Table of Contents

Background and Related Work

Introduction

The foundation of this project lies in investigating modern health and hygiene aspects within the field of hydration. A central issue with the use of reusable bottles is often inadequate cleaning, which increases the risk of contamination from bacteria, yeast, or mold. Parallel to this, many individuals neglect their daily water intake due to forgetfulness or a lack of awareness, leading to significant health risks associated with dehydration.

This chapter provides the necessary concepts and background information to address these challenges technologically. We focus on this target group: young, health-conscious and tech-savvy individuals who view a user-friendly app as an enrichment of their daily lives and who prioritize not only clean water and bottles but also a sufficient supply of minerals and consistent hydration. Especially travelers who are often unsure about the local water quality abroad can benefit from a smart bottle.

Before presenting our own solution, we will first analyze concepts, existing products and projects on the market. Finally, a detailed comparative table will be provided, evaluating current market leaders alongside the specific sensors and features relevant to our project.

Concepts

The IoT and Digital Health Framework

The smartification of everyday objects is a key aspect of the Internet of Things (IoT) and digital health technologies **[1]**. Water bottles represent an interesting application area because hydration plays an essential role in human health and can be influenced through behavioral interventions. Smart water bottles typically combine sensors, microcontrollers and mobile applications to monitor water consumption, motivate users to drink regularly, and potentially analyze certain aspects of water quality **[2]**.

Physiological Hydration and Health Dynamics

The primary concept behind smart hydration is the body's requirement for an adequate water supply to ensure waste excretion via the kidneys, correct electrolyte balance, and efficient heat dissipation through sweat **[3]**. Beyond the total volume, the frequency of intake is crucial; regular hydration promotes brain function, improves physical performance, and positively impacts chronic diseases **[4]**. Since it is difficult for individuals to subjectively assess their daily intake, technology serves as an objective tool for self-monitoring to prevent dehydration, which is a common risk for the elderly, the sick, and highly active individuals. Nevertheless, adequate hydration affects everyone **[5]**.

Hygiene, Biofilms, and Contamination Risks

While reusable bottles are generally more sustainable and economical, they also require regular cleaning. Observations of user behavior suggest that many consumers frequently refill their bottles without cleaning them sufficiently. A major theoretical challenge is the hygiene gap, because these bottles often harbor heterotrophic plate counts (HPC), which include bacteria, yeast, and mold **[6]**. The Colony Forming Units per milliliter (CFU/ml) is a measure for the number of living, reproducible bacteria or fungi in a liquid sample **[7]**. In the EU, the safety limit of 100 CFU/mL is frequently exceeded because users often refill bottles without sufficient cleaning **[8]**. Microorganisms form biofilms on internal surfaces, especially when nutrients are present and disinfectants are absent, potentially leading to foodborne illnesses in vulnerable groups **[9]**.

Mineralization and Nutritional Value

Another important components of drinking water are minerals. Minerals such as calcium and magnesium contribute essential bodily functions support bone health, muscle function, and nerve signaling. They also help maintain the body’s electrolyte balance and proper hydration. Although most minerals are obtained from food, drinking water can provide a valuable additional source. A study examined the relationship between drinking water total dissolved solids (TDS) and serum mineral levels in adults. Participants consuming higher-TDS water showed higher levels of calcium and magnesium in their blood compared to those drinking low-TDS water. The results suggest that mineral content in drinking water can contribute to overall mineral intake and electrolyte balance. The findings demonstrate that mineral water can play an important role in supporting dietary mineral balance **[10]**.

Recommended water requirement

The determination of an individual’s optimal water requirement is a complex concept that transcends the standardized “eight-glass” rule. According to the National Academies of Sciences, Engineering, and Medicine, the general adequate intake (AI) for healthy adults in temperate climates is approximately 3.7 l for men and 2.7 l for women per day. The adequate intakes represent an amount that should meet the needs of almost everyone in a specific life-stage group who is healthy, consumes an average diet, and performs moderate levels of physical activity. This value is a guideline for adults over the age of 19. A distinction is also made between pregnant and breastfeeding women. For infants, children, and adolescents, the value varies depending on age. In Europe, the recommended water intake is lower than in the US, at 2.5 l for men and 2.0 l for women. However, these figures represent total fluid intake, including moisture from food, which typically accounts for 20 % of the daily total **[11]**.

In addition to age and gender, daily water requirements depend on many other factors, such as physical and cognitive activity and diet, for example, whether a lot of protein is consumed. Of course, medical factors such as body mass index, blood pressure, blood volume, and hormone status also play a role. Another influencing factor is environmental conditions, as climatic conditions are decisive for the water consumption required to regulate the body's condition. Despite numerous efforts to determine the daily water requirements of children, men, women, and older adults, no empirical research provides clear answers, and there is no consensus. The dynamic complexity of the water regulation network and interindividual differences are the main reasons why no general consensus on daily water requirements has been reached to date. It is therefore not generally possible to make fundamental statements. By integrating these variables into a smart system, hydration tracking can move from a static goal to a personalized health intervention **[12]**.

Sensors and components

Total Dissolved Solids Sensor

A TDS sensor measures the amount of dissolved substances in water by detecting its electrical conductivity. When minerals such as salts, calcium, or magnesium dissolve in water, they release charged ions that allow electricity to pass through the liquid. The sensor measures this conductivity and converts it into an estimated concentration of dissolved solids, usually expressed in mg/l. The advantage of this sensor is that it is inexpensive, compact, and able to provide quick measurements that indicate the general mineral content of water. However, it cannot identify which specific substances are present, and it also cannot detect biological contamination such as bacteria or viruses. The temperature is required to evaluate the TDS data. Therefore, an additional temperature sensor is necessary.

Temperature Sensor

A temperature sensor measures the temperature of water or the surrounding environment. In many water monitoring systems, temperature plays an important role because physical properties such as electrical conductivity change depending on temperature. For example, the conductivity of water increases by about two percent for every °C increase. By measuring temperature, the system can correct other sensor readings and improve their accuracy. The main advantage of temperature sensors is that they are highly precise, energy-efficient, and easy to integrate into electronic systems. Their limitation is that they do not provide direct information about water quality and mainly serve as supporting sensors for other measurements.

UV-C LED Module

An Ultraviolet-C (UV-C) light-emitting diode (LED) module uses ultraviolet light with wavelengths typically between 250 and 280 nm to disinfect water. This type of light damages the DNA of microorganisms such as bacteria and viruses, preventing them from reproducing and effectively inactivating them. UV-C sterilization is widely used in water treatment because it works quickly and does not require chemicals. Its advantages include fast disinfection and relatively low maintenance once installed. However, UV-C technology requires electrical power and does not remove dissolved chemicals or particles from the water, meaning it is often combined with other filtration methods.

pH Sensor

A pH sensor measures the acidity or alkalinity of water by detecting the concentration of hydrogen ions. Organic substances can sometimes influence the pH indirectly when they are broken down by bacteria, which may produce organic acids and slightly lower the pH. However, this process is slow and indirect, meaning the sensor does not detect organic compounds themselves but only changes in acidity.

The main limitation is that many other factors, such as dissolved carbon dioxide, minerals, or chemicals, can also affect the pH value. This makes the results non-specific and often difficult to interpret. In addition, pH sensors require regular calibration to maintain accuracy.

Overall, pH measurements provide only rough indications of possible organic activity in water rather than clear information about contamination. Since microorganisms can be directly inactivated through UV-C disinfection, pH monitoring often adds limited additional value in such systems.

Turbidity Sensor

A turbidity sensor measures the cloudiness of water by detecting how much light is scattered by particles suspended in the liquid. An LED shines light into the water while a photodiode measures how much of this light passes through or is scattered. If many particles such as sediments or microorganisms are present, more light is scattered and less reaches the sensor, indicating higher turbidity.

However, turbidity sensors only respond to physical particles and cannot detect dissolved substances such as minerals or chemicals. Their measurements can also be affected by air bubbles, biofilm, or deposits on the sensor surface, which may lead to inaccurate readings and require regular cleaning. While turbidity sensors are relatively cheap and easy to integrate, they provide only limited information about overall water quality. Turbidity sensors are therefore used in heavily contaminated water. Also because they primarily measure flowing water this is the reason why they are not suitable for the usage in a water bottle.

Pressure Sensor

A pressure sensor detects the force exerted by a fluid on a surface. In water-related applications, this measurement can be used to estimate the height of a water column and therefore determine the liquid level inside a container. Since pressure increases proportionally with depth, the sensor can calculate the amount of water present. Pressure sensors are advantageous because they offer high precision and reliable measurements even in small spaces. Many pressure sensors include temperature sensors.

Gravity Sensor

A tri-axial accelerometer measures acceleration and orientation relative to gravity. By detecting changes in motion and tilt, the sensor can determine whether an object is upright, tilted, or moving. This type of sensor is commonly used in smartphones, wearable devices, and other portable electronics. The main advantages of accelerometers are their extremely small size, low energy consumption, and versatility in detecting movement and position. Their limitation is that they do not measure environmental conditions such as water quality, and the collected data often requires additional software processing to interpret correctly.

Activated Carbon Filter

Activated carbon filters work through a process called adsorption, where contaminants attach to the surface of the carbon material. The carbon is processed to create a highly porous structure with an enormous surface area, which allows it to trap chemicals such as chlorine, organic compounds, and substances that cause unpleasant taste or odor. One major advantage of activated carbon is that it is inexpensive, widely available, and does not require electricity. However, it cannot effectively remove microorganisms like bacteria or viruses, and its performance decreases over time as the pores become saturated.

Carbon Block Filter

A carbon block filter is a more compact and dense form of activated carbon filtration. The carbon is compressed into a solid block with very small pores, forcing water to pass through the material slowly. This increases the contact between the water and the carbon surface, improving the removal of chemicals, chlorine, and some heavy metals. The advantage of carbon block filters is that they generally provide better filtration performance than loose carbon particles and can also improve the taste and smell of water. However, the filter must be replaced periodically, and it still cannot reliably remove microorganisms.

Material

Some of the caps on the market are be made of polypropylene (PP). This material is chosen for its excellent resistance to mechanical fatigue, meaning it can withstand repeated opening and closing without degrading. Polypropylene is also lightweight, waterproof, and chemically resistant, making it ideal for a bottle cap that must ensure a tight seal over long-term use.

Polished aluminum has proven to be a reliable choice for the body of the bottle, which contains the water. Aluminum is selected for several key reasons. First, when polished, aluminium becomes highly reflective. By reflecting the UV-C light throughout the interior surface, the aluminum increases the exposure of the water and the bottle walls to the UV-C radiation, which improves the disinfection and cleaning efficiency of the system. Additionally, the reflective aluminum can help reduce heat loss or gain by reflecting thermal radiation. Second, it is lightweight, durable and resistant to corrosion, making it suitable for everyday use.

The part of the bottle, which contains the electronic components (such as the battery, sensors, and LED), is often be made of plastic, like polycarbonate. This material is essential because it provides electrical insulation, preventing any contact between the conductive aluminum body and the electronic systems. It also offers waterproof protection, ensuring that the electronics remain safe and functional even in a humid environment. The plastic structure also helps absorb shocks and protect sensitive components.

In conclusion, the combination of polypropylene for durability, polished aluminum for thermal and reflective performance, and plastic for electrical insulation and protection ensures that the smart water bottle will be safe, efficient, and suitable for everyday use.

Products

Since various smart water bottles already exist on the market, analyzing these products can provide valuable insights for the development of a new design. By examining existing solutions, it is possible to identify useful technologies, components, and design approaches that may be relevant for the proposed system. This chapter therefore reviews several existing products and highlights their most important features, with a particular focus on the differences in their design concepts and functionalities. A summary table at the end of the chapter provides a direct comparison of the analyzed products.

The **LARQ Bottle PureVis** focuses primarily on water hygiene rather than hydration tracking. Its key feature is an integrated UV-C LED system, which disinfects both the water and the inner surface of the bottle. The UV-C light can be activated manually or automatically at regular intervals to eliminate up to 99.99 % of bacteria and viruses inside the bottle. The desinfection process takes 10 seconds. Some versions also include optional hydration tracking via a smartphone app and may be equipped with a replaceable filter to remove contaminants such as chlorine or heavy metals. The bottle is typically available in 500 ml and 740 ml versions, weighing around 380 g and 500 g. Thanks to its double-walled stainless-steel insulation, it can keep drinks cold for up to 24 hours and hot for about 12 hours. With a price range of about 90 € to 120 €, the LARQ bottle is relatively expensive, but its main advantage lies in the self-cleaning function and improved water hygiene, making it particularly suitable for travel and outdoor use **[13]**.

Aqua Vault is a smart reusable water bottle designed to provide safe and clean drinking water wherever you are. The bottle features a UV-C sterilization system integrated into the lid, which effectively eliminates bacteria, viruses, and organic residues both in the water and inside the bottle. A built-in screen on the lid allows users to easily start and monitor the cleaning cycle. With a 3-minute sterilization process, Aqua Vault quickly disinfects the water and the interior of the bottle, ensuring a reliable and hygienic drinking experience **[14]**.

Compared to the LARQ bottle, which also uses UV-C technology for water purification, Aqua Vault focuses on greater user interaction and transparency through its integrated display, allowing users to clearly see the cleaning status and cycle progress. While LARQ emphasizes automated purification, Aqua Vault combines UV-C sterilization, user feedback through the screen, and a simple 3-minute cleaning cycle to give users more control and confidence in the quality of their water.

In contrast, the **HidrateSpark Pro Tumbler** focuses on hydration monitoring and behavioral motivation. The bottle contains a sensor in the base that measures the water level, allowing it to automatically track how much water the user drinks. The data is transmitted via Bluetooth to a smartphone app, where users can monitor their hydration level, set personal drinking goals, and view statistics or achievements. A distinctive feature of this bottle is its LED light system, which lights up in different colors to remind users to drink throughout the day. The bottle can also integrate with health platforms such as Apple Health and it supports Apple Find My for locating the bottle. The bottle typically has a capacity of about 620 ml, weighs around 400 g to 500 g, and costs approximately 70 € to 90 €. Its main advantage is the automatic tracking of drinking behavior, although it requires charging and may occasionally experience Bluetooth connectivity issues **[15]**.

The **Ozmo Active** Smart Bottle extends the concept of hydration tracking by integrating fitness and lifestyle data. Similar to the HidrateSpark bottle, it uses sensors to measure fluid intake and sends the data to a smartphone app via Bluetooth. However, a key difference is that the Ozmo system can distinguish between different beverages, such as water and coffee, allowing users to monitor their total fluid consumption more comprehensively. The system also provides hydration reminders and integrates fitness and health platforms, linking hydration with physical activity data. The bottle has a capacity of around 600 ml, weighs approximately 400 g to 450 g, and costs around 60 € to 80 €. While the ability to track multiple beverage types provides a broader overview of fluid intake, the system can be more complex to use and mainly targets users interested in detailed health and fitness monitoring **[16]**.

The **equa** Smart Water Bottle, on the other hand, focuses on simplicity and user motivation. Its main feature is a light signal integrated into the bottle, which illuminates to remind the user to drink regularly. The bottle connects via Bluetooth to the EQUA Hydration App, where the user’s daily water intake is tracked. The app also calculates a recommended daily hydration level based on personal parameters, such as body characteristics and activity level. In contrast to more sensor-focused systems, the Equa bottle mainly encourages hydration through reminders and app-based tracking rather than precise intake measurement. The bottle is made of double-walled, vacuum-insulated stainless steel, has a capacity of 680 ml, and weighs around 350 g to 400 g. Its typical price is 70 € to 90 €. The main advantage of the Equa bottle is its simple and intuitive reminder system, although, like other smart bottles, it requires charging and is more expensive than conventional bottles **[17]**.

Overall, these products demonstrate different approaches to smart hydration systems. While the LARQ bottle emphasizes water purification, the HidrateSpark focuses on precise hydration tracking, the Ozmo system integrates hydration with broader health data, and the Equa bottle prioritizes simple reminders and user motivation. These differences highlight the range of possible functionalities and design strategies that can be considered when developing a new smart water bottle system. It turns out that all these areas, disinfection, water quality control, quantity tracking, and motivation and overview via a connected app, are already covered by individual bottles. However, there is currently no water bottle that combines all these aspects.

Projects

Clinical Trials on Behavioral Intervention

Various projects have used clinical settings to test the efficacy of smart hardware. A randomized trial showed that patients using smart bottles with integrated hydration reminders achieved a much higher daily fluid intake compared to a control group **[18]**. Similarly, research involving college students demonstrated that digital feedback loops and historical data provided via an app significantly increase a user's awareness of their hydration patterns **[19]**.

Technical Execution: Acoustic and Visual Feedback

Specific engineering projects have explored different ways to alert users. While most rely on smartphone notifications, some projects have successfully implemented reminders, such as acoustic signals or glowing LED bases, to prompt hydration without requiring the user to check a screen **[20]**.

The UV-C Sterilization Project

The study **[21]** found that more than 20 % of reusable bottles had bacterial counts that exceeded the limit. Organic substances are referred to as heterotrophic plate count (HPC) and include mold, bacteria, and yeast. Different countries have different limit values for HPC in tap water **[22]**. In the EU, the limit is 100 CFU/ml which is exceeded in many water bottles even though the tap water used to fill them is clean. The design of the bottle, how it is used, the material, whether it is used for water or other beverages, the age of the bottle, and how it is cleaned are all important factors. Improperly cleaned bottles may therefore present a contamination risk and potentially contribute to foodborne illness, especially for vulnerable groups such as children, older adults, or immunocompromised individuals. Microorganisms commonly grow in water and on surfaces in contact with water in the form of biofilms, particularly when nutrients are available and no disinfectant is present **[23]**.
A major project-based advancement in smart bottles is the implementation of UV-C LED technology

for internal sterilization. This addresses the hygiene problem of bacteria, yeast and mold without requiring physical filters or chemicals. It turns a standard container into a self-cleaning medical-grade device. There is a new approach in which the UV-C light spectrum is used to disinfect both the water and the bottle itself. The spectrum range between 250 nm and 280 nm is crucial. Only this can ensure that the DNA and mRNA of the microorganisms in the water are destroyed and the organic matter is killed. It is also important that the inner surface of the bottle is reflective and that all materials exposed to the light are UV-C resistant **[24]**. This concept will be introduced in connection with the products of the company LARQ and ensures that organic contaminants are eliminated.

Environmental Impact and Sustainability Projects

The development of smart reusable bottles is also a response to the global plastic crisis. Normal plastic water bottles have a significant environmental impact throughout their entire life cycle. Studies have shown that bottled water can have an environmental footprint up to 3500 times greater than tap water, mainly due to plastic production, packaging, transportation, and waste management. The manufacturing of single-use plastic bottles requires large amounts of energy and fossil resources, which contributes to greenhouse gas emissions **[25]**. In addition, many plastic bottles are not properly recycled and end up in landfills or in natural environments such as rivers and oceans. This can lead to long-term pollution, the formation of microplastics, and harm to wildlife that may ingest or become trapped in plastic waste. These consequences highlight the environmental importance of reducing single-use plastic bottles and promoting reusable and more sustainable alternatives. The use of reusable bottles is one opportunity to reduce the consumption of plastic bottles and therefore offer a way to face the environmental impact **[26]**.

Advanced Sensing and Future Integration

Recent research projects are exploring the integration of advanced sensors into portable bottles to detect specific contaminants and monitor real-time mineral content. While no commercial bottle currently measures TDS or minerals directly, studies have proven the health benefits of such data **[27]**. Current project goals focus on overcoming technical hurdles like sensor miniaturization and power consumption to make these features a reality in everyday life.

Comparative Analysis

Table 1 compares the different products.

Table 1: Product comparison

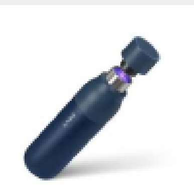
Photo	Product	Price (€)	Volume (ml)	Weight (g)	Material	Feature	App	Design
	LARQ Bottle PureVis	90–120	500, 740	380, 500	Stainless steel, UV-C LED for disinfection, optional filter	UV self-cleaning (10 s), hydration tracking	Yes	Minimalist cylindrical design focused on hygiene, large lid

Photo	Product	Price (€)	Volume (ml)	Weight (g)	Material	Feature	App	Design
	Aqua Vault	90–130	500, 750	420–520	Stainless steel body, UV-C LED in lid, integrated display	UV-C sterilization cycle (3 min), screen	No	Modern smart bottle design with integrated screen in large lid
	HidrateSpark Pro Tumbler	70–90	620	400–500	Stainless steel or Tritan plastic, sensor in bottle base	Tracks water intake, LED drink reminders, Bluetooth	Yes	Classic bottle shape with LED ring in the base
	Ozmo Active Smart Bottle	60–80	600	400–450	Plastic/stainless steel with integrated sensors	Tracks water and other beverages, hydration reminders	Yes	Technical design with integrated sensor system
	Equa Smart Bottle	70–90	680	350–400	Stainless steel, LED reminder module	Hydration reminders and intake tracking	Yes	Minimalist insulated bottle with light indicator

Table 2 compares and discusses the different components.

Table 2: Product comparison

Component	Size (mm)	Price (€)	Power Consumption (mW)	Weight (g)
TDS Sensor (SEN0244)	42 x 32 (cable ~800)	23	10–30	~32
Pressure Sensor (FSR406)	43.7 x 43.7	13	2–3	~3
UV-C LED Module	30 x 30	~30	0–5 (standby), 1000 (cleaning)	~3
Accelerometer (LIS3DHTR)	20 x 15 x 3	~10	0,165	2
Temperature Sensor (KY-015 DHT)	32 x 14 $\times$ 7	11	7	8
Piece of activated carbon	50 x 30	12	0	5 (dry), 10 (wet)
Microcontroller (ESP32 DevKit V1)	56 x 28 x 13	13	792	20
SSD1306 OLED Display (0.96“)	25 x 26	4	82,5	4

Summary

The analysis of existing concepts, projects and smart water bottles shows that many products address individual aspects of hydration and water quality. Some focus on hydration tracking and behavioral motivation through smartphone apps, while others integrate UV-C technology for disinfection or include filtration systems. However, there is currently no product on the market that combines UV-C disinfection, water filtration, volume tracking, mineral content measurement, and a user-friendly app with gamification in one integrated system. While individual features exist across different products, they have not yet been combined into a single solution. This represents a potential market opportunity for the TRAQUA concept.

At the same time, there is a growing trend toward tracking everyday behavior and focusing more on personal health and wellbeing. People increasingly monitor activity, sleep, and nutrition using digital tools. However, hydration and especially bottle hygiene are often neglected. Studies show that reusable water bottles are frequently not cleaned adequately, which can lead to bacterial growth, and many people drink less water than recommended. Research also demonstrates that digital reminders and tracking apps can significantly increase daily water intake.

These insights highlight the potential for a smart bottle like TRAQUA that combines hydration tracking, water quality monitoring, and bottle hygiene in one system while supporting healthier habits through an intuitive and motivating app.

---

[1], **[2]** Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, Marimuthu Palaniswami, 2023. Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions. *Smart Agricultural Technology*, [Accessed in March 2026]: Department of Electrical and Electronic Engineering, The University of Melbourne, Vic - 3010, Australia.
[3], **[4]** Barry M. Popkin, Kristen E. D'Anci, Irwin H. Rosenberg, 2010. Water, Hydration and Health. *NATIONAL INSTITUTES FOR HEALTH*, [Accessed in March 2026]: Department of Electrical and Electronic Engineering, The University of Melbourne, Vic - 3010, Australia, ISSN 1877-0509.
[5] Bo Dong, Ryan Gallant, Subir Biswa, 2014. *A self-monitoring water bottle for tracking liquid intake.* [Accessed in March 2026]: IEEE, ISBN 978-1-4673-6364-8.
[6], **[7]**, **[21]** Xiaodi Sun, Jooho Kim, Carl Behnke, Barbara Almanza, Christine Greene, Jesse Miller, Bryan Schindler, 2017. The Cleanliness of Reusable Water Bottles: How Contamination Levels are Affected by Bottle Usage and Cleaning Behaviors of Bottle Owners. *Food Protection Trends*, [Accessed in March 2026]: International Association for Food Protection, p.392-–402.
[9], **[23]** J. Bartram, 2002. Heterotrophic Plate Count Measurement in Drinking Water Safety Management. *Report of an Expert Meeting Geneva, 24-25 April 2002*, [Accessed in March 2026].
[10], **[27]** Ananta Jadhav, Kirti Sarkate, Sangita Phatale, 2025. Impact of drinking water TDS on serum calcium and magnesium levels: A Cross-Sectional Study. *International Journal of Medical Science in Clinical Research and Review*, [Accessed in March 2026]: IEEE, p.1269–1273, ISSN 2581-8945.
[11], **[12]** van C. Johnson, William M. Adams, 2020. Water Intake, Body Water Regulation and Health. *nutrients*, [Accessed in March 2026]: IEEE, p.702, ISBN 978-3-03928-657-7.
[13] LARQ, 2026. *LARQ Shop.* [Accessed in March 2026].
[14] AQUA VAULT PureX Bottle, 2026. *AQUA VAULT PureX Bottle Shop.* [Accessed in March 2026].
[15] HidrateSpark PRO Tumbler, 2026. *HidrateSpark Favorites. Shop.* [Accessed in March 2026].
[16] Medium A. Meer, 2024. *Smart Water Bottles.* [Accessed in March 2026].
[17] EQUA Smart Bottle Shop, 2026. *EQUA Smart Bottle Shop Smart Thermo Bottles.* [Accessed in March 2026].
[18] Thomas E. Stout, James E. Lingeman, Amy E. Krambeck, Mitchell R. Humphreys, Anna Zisman, Sarah Elfering, Tim Large, Philipp Dahm, Michael Borofsky, 2022. *A Randomized Trial Evaluating the Use of a Smart Water Bottle to Increase Fluid Intake in Stone Formers.* [Accessed in March 2026]: Elsevier Inc.

[19] YuChun Chena, Farrah Castleman, 2023. *Effects of Smart Bottles on Water Consumption and Health Status of College Students.* [Accessed in March 2026]: School of Kinesiology; Recreation & Sport; Western Kentucky University.
[20] Kavya M. Divakar, Pavan Kumar, Prajwal Naik, Moed Taha, 2023. *IoT Based Smart Water Bottle.* [Accessed in March 2026]: International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN 2321-9653.
[25] Joey Grostern, 2021. *Environmental impact of bottled water 'up to 3,500 times greater than tap water.* [Accessed in March 2026]: The Guardian.
[26] Pascal Nuti, 2023. *Welche Umweltauswirkungen haben Wasserflaschen aus Plastik und wie kann man sie vermeiden?.* [Accessed in March 2026]: lavie.