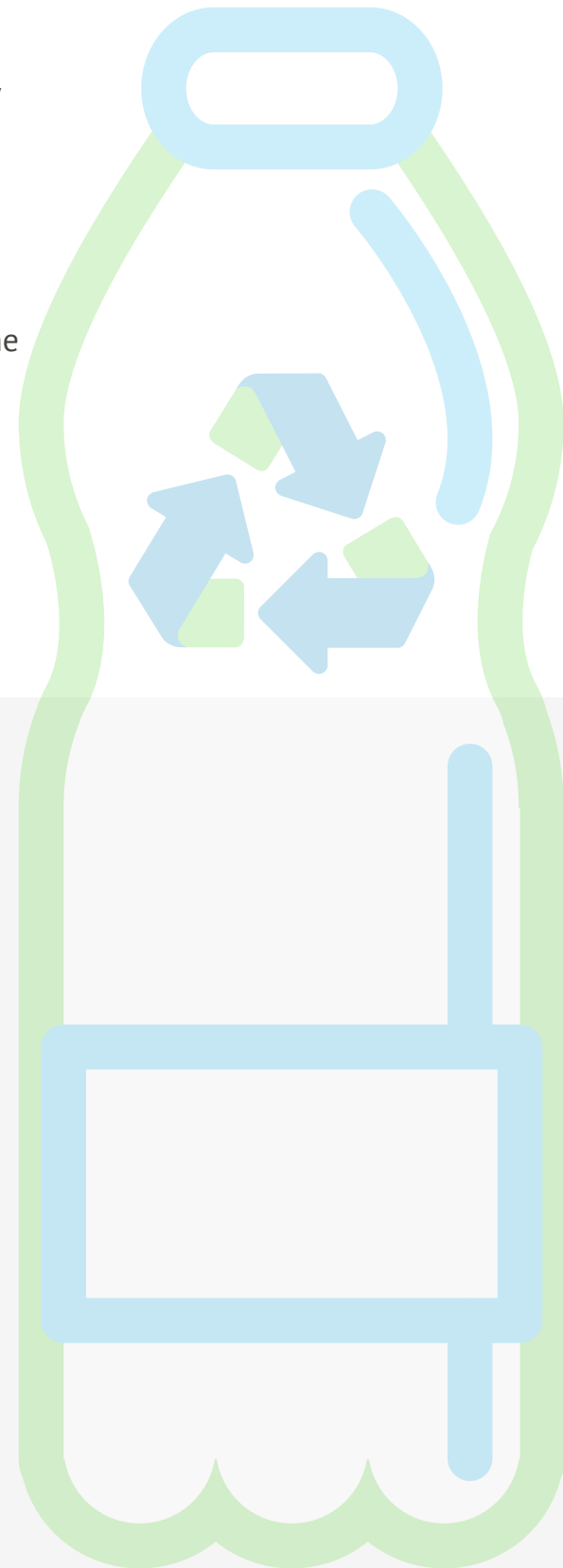
**This report will analyze and interpret various academic and anecdotal sources to gain an understanding of the environmental and public health impacts of single-use plastic water bottle bans. Using this information, next steps will be recommended to McMaster University regarding the possibility of a water bottle ban on their campus.**

# ENVIRONMENT & WASTE REDUCTION

It is evident that improperly recycled plastics, manufacturing, and distribution of them can have harmful implications on the environment (D'Altrui, 2017). Many North American post-secondary institutions have demonstrated commitment to reducing their contribution to environmental pollution by banning the sale and distribution of single-use plastic water bottles on their campuses (D'Altrui, 2017). These actions suggest that there is a general assumption that eliminating the sale of plastic water bottles will naturally lead to a reduction in total number of plastic bottles in the waste stream.

The data from a study conducted by the University of Washington in St. Louis shows an overall **39.4% decrease** of all bottled product purchases in the academic year 2014-2015 compared to the academic year 2008-2009 when the ban was implemented (D'Altrui, 2017).

According to a 2018 waste audit of non-hazardous waste, McMaster University produced a total of 1990.87 metric tons of waste with 30.8% being recycled (Waste Reduction Group Inc, 2019). If a ban were implemented, it is possible that these numbers may be reduced, however there is little evidence available from public institutions that would support this theory.



# UNDERSTANDING CONSUMER BEHAVIOUR

At Illinois Wesleyan University (IWU), a survey was completed by students, faculty, and staff. Key topics included purchasing bottled water, locations of purchases, and reasoning behind supporting a ban. One of the main findings from this survey was that a common perceived barrier to eliminating single-use plastic water bottles is the **convenience factor**. It is easy to grab a bottle on the go, and challenging to remember to bring a reusable water bottle to campus. Another barrier is the **stigmatization of tap water**. Many students don't believe that tap water is safe to drink. An overwhelming majority of the respondents already own a reusable water bottle; however, a quarter of those who own a bottle regularly purchase single-use plastic water bottles (Daniels, 2013).



ABOUT  
**50%**

who buy water bottled water  
claim to obtain it from off-campus

As referenced above, about half of students surveyed at IWU claim to purchase their single-use plastic bottled water off campus. Therefore, a ban would still allow for people to purchase bottles elsewhere. The most critical piece of data from the survey suggests that approximately 70% of students would support a ban on single-use plastic water bottle sales on campus (Daniels, 2013). McMaster University students would likely share this sentiment, as the school is a leader in championing sustainability, ranking fourteenth worldwide in sustainable cities and communities (Donovan, 2019). McMaster holds a high rank because of the student population's commitment to sustainability and the various programs and initiatives available to the school community.

# 2019 WASTE AUDIT: MCMASTER UNIVERSITY

The Waste Reduction Group Inc. conducted a waste audit for McMaster University in the 2018-2019 annum and compared this to the waste audits of previous years to observe the changes in waste content. Waste was collected from Hamilton Hall, Burke Science Building, John Hodgins Engineering Building, Student Center, Brandon Hall, Mills Library, and McKay, Edwards, and Whidden Hall over a two day period (Waste Reduction Group Inc, 2019).

The Waste Reduction Group Inc has suggested that educating students and faculty about recycling is necessary and can be done through promotions and improved labelling in order to ensure more plastic is put in the proper recycling bins (Waste Reduction Group Inc, 2019). Based on the audit, it is estimated that approximately 54.6% of PET's (plastic food and beverage containers, which includes single-use plastic water bottles) were recycled in 2018-2019, meaning that the remaining **45.4% of PET's were disposed in the garbage**. The chart below will break down this same statistic by tonnes of waste.

## 45.4%

of plastic food and beverage containers were improperly disposed of in 2018-19 (estimate)

## PLASTIC FOOD AND BEVERAGE CONTAINER WASTE

\*Reproduced from The Waste Reduction Group Inc.'s 2018 Waste Audit of McMaster University

| Estimated Amount of Waste |                  |                      |                |                  |                      |               |                  |                      |               |                  |                      |
|---------------------------|------------------|----------------------|----------------|------------------|----------------------|---------------|------------------|----------------------|---------------|------------------|----------------------|
| Generated                 |                  |                      | Reduced/Reused |                  |                      | Recycled      |                  |                      | Disposed      |                  |                      |
| "A" Base Year             | "B" Current Year | "C" * Change (A - B) | "A" Base Year  | "B" Current Year | "C" * Change (A - B) | "A" Base Year | "B" Current Year | "C" * Change (A - B) | "A" Base Year | "B" Current Year | "C" * Change (A - B) |
| Tonnes                    | Tonnes           | Tonnes               | Tonnes         | Tonnes           | Tonnes               | Tonnes        | Tonnes           | Tonnes               | Tonnes        | Tonnes           | Tonnes               |
| 36.60                     | 54.20            | -17.60               | 0.00           | 0.00             | 0.00                 | 1.77          | 29.60            | -27.83               | 34.84         | 24.60            | 10.23                |

\*Base Year is 2012

The above chart estimates that 54.20 tonnes of PET waste was generated at McMaster University in the 2018-2019 annum, and of this waste, 29.6 tonnes were recycled, while the remaining 24.6 tonnes were disposed of in garbage cans or through other improper methods (assuming none of this waste was reduced/reused). This category includes single-use plastic water bottles, which supports current findings that suggest that a large portion of consumers do not demonstrate proper recycling habits.

# EFFECTIVENESS OF BOTTLE BANS

As previously stated, there is little conclusive evidence supporting the question of whether or not eliminating single-use plastic water bottles leads to waste reduction. One article, titled *Curb the Thirst*, noted that outcomes of bottle bans are not consistent, and vary among university campuses (D'Altrui, 2017). This is due to a variety of factors, such as consumer behaviour and location of the school. When searching for other studies regarding the elimination of plastic bottles, the two most cited sources were the University of Washington St. Louis and University of Vermont studies. These studies, however, only discuss whether or not plastic bottle consumption was reduced, and do not discuss in detail whether or not the respective institutions saw a reduction in overall plastic waste.



Upon viewing the websites of various Canadian post-secondary institutions that have banned plastic bottles as well as the websites of their sustainability offices, it would appear that there is little information available about the success of their bans or how they measured their success. Currently, most public information regarding these respective plastic water bottle bans comes in the form of press releases from the time of the ban but no further information or follow up. In one case, McGill University expects to reduce their consumption by over **85 000 bottles** annually (Litwin & Ling, 2019). McGill's plastic bottle ban is a recent one, having taken place over 14 months in 2018 to 2019, so this may be one school to monitor in the future for information or data regarding their bottle ban, which many are hailing as a success.

# WASTE REDUCTION STRATEGIES

Based on present research, there have been no distinct indicators that would suggest waste was reduced as a result of a plastic bottle ban. Washington University St. Louis stated that they saved \$37 270 in recycling costs, however this is only one isolated case where plastic waste may have been reduced (Curtis-Murphy & Sessions, 2014). It should also be noted that lower recycling costs does not necessarily indicate that less waste was produced, since only approximately 29 percent of plastic bottles are actually recycled (Environmental Protection Agency, 2017). Since such a large amount of plastic waste is not disposed of properly, associated fees for collection, recycling, and disposal are consequentially lowered. A plastic bottle ban may only be successful in reducing plastic waste if proper waste diversion practices are present on campus, as well as adequate education on proper recycling.



Benchmarking programs and inter-collegiate comparison initiatives, such as Campus Race to Zero Waste (formerly RecycleMania), a growing initiative among North American post-secondary institutions, are unique programs that aim to reduce waste on campus through friendly competition and benchmarking programs. While Campus Race to Zero Waste is not directly related to banning single-use plastic water bottles, many institutions that have banned the sale of bottled water are part of this initiative, such as the University of Ottawa and Washington University (RecycleMania, 2020). Additionally, the competition consists of various categories related to waste diversion, including a category specific to basketball game days, which are notorious for consumption and distribution of single-use plastic bottles.



(RecycleMania, 2020)

The 2020 edition of the competition, in which 300 institutions in the United States and Canada competed, was not conducted throughout the entire school semester as usual due to COVID-19. However, according to the RecycleMania website, a projected 380 million plastic containers were kept out of landfill between February 2nd to March 7th alone. While this is not conclusive evidence that a water bottle ban would lead to such waste diversion, it does show that community-based education or engagement programs like Campus Race to Zero Waste can actively raise awareness and lead to improved recycling and waste diversion practices among university campuses. In the fall of 2020, Campus Race to Zero Waste will release a guide which will provide potential solutions to reducing plastic consumption and promote proper recycling on university and college campuses.

# POTENTIAL PUBLIC HEALTH IMPACTS

After thorough content analysis, two studies were found that examined the correlation between a plastic water bottle ban and sugar consumption: the University of Vermont, and Washington University in St. Louis.

## UNIVERSITY OF VERMONT

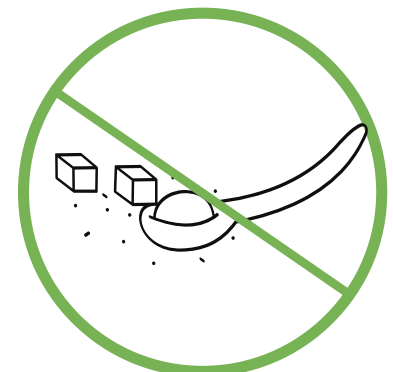
The University of Vermont (UVM) was concerned about how a plastic water bottle ban could potentially impact student health in terms of purchasing more sugary beverages, so they began their study in two phases. For the fall semester of 2012, the university put a 30% healthy beverage requirement in place for all vending machines and food service locations, then banned single-use plastic water bottles entirely in the winter semester of 2012 (Berman & Johnson, 2015). They conducted their study by analyzing the calories, sugars, and added sugars from beverage shipment data across three semesters: Spring 2012, before any changes took place, Fall 2012, with the healthy beverage requirement, and Winter 2012, with the plastic water bottle ban.

The number of plastic bottles shipped to the campus did not change significantly between Spring and Fall of 2012, from 24.2 bottles per person to 21.8 bottles per person after the healthy beverage requirement. The number of bottles increased from Fall 2012 to Winter 2013, from 21.8 bottles per person to 26.3 bottles per person after the plastic water bottle ban (Berman & Johnson, 2015). The result of the university's increased plastic waste displays the opposite result of what the ban was hoping to do-decrease the university's plastic waste. However, there was not a statistically significant change from Spring 2012 to Spring 2013.

Another unintended consequence of the ban was an increase in per capita calorie, sugar, and added sugar intake. The study found **an 8.5% increase from Spring 2012 to Spring 2013 in purchases of "Red" drinks**, drinks defined by the Nutrition Environment Measures Survey-Vending Rating (NEMS-V) as drinks that should be consumed in limited amounts (Berman & Johnson, 2015). This was accompanied by a significant decrease of "Green" beverages over the same period, defined as okay to consume regularly by the NEMS-V, which the study suggests was students replacing their bottled water purchase with an unhealthy sugar-free or sugar-sweetened beverage (Berman & Johnson, 2015).

The university engaged in efforts to encourage reusable water bottle use, such as 68 retrofitted water fountains, promotional campaigns to make students aware of the ban, and free reusable water bottles and promotional stickers that were given out at events on campus (Berman & Johnson, 2015).

The findings of the study are concerning and not to be ignored, but a major limitation of the study is that it only took place over three semesters, which Bohme (2016) claims is not enough time to examine effects of either policy. Bohme also explains how the study did not look at any previous trends to see if there was already an increasing trend of sugary drink consumption and did not control confounding factors such as the weather from each season (2016). It is also important to note that UVM did not get rid of the ban after this study was released, but instead began attempting to find ways to deal with it, such as offering even more healthy beverages, filtered water in beverage machines at dining halls and Coca-Cola Freestyle machines to mix your own non-water drink into a reusable cup (Municipality of Dysart et al., 2019). One of the key messages from UVM is "that it is essential to continue to provide water as an option through a variety of formats, and additionally, ensure that it is promoted" (Municipality of Dysart et al., 2019).





# POTENTIAL PUBLIC HEALTH IMPACTS

## WASHINGTON UNIVERSITY IN ST. LOUIS

The University of Washington in St. Louis thoroughly planned out their water bottle ban, which was enacted at the beginning of 2009. Their published report spans from 2009 to 2015, and uses a variety of metrics to weigh their successes and areas of improvement. Overall, their ban was an impressive success, not only decreasing the amount of plastic waste produced, but also decreasing the amount of sugary drinks consumed, both in bottled form and from soda fountains. The following table summarizes the metrics used and the results (Vasquez, 2015):

| Metric   | Result                                   |
|--|--|
| Total Bottled Beverage Purchases by Academic Year<br>(packs of 24 plastic bottles) | A decrease of ~40% between 2009 and 2015 |
| Fountain Drink Purchases (gallons of syrup purchased)                              | A decrease of ~46% between 2009 and 2015 |

With exception of the “other” category of drinks (mostly encompassing energy and caffeinated drinks), which saw a slight increase in consumption, all single-use plastic bottle categories saw a significant decrease in consumption between 2009 and 2015 (from 60 000 cases of 24-packs purchased per year by the university, to about 35 000 cases) (Vasquez, 2015). This includes sugary drinks, such as juice and carbonated drinks. Furthermore, they also noted a decrease in fountain drink consumption, measured by gallons of syrup purchased by the campus.

In order to support the ban’s success, they put in significant and continuous effort and capital into educational and awareness campaigns. They attribute a strong culture of sustainability and stewardship to their success, which they carefully fostered. Some of their supporting initiatives included:

- Adding water fountains in ‘dry areas’ on campus (108 fountains as of 2015)
- Ensuring all first years are aware that the campus had banned the bottle via 2-3 publications, prior to arriving on campus
- Supplying students with a reusable water bottle (through a variety of departments)
- Having a team of Green Ambassadors help welcome students to campus, and educate them on green initiatives such as the bottle ban, as well as a team of representatives who lead sustainability efforts on campus
- Partnering with Hospitality Services to promote healthy dietary choices, including the importance of drinking water
- Posting educational infographics around campus about the benefits of using a reusable water bottle

The university also had some exceptions to the ban, which may mirror McMaster University’s situation - they did not ban single-use plastic water bottles in the medical building, over concerns that medical patients may need access, and during certain large events where alternative methods of water delivery were too costly or unwieldy.

Their successful water ban shows that, with a sufficiently thorough educational campaign, it is possible to ban single-use plastic water bottles on campus and avoid an increase in sugary drink consumption. Something to keep in mind, however, is that McMaster University is not Washington University in St. Louis, and any plan would have to be adapted to fit the culture and status of the university. For example, the population sizes are different, with McMaster having about 32 000 students (undergrad and graduate) as of 2018, and Washington University having 15 000 as of 2018. It may be easier to implement a program like this on a smaller scale, which is important to take into consideration when considering evaluation tools or milestones.

# TABLE OF COMPARISON

| Study                                 | Duration                | Methodology   | Limitations/Criticisms  |
|---------------------------------------|-------------------------|---|---|
| University of Vermont, Burlington, VT | 3 semesters (2012-2013) | <ul style="list-style-type: none"> <li>• 3 phase <u>plan</u>:               <ul style="list-style-type: none"> <li>○ 1<sup>st</sup> Semester: Baseline (no policy)</li> <li>○ 2<sup>nd</sup> Semester: 30% healthy beverage policy</li> <li>○ 3<sup>rd</sup> Semester: Healthy beverage policy and bottled water ban</li> </ul> </li> <li>• Metrics: Per-capita shipments of bottles; calories; sugars</li> <li>• Campaigns including:               <ul style="list-style-type: none"> <li>○ Adding retrofitted fountains</li> <li>○ Education programs</li> <li>○ Supplying reusable bottles and promotional stickers</li> <li>○ 30% healthy beverages required in vending machines and dining locations</li> </ul> </li> </ul> <p>(Berman &amp; Johnson, 2015)</p> | <ul style="list-style-type: none"> <li>• Short duration of data collection</li> <li>• Limited number of sale locations</li> </ul>   |
| Washington University, St. Louis, MO  | 6 years (2009-2015)     | <ul style="list-style-type: none"> <li>• Metrics: Purchases of Bottled and Fountain Drinks</li> <li>• Campaigns including:               <ul style="list-style-type: none"> <li>○ Adding retrofitted fountains</li> <li>○ Educating arriving students on ban</li> <li>○ Supplying reusable bottles</li> <li>○ “Green Ambassador” program to educate</li> <li>○ Providing healthier drink choices</li> </ul> </li> <li>• Exceptions: Medical building, large events</li> </ul> <p>(Vasquez, M. et. al.)</p>  | <ul style="list-style-type: none"> <li>• Smaller student population than McMaster (15k vs 32k)</li> <li>• Differences in university culture</li> <li>• Not a peer reviewed study</li> </ul> |

# CONCLUSION

## AND FINAL RECOMENDATIONS

After researching both the potential successes and pitfalls of the "Ban the Bottle" initiative, the evidence suggesting that a plastic water bottle ban leads to plastic waste reduction or public health impacts is **inconclusive**. The existing literature on the consumption of sugary drinks and waste reduction as a result of a bottle ban was limited but has presented a foundation to build upon. Given McMaster University's status as a world leader in research and sustainability, **the university is well-equipped to conduct its own research on the impacts of banning single-use plastic water bottles through a mixed methods research study supported by a thorough pilot project, and this is what we recommend.** This will allow McMaster to determine if a bottle ban would have any impacts on waste reduction or health, and decide whether to continue with a permanent ban or not. We are advocating for the importance of research and evidence based practice rather than an uneducated ban or deciding to not consider a ban at all. Additionally, the multidisciplinary nature of this project would allow for inter-Faculty involvement in the research, as well as various opportunities for student engagement and promotion of the research through signage and advertising. McMaster's research could also provide other universities with valuable information and evidence to make a decision if they are considering a bottle ban.

There are a number of components that we recommend as part of this research project, which includes further consultation with other Ontario post-secondary institutions who have implemented the bottle ban to obtain further data. A campus-wide student survey is also recommended, as literature suggests that institutions should conduct their own research to understand the specific reasons why and where their students purchase single-use plastic water bottles (Choate et al., 2018). This allows campuses to tailor their bans to their students. More foundational research in terms of waste audits and purchasing data is necessary, and then the sale of plastic bottles can be eliminated during the pilot. The formation of a thorough and ongoing educational campaign is also necessary, in order to inform and engage the university community. A Dutch survey demonstrated that when university students are provided with persuasive information in flyers, about "health, taste, quality, convenience and the environment" with respect to single-use plastic water bottles, students are more likely to change their behaviour (Choate et al., 2018). Lastly, heavy promotion of the ban is important so that as many students are aware as possible.



**With this information, we are hopeful that McMaster University will follow our recommendations to conduct their own research and further its goal to be a sustainable and responsible environmental leader.**

# APPENDIX 1

## PROJECT SCOPE 1: WASTE REDUCTION

In order to determine whether or not banning single-use plastic water bottles reduces waste on university and college campuses, various exploratory research methods were used. Liana Bontempo, the Wellness and Sustainability Manager at McMaster Hospitality Services and the community partner for this project, was a primary source of information for this project. She provided past waste audits from McMaster University and connected us with Alanna Bodo, a PhD Candidate in Hydrometeorology and the Chair of the Student Chapter at the McMaster Centre for Climate Change. Alanna was able to provide many resources, including some of the studies referenced in this report, past presentations to McMaster University committees, and plastic bottle sales information from stores on the McMaster campus. Another source of information for this project was The Association for the Advancement of Sustainability in Higher Education (AASHE) database, which is available to current McMaster students. Using this database, the following combinations of keywords were used:

- Plastic bottle waste reduction
- Plastic bottle ban waste
- Plastic bottle ban waste reduction
- Plastic waste reduction
- Bottle ban
- Plastic bottle ban
- Reduce waste plastic bottle

## PROJECT SCOPE 2: BOTTLE BAN VS. SUGAR

Exploratory research was conducted in this project with the aim of collecting secondary data to gain insight on any correlation between a plastic bottle ban and public health. Specifically, a scientific literature review was conducted to gauge the impacts of a university campus bottled water ban on student consumption of sugary or unhealthy beverages.

The following search engines and databases were used:

- Google Scholar
- JSTOR
- EBSCO
- ProQuest

The following combinations of keywords were used:

- Plastic, water, bottle, ban, sugar
- Plastic, water, bottle, ban, sugar, beverage
- Plastic, water, bottle, ban, sugar, university
- Plastic, water, bottle, ban, unhealthy
- Plastic, water, bottle, ban, unhealthy, university
- Plastic, water, bottle, ban, unhealthy, beverage
- Plastic, water, bottle, ban, unhealthy, beverage, sugar
- Ban, the, bottle, sugar, consumption
- Ban, the, bottle, water, sugar, consumption

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