3.5. Tea Consumption in Relation to Health Outcomes

Table 6 shows associations between tea consumption and selected biomarkers. Blood draws for lipid analyses were based on fasting participants tested in the morning. For those analyses, the sample size was accordingly reduced. As shown, tea consumption was associated with higher high-density lipoprotein (HDL) cholesterol. There were no significant differences between tea consumers and non-consumers in terms of plasma triglycerides, LDL cholesterol, or blood pressure. There was a very weak but significant negative association between tea consumers and body weight: tea consumers had lower BMI values.

Table 6. Cardiovascular disease biomarkers and body weight among adults among tea consumers and non-consumers.

	N	Non-Consumers	Consumers	*p*-Value (Unadjusted)
High-density lipoprotein (HDL) Cholesterol				
Direct HDL Cholesterol (mg/dL)	12,416	53.49 (0.34)	55.41 (0.51)	0.0013
Direct HDL Cholesterol (mmol/L)	12,416	1.38 (0.01)	1.43 (0.01)	0.0012
Triglyceride and LDL cholesterol				
Triglyceride (mg/dL)	5900	121.7 (1.86)	125.88 (3.71)	0.3097
Triglyceride (mmol/L)	5900	1.37 (0.02)	1.42 (0.04)	0.3096
LDL cholesterol (mg/dL)	5817	113.99 (0.87)	115.75 (1.22)	0.2235
LDL cholesterol (mmol/L)	5817	2.95 (0.02)	2.99 (0.03)	0.2237
Blood pressure				
Average systolic blood pressure (mmHg)	12,725	122.21 (0.33)	123.52 (0.66)	0.0617
Average diastolic blood pressure (mmHg)	12,691	70.54 (0.25)	70.41 (0.4)	0.7097
Body weight				
Body mass index	12,711	29.29 (0.13)	28.70 (0.28)	0.0389

Correlation analyses examined the relation between amount of tea consumed (among consumers only) and cholesterol, triglyceride, and blood pressure outcomes. A weakly significant ($p = 0.048$) negative relation between tea consumption and direct HDL cholesterol was observed.

4. Discussion

As both research and dietary guidance shift from individual nutrients to composite food patterns [28,29], the relation between tea drinking and diet quality metrics is waiting to be explored. Tea can have a direct effect through bioactive compounds, but it can also be an indicator of, if not a vector for, healthier diets.

For the total NHANES sample aged ≥9 years, 18.5% were tea consumers. The prevalence of tea consumers was higher among adults >19 years (20.77%) and increased sharply with age: approximately 26% of adults aged >51 years drank tea. Song and Chum [8] noted in 2003 that 21.3% of US adults aged >19 years reported drinking tea daily; those numbers were comparable to those observed here. In parallel with the 1999–2002 HNANES [8], tea drinking was associated with higher education and incomes and was most common among non-Hispanic Asians and non-Hispanic Whites. Based on comparisons with other studies on beverage consumption patterns [5], that sociodemographic profile was counter to that observed with HC beverages. The consumption of sugar-sweetened beverages in the US generally tracks lower education and incomes.

Tea consumption among adults in the 2011–2016 NHANES was associated with higher diet quality scores, measured using NRF9.3 and HEI-2015 indices. The NRF9.3 index is nutrient-based and was adjusted per 2000 kcal to assess dietary nutrient density [25]. Tea consumers had more nutrient-rich diets with more protein, vitamins and minerals, and less added sugars. The HEI-2015 was designed to assess compliance with the 2015–2020 Dietary Guidelines and is mostly food based. Adult tea

consumers' higher HEI-2015 scores were largely due to a higher consumption of fruit, vegetables, seafood, and oils and lower consumption of added sugars and alcohol.

As shown in Table 3, adult tea consumers had significantly lower intakes of HC beverages and had diets with significantly less added sugar (Table 5). Coffee consumption was reduced among the top two tertiles of tea consumers by volume and milk among the top tertile only. The consumption of plain water, juices, diet beverages, or other tea (including herbal infusions) was not different across the two groups. Arguably, tea consumption was a characteristic of, if not a vector for, healthier beverage consumption patterns.

The flavonoid content of tea deserves a mention. The USDA nutrient composition databases now include bioactives and antioxidants [30,31], one major dietary source of which is tea. The relative healthfulness of different beverages has been explored before [32,33]. For example, the Beverage Guidance Panel [32] used the previously developed nutrient profiling approach to rank beverages according to their energy and nutrient contents. Water was ranked highest in order of preference and was followed by tea and coffee, low-fat (1.5% or 1%) and skim (nonfat) milk and soy beverages, and then low-calorie (LC) beverages, fruit and vegetable juices, whole milk, alcohol, and sports drinks, and finally by high-calorie (HC) sugar-sweetened beverages [32]. Even though tea and coffee were ranked second behind water, they were still viewed as problematic. The authors cautioned that the addition of milk, cream, or caloric sweeteners to tea or coffee would increase their energy density and lower nutritional value [32]. A version of beverage guidelines for Mexico [33] assigned beverages into 6 categories from most to least healthy: The levels were water, skim or low-fat milk, coffee and tea without sugar; LC beverages, HC beverages, and sugar-sweetened beverages [33]. In other words, the nutrient density of beverages was not based on their content of vitamins, minerals or bioactives but on the absence of calories, total or added sugars or total or saturated fat.

Measures of beverage nutrient density that rely on the absence of sugar and fat are themselves problematic. Popkin et al. [32] did suggest that the potential health benefits of flavonoids in tea ought to be more fully explored. Since then, studies have examined the impact of tea consumption on health outcomes [34–36]. Greyling [9] found a small effect in a meta-analysis of 11 pooled studies. Habitual tea consumption was associated with better health-related quality of life in older adults in China [37]. Another study reported a small reduction in blood pressure (SBP 2.36; DBP 1.77) [38]. Black tea also lowered LDL cholesterol especially among subjects at risk for CVD [36].

Recent activities by the US Food and Drug Administration (FDA) provide a further illustration of the shift in dietary guidance to from nutrients to foods, food groups and dietary ingredients [28,29]. The FDA's current definition of a healthy food is based on nutrient content per serving. The criteria include those for nutrients to limit (fat, sugar, and salt) and those for nutrients to encourage, including vitamin A, vitamin C, calcium, iron, protein, and fiber. The criteria are linked to elements in the Nutrition Facts label and serving size regulations. The 2015 citizen petition by KIND Inc, requested that the FDA revisit the definition of what constitutes a "healthy" food. The KIND bars, which contained nuts, did not meet the nutrient content claim for "healthy" because they contained more than 1 g of saturated fat per Reference Amount Customarily Consumed and because >15% of energy came from saturated fat. The KIND petition argued that nutrient density was more important than low fat content. Although the FDA has long favored the nutrient-based approach, certain food groups or ingredients may well be recognized as intrinsically healthy by the agency. Tea drinking may be one characteristic of healthy food patterns, along with whole grains, whole fruit and nuts and seeds. In that case, there is a need to adapt current nutrient profiling methods to facilitate federal regulations, recommendations and guidelines.

The present study had limitations. The sample size for <19 years old was limited by low tea consumption among children and adolescents, the groups most likely to consume SSBs. Because of the cross-sectional study design, any associations between tea consumption and obesity, BMI or health outcomes (blood pressure and lipid levels) should be interpreted cautiously and no causal inferences should be made. While NHANES dietary intakes were based on self-report, the scale and

representativeness of the NHANES sample make it the premier study of dietary intakes in the US and the foundation of food and nutrition policy.

5. Conclusions

Adult tea consumers had more nutrient-rich diets, containing more desirable food groups and more nutrients to encourage. Tea drinking, associated with higher socioeconomic status, was also associated with better dietary choices. In particular, tea consumption was associated with a significantly lower consumption of HC beverages and of added sugars.

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