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Analysis of the Impact of Population Share of Young Adults on the Healthy Beverage Market in High-income Countries

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by

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Abstract

In order to improve companies' and public health organizations' abilities to forecast the future beverage market volumes, it is crucial to identify the determinants of beverage consumption. Based on the market volume panel data from 2005 to 2020, this thesis formulates a fixed-effect model to examine the causal relationship between the population share of young adults and the market volumes of healthy beverages compared to unhealthy beverages in high-income countries. Furthermore, we conduct heterogeneity analyses of this relationship at the country and product levels. The results show that 1) the population share of young adults has a significant positive impact on the market volume of healthy beverages relative to unhealthy beverages in high-income countries; 2) in middle- and low-income countries, the population share of young adults has no significant impact on healthy beverages' market volumes; 3) among three product groups of cream, juice, and milk, the population share of young adults only positively impacts the market volume of healthy milk products. The findings suggest that beverage companies should make good use of the information of the young adult population to improve forecasts on future beverage consumption. At the same time, public health organizations need to improve young adults' nutrition knowledge, which plays an active role in their healthy beverage consumption behaviors and helps better prevent diseases such as obesity and diabetes.

Keywords: fixed effects, causal analysis, beverage consumption, population share of young adults, sugar-sweetened beverages

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Table of Contents

1 Introduction

1.1 Background

Every day, consumers are faced with a variety of beverage options and have to make their decisions. These decisions are of specific interest to the food and beverage companies. Meanwhile, under the pressure of globalization and continuous intensifying competition, companies are introducing a more comprehensive range and a more extensive variety of products to compete with each other (Kurajdová, Táborecká & Kašþáková, 2015). In this situation, well-established business plans and strategies are the keys for the company to stand out from its competitors. More companies in the food and beverages business have started paying attention to the underlying determinants of the beverages consumption patterns and use them as inputs for developing production and marketing strategies and forecasting future demand.

Moreover, beverage consumption patterns in a country are also of interest to public institutions, especially the public health organizations. The reason is that each kind of beverage is of different nutrition and thus is associated with different health outcomes in people. Some beverages, such as sugar-sweetened beverages (SSB), are considered to have an adverse effect on health and be highly associated with obesity and type 2 diabetes (DiMeglio & Mattes, 2000; Mattes, 2006; Schulze et al., 2004). Instead, other beverages such as white milk are considered beneficial to health. Milk is one of the most nutritious foods and has a positive impact on disease prevention of osteoporosis, type 2 diabetes, and breast cancer (Dairy UK, 2022). The public health organizations try to control the consumption volumes of SSB for certain groups of people susceptible to diseases of obesity and type 2 diabetes while recommending the consumption of beverages associated with health benefits. In recent years, public health organizations of some countries have been studying the determinants of beverage consumption which can help them better develop national dietary guidelines and address the significant public health challenges.

Previous studies have already outlined some demographic and economic factors that can be the determinants of beverage consumption in certain countries and regions. However, the factors still vary across time and countries; therefore, their impacts on beverage consumption volumes are also changing. In recent years, there have been two major trends influencing customers' perceptions and selections of food and beverages: the increasing desire to live a healthy life while also in balance with a more fast-paced lifestyle (Tetra Pak, 2015). A Tetra Pak Consumer Intelligence study found that more consumers are paying attention to the labels of food and beverages, and 55% of them are looking for nutrients that offer health benefits. Especially younger consumers and the consumers from developing markets are most likely to pay a premium price for products associated with health benefits (Nielsen, 2015), which shows that people from different age groups and

markets react differently to the healthy eating trends. Da Silva et al. (2022) also argue that people in high-income countries acquire more than 50% of their daily energy intake from ultra-processed foods, usually associated with unhealthy lifestyles.

On the other hand, consumers' busy lifestyles have posed a challenge to the traditional consumption patterns of food and beverages. NPD Group (2011) found that 10% of the U.S. population skip breakfast, and among those males aged 18-34 are most likely to skip breakfast. These strengthening trends of new consumption patterns among consumers must be carefully considered when studying the beverages markets. Specifically, heterogeneity of such impact on consumption between age groups and markets is of particular interest to both companies and public health organizations. Therefore, more studies have explored the relationships between the beverage's consumption patterns and the consumers' health perceptions and behaviors.

As people are increasingly conscious about their health and tend to prioritize the health benefit in the first place when they are making food choices, beverage companies are devoting their resources to exploring the nutritional beverages market. The global healthy drinks market is experiencing a fast-growing pace and is projected to see a compound annual growth rate of 7.88% from 2022 to 2027 (Mordor Intelligence, 2022).

Under this trend, the young adult sector is the market segment with significant future potential. Arnett (2000) refers to young adults as the age segment that possesses economic autonomy and can make independent decisions. Companies find the young adult sector to be appealing since it has the capacity to generate more revenues, and they invest a major percentage of their advertising budget in this demographic (Sheriff & Nagesh, 2007; Xie & Singh, 2007). Brownbill, Miller and Braunack-Mayer (2018) exemplify that sports and energy beverage companies heavily target young people that are interested in sports. This strategy contributes positively to the market growth by leveraging the interconnectedness and comprehensive coverage of social media. An example from Brazil where the healthy textured drink with rich grains and fruits was promoted as a healthy option for young adults who are concerned about their appearance and wellness (Tetra Pak, 2015), and the advertising is prevalent on the internet as it is the main platform where young adults obtain information. Besides, flavored milk is also introduced as a breakfast substitute to the young adult sector via the internet (Tetra Pak, 2015).

Additionally, the role of beverages is no longer drinks that provide essential hydration. It also serves as a source of nutrition which aids in sustaining physical and mental health. The transformation of beverages corresponds to the shift in people's lifestyles, particularly for young adults who are challenged by the pressures from school and jobs. They require healthy beverages to balance their lives.

Therefore, the young adult group is considered one of the driving forces in the healthy beverage market. As mentioned, many beverage companies are focusing on the healthy drinks market of the young adult segment, because healthy beverages can help them achieve a balanced lifestyle. Therefore, analyzing the healthy beverage consumption patterns of young adults across the factors

such as income, education level, and gender can help companies gain a bigger picture of this population.

1.2 Research Question and Purpose

The primary objective of our research is to examine the relationship between the population share of young adults and the beverages market volumes, which indicates the consumed volumes of a particular product in a country. Specifically, we want to test our hypothesis that the population share of young adults has a causal impact on the beverage market volume of healthy products compared to unhealthy products in high-income countries. By doing so, we will know whether this feature can be used to predict future market volumes.

In this paper, we only focus on ready-to-drink and non-alcoholic beverages. In order to test our hypothesis, we divide all the beverages into two categories, healthy and unhealthy, and investigate whether this relationship varies across these two categories. Furthermore, we divide all the countries into three groups according to their income levels: high income, middle income, and low income. Based on a company's current market volume data in the food and beverages business, we formulate a fixed-effects model to test our hypothesis and conduct heterogeneity analysis across country groups and product types.

Considering there has been a strengthening trend towards healthy products in recent years, companies need to know if this trend impacts the consumers' consumption patterns and how the impact would be on different beverage categories. Furthermore, by finding this causal relationship, companies can easily improve their ability to forecast future market volumes over mid to long-term horizons by forecasting the determinants and using them to predict the future market volumes. In the case of short-term forecasts, the time-series-based models can also be combined to improve the forecasting accuracy.

Finding the beverage market volume determinants and having accurate market volume forecasts is significant for businesses and public health organizations. For businesses, marketing strategies and supply chain management can be improved based on accurate forecasts of future market volume. Hashim et al. (2017) claim that management can achieve optimal profitability by applying strategic and tactical planning based on demand and sales prediction. Schmit and Kaiser (2006) point out the significance of future demand predictions and market factors forecasts in developing marketing strategies and production planning decisions. If a factor is proven to have significant effects on beverage consumption volumes, then it can provide product marketers with critical information such as customers segmentation; therefore, future marketing campaigns can also be adjusted accordingly to enhance the demand for particular products (Schmit & Kaiser, 2004; Kurajdová, Táborecká & Kašþáková, 2015). By identifying the determinants and forecasting the future market demand, we can examine whether the current consumption trends will extend or alter (Schmit &

Kaiser, 2006). For public health organizations, a better understanding of the key drivers in beverage consumption is of great value for policymakers, who can better develop the national dietary guidelines and thus improve the disease control and prevention efficiency for the diseases highly related to dietary habits. Mazarello Paes et al. (2015) studied the determinants of SSB consumption in young children to develop effective measures to control SSB consumption. Because previous studies have found that obesity and obesity-related diseases can be effectively controlled when the SSB consumption decreases (Hu, 2013).

However, although previous studies have found some macroeconomic, demographic, and behavioral factors that have a causal impact on the beverage market volumes, the conclusions are divergent between different studies. Therefore, based on the market volume data provided by a company in the food and beverages processing business, we want to investigate these market volume determinants in our specific context and hopefully provide the company with some implications for improving decision-making in the future.

2 Literature Review

2.1 Factors Influencing Beverage Consumption

Previous studies have explored factors that influence consumers' beverage consumption and these factors can be generally summarized into three aspects which are demographic factors, socio-economic factors, and other factors such as consumers' behavioral characteristics.

Several studies have found significant relationships between some demographic factors and beverage consumption volumes. Age is one of these factors. Some studies found that younger consumers tend to drink more high-calorie beverages. Storey, Forshee, and Anderson (2006) conclude an increasing trend in calorie intake from beverages for those under age 39; however, the trend starts to decrease for those above age 40. Besides, Da Silva et al. (2022) conduct a population-based study in Brazil to investigate the sociodemographic factors that affect the food consumption levels according to the degrees of food processing and the results show that age is negatively associated with the consumption of ultra-processed foods which includes dairy products, soft drinks, and juices. Popkin (2010) also showed that middle-aged adults drink more pure tea, coffee, and diet beverages which are usually associated with low calories than other age groups. Some studies have a special focus on milk consumption, and most of the results show that households with a greater presence of young children generally purchase more milk products (Kapaj & Deci, 2017; Kaiser, 2005).

According to previous studies, in addition to age, gender and ethnicity are also found to have causal impacts on beverage consumption volumes. Women are generally more health-conscious than men, and women are more likely to consume green food than men (Radam et al. 2010; Tobler et al. 2011). This conclusion is supported by Kim and House (2014) that men consume more noncarbonated SSBs such as fruit drinks, sports drinks, and energy drinks because those drinks account for a larger share of men's beverage consumption than women's. Besides, Nguyen et al. (2013) show that female-headed families significantly affect dairy products' expenditure. However, some studies found no significant relationship between genders and beverage consumption (Ebru & Neslihan, 2013). Although ethnicity has been a commonly studied factor in beverage consumption research, the conclusions are complex. They lack generalization because ethnic compositions vary across different countries and regions. Still, ethnicity is one of the important contributors to beverage consumption patterns and is usually considered in the modeling. For example, Storey, Forshee, and Anderson (2006) found some ethnicity-based evidence that Caucasians consumed more diet soft drinks than any other ethnic group and they also drank more sugary soft drinks than African Americans.

Moreover, socio-economic factors have also been widely discussed by researchers. Kapaj and Deci (2017) found that higher household income and higher education levels are positively associated with the consumption volume of dairy products within a household. Schmit and Kaiser (2004) also found that real per capita disposable income directly affects the per capita fluid milk demand in the U.S. However, Kim and House (2014) conduct a survey about beverage consumption habits, and the results show that milk and carbonated SSB consumption share is relatively smaller when consumers have higher income. Another study shows that in high-income countries, income has a negative effect on the consumption of high-calorie ultra-processed food, which means that as the income increases, the ultra-processed food consumption will decrease (Baraldi et al. 2018). In contrast, in a middle-income country, income positively affects ultra-processed food consumption (Cediel et al. 2018). Also, Vanderlee et al. (2021) conclude from their study which compares the SSBs consumption between countries (Australia, Canada, Mexico, the UK, and USA) that the participants (over 18 years old) from Mexico consume the most SSBs over the past seven days, while the other countries' participants have relatively low SSBs consumption, which indicates the difference between different income-level countries.

Education level is often used to indicate consumers' knowledge about beverages' nutrition which influences their consumption decisions (Kolodinsky et al. 2007). For example, Zhu et al. (2013) argue that education significantly affects consumers' perceptions towards green food in China, and consumers with higher education tend to consume more healthy green food. However, in middle-income countries such as Brazil, the level of education is shown to be positively related to less healthy ultra-processed food consumption (Da Silva et al. 2022). Interestingly, Kim and House (2014) studied how the US consumers' education levels affect their consumption patterns, and the results show no significant relationship between consumers' education level and their beverage consumption share.

Other factors such as consumers' behavioral characteristics, product characteristics, and residents' areas have also been discussed in the previous research. For example, Schmit and Kaiser (2006) have considered consumers' food consumption patterns of eating at home or eating out when investigating the primary factors contributing to fluctuations in demand for milk and cheese. Also, Da Silva et al. (2022) have considered two behavior variables, smoking status and sedentary behavior, in analyzing the food consumption patterns. The results show that non-smokers and consumers with sedentary behavior are associated with higher consumption of less healthy ultra-processed foods. Besides, many studies have found that the products' perceived taste, price, and nutritional content are also important motives for consumers' beverage selections (Krešić et al. 2010). Furthermore, according to some studies, the area of consumers' residency is also shown to influence beverage consumption patterns. For example, urban households tend to consume more processed milk and packaged milk, whereas most rural households prefer bulk milk (Gallup & Gilani, 2011).

2.2 Beverage Consumption Patterns of Young Adults

Beverage consumption patterns are significantly influenced by the availability and accessibility of food information, and media has become the essential platform for knowledge acquisition (Paquette, 2005). Freeman et al. (2016) point out that young adults (18-29) are highly active on the internet. They have more access to online information than the other age group, and often interact with each other by sharing and commenting on the online content, which accelerates the information flow between individuals. Marketers harness the peer-to-peer influence to promote their products to young adults since most young adults' purchasing decisions are inspired by their peers. Additionally, the marketing strategies for this age group yield better results because this population is an easily accessible market segment for commercial marketing and branding, and this population has low resistance to commercials (Calvert, 2008; Pechmann et al. 2005).

Mass media has a great capacity to affect consumers' behaviors. However, the evidence of the influence of social media and advertising on the beverage choices of young adults is mixed. Some argue that mass media shape the preferences of young adults toward healthy diets. They are obtaining health-relevant information from media and are inspired by positive images, making them increasingly health-conscious and paying more attention to the components and the nutrient content of the food or beverage (Lim et al. 2022). The study of the SSB consumption in the US (1999-2010) shows that the energy intake from SSBs experienced a downhill over the 12-year study period for the population of 20-39 years old for both sexes (Kit et al. 2013), the reduction of SSBs comes from the collaborative effort of public health and clinical medicine. Besides, the national public guidelines and campaigns also help improve health awareness through the mass media in the US (Benjamin, 2010). Korda and Itani (2013) summarize that mass media can be utilized as potential health promotion and education tools to change dietary patterns. However, people's ability to build a balanced diet has been hindered by information overload on the internet.

Some people disagree with the benefits of mass media and argue that online information misleads consumers. Because SSB producers use marketing campaigns to naturalize the brands within the adult culture and encourage more SSB consumption, particularly with sports and energy drinks that use athletes' or celebrities' endorsement to reinforce the value of the products (Brownbill, Miller & Braunack-Mayer, 2018). Moreover, they explain that SSBs are closely associated with weight gaining, and obesity, the regular intake of SSB beverages impairs health-related quality of life, and the intensive advertising on mass media is responsible for the current rise in the obesity rate among young adults.

Escoto et al. (2012) conclude from their research that time constraint is one reason that refrains young adults from keeping on a healthy diet. The survey participants (20-34 years ago) in the research explain that the challenges mainly come from the work and school pressures. It potentially affects the amount of time they spend making healthy meals and often skip breakfast at the cost of their health. Previous studies suggest that young adults consider beverages as conventional food replacement. They opt for beverages they perceive to be high in nutrition and value, such as dairy products and juices (Vella et al. 2014; Cong, Bremer & Mirosa, 2020). It is suggested that the characteristics of beverages make this food category the most popular alternative to traditional meals since (1) packaged beverages have a prolonged shelf life and protect the nutritional substances from spoilage; (2) they are lightweight and easy to be allocated and distributed; (3) the size, shape, and appearance of the beverages meet the demand of customers and create the opportunities for eating healthy on-the-go and between meals (Sanguansri & Augustin, 2009; Wootton-Beard & Ryan, 2011; Kausar et al. 2012). In addition to the time constraints of young adults, which result in the increased consumption of healthy beverages, Granato et al. (2020) describe that insufficient exercise, increased awareness of the benefits of diets, and the deteriorated health condition also drive up the healthy beverage market. Because young adults are seeking a balance between a high pace of life and a healthy lifestyle, as suggested by Otles and Cagindi (2012), a healthy diet may provide nutritional needs and aid in treating various disorders.

As discussed in the previous section, gender can impact beverage consumption patterns. Specifically, some studies have shown that males and females perceive the healthfulness of the food differently. According to the survey of the adult population (20-65 years) in Sweden (Bärebring et al. 2020), the gender difference in the healthfulness of food is distinct as most women hold negative attitudes toward the components such as sugar, alcohol and coloring agents, while men are less concern about the negative effect of those ingredients. Another study has demonstrated that young women pay more attention to foods' nutrition values and healthy eating information. They often read the label of food products regarding the content of sugar, salt, saturated fat, and calories before they make the purchases (Grunert, Wills & Fernandez-Celemin, 2010). The effects of gender on consumption are also shown to be significant among young adults. Piggford et al. (2008) conclude in their study on the Australian young adults (18-24) that gender makes a difference in the choice of healthy or unhealthy products. Because females have more concerns about weight control and pay more attention to the health benefits of the food and the expenditure on healthy food is higher than males. The gender consumption pattern holds consistent in the study

of US young adults (20-39) (Rosinger et al. 2017). They explain that males ingested an average of 179 kilocalories from sugar-sweetened beverages, accounting for 6.9% of total daily caloric consumption, compared to 113 kcal per woman, which accounts for 6.1 percent of woman's total caloric intake.

Storey, Forshee and Anderson (2006) focus on the beverage consumption pattern of the young adult (20-39) segment in the US, illustrating that this population acquires the most energy from beverages among the other age groups and consumption reaches the peak at this age. Additionally, females generally consume less energy from beverages than males in this demographic (20-39). Other factors such as ethnicity also influence the beverage intake in this age group, with African American young adults consuming more fruit juice than whites.

2.3 Summary

The current research gaps can be summarized in the following aspects. First, most of the previous studies are based on relatively small sample survey data (Da Silva et al. 2022; Ebru & Neslihan, 2013; Zhu et al. 2013) and many of them only focus on a specific country or region; few studies have done global analysis within this topic. Second, although many previous studies have examined the relationship between the beverage consumption patterns and many factors from economic, sociodemographic, and behavioral perspectives, some conclusions of those studies are contradictory. Thus, it is difficult to generalize a widely applicable rule from those studies. Third, much of the existing research on young adults mainly focuses on their links with alcoholic beverage consumption. There are relatively few studies that have focused on young adults' impact on non-alcoholic beverage consumption.

In order to narrow these research gaps, our study is based on a more global context with consideration of 106 countries' beverage market volumes around the world, and we have also considered a wider range of non-alcoholic beverage products. Considering that the conclusions from previous studies are divergent, we focus on our case's specific context and issues and conduct an empirical analysis. We compare our results to previous studies and arrive at our conclusions. Besides, we have a special focus on the role young adult consumers play in beverage consumption patterns. Hopefully, our study can contribute to a greater understanding of beverage consumption patterns and provide new insights for business practice, especially for food and beverage industry sales forecasts.

3 Hypothesis Development

Population demographics have always been considered in previous studies, and some age groups have been found to have significant associations with the consumption of some beverages. For example, Kaiser (2005) found that the population share of 5-year-olds and younger is the primary determinant of the per capita demand for fluid milk in the US. Also, Da Silva et al. (2022) consider several age groups (20-29, 30-39, 40-49, and 50-59 years old) in analyzing the food consumption patterns in Brazil. The results show that consuming fresh food and minimally processed foods, such as milk, 100% fruit juice, tea, and coffee, are positively associated with 30-39 age groups. In contrast, the consumption of ultra-processed food, such as soft drinks and juices, is negatively associated with age and is more popular among younger people. Therefore, we want to know whether the portion of the population of young adults (20-39 years old) could have potential effects on the beverage consumption volume in different research settings in our case.

The effects of different age groups on beverage consumption are usually associated with some specific characteristics of the corresponding age groups, which are typically the underlying causes for their impact on consumption. As discussed in the literature review, young adults are the main audiences of the new media platforms. They can be easily affected by the new food consumption trends of eating healthy and fast-moving consumption. On the one hand, the trend of eating healthy comes from people's increasing desire for health and wellness, and the trend is toward food and beverages associated with health benefits. On the other hand, the fast-moving consumption trend comes from today's busy and complex lifestyles, especially among urban consumers. Furthermore, the trend is towards food and beverages that offer convenience and sufficient energy supply, but those foods and beverages are usually associated with low nutrition values and high calories. In this case, we want to investigate how young adults would respond to these new trends of consumption patterns. Specifically, we want to know whether the population share of young adults would positively or negatively affect the consumption of beverages that offer more health benefits.

In our study, 106 countries from the world are considered. The consumption patterns of these countries can be wildly divergent because of differences in economics, population demographics and culture. Notably, a country's income level significantly impacts domestic consumption patterns. For example, consumers in high-income countries might pay more attention to the taste and quality of beverages. They would be more likely to pay premium prices for beverages that offer health benefits. However, compared to the high-income countries, consumers in the middle- and low-income countries might be generally more price-sensitive and less health-conscious. They might prefer beverages that offer good taste and sufficient energy regardless of the high sugar and calories. Da Silva et al. (2022) have found that higher-income consumers tend to consume less high-calorie ultra-processed food in high-income countries such as the US. In contrast, in middle-income countries such as Chile, higher-income consumers tend to consume more high-calorie ultra-processed food. Therefore, we divide the 106 countries into three income groups in our study to

examine whether young adults in countries of different income levels would have a different impact on the consumption volume of healthy beverages.

Therefore, the main hypothesis of our study is that the population share of young adults has a causal impact on the market volume of healthy products compared to unhealthy products in high-income countries. Moreover, the primary objective of our study is to examine this relationship and quantify its impact.

Our hypothesis also assumes heterogeneity in the relationship between the population share of young adults and beverage consumption of different products (healthy and unhealthy) in different country groups (high income, middle income, and low income). Furthermore, an increase in the population share of young adults in high-income countries is expected to have a positive effect on the consumption of healthy beverages relative to unhealthy beverages compared to the middle- and low-income countries. Therefore, we also conduct product and country heterogeneity analyses to test this hypothesis.

4 Data

4.1 Data Sources

Data used for our study is aggregated from different sources. The market volume of food and beverages data is provided by a company in the food and beverages industry. It covers 116 different countries over sixteen years (2005-2020) on an annual basis. The market volume dataset also contains information on a wide range of product types, package sizes, and ways of preservation. There are 27 different product categories. However, some products are not available in some markets over the entire time period. For example, 19 products were available from 2005 to 2016 in Australia; however, data on coffee-based drinks were not observed from 2017 to 2020.

In addition to the variable of our interest, other socio-economic factors, such as education, gender, and income are potential factors that affect the consumption of food and beverages. Therefore, based on the review of previous studies, we consider tertiary school enrollment ratio, young female share, and GNI per capita as our control variables. Data on these control variables are publicly available on online databases, such as the databases of the United Nations and the World Bank.

The population data is the latest 2019 Revision obtained from the United Nations. It contains detailed records on the population size from age 0 to 100 for different genders with a long horizon

from 1950 to 2100, which can be subdivided into estimates (1950-2019) and projections (2020-2100) according to the report from the United Nations (2019). It also states that the primary data source comes from the population censuses, which were conducted between 1950 and 2018. The population data provided by the United Nations is of high quality. Firstly, it covers 200 different countries and areas over a long period. Secondly, in the absence of data points, the estimates are acquired by projecting forward from the last available value while considering the estimated trend and the other demographic features such as fertility, mortality, and migration (United Nations, 2019). Since the data on the market volume is made available from 2005 to 2020, only the data points of the same period are considered in the hypothesis test.

The gross tertiary enrollment rate and GNI per capita are available through the World Bank, which offers country-level and annual records. The World Bank collaborates with 189 member countries to support the statistical system, and data at the country level is collected with professional standard guidance (The World Bank Group, n.d.). However, the quality of global data depends heavily on how well the national systems of member countries perform. Data from underdeveloped countries is not complete, and its quality is relatively low due to the limited statistical capacity. The incomplete data in underdeveloped countries can also be attributed to other factors, such as politics, economies, and wars.

4.2 Classification of Countries and Products

Although our hypothesis mainly focuses on the market volume of healthy products in high-income countries, we also want to investigate the heterogeneity between different countries and different products. Therefore, we classify our observations into three country groups by income levels and classify the beverage types into two product groups by their health benefits.

For the country classification, we use the Atlas GNI per capita indicator from the World Bank as our criterion. GNI is used to measure national wealth, and GNI per capita is the gross national income divided by the mid-year population and converted to U.S. dollars by the Atlas method of the World Bank (The World Bank, 2022). Based on the GNI per capita in U.S. dollars, the World Bank (2022) classifies countries and regions into four income levels: high-income, upper-middle-income, lower-middle-income, and low-income. Specifically, based on the data for 2020, the classification thresholds are higher than 12535 (high-income), 4046 to 12535 (upper-middle-income), 1035 to 4045 (lower-middle-income), and the rest are classified as low-income (Hamadeh, Rompaey & Metreau, 2021). In this paper, we combine the upper-middle-income and lower-middle-income into a combined middle-income group to make comparisons easier.

To classify healthy and unhealthy beverages, we combine criteria from different organizations. The Public Health Law Center (2020) at Mitchell Hamline School of Law published the Healthy Beverage Policies, consisting of key definitions and sample standards of healthy beverages and sugar-sweetened beverages. According to the policies, an essential criterion in defining healthy and

unhealthy drinks is whether it contains added sugars. Healthy beverages mainly include water, unsweetened milk, unsweetened coffee and tea, and 100% fruit juice. Instead, unhealthy beverages mainly include soft drinks, fruit drinks, tea and coffee drinks, energy drinks, sports drinks, and sweetened milk. However, these definitions are not comprehensive because some beverages have more complicated impacts on health, calorie intake, and weight gain (The Public Health Law Center, 2020). For example, flavored milk is typically classified as unhealthy because it contains added sugars; however, the Public Health Law Center considers flavored milk a healthy beverage because of its nutritional value, regardless of its added sugars. Similarly, 100% fruit juice is typically considered as healthy because it is free of any added sugars, but it's also recommended for limited consumption because of its natural sugars. Apart from the Healthy Beverage Policies, Popkin et al. (2006) proposed a Beverage Guidance Panel, which ranked the beverages into six levels based on their essential nutrient contents and health benefits. This panel is also used as the Healthy Beverage Guidelines by the School of Public Health at Harvard University. The U.S. Centers for Disease Control and Prevention (2022) defines healthier drink options consisting of drinks with limited calories and important nutrients.

Based on the policies and guidelines mentioned above, Table 1 shows the classification results of the products in our dataset. It is interesting to note that soy milk is classified as healthy, whereas rice, nut-, grain- and seed-based drinks are unhealthy. This is based on the U.S. Dietary Guidelines for Americans (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015), which argue that soy beverages are better milk alternatives and point out that other plant-based milks including almond and rice milk are not recommended because of their complex nutritional contents. Besides, the classification of non-dairy cream and liquid cream classification is mainly based on their relative nutrition. Compared to liquid cream, non-dairy cream is generally a healthier choice since it typically contains less fat and fewer calories.

Table 1. Product Classification

Healthy Beverages	**Unhealthy Beverages**
Baby & Toddler Dairy Drinks Buttermilk Drinking Yogurt Evaporated Milk Juice (100%) LAD (Lactic Acid Drinks) White Milk Soy Milk Non-Dairy Cream	Energy Drinks FFSD (Fruit-Flavored Still Drink) Flavored Milk Nectar Sports Drinks Sweetened Condensed Milk Tea Based drinks Coffee Based drinks Rice, Nut, Grain and Seed Based Drinks Liquid Cream

We removed some products in our study for the following reasons. Firstly, we remove all the alcoholic drinks because whether alcohol can be considered as healthy or not is extremely sensitive to how much and how often people drink alcohol. Therefore, it is not appropriate to simply classify

alcoholic drinks as healthy or unhealthy. Traditional cultured drinks are also removed from our research because the products within this category are too dissimilar and complex. For example, some traditional cultured drinks can be alcoholic. Therefore, it is difficult to define this category as healthy or unhealthy without detailed specifications. Lastly, carbonated soft drinks, hot coffee, and hot tea are also removed from our research because our market volume data is acquired from a company in the food and beverage business and these products are not of their interest.

According to the company that provides the data, data on water consists of water beverage consumption and the amount of tap water used. However, tap water is used for both drinking and other purposes, such as cooking, washing, and laundering, and water for different usages is delivered through the same pipe. Therefore, it is difficult to accurately measure the proportion of water used for drinking, which also varies considerably across countries. As a result, the data quality of water is relatively low. Moreover, water is typically regarded as a basic necessity, and most consumers drink water to stay hydrated. Although water is the healthiest beverage recommended by the Public Health Law Center (2020), in most cases, consumers do not drink water for its health benefits. Therefore, from customers' perspectives, water is a neutral product rather than a healthy or unhealthy product. Considering that our study focuses on the differences between healthy and unhealthy products, we remove water from our analysis otherwise water will add noise and make the results less accurate.

4.3 Data Processing

We combine data from three different sources to construct the dataset in our research. The dependent variable, market volume per capita, is obtained by dividing the products' market volume by the country's total population each year. In the original market volume data, there are 52 records showing zero market volume which is because those data are not observed by the company. These zero market volume records do not provide any useful information for our analysis and may cause bias. Therefore, we remove these observations.

Independent variables, such as young adults (20-39) share and young females share, are calculated from the population dataset. The ratio of males to females is computed to see if there is any extreme gender imbalance problem. The interquartile range is introduced by Vinutha, Poornima, and Sagar (2018) to detect data points that deviate from the general pattern. They state that the presence of outliers may distort the result of statistical analyses. Therefore, observations from countries such as Qatar, Saudi Arabia, Kuwait, and other 15 countries are removed because the gender ratio in these countries are abnormal.

A dummy variable is constructed to indicate whether a product is healthy or not, with 1 representing healthy and 0 for unhealthy. Furthermore, a new variable is created to specify which income level

the countries belong to. There are three levels, ranging from 1 to 3 for high-, middle-, and low-income, respectively.

Data on GNI per capita and tertiary enrollment rate are observed from 1960 to 2020. However, the data is sparse and contains a lot of missing values. Chen (2014) suggests that the education level of the population has a slow and steady increasing trend, therefore linear interpolation is employed to fill in the missing values of tertiary enrollment rate from 2005 to 2020. Honaker and King (2010) recognize the smooth growing tendency of some economic indicators, such as GDP, human capital, and GNI per capita. They argue that the true values do not fluctuate much and often lie around the smooth trend. Therefore, the linear imputation technique is employed to fill in the missing values of GNI per capita from 2005 to 2020.

Additionally, Taiwan accounts for most of the missing values in GNI per capita and tertiary enrollment rate, as the observations from 2005 to 2020 are missing. No available statistics records can be found in the World Bank. Data on the GNI per capita can be found on the National Statistics website of the Republic of China (Taiwan). However, there is no clear demonstration about which method is used in the calculation of GNI per capita. In order to avoid errors, those data are not used in our study. Therefore, we remove Taiwan's missing values in GNI per capita and tertiary enrollment rate, which account for 1.3% of the total observations.

In the original data, the numeric variables are measured in different units. Variables such as GNI per capita, market volume per capita, young adults share, and tertiary enrollment rate are not normally distributed. In particular, market volume per capita is highly skewed and has a long right tail because the values vary considerably between countries and products, resulting in a wide range. Wooldridge (2015) suggests taking the log of the variables to narrow the range and reduce the negative impact of outliers in this case. Moreover, the logged variables are easier to interpret regardless of their different measurements. To ensure the data quality and improve the linearity between variables, the natural logarithmic transformation is applied to all the numeric variables.

4.4 Descriptive Statistics

The dataset contains 21899 observations and 10 variables, and the variable description is shown in Appendix A, covering 106 countries and 19 different types of products. As shown in Table 2, the country observations in different income levels are not balanced. There are fewer observations in low-income countries compared to high- and middle-income countries. The poverty problem and the lack of technical support are the main reasons contributing to the shortage of data in low-income countries. Also, the available products in low-income countries are not as common as in high- and middle-income countries. For example, only 9 different product types in Yemen are reported in our market volume data.

The average population shares of young adults are 0.27, 0.31, and 0.29 in high-, middle-, and low-income countries, as middle-income countries' population comprise relatively more young adults. Moreover, the proportion of young females is almost the same in countries with different income levels. However, the difference in average tertiary enrollment rate is significant between different income levels. High-income countries have the highest tertiary enrollment rate, which is 72.95% on average. In contrast, middle- and low-income countries have only 37.24% and 10.71% average tertiary enrollment rate. On average, the per capita market volume for all beverage types is the highest in high-income countries and the lowest in low-income countries. The difference in GNI per capita between different income groups is considerable as expected because this is our criterion for classifying income groups.

Table 2. Descriptive Statistics

	High-income		Middle-income		Low-income	
Countries	35		62		9	
Observations	8666		11865		1368	
Variable	Mean	S. D	Mean	S. D	Mean	S. D
Market Volume Per Capita	0.00034	0.00068	0.00017	0.00039	0.00007	0.00026
Young Adult Share	0.27	0.03	0.31	0.02	0.29	0.02
Young Female Share	0.49	0.01	0.50	0.01	0.50	0.01
Tertiary Enrollment Rate	72.95	16.57	37.24	23.01	10.72	10.07
GNI per capita	36401.31	18581.91	4938.95	3380.12	1189.67	1862.40

Note: The table provides descriptive statistics for variables used in the empirical analyses. Numeric variables are reported with their values before the logarithmic transformation. No statistics are available for string variables.

5 Econometric Approach

Our main objective is to examine the hypothesis that the population share of young adults has a significant impact on the market volumes of healthy beverages in high-income countries, compared to unhealthy beverages. In order to examine this hypothesis, we conduct empirical analyses using

a fixed-effect model. Moreover, to test the heterogeneity in the effect of the population share of young adults on market volumes, we conduct country-based and product-based heterogeneity analyses.

Following previous studies (Da Silva et al. 2022; Kim & House, 2014; Schmit & Kaiser, 2004), we consider the following fixed effects panel data model to examine our hypothesis about the relationship between the population share of young adults and the beverage market volumes:

$$\begin{aligned}\ln MV_{ipt} &= \beta_1 \ln POP_{it} + \beta_2 \ln FEM_{it} + \beta_3 \ln EDU_{it} + \beta_4 \ln INC_{it} \\ &+ \beta_5 \left(\ln POP_{it} \times healthy_p\right) + \beta_6 \left(\ln FEM_{it} \times healthy_p\right) \\ &+ \beta_7 \left(\ln EDU_{it} \times healthy_p\right) + \beta_8 \left(\ln INC_{it} \times healthy_p\right) + I_{ip} + I_t + \varepsilon_{ipt}\end{aligned}$$

Here, *i* indexes countries, *p* indexes products, and *t* indexes years. MV_{ipt} is product *p*'s per capita market volume in year *t* and country *i*. POP_{it} is the population share of young adults in country *i* in year *t*. Besides, FEM_{it}, EDU_{it} and INC_{it} are the control variables, which respectively indicate year *t*'s portion of female population in the young adults' group, the country's tertiary education enrollment ratio and the per capita gross national income in country *i*. $healthy_p$ is a dummy variable, indicating whether a beverage is healthy (1) or unhealthy (0), based on the classification criteria in the previous section. Interaction terms of the healthy dummy and all the independent variables are also introduced. All the independent variables and the dependent variable are in natural logarithms. I_{ip} and I_t are country-product and time fixed effects, respectively. ε_{ipt} is the error term.

POP_{it} is the independent variable we are most interested in. It is measured by the portion of young adults' (aged 20-39) of a country's total population in a specific year. The association between young adults' population share and market volumes is expected to vary across healthy and unhealthy products, we therefore include an interaction term, $POP_{it} \times healthy_p$, which measures the specific effect of young adults' population share on the healthy products' market volumes. Based on our hypothesis, an increase in the population shares of young adults in high-income countries will increase the market volumes of healthy products. Therefore, the coefficient estimate of the interaction term is expected to be positive.

In order to better observe how young adults' population share will affect the market volumes, we considered gender share, tertiary education enrollment ratio and income level as our control variables, which are FEM_{it}, EDU_{it} and INC_{it}, respectively. Besides, we also want to know whether the relationship between these control variables and the market volumes would vary across the healthy and unhealthy products, so the interaction terms of the control variables and the healthy dummy variable are introduced.

According to Ebru and Neslihan (2013) and De Alwis et al. (2009), family income significantly affects packaged milk consumption. Also, Kapaj and Deci (2017) found that a household's consumption of dairy products will increase as the household's income increases. Additionally, Zhu et al. (2013) found that education has significant effects on consumers' green food

consumption desires in China. Based on these previous studies, we assume that increasing the income level and the tertiary education enrollment ratio in a country will increase the market volumes of healthy products. The coefficient estimates of these interaction terms are expected to be positive. As for the impact of gender, Radam et al. (2010) conclude that women are generally more health-conscious than men. Moreover, Nguyen et al. (2013) found that female-headed households have a significant effect on the expenditure on dairy products. Besides, Kim and House (2014) found that men may consume more noncarbonated SSB than women, such as fruit drinks, sports drinks, and energy drinks, which are classified as unhealthy products in our study. Therefore, based on previous studies, we expect that women are more likely to consume healthy products than men and the coefficient estimate of the interaction term of female share and the healthy dummy is expected to be positive, meaning the market volumes of healthy products will increase when the portion of the female population increases in a country.

Country-product, and time fixed effects are introduced to control for omitted variables. They allow us to control the effects of time-invariant omitted variables, and country-product invariant omitted variables without the need to have observations on all these confounders. For example, year fixed-effects can control the impact of changing business cycles and macroeconomic fluctuations over the time period of the study; otherwise, we need to quantify these effects which are sometimes unobservable. Therefore, fixed effects allow us to control the endogeneity caused by omitted variables and make the causal effect estimation much easier.

Considering that fixed effects are introduced in our model and the relatively small sample size, we conduct a linear regression with both country-product fixed effect and year fixed effect, using the ordinary least squares (OLS) method. The panel data we used in our study has three dimensions: country, product, and year. There are many observable and unobservable confounders at the country level and year level; this is where the fixed effects come and play a role. Also, an F-test of the individual and time fixed effects is conducted, and the result shows that the fixed effects model with individual and time effects is a better choice than the pooled OLS model. In addition, in order to account for the heteroscedasticity problem caused by serial and cross-sectional correlations, we apply robust standard error clustered at the country level and year level.

6 Main Results

6.1 All Products in Each Income Group

In this section, we conduct analyses on all products for each income group. The results are shown in Table 3. We will first focus on the results of high-income countries. Furthermore, we also discuss

the results of middle- and low-income countries and explain the heterogeneity in different income groups.

Table 3. Results for All Products in Each Income Group

Variables	**ln *MV***		
	High-income	**Middle-income**	**Low-income**
ln *POP*	0.4056 (0.3569)	0.4239 (0.7876)	-0.1655 (2.033)
ln *FEM*	-3.6711 (2.524)	-2.0608 (5.223)	-0.9274 (8.843)
ln *EDU*	-0.1248 (0.1538)	0.4458** (0.1434)	0.4220 (0.4458)
ln *INC*	0.4582* (0.1566)	0.4896** (0.1285)	0.5634*** (0.0530)
ln *POP* × *healthy*	0.9680* (0.4126)	0.0188 (0.6302)	1.1904 (0.8778)
ln *FEM* × *healthy*	6.5842* (3.048)	0.6825 (3.636)	-14.4802 (8.445)
ln *EDU* × *healthy*	-0.3550 (0.1957)	-0.4105* (0.1583)	-0.0414 (0.3247)
ln *INC* × *healthy*	-0.4475** (0.1160)	-0.1250 (0.0892)	0.0053 (0.1073)
Country-Product Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Observations	8,666	11,865	1368
Within R2	0.0460	0.0414	0.1074

Notes: ① the dependent variable is the logarithm of the market volume per capita. ② Numbers inside the parentheses are robust standard errors clustered at the country and year levels. ③ Healthy is a dummy variable indicating the product is healthy. ④ *** indicates $p<0.001$, the result is significant at a 0.1% level; ** indicates $p<0.01$, the result is significant at a 1% level; * indicates $p<0.05$, the result is significant at a 5% level.

6.1.1 All Products in High-income Countries

According to the results shown in Table 3, the estimated coefficient of the interaction term of young adult population shares and healthy dummy variable is 0.968, and it is significant at a 5% level. Since the variables are in logarithm, the estimated coefficients indicate the effect on the percentage changes of per capita market volume when an independent variable changes by one percent. Therefore, when the population share of young adults increases by 1%, the per capita market volume of healthy products will increase by 0.968% relative to unhealthy products in high-income countries, holding all other conditions constant. It indicates a significant difference in the effects of young adults on the market volumes of healthy and unhealthy products in high-income countries, and young adults have significant positive effects on healthy products' market volume. However, the results show that the population share of young adults has no significant effect on the market volume of unhealthy products.

The results support our hypothesis about the relationship between the population share of young adults and market volumes of healthy products compared to the unhealthy products in high-income countries. Furthermore, the relationship is shown to be positive. This suggests that in high-income countries young adult consumers attach significant importance to healthy products. They tend to consume more beverages associated with better nutrition, lower sugar, and lower calories which are the classification criteria for the healthy beverages in our study. This finding is consistent with Kit et al. (2013). They found that the consumption of SSB decreased from 1999 to 2010 among the population of 20- to 39-year-old in the US, indicating that young adult consumers in high-income countries are getting more health-conscious and tend to purchase fewer unhealthy SSB beverages. Nielsen (2015) published a report about healthy eating trends around the world. They found that younger consumers (21-34) pay the most attention to healthy attributes of the food. They are also most willing to pay a higher price for foods and beverages that offer health benefits. In addition, in high-income countries, consumers are facing more available healthy product choices and the healthy categories are growing faster than the indulgent categories, which are mostly associated with unhealthy foods (Nielsen, 2015). Therefore, the strengthening health consciousness of young consumers and the increasing healthy choices in the market might be the primary reasons for the significant impact of young adults on healthy beverage consumption in high-income countries.

The results also support the expected effects of the control variables on per capita market volume. Income shows a significantly positive impact on the market volume of unhealthy products. Meanwhile, gender and income are shown to impact healthy product consumption compared to unhealthy products significantly. However, the results show that education has no impact on both healthy and unhealthy products' market volumes, and gender does not impact unhealthy products' market volumes.

Although income has a significant impact on both healthy and unhealthy products' market volumes, it is interesting to note that income only has little impact on the healthy products' market volume in general, because the sum of the income term's and its interaction term's coefficients

approximates zero. This indicates that income generally does not affect healthy products' consumption, but it has a much larger positive effect on unhealthy products' consumption. The finding is different from some previous studies, and several reasons can potentially account for it. First, Kaiser (2005) found that the patterns of eating at home or eating out could impact the food and beverages demand. In high-income countries, more people like to eat away from home when their incomes increase; in this case, they tend to consume more unhealthy sugar-sweetened beverages, usually ordered by people when eating in restaurants. Also, the results vary from some previous studies due to the differences in product classification criteria. For example, Baraldi et al. (2018) found that the consumption of less healthy ultra-processed food decreases as income increases in the US. However, their definition of ultra-processed foods contains various food categories other than beverages.

Compared to unhealthy products, we find that the consumption of healthy products will increase when the proportion of female consumers increases. It suggests that women are generally more health-conscious than men, which is consistent with previous studies (Radam et al. 2010; Tobler et al. 2011). However, education level has no significant impact on the consumption of healthy beverages, indicating that consumers with higher education would not necessarily be more health-conscious and purchase more healthy beverages. This is consistent with Kim and House (2014), who found that education levels did not significantly correlate with the beverage consumption share of consumers from the US.

6.1.2 All Products in Middle- and Low-income Countries

In middle-income and low-income countries, the population share of young adults does not have a significant effect on the market volume of healthy beverages compared to unhealthy beverages. However, as mentioned in the previous section, the population share of young adults is positively related to healthy beverage consumption in high-income countries.

In high-income countries, increasing health awareness might be the primary reason which makes young adults the driving force behind the consumption of healthy products compared to unhealthy products. However, the result in Table 3 suggests that it does not apply to the young adults in the middle- and low-income countries. Sinclair (2016) suggests that the market for sugary drinks is suffering a loss as a result of the rising health concerns in high-income countries, and companies are shifting their focus to the emerging market, namely Asia, Latin America, and the Middle East, where people do not commonly realize the negative effect of sugar-sweetened beverages. She further explains that sugary drink companies use social media platforms to promote their products and the marketing approach is particularly effective at engaging young adult groups. This illustrates that the behaviors of young adults in the middle- and low-income countries are affected by the marketing information which encourages the consumption of unhealthy beverages relative to healthy beverages. Furthermore, our results are consistent with the finding of Vanderlee et al.

(2021), who point out that consumers from middle-income countries are less likely to contribute to healthy beverage consumption.

Income positively impacts unhealthy beverages' consumption in the middle- and low-income countries, but it does not contribute to healthy beverages' consumption compared to unhealthy beverages. In middle- and low-income countries, people consume more unhealthy products as their income increases. Previous studies found that people in developing countries are less likely to spend their money on the healthy food (Rocha et al., 2021), which usually charge a higher price than the less healthy food (Drewnowski & Darmon, 2005; Darmon, Briend & Drewnowski, 2004; Darmon, Ferguson & Briend, 2002). Healthy products are typically perceived as premium products with multiple benefits in these countries, and consumers are less interested in them because it is more important for them to satisfy their basic needs through regular products regardless of low nutrition.

Education significantly affects the unhealthy beverages' market volumes in middle-income countries. Unhealthy products' per capita market volume will increase by 0.4458% when the tertiary enrollment rate increases by 1%. In comparison, the per capita consumption of healthy products increases less than unhealthy products, with a coefficient of -0.4105, significant at a 5% level. This suggests that young adults with higher education consume more unhealthy beverages than healthy beverages. Our result is consistent with Guzman-Vilca et al. (2021). They suggest that people with higher education levels are associated with more SSB beverage consumption than people with low education levels in Peru (middle-income country). However, the result is different from the conclusion of Epifânio et al. (2020). They suggest that the consumption of sweetened soft drinks is lower among young people (18-29 years old) with a higher level of education in Brazil (middle income country). The divergence of the results could be explained by the fact that Epifânio et al. (2020) only compared the consumption of juice and soft drinks. Additionally, their survey respondents were people aged 18 to 29 in Brazil. However, our study considers a wider variety of products, and our definition of young adults is people aged from 20 to 39 in 62 different middle-income countries.

Young females' population share has no significant effect on healthy beverage consumption in the middle- and low-income countries. In contrast, the young female share significantly impacts healthy beverage consumption relative to unhealthy beverages in high-income countries. Previous studies have highlighted the gender differences in food preferences, and most studies suggest that females in middle-income countries positively impact the consumption of healthy food and beverages. For example, the research by Nguyen et al. (2013), who investigated dairy products in Vietnam, and the study by Zhu et al. (2013) who compared consumption of green foods in China, concluded that the effect of females on healthy food consumption is significant. However, previous studies are primarily focused on a specific country or a selected group of middle-income countries with specific products. Our study considers a more comprehensive range of countries with a wide range of products. Therefore, the differences in product categories, sample size, and demographics might be the primary factors that contribute to the inconsistent results. For low-income countries, Lampietti and Stalker (2000) explain that females in low-income countries are at a socio-economic

disadvantage. They are worse off than males in terms of food allocation. Therefore, the change in young females' share does not associate with the consumption of healthy beverages in low-income countries.

In summary, income is a determinant that affects the consumption patterns of young adults in countries of different income levels. However, there is no significant evidence suggesting the impact of young adults' population share on the market volume of healthy and unhealthy beverages in the middle- and low-income countries.

6.2 Different Products in High-income Countries

In this section, we select three groups of products where each group consists of healthy and unhealthy products that are generally perceived as alternatives to each other. For example, the first group consists of liquid cream and non-dairy cream, and non-dairy cream is considered a healthier choice because it typically has fewer calories and less fat than liquid(dairy) cream (Shoemaker, 2022). After the grouping, we conduct a separate analysis of each group. The results are shown in Table 4. We want to examine whether the effect of young adults on beverage market volumes would vary across different product groups in high-income countries.

The first group consists of liquid cream and non-dairy cream. As previously mentioned, non-dairy cream is typically a healthier choice than liquid cream. Thus, we classify non-dairy cream as a healthy product and liquid cream as an unhealthy product. According to the results, the effect of young adults is not significant on both liquid cream's and non-dairy cream's market volume. It indicates that the population share of young adults does not impact the per capita market volume of liquid cream and non-dairy cream. However, the results also show that consumers' education levels are positively related to the market volume of non-dairy cream. According to Kim and House (2014), consumers will drink a relatively larger proportion of the beverages which they consider as healthy. However, most consumers do not perceive non-dairy cream as a healthy alternative to liquid cream. When the nutrition information of a product is not widely recognized, consumers' knowledge plays a more important role in selecting healthy products. This may also be the reason that higher education levels have a significant positive impact on healthier non-dairy cream consumption compared to the dairy cream which is less healthy. Because consumers with higher education levels might pay more attention to the nutrient contents and are more likely to recognize that non-dairy cream is a healthier option whereas most people do not do that.

The second group consists of 100% juice and fruit-flavored still drinks. 100% Juice is usually considered healthy because it is natural and it provides important nutrients. However, fruit-flavored still drinks are considered unhealthy because they contain added caloric sweeteners (The Public Health Law Center, 2020). In this group, the results show no significant relationship between the population share of young adults and the per capita market volume of both 100% juice and fruit-

flavored still drinks. In addition, other control variables' effects are also not significant. According to Kim and House (2014), consumers cannot differentiate between added and naturally occurring sugar in beverages. This is consistent with our results that young adult consumers have no significant preferences towards naturally sugary 100% juice or fruit-flavored still drinks that contain added sugars. Although they both contain sugar, 100% juice is much healthier than fruit-flavored still drinks.

Table 4. Results for Different Products in High-income Countries

Variables	**ln *MV***		
	Cream	**Juice**	**Milk**
ln *POP*	0.9422 (0.5543)	-0.5036 (0.6101)	-1.5609* (0.5829)
ln *FEM*	6.6107 (3.315)	1.4371 (3.201)	-15.2745* (6.782)
ln *EDU*	-0.0933 (0.2023)	0.0950 (0.2036)	0.2941 (0.5417)
ln *INC*	0.2117 (0.2154)	0.2669 (0.1471)	0.2768 (0.2886)
ln *POP* × *healthy*	0.8925 (1.260)	0.6179 (0.7137)	3.2460*** (0.6617)
ln *FEM* × *healthy*	-6.9705 (11.94)	-7.1019 (3.517)	21.0560* (7.811)
ln *EDU* × *healthy*	1.9127* (0.7894)	-0.1990 (0.3144)	-0.9313 (0.7212)
ln *INC* × *healthy*	-0.6956 (0.5682)	-0.1298 (0.2170)	-0.3939 (0.3241)
Country-Product Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Observations	829	1,110	2,031
Within R2	0.1087	0.0604	0.0985

Notes: ① the dependent variable is the logarithm of the market volume per capita. ② Numbers inside the parentheses are robust standard errors clustered at the country and year levels. ③ Healthy is a dummy variable indicating the product is healthy. ④ *** indicates $p<0.001$, the result is significant at a 0.1% level;

** indicates $p<0.01$, the result is significant at a 1% level; * indicates $p<0.05$, the result is significant at a 5% level.

The third group consists of four kinds of beverages within the milk category, which are white milk, soy milk, nut-, grain- and seed-based drinks, and flavored milk. Typically, white milk and soy milk are considered more natural and healthier, while flavored milk and nut-, grain- and seed-based drinks are considered to have added contents and thus as unhealthy (The Public Health Law Center, 2020). In this group, the population share of young adults has a significant positive impact on the market volume of white milk and soy milk. The estimated coefficient is 3.246, which is significant at a 0.1% level. This result suggests that the per capita market volume of white milk and soy milk will increase by 3.246% relatively as the population share of young adults increases by 1%. The portion of the female population is also shown to be positively related to the market volume of white milk and soy milk compared to the other two products. Additionally, the population share of young adults and the portion of the female population are shown to have negative effects on the market volume of flavored milk and nut-, grain- and seed-based drinks.

According to the results, the population share of young adults only positively impacts the market volume of healthy milk products among the three beverage groups. These results suggest that compared to other beverage categories, young adults pay more attention to the healthy choices of milk when they purchase milk products. This may be due to people typically having a higher daily consumption volume of milk products than cream and juice. In addition, the classification criteria of milk products are more detailed and diverse, for example, low-fat milk, skimmed milk, lactose-free milk, and many others, so the nutrition differences between different milk products are more distinct. Therefore, young adult consumers are provided with more precise information about milk beverages' nutrient contents and can make healthier choices more easily based on this information. This is consistent with Kim and House (2014) that consumers will drink a relatively larger proportion of the beverages they consider healthy. However, for other beverage groups, such as cream and juice, there are relatively fewer segmentations within each category. Therefore, young adult consumers are less likely to tell the differences between healthy and less healthy choices from their knowledge and perception, so they may tend to be indifferent to it.

6.3 Robustness Test of All Products in High-income Countries

In order to assess the robustness of the results of all products in high-income countries, we will change the fixed effects setting and conduct the estimation again. The new results are shown in Table 5.

If the previous results are robust, the new results will not change too much after changing the setting of fixed effects. Therefore, we change the time fixed effect of the preliminary model to the country-time fixed effect and apply it together with the country-product fixed effect to the model

and conduct the estimation again. In this case, the model allows for more flexibility at the product level. Additionally, only the interaction terms are kept in the model, and other terms are removed because of collinearity in this setting.

Table 5. Robustness Test of All Products in High-income Countries

Variables	**ln *MV***
ln *POP* × *healthy*	0.9972* (0.4169)
ln *FEM* × *healthy*	6.6590 (3.133)
ln *EDU* × *healthy*	-0.3403 (0.1931)
ln *INC* × *healthy*	-0.4523** (0.1156)
Country-Product Fixed Effect	Yes
Time Fixed Effect	No
Country-Time Fixed Effect	Yes
Observations	8,666
Within R2	0.0296

Notes: ① the dependent variable is the logarithm of the market volume per capita. ② Numbers inside the parentheses are robust standard errors clustered at the country and year levels. ③ Healthy is a dummy variable indicating the product is healthy. ④ *** indicates p<0.001, the result is significant at a 0.1% level; ** indicates p<0.01, the result is significant at a 1% level; * indicates p<0.05, the result is significant at a 5% level.

According to the results, the population share of young adults still has a significant positive impact on the healthy beverages' market volumes compared to unhealthy beverages in high-income countries. The results show the new estimate is also positive and significant at a 5% level. There is only a slight difference in the coefficient value compared to the previous results. Besides, income is still negatively related to the market volume of healthy products. However, the proportion of females is not significant compared to the previous results. In general, it suggests that the previous results are robust except for the effect of the female proportion.

7 Conclusions

7.1 Conclusions and Implications

In this paper, we focus on the market of ready-to-drink and non-alcoholic beverages. Based on a 16-year (2005-2020) market volume panel dataset provided by a company in the food and beverages business, we formulate a fixed-effects model and examine our hypothesis that the population share of young adults in high-income countries has a causal impact on the market volumes of healthy products, compared to unhealthy products. Furthermore, we conduct heterogeneity analyses across countries from different income levels and different product types to investigate whether the effect of young adults on beverage market volume would vary across country groups and product groups.

Our study suggests that in high-income countries, the population share of young adults has a significant positive impact on healthy products' market volume compared to unhealthy products. The finding shows that healthy products' per capita market volume will increase by 0.968% relative to unhealthy products as the population share of young adults increases by 1%, holding all other conditions constant. The robustness test also supports this conclusion. However, the population share of young adults in the middle- and low-income countries show no significant impact on the market volume of healthy products because young adults in developing countries are heavily affected by the marketing of unhealthy beverages. Furthermore, the consumption of beverages is constrained by income levels and consumers' lack of general health awareness resulting in the increased consumption of unhealthy beverages. In the product heterogeneity analysis, the population share of young adults only shows significant positive impacts on the market volume of healthy milk products (white milk and soy milk) and the coefficient is 3.246, indicating that a 1% increase in the share of the young adult population will increase the market volumes of white milk and soy milk by 3.246%, compared to the flavored milk and rice, nut-, grain- and seed-based drinks.

The findings of our study provide some practical implications for both companies and public health organizations whose works are highly associated with food and beverage consumption. First, we find that young adult consumers attach significant importance to healthy products in high-income countries, whereas this relationship is not significant in the middle- and low-income countries. Second, compared to other beverage categories, young adults in high-income countries pay significant attention to the healthy choices of milk when they purchase milk products. At the same time, they tend to be indifferent to the healthy alternatives within the cream and juice categories.

For companies in food and beverage businesses, they need to pay more attention to the role young adults play in beverage consumption, especially for healthy beverages. As the impact of young adults is shown to be positively related to market volumes, companies can use the future population

data on young adults to predict the future beverage consumption volumes in high-income countries, together with other significant influencing factors. For example, companies can acquire credible forecasts of the young adult population from 2020 to 2100 through the World Population Prospects 2019 presented by the United Nation. The United Nation made the country-level population projections based on the cohort-component projection approach which can reflect the population dynamics by considering many demographic components such as fertility, mortality, and international migration. Please see Appendix B for more information on the projection methods, accuracy and forecast of the young adult population from 2021 to 2030 in high-income countries.

A company with accurate forecasts on future beverage consumption is most likely to establish competitive advantages in the market, as those forecasts can help the company develop more efficient business plans and strategies. For example, when food and beverage companies try to develop marketing strategies for healthy products, they will have a special focus on the young adults in high-income countries and therefore achieve better marketing performance. Besides, they can also introduce more beverage types that offer health benefits and target the young adult segmentation, in order to achieve new business growth and higher revenue.

For public health organizations to improve society's total health and wellness, they need to provide more information regarding healthy diet for the young adults since our findings show that young adults do have a significant positive impact on healthy beverage consumption in high-income countries. However, in the middle- and low-income countries, young adults are indifferent between healthy and unhealthy products. Therefore, public health organizations need to improve people's general nutrition knowledge, especially in the middle- and low-income countries, to improve their health consciousness and rebuild their perceptions of the benefits of healthy products. Moreover, it's also important to provide consumption subsidies for people in low-income countries and therefore make it easier for them to choose healthy products. When more people choose healthier foods and beverages, we can better prevent and control diseases such as obesity and type 2 diabetes which are typically associated with high-calorie and high-sugar diets.

7.2 Limitations and Future Work

The first limitation is the relatively small data size and the partially poor data quality. Given the limited observations in our dataset, it is difficult to apply more advanced machine learning and deep learning methods such as neural networks to solve the problem because these methods can only have good performance if there is a large amount of data to learn from. Besides, our data is acquired from a company in the food and beverage business, and the data quality of different products is not symmetrical because some data specifications are ambiguous for those products that are not the company's primary interests. For example, water accounts for a large amount of the total market volume in the dataset. However, the data quality for water is low. For example, tap

water is a large part of water consumption, but we do not know how much tap water is used for drinking or sanitary purposes such as washing dishes and it is also difficult to estimate it.

The second limitation is the classifications of products. We classified all the beverages into healthy and unhealthy products according to the general definitions of the beverage categories. However, there are still many subcategory products within each product type that are out of our consideration because of the limited information in our product data.

The findings for different products show that the effects of young adults on consumption vary across products in high-income countries. Therefore, future studies can conduct a more comprehensive analysis of products with subcategories and investigate how young adults react between different product subcategories. In addition, water is also an interesting product to study further because of its special characteristics. However, water is removed from our study due to our data lacking important information to distinguish tap water that is used for drinking purposes and sanitary purposes. Furthermore, other than healthy or unhealthy, future studies can consider different ways of labeling the beverages based on questionnaires or a Likert scale. Besides, the tendency towards veganism and the increasing environmental awareness of consumers can also be considered in the future studies regarding beverage consumption patterns.

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Appendix A

Table 6. Variables Description

Variables	**Description**
Dependent Variable	
Market Volume Per Capita	Per-capita volume consumption of different products in different markets
Independent Variables	
Year	From 2005 to 2020
Market	The name of the markets where the market volume of products is measured
Product Type	The types of products
Income Level	1 for high-income countries, 2 for middle-income countries, 3 for low-income countries
Young Adults Share	The population share of young adults (Aged 20-39)
Young Female Share	The population share of females in the young adult group (Aged 20-39)
Healthy Dummy	1 if the product is healthy, 0 otherwise
Tertiary Enrollment	Gross tertiary school enrollment rate in each country %
GNI Per Capita	GNI per capita in the current US $

Note: The table summarizes the definition of each of the variables used in the empirical analysis.

Appendix B

The United Nation's cohort-component projection method is under the assumptions that: (1) the future fertility converges towards a low level; (2) the life expectancy is increasing for all countries resulting in low mortality in the future; (3) the international migration is volatile and affected by economic, political and environmental factors over time. The median of thousands of projected trajectories of the demographic components, such as fertility rate, and life expectancy, is used as the population projections. Furthermore, the trajectories of each element are derived using the probabilistic model, which is based on the historical variability, experience, and future trends.

As for the projection accuracy, the United Nations reports that the projected population over the near future is relatively certain. The 95 and 80 percent prediction intervals are used to express the uncertainty of the forecasting trend. From 2021 to 2030, the projected values fall within the narrow prediction interval; therefore, projections during this period are of relatively high certainty.

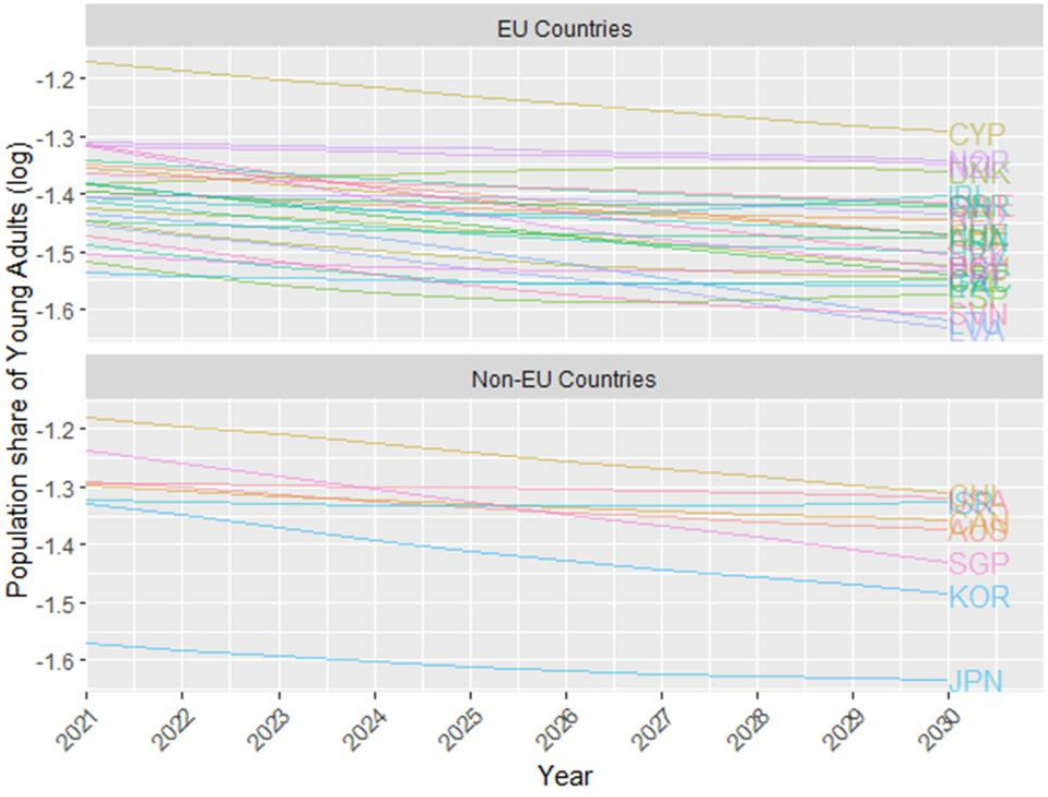

Figure 1. The projected population share of young adults (log) of high-income countries from 2021 to 2030, facet by region.

As shown in Figure 1, decreasing trends can be seen in the population share of young adults in most high-income countries from 2021 to 2030, except Denmark, where the population share of

young adults is rising. The decreasing trends in countries such as America, Norway, and Finland seem steady compared to Singapore and South Korea, where the population share of young adults is expected to experience a significant decrease.