Article

First Evidence of the Possible Influence of Avoiding Daily Liquid Intake from Plastic and Glass Beverage Bottles on Blood Pressure in Healthy Volunteers

Liesa Geppner 1, Sophie Grammatidis 1, Harald Wilfing 2 and Maja Henjakovic 1,*

1 Department of Medicine, Faculty of Medicine and Dentistry, Danube Private University, Steiner Landstrasse 124, 3500 Krems, Austria
2 Human Ecology Research Group, Department of Evolutionary Anthropology, University of Vienna, 1030 Vienna, Austria
* Correspondence: maja.henjakovic@dp-uni.ac.at

Abstract: The global microplastic pollution issue, as a result of the indispensable usage of microplastics in building materials, packaged food, medical products and consumer goods, poses significant health problems for the population. These small particles can penetrate intact cell barriers in the intestines and alveoli, thereby entering the bloodstream. The aim of this pilot study was to investigate the effects of reduced plastic consumption on blood pressure. Eight adult and healthy participants abstained from consuming commercially produced bottled beverages and restricted their primary fluid intake to tap water. Blood pressure was measured on both sides before, after 14 days and after 28 to 30 days of this partial plastic diet. Women exhibit a significant change in systolic blood pressure on the right arm after 2 and 4 weeks, while the left arm demonstrates no significant changes in blood pressure. On the contrary, in men, systolic blood pressure values on both arms show no significant alterations, attributable to the high variability across the three participants. Moreover, no significant differences in systolic blood pressure were observed when analysing the entire cohort. Significant findings are evident only at the two-week mark for diastolic blood pressure for all participants in both arms. When considering diastolic blood pressure separately for women and men, men again show no significant changes in blood pressure on either arm. However, women exhibit a significant decrease in diastolic blood pressure on the left arm after 2 weeks and a statistically significant decline in diastolic blood pressure on the right arm after both 2 and 4 weeks. The results of the study suggest, for the first time, that a reduction in plastic use could potentially lower blood pressure, probably due to the reduced volume of plastic particles in the bloodstream. To confirm this hypothesis, a larger sample of male and female participants must be examined, ideally with the monitoring of plastic concentration in the blood.

Keywords: microplastics; nanoplastics; partial plastic reduction; drinking water; blood pressure

1. Introduction

Due to the absence of viable substitutes, plastics remain indispensable. It is important to acknowledge the role of plastics in items such as car tires, multiple building materials, medical products and food packaging that require transportation over long distances. Different types of plastics exist, with the most widely used polymers being polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC), and polystyrene (PS) [1]. Microplastics, comprising small fragments measuring between 5 mm and 1 µm, emerge as a consequence of plastic degradation induced by UV radiation, wind, and mechanical abrasion and have been identified in various environmental matrices including air, water, and soil [2,3]. The definition of the size of nanoplastic particles varies between 0–100 nm and 0–1000 nm (i.e., 1 µm) [4–6]. In some cases, the range between 100 nm and 1 µm is defined as sub-microplastics [7,8]. Particularly, smaller micro- and
nanoplastic particles can penetrate intact cell barriers in the intestines and alveoli, thereby entering the bloodstream and accumulating in various organs. Plastic particles larger than 0.7 µm have been detected in human blood [9] and different microplastic polymers have been found in human liver tissue [10]. This study identified commonly used plastics such as PP, PE, PS, and the typical material used for beverage bottles, PET [9]. The average plastic concentration of 1.6 µg per mL of blood [9] has drawn the attention of human toxicologists. However, direct evidence of the impact of plastics on human health is still lacking, as previous studies mainly investigated plastic-dependent effects in vitro and in animal models.

Based on in vitro, ex vivo, and animal studies, it can be assumed that plastic particles present in the bloodstream may have an impact on cardiovascular functions. Numerous in vitro studies have demonstrated that plastic particles have the capacity to damage the cell membrane of erythrocytes as well as activate platelets [11–14]. Ex vivo experiments have shown that plastic particles have the capacity to cause thrombus formation in blood vessels, which may ultimately result in vascular occlusion [14,15]. Additionally, it has been observed that anionic nanoplastics can induce endothelial leakage [16]. Similarly, findings indicate that PS microplastic beads are internalized in endothelial model cells (HUVECs) and inhibit angiogenic tube formation in a dose-dependent manner and that PS nanoplastics can induce autophagy [17–19]. While primary human umbilical vein endothelial cells (HUVECs) were incubated with relatively high concentrations of spherical PS nanoparticles in this model, the findings suggested the possibility of damage to the vascular wall by circulating plastic particles in the blood. It is also conceivable that plastic particles in the blood may have different shapes and chemical properties compared to model plastic particles, which could induce greater damage at significantly lower concentrations.

Furthermore, it has been shown that following single or continuous exposure to nan- and very small microplastics, heightened concentrations of the particles can be detected in animal blood, organs, and hearts [20–23]. Plastic particles have also recently been detected in human cardiac tissue extracted during cardiac surgery and within arterial plaque deposits [24–26]. Meanwhile, preliminary findings suggest that exposure to nano- and microplastic particles could negatively affect cardiovascular function in rats [21,27,28].

The purpose of this study was to investigate blood pressure in relation to plastic consumption. We sought a straightforward strategy to decrease plastic usage and concluded, following extensive research, that beverages packaged in plastic bottles should be avoided. Numerous studies have demonstrated a relatively high concentration of plastic particles in drinking water from plastic bottles [29–33], notably two studies that examined microplastics under 10 µm [34,35]. As described in these scientific publications, the quantity of plastic particles identified in water from plastic and glass bottles differs depending on the brand of bottle examined, the quality of the plastic bottles and, most notably, the size of the filtered particles. The number of particles is lower when microplastics larger than 10 µm are examined [29,34]. Few or no plastic particles have been found in tap water in several countries, e.g., in Spain, Germany, the Netherlands, Denmark, and Norway [36–40]. However, some exceptions may exist depending on whether the tap water derives from surface waters or groundwater, as seen in a particular region of China or in the Barcelona metropolitan area where a significant amount of plastic particles were detected [36,41].

Based on this literature research, it was hypothesized that daily tap water consumption could significantly decrease plastic usage. A microplastic analysis of tap water was not conducted on the assumption that the number of microplastic particles in tap water would be significantly lower than in beverage products packaged in plastic bottles. The responsible representatives of the waterworks in Austria have made a clear statement: “Microplastics could not be detected in Austrian drinking water,” which aligns with the current understanding of drinking water research [42]. To the best of our knowledge, there is no evidence to suggest that microplastics are present in drinking water in Krems City or elsewhere in Austria. Therefore, in this pilot study, participants obtained their daily fluid requirements exclusively from tap water while refraining from consuming plastic and
commercially produced bottled water. The initial results of blood pressure were recorded before and after following a partial plastic diet for a minimum of four weeks.

2. Materials and Methods
2.1. Study Participants

In the course of this study, we recruited 8 healthy participants without any pre-existing health conditions (5 women and 3 men, mean age 24 ± 2.9 years) with normal weight (body mass index, BMI 18.5–24.9 kg/m²) (Table 1). Data were collected at the Department of Medicine of Danube Private University in Krems at three distinct time points through interviews and physiological examinations.

Table 1. Subject characteristics.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Age</td>
<td>25 ± 3.5</td>
<td>23 ± 1.5</td>
</tr>
<tr>
<td>Size</td>
<td>167 ± 5.1</td>
<td>180 ± 8.7</td>
</tr>
<tr>
<td>Weight</td>
<td>59 ± 4.7</td>
<td>77 ± 9.5</td>
</tr>
<tr>
<td>BMI</td>
<td>21 ± 0.9</td>
<td>24 ± 0.9</td>
</tr>
</tbody>
</table>

Values represent means ± SD; n, number of participants. BMI, body mass index.

2.2. Experimental Design

During the course of the physiological measurements, the subjects were instructed to undertake a partial plastic diet, which involved minimizing the consumption of liquids from plastic and glass bottles and restricting their primary fluid intake to tap water. The restriction of daily fluid intake to tap water in Krems (Austria) is considered safe as the tap water meets drinking water standards. For this purpose, an initial measurement was performed prior to the initiation of the diet (day 0) and around the 2-week (day 14) and 4-week (day 28, 29 or 30) marks of abstaining from plastic bottled water consumption. The time intervals between these measurements were set at two-week intervals, with careful consideration to ensure that the subjects were consistently measured at the same time of day to avoid diurnal variation.

2.3. Data Collection

Participants were asked to lie comfortably on a reclining chair in a quiet examination room. To prevent the measured values from fluctuating according to the time of day, participants were always scheduled to be measured at the same time of day. Measurements were taken in a room with standard environmental conditions (temperature of 22–25 °C) to decrease the influence of external temperature changes on blood pressure values.

First, a questionnaire was filled out. At the first appointment, the participants’ health status was questioned, personal data were collected and the average consumption from plastic bottles was evaluated. In the subsequent sessions, it was asked on how many days the complete avoidance of plastic bottles could actually be implemented. After the query and following the relaxation of the participants, measurements were initiated. Participants were equipped with headphones playing soothing relaxation music and an eye mask to minimize the influence of visual and auditory factors. Participants spent at least 30 min in the examination room before blood pressure was measured, including a 20 min relaxation period.

A blood pressure cuff (Henry Schein Medical Austria GmbH, Vienna, Austria) was cautiously wrapped around the upper arm and gradually inflated until it surpassed the estimated systolic value, after which the cuff pressure was gradually released. Using a stethoscope (3M™ Littmann® Cardiology IV™ Diagnostic, Henry Schein Medical, Vienna,
Austria), Korotkoff sounds were recorded above the brachial artery. Measurements were taken from both the right and left upper arm.

2.4. Statistical Analysis

All data are represented as means ± SD. Statistical analyses were performed using one-way analysis of variance with Dunnett’s multiple comparison test for within-group comparisons (GraphPad Prism9, version 9.3.1). To assess the normal distribution of our data, the Shapiro–Wilk test was applied. For normally distributed data, a repeated-measures one-way ANOVA was subsequently performed, while for non-normally distributed data, a Friedman test was employed. Statistical significance was set at \( p < 0.05 \).

3. Results

Before initiating all measurements, participants were initially asked if they solely consumed tap water for their daily fluid intake or if there were any unique circumstances. Table 2 revealed that, with a few exceptions, most participants abstained from consuming plastic and glass bottled beverages.

Table 2. Compliance with the partial plastic-free diet was assessed by having the participants report daily on their ability to restrict their fluid intake to tap water. The data were collected over a certain period and expressed as a percentage.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Sex</th>
<th>Period Where the Plastic Diet Was Followed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 0–Day 14</td>
</tr>
<tr>
<td>P1</td>
<td>W</td>
<td>57</td>
</tr>
<tr>
<td>P5</td>
<td>W</td>
<td>100</td>
</tr>
<tr>
<td>P6</td>
<td>M</td>
<td>86</td>
</tr>
<tr>
<td>P9</td>
<td>M</td>
<td>71</td>
</tr>
<tr>
<td>P11</td>
<td>W</td>
<td>93</td>
</tr>
<tr>
<td>P12</td>
<td>M</td>
<td>86</td>
</tr>
<tr>
<td>P13</td>
<td>W</td>
<td>100</td>
</tr>
<tr>
<td>P14</td>
<td>W</td>
<td>100</td>
</tr>
</tbody>
</table>

To assess the possible effects of plastic reduction on the cardiovascular system, blood pressure measurements were carried out. Blood pressure was measured on both the left and right arm. In addition, the difference between systolic and diastolic blood pressure was examined and the variation between women and men was considered.

No statistically significant changes were found in systolic blood pressure on the left arm among the three measurement time points (Figure 1A). Significances also remained unchanged when the data were divided by sex (Figure 1B,C). In participants 1, 5, 12, 13 and 14, systolic blood pressure decreased from day 0 to day 14 and decreased again from day 14 to days 28–30 (Table 3). In participants 6 and 9, systolic blood pressure remained constant after one month (Table 3). Only in participant 11 did systolic blood pressure increase after a month of plastic reduction (Table 3).

Similar results were observed for diastolic blood pressure on the left arm. However, in Figure 2A, statistical significance was evident between day 0 and day 14. On measurement days 28–30, diastolic blood pressure slightly increased again, resulting in the significance value rising above the 0.05 threshold. Similar conclusions were observed for the women in Figure 2B. Among the men (Figure 2C), the values remained constant over time in two participants, but diastolic blood pressure increased in participant 6.

Systolic blood pressure on the right side exhibited similar results to that of the left side. There are no significant differences between the individual time points in Figure 3A. Only when a separation was made between women and men, both measurement times were statistically significant for women, with the lowest values after days 28–30 (Figure 3B, Table 4). For the men (Figure 3C, Table 4), a minimal increase in systolic blood pressure was
observed in the case of participant 6 and participant 9 and a greater decrease in participant 12, which did not lead to any significant changes in the male group.

Figure 1. Effect of plastic restriction on systolic blood pressure (BP) in the left arm. Systolic BP was measured at the left brachial artery at beginning of the plastic restriction (day 0), midway through the acquisition period (day 14) and upon completion of the plastic diet (days 28–30). Systolic BP data are presented (A) regardless of gender (n = 8), (B) for women only (n = 5) and (C) for men only (n = 3). Data points represent participants and crossbar represents the mean. Statistical significance was determined using a repeated-measurements analysis of variance with Dunnett’s multiple comparison test for within-group comparisons. n.s.: not significant.
Figure 2. Effect of plastic restriction on diastolic blood pressure (BP) in the left arm. Diastolic BP was measured at the left brachial artery at beginning of the plastic restriction (day 0), midway through the acquisition period (day 14) and upon completion of the plastic diet (days 28–30). Diastolic BP data are presented (A) regardless of gender (n = 8), (B) for women only (n = 5) and (C) for men only (n = 3). Data points represent participants and crossbar represents the mean. Statistical significance was determined using a repeated-measurements analysis of variance with Dunnett’s multiple comparison test for within-group comparisons. n.s.: not significant; *: p < 0.05.
Systolic blood pressure on the right side exhibited similar results to that of the left side. There are no significant differences between the individual time points in Figure 3A. Only when a separation was made between women and men, both measurement times were statistically significant for women, with the lowest values after days 28–30 (Figure 3B, Table 4). For the men (Figure 3C, Table 4), a minimal increase in systolic blood pressure was observed in the case of participant 6 and participant 9 and a greater decrease in participant 12, which did not lead to any significant changes in the male group.

Figure 3. Effect of plastic restriction on systolic blood pressure (BP) in the right arm. Systolic BP was measured at the right brachial artery at beginning of the plastic restriction (day 0), midway through the acquisition period (day 14) and upon completion of the plastic diet (days 28–30). Systolic BP data are presented (A) regardless of gender (n = 8), (B) for women only (n = 5) and (C) for men only (n = 3). Data points represent participants and crossbar represents the mean. Statistical significance was determined using a repeated-measurements analysis of variance with Dunnett’s multiple comparison test for within-group comparisons. n.s.: not significant; *: p < 0.05.
Table 3. Individual values of systolic blood pressure (BP) measured at the left brachial artery at three time points: at the beginning of plastic restriction (day 0), midway through the acquisition period (day 14), and upon completion of the diet (days 28–30).

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Sex</th>
<th>Systolic BP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 0</td>
</tr>
<tr>
<td>P1</td>
<td>W</td>
<td>98</td>
</tr>
<tr>
<td>P5</td>
<td>W</td>
<td>92</td>
</tr>
<tr>
<td>P6</td>
<td>M</td>
<td>102</td>
</tr>
<tr>
<td>P9</td>
<td>M</td>
<td>122</td>
</tr>
<tr>
<td>P11</td>
<td>W</td>
<td>95</td>
</tr>
<tr>
<td>P12</td>
<td>M</td>
<td>122</td>
</tr>
<tr>
<td>P13</td>
<td>W</td>
<td>96</td>
</tr>
<tr>
<td>P14</td>
<td>W</td>
<td>106</td>
</tr>
</tbody>
</table>

Table 4. Individual values of systolic blood pressure (BP) measured at the right brachial artery at three time points: at the beginning of plastic restriction (day 0), midway through the acquisition period (day 14), and upon completion of the diet (days 28–30).

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Sex</th>
<th>Systolic BP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 0</td>
</tr>
<tr>
<td>P1</td>
<td>W</td>
<td>96</td>
</tr>
<tr>
<td>P5</td>
<td>W</td>
<td>90</td>
</tr>
<tr>
<td>P6</td>
<td>M</td>
<td>102</td>
</tr>
<tr>
<td>P9</td>
<td>M</td>
<td>118</td>
</tr>
<tr>
<td>P11</td>
<td>W</td>
<td>102</td>
</tr>
<tr>
<td>P12</td>
<td>M</td>
<td>114</td>
</tr>
<tr>
<td>P13</td>
<td>W</td>
<td>96</td>
</tr>
<tr>
<td>P14</td>
<td>W</td>
<td>96</td>
</tr>
</tbody>
</table>

For the diastolic blood pressure of the right arm (Figure 4A), a statistically significant drop in blood pressure was only observed between day 0 and day 14, but after days 28–30, the values increased again slightly, showing no statistically significant difference compared to day 0. When examining women separately (Figure 4B), the comparison between day 0 and day 14 as well as days 28–30 was statistically significant. Men, however, (Figure 4A) exhibited constant blood pressure values.
Figure 4. Effect of plastic restriction on diastolic blood pressure (BP) in the right arm. Diastolic BP was measured at the right brachial artery at beginning of the plastic restriction (day 0), midway through the acquisition period (day 14) and upon completion of the plastic diet (days 28–30). Diastolic BP data are presented (A) regardless of gender (n = 8), (B) for women only (n = 5) and (C) for men only (n = 3). Data points represent participants and crossbar represents the mean. Statistical significance was determined using a repeated-measurements analysis of variance with Dunnett’s multiple comparison test for within-group comparisons. n.s.: not significant; *: p < 0.05.
4. Discussion

The objective of this pilot study was to investigate the hypothesis that a partial plastic diet could potentially impact blood pressure. The study focused on a group of eight young and healthy adults, comprising five females and three males. The participants consented to follow a partial plastic diet for four weeks and attend all examination appointments. Owing to the numerous instances of plastic particles found in both plastic and glass bottles [29,31,34,35], we devised a simple and widely applicable plastic-restricted diet. Consequently, we instructed participants to replace their daily fluid intake with tap water and abstain from drinks stored in plastic or glass bottles.

Blood pressure was measured on both the left and right sides on day 0, at 14 days, and at 28–30 days of the plastic diet. There were no significant differences found in systolic blood pressure before and after the plastic diet on the left side. On the right side, the systolic blood pressure of female participants significantly lowered after two and four weeks of reducing their plastic intake. However, due to the similar measurement pattern and high variance in blood pressure values on the left and right sides of the entire study group, no statistical significance could be determined with this limited sample size. Ideally, a larger sample size of participants should be used, and blood pressure should be measured on multiple days as recommended by experts [43]. However, taking multiple measurements may not always be feasible, particularly with an increased number of participants.

In both the whole group of participants and in females only, diastolic blood pressure on the left was lower after two weeks but not significantly altered after four weeks of the plastic diet. On the right side, diastolic blood pressure was significantly decreased in the whole group following 14 days of the plastic diet, as well as in females after two and four weeks.

Gender-specific disparities in the cardiovascular system are often discussed. For instance, one investigation indicates that young women exhibit lower arterial stiffness levels compared to their male counterparts [44]. In addition, studies have found a significant reduction in the activity of the autonomic nervous system in the regulation of blood pressure in females compared to males [45,46]. The exercise-dependent regulation of blood pressure has been found to vary with gender, similarly to how oestrogen is believed to protect middle-aged women against cardiovascular disease [47]. Our pilot study revealed significant differences in women on the partial plastic diet but not in the whole group or in the male participants. It is important to note that this interpretation is based on the sample size rather than biological sex differences. A decrease in blood pressure can be noted on both the left and right side when measured in male subjects individually, such as P12. As a result of some test subjects being unable to participate due to illness, the male subject group decreased, resulting in a more significant individual variance in the statistical analysis. It could be speculated that the female participants may have adhered more strictly to the plastic diet by abstaining from packaged foods. On average, all test subjects mostly followed the agreed-upon diet.

In considering the data, the influence of rising outside temperature during the study on diastolic blood pressure was considered. Previous research has described an association between high temperature and reduced systolic blood pressure in elderly patients due to a change in total peripheral rest, as summarized by Ferreira and colleagues [48]. However, as the pilot study subjects were young, athletic adults, it is unlikely that their blood vessels were significantly impacted by temperature. Furthermore, blood pressure measurements were obtained approximately 30 min after exposure to the ambient temperature, which averaged 22–25 °C, indicating that temperature impacts were minimal.

An alternative explanation for the reduction in blood pressure observed in this study could be linked to the decreased levels of phthalates found in the bloodstream of participants who refrained from consuming water from plastic bottles. Notably, multiple types of phthalates have been identified in plastic bottled water, including in commercially available products from Saudi Arabia and Spain, irrespective of brand [49,50].
The exposure of mice to di-(2-ethylhexyl) phthalate (DEHP), one of the commonly found phthalates, is known to increase their systolic blood pressure and heart rate [51]. Moreover, Wu and colleagues [52] have reported that exposure to phthalates during late pregnancy is associated with elevated blood pressure in affected women, as well as long-term changes in blood pressure trajectories.

A correlation between elevated urinary phthalate concentrations and cardiovascular diseases, such as type 2 diabetes and hypertension, has been shown in Australian men [53]. Additionally, a correlation between elevated phthalate concentrations and blood pressure levels has been demonstrated in Chinese adults aged 22–36 years [54]. The link between heightened phthalate levels and cardiovascular disease was also established in research conducted in the United States [55,56].

It is uncertain to what extent the blood pressure values of our test subjects were decreased by a four-week reduction in phthalate exposure. Based on these preliminary data, we believe that reducing the oral intake of plastic particles could potentially make a significant contribution to lowering blood pressure. These particles have been detected in high levels in plastic and glass bottles [34,35], and reducing their intake can potentially decrease their absorption into the bloodstream via the intestines. The limited presence of plastic particle circulation in the bloodstream may contribute to a diminished cardiovascular burden. As highlighted in various publications, the increased inhalation of particles, such as particulate matter, can be associated with elevated blood pressure values [57–59]. It is also assumed that particles present in the bloodstream may mechanically burden the circulation through their interactions with blood cells or the endothelium.

Based on the findings of our pilot study, indicating a reduction in blood pressure with decreased plastic consumption, we hypothesize that plastic particles present in the bloodstream might contribute to elevated blood pressure. This proposition is supported by research identifying plastic particles in human surgically excised artery plaques [25,26]. A study conducted by Marfella and colleagues further reinforces this notion, illustrating a positive association between elevated levels of plastic within arterial plaques and heightened risks of cardiovascular disease and mortality [26]. While factors such as physical fitness, diet, age, gender, and genetic predisposition are recognized influences of hypertension development, emerging evidence suggests that circulating plastic particles may also have an impact. These particles have the potential to interact with blood cells, potentially activating platelets, inducing vascular changes, triggering inflammatory responses, and consequently facilitating plaque formation. A significant reduction in the concentration of plastic particles within the bloodstream should mitigate the likelihood of adverse effects associated with plastic particle exposure.

5. Conclusions

In conclusion, this pilot study investigated the hypothesis that a partial plastic diet could potentially impact blood pressure levels in a small group of young and healthy adults. Although consistent statistical significance could not be established due to the limited sample size, remarkable trends were observed. Diastolic blood pressure, measured on the left and right arm, shows a statistically significant decline after two weeks. After four weeks, the statistical significance of diastolic blood pressure retention is evident in the left arm, whereas no statistically significant change is observed in the right arm due to greater data variability. The reduction in blood pressure in the female participants suggests a possible link between lower plastic intake and better cardiovascular health. The study recommends that further research with larger participant groups and expanded measurement protocols is needed to validate these preliminary findings. Factors such as gender differences in cardiovascular function and possible influences of reduced phthalate exposure were not relevant in our study, but should be investigated further. This research indicates that plastic exposure may be harmful, though the causal relationship is not fully understood. Observed changes in blood pressure suggest that reducing the oral intake of plastic particles could lower cardiovascular risk. These findings underscore the
importance of minimizing plastic use to prevent adverse health effects and highlight the need for more comprehensive research to clarify the connection between plastic exposure and cardiovascular health.

**Author Contributions:** L.G.: methodology, validation, formal analysis, investigation, writing—original draft, writing—review and editing. S.G.: formal analysis, investigation. H.W.: writing—review and editing. M.H.: conceptualization, methodology, formal analysis, investigation, writing—original draft, writing—review and editing, supervision, project administration. All authors have read and agreed to the published version of the manuscript. **Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Academic Integrity and Ethics Committee of Danube Private University (DPU-EK/045).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Data are contained within the article.

**Acknowledgments:** The authors wish to thank all participants of this study.

**Conflicts of Interest:** The authors declare no conflicts of interest.

**References**


