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Exploring Adolescents' Consumption of Alcohol-Free and Low-Alcohol Drinks: A Review of the Literature and a Drinking Profile Analysis

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Abstract

Non-alcoholic and low-alcohol (NoLo) beverages are increasingly popular among adolescents, raising concerns about their potential gateway effect on alcohol use. This study combines a mapping review of the literature and an analysis of the Dutch Health Behavior in School-Aged Children (HBSC) study ($N=4746$, mean age 13.74). The review identified three studies on NoLo prevalence (18.35–31.8%, all in Eastern populations) and two on parental attitudes. National data revealed that 46% of Dutch adolescents aged 12–16 had tried NoLo beverages, with 8% reporting weekly use. NoLo drinkers are overall more similar to non-drinkers, but exhibit characteristics like fewer peer problems and more hyperactivity similar to alcohol drinkers. NoLo use is most common among younger adolescents and those in pre-university tracks. Our findings highlight the need for nationally representative research on NoLo consumption in Western societies. Adolescents may use NoLo beverages to experiment with risk behaviors as an alternative to alcohol, driven by social conformity or a desire for new experiences.

Keywords NoLo beverages · Adolescents · Alcohol · Risk profile · Substance use

Non-alcoholic and Low-alcoholic (NoLo) Consumption

In Europe, the availability and popularity of non-alcoholic or low-alcohol beverages—also referred to as NoLo beverages—such as alcohol-free or low-alcohol beer, wine, and spirits—is increasing (Kokole et al., 2022). In the Netherlands, for example, one in ten of the 12–16-year-olds consumes non-alcoholic beverages at least monthly (Rombouts et al., 2023). NoLo

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beverages are an umbrella term for the reference to no and low-alcoholic beverages that mimic alcoholic variants but have had most of the alcohol removed. The accepted amount of alcohol in non-alcoholic drinks differs between countries, but in general, non-alcoholic drinks (as alternative for an alcoholic beverage) are defined as containing not more than 0.5% alcohol by volume (ABV; Perman-Howe et al., 2024). The rise of NoLo drinks is often associated with motivations for a healthier lifestyle and reduction of harmful alcohol consumption (Kokole et al., 2022). A large shopping panel study from the UK revealed reductions in volume and gram of alcohol purchased by households after the introduction of new NoLo beverages (Anderson et al., 2020). However, recent cross-sectional studies among Dutch university students Groefsema et al., 2024) and adults (van Dorsselaer et al., 2024) showed that non-alcoholic beverages are often consumed on top of alcoholic beverages, instead of replacing them. A report from the United Kingdom (UK) revealed that the consumption of NoLo as an alternative for alcohol intake is the lowest among the heaviest drinkers group, limiting the harm reduction potential of NoLo beverages (Corfe et al., 2020). As NoLo beverages might function as a gateway to alcoholic beverages because young people get used to the taste, smell, and branding, NoLo beverages may contribute to the onset of alcohol consumption in young adolescents (Harrison et al., 2024; Miller et al., 2022). To date, little is known about NoLo use among adolescents. In the current paper, we therefore provide a mapping overview of the international empirical research that is available and make a first attempt in identifying typical characteristics of Dutch NoLo adolescent drinkers aged 12–16 years old.

International Policies and Regulations for NoLo Consumption and Marketing

While there are strict laws to restrict adolescent alcohol use across countries, such regulations appear to be lacking for the purchase and consumption of NoLo beverages (Waehning & Wells, 2024). This is partly related to the lack of an international definition of NoLo beverages and because there are differences between non-alcoholic and low-alcoholic beverages in terms of allowed percentage alcohol (Waehning & Wells, 2024). In most European countries, NoLo beverages contain up to either 0.5% or 1.2% alcohol, but variations exist, for example in Finland and Iceland which accept up to 2.5%, (UK Governance Consultation, 2023). Laws on the sale, marketing, and availability of NoLo beverages to minors vary internationally. For instance, in Australia, NoLo beverages are regulated like soft drinks, allowing minors to purchase them freely, with fewer marketing restrictions than alcohol (Miller et al., 2022). Brands can promote them in new contexts and to younger audiences. In contrast, Norway applies alcohol advertising laws to NoLo beverages, banning mass communication by alcohol brands (Critchlow et al., 2024). In the Netherlands, minors can buy NoLo drinks, but advertising to this specific target group is discouraged (Advertising Code Foundation, 2024). In the UK, sales to minors are legal, though a voluntary agreement discourages it. Advertising guidelines treat NoLo similarly to alcohol, with some contextual exceptions (Advertising Standards Authority, UK, 2024).

Comparing Correlates of Adolescent NoLo and Alcohol Use

Studies in the Netherlands and Australia found that adolescents and young adults often consume NoLo beverages to fit into social situations that involve the consumption of alcohol (de Wit et al., 2021; Booth et al., 2024). Adolescents often consume alcohol to gain

status among peers or imitate popular behaviors (Balsa et al., 2011; Dijkstra et al., 2015). NoLo beverages—designed to mimic alcoholic—may offer adolescents a similar sense of peer acceptance and maturity status (Bartram et al., 2024). Although these results can be interpreted as positive—adolescents who may find alternative and more healthy behaviors that provide them accessibility to peer groups by “risk-taking behavior—there are two concerns that should be addressed in this regard. First, adolescents may develop a taste for alcoholic beverages earlier, normalizing drinking in situations and at ages previously considered inappropriate (Bartram et al., 2024). Additionally, distinguishing NoLo beverages from low-alcohol drinks (up to 1.2% alcohol) can be challenging, especially for adolescents (Miller et al., 2022).

Research on adolescent drinking behavior has identified several risk and protective factors for alcohol use both on an individual as well as a contextual level (Degenhardt et al., 2016). On an individual level, impulsivity and sensation seeking are two examples of personality characteristics commonly associated with alcohol use in adolescence (Stautz & Coopers, 2013). Additionally, externalizing problems such as aggression, attention problems, and minor delinquency have been associated with alcohol use, both as predictor but also as a consequence of these behavioral problems (Patrick & Schulenberg, 2014). Although many adolescents only experiment with alcohol, the use of other substances such as nicotine or cannabis is associated with alcohol use, particularly among the more problematic alcohol users (Halladay et al., 2020). Correlates of adolescent alcohol use at the contextual level include parenting factors (e.g., rules, monitoring and family situation); (Rodríguez-Ruiz et al., 2024) and educational level. Overall, early alcohol use is more common among adolescents in vocational tracks than in pre-university tracks (Schmengler et al., 2022). Adolescents growing up in single parenthood families more often drink alcohol (Degenhardt et al., 2016). Reduced parental monitoring and an increase in unsupervised activities is associated with more alcohol use among adolescents (Rodríguez-Ruiz et al., 2024). In contrast, non-drinkers are less likely to use other substances, have fewer conduct problems, and have fewer social interactions with friends, together suggesting a possible association between non-drinking and a relatively more introverted personality styles (Boson et al., 2024). Up till now, we know little about the characteristics of the NoLo adolescent consumers. This knowledge could support in determining more effectively whether the risk and protective factors we see in alcohol consumption are of a similar nature to those of NoLo consumption.

Current Study

The aim of the current study is twofold. First, we provide a mapping review of the relevant literature on NoLo drinking behavior of adolescents (10–25 years), including studies in which parents report on NoLo consumption of their adolescent child. This age range was chosen as broad and more contemporary definition of adolescence consistent with recent shifts in social roles transitions that mark the adolescent period (Sawyer et al., 2018). Secondly, based on cross-sectional nationally representative Dutch data, we identify socio-demographic characteristics of adolescent NoLo drinkers (12–16 years) and compare these characteristics with adolescent alcohol- and non-drinkers. Based on these findings, we provide recommendations for parents, professionals, and policy development regarding the use, availability, price, marketing, and selling of NoLo beverages to minors.

Method

Mapping Review

Since our main aim was to determine the available evidence on NoLo consumption among adolescents (10–25 years), a mapping review was the most suitable method to apply (Munn et al., 2018). Two search engines were consulted in January, 2024 to identify relevant studies: Scopus and Web of Science. Two researchers searched for relevant studies, screened titles, and abstracts and selected relevant literature. The following search terms were used: “non-alcohol beverages” OR “NoLo”, OR “non-drinking” OR “zero alcohol” “non-alcoholic beer” OR “low-alcoholic” OR “non-alcoholic” AND “adolescents” OR “consumers” OR “young adults” OR “youth” OR “adolescence”. An additional search strategy was performed in April, 2024 in Google Scholar to identify possible new published studies after our initial search. One additional study was identified. We additionally screened all reference lists of the selected studies as well of studies reported on but not included in the mapping review.

Eligibility Criteria

Studies who met the following criteria were included:

1. Studies with adolescents or young adults as the target group (10–25 years)
2. Studies with parents reflecting on rules and/or attitudes regarding adolescents’ NoLo consumption.
3. Studies which included a clear definition of non-alcohol or low-alcoholic beverages
4. Studies in peer-reviewed journals with abstracts available and written in English

Studies were excluded when they were not written in English or were not published in peer-reviewed journals. Grey literature (e.g., policy reports, factsheets, infographics) were excluded from this mapping review as they often reflected specific national/regional situations, were written in non-English language, did not included an abstract, and/or had limitations in research methodology (e.g., sample size, analyzing techniques).

Procedure

Two research assistants screened the abstracts of the initial search results and summarized the findings. The results were discussed in the research team, consisting of two senior researchers and two research assistants. This team selected the papers that met the eligibility criteria. In total, six studies were included that were evaluated, and information on sample, definitions, method of research, and results was summarized.

Cross-Sectional Study

Procedure and Participants

The current cross-sectional study used the most recent data wave (2021) of the Health Behaviour in School-aged Children (HBSC) study in the Netherlands. The HBSC study

is a nationally representative study on the health, well-being, and social context of adolescents, carried out by Utrecht University, the Institute for Mental Health and Addiction (Trimbos Institute), and the Netherlands Institute for Social Research (SCP). The study includes data from adolescents aged 11 to 18 years old attending general secondary education. In the current study, only adolescents from the first four grades (age 12–16 years) were included as the highest two grades (16–18 years) only survey adolescents with an academic educational track (i.e., the vocational tracks are four-year programs). The study sample included 4746 adolescents (51.2% boy), with a mean age of 14.23, $SD = 1.25$). The sample was obtained using a two-stage random sampling procedure. First, a random sample of schools was drawn stratified by level of urbanization to ensure population representativeness. Second, within each school, depending on school size, three to five classes of adolescents were selected to participate. The school level response rates were 42%. At the adolescent level, the response rate was 88%, with non-response mainly because of sickness (including COVID-19).

Research assistants administered an online questionnaire in the classroom. Schools were asked to inform parents or legal representatives of adolescents from participating classes at least 1 week before data collection. If parents objected, they could notify their child's mentor. Researchers sought active permission from participating adolescents after they were assured of the anonymity and confidentiality of their responses. In total, 69 adolescents did not participate because they or their parents did not give active permission. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all adolescents for being included in the study. This study was approved by the ethical committee of the Trimbos Institute for Mental Health and Addiction (2021, nr. 202.109).

Measures

- Alcohol use
- Adolescents were asked the question: "On how many days did you drink alcohol in the last four weeks? Answer categories ranged from 1 = never to 7 = 30 days (or more). This was recoded into 0 = never and 1 = ever.
- Non-alcoholic drinking
- Adolescents were asked the question: "How often do you drink alcohol-free beer, wine or cider, such as Radler 0.0, Hugo 0.0 or Jillz 0.0?" Answer categories were: every day; every week; every month; rarely; never. This was recoded into 0 = never and 1 = ever. Note that only non-alcoholic beverages were included in this question. It did not examine low-alcohol beverages.
- Educational track
- The Dutch educational system has four educational tracks, ranging from vocational training (VMBO-b) to higher academic education (VWO). Adolescents were asked to indicate their educational track in the questionnaire. This variable was recoded into vocational (VMBO-b and VMBO-t) and pre-university (HAVO and VWO).
- Migration background
- Participants were asked to indicate where they and their parents were born. If adolescents themselves or at least one parent was born abroad, adolescents were identified as having a migration background. This was recoded into 0 = no and 1 = yes.

- Family composition
- Family composition was assessed through binary variables (0 = No, 1 = Yes) asking whether a certain family member lives in the “main home” with the respondent. This format was used in the HBSC questionnaire for mother, father, grandmother, grandfather, stepmother, stepfather, brother(s) and sister(s). Two more binary variables assessed whether the respondent lives in a “foster/child home”, and whether they lived with “someone or somewhere else”. Respondents indicating they lived with both their mother and father received a 1 on this variable; respondents who did not, received a 0.
- Parental rules on adolescent drinking
- Adolescents were asked to indicate to what extent their parents allow, or would allow, them to (1) drink one glass of alcohol when their father or mother is home; (2) drink several glasses of alcohol when their father or mother is home; and (3) drink alcohol at a party with friends. Answer categories ranged from 1 = definitely not true to 5 = definitely true (adapted from Van der Vorst et al., 2005). The scores were averaged across the questions and recoded into < 1.5 = adolescents were definitely not allowed to drink alcohol and, > 1.5 adolescents were allowed to drink alcohol (cf. de Boer et al., 2022).
- Parental rules on adolescent smoking
- Adolescents were asked to indicate to what extent their parents allow, or would allow, them to (1) try out smoking a cigarette; and (2) smoke every now and then. Answer categories ranged from 1 = definitely not true to 5 = definitely true. The scores were averaged across the two questions and then were recoded into < 1.5 = adolescents were definitely not allowed to smoke tobacco, > 1.5 adolescents were allowed to smoke tobacco.
- Smoking. Adolescents were asked “On how many days have you smoked tobacco in the last four weeks?”. Answer categories range from 1 = never to 7 = 30 days (or more). This was recoded into 0 = never and 1 = ever.
- Vaping
- Adolescents were asked: “On how many days have you used an electronic cigarette (e-cigarette, shisha pen, e-hookah, e-smoker) in the last four weeks?” Answer categories ranged from 1 = never to 7 = 30 days (or more). This was recoded into 0 = never and 1 = ever.

Psychosocial problems. Four subscales (including 5 items each) of the Strengths and Difficulties Questionnaire (SDQ) were used to assess psychosocial problems (i.e., emotional, behavioral, hyperactivity, and peer problems). The SDQ is a screening questionnaire that asks adolescents to report on their behaviors and emotions in the past 6 months (Goodman et al., 1998). Items (e.g., “I worry a lot”; “I am easily distracted; I find it difficult to concentrate”) were scored on a three-point Likert scale “not true,” “somewhat true,” “certainly true”. Per scale, the responses were summed up with higher scores indicating more problems. The SDQ subscales are measurement invariant over time and between boys and girls, adolescents with a native Dutch versus immigrant background, and vocational and academic educated adolescents (Duinhof et al., 2015).

Analytical Strategy

The dichotomous variables for NoLo and alcohol drinking behavior in the last 4 weeks were used to compute four groups: non-drinkers, “NoLo only drinkers,” “alcohol-only

drinkers,” and “alcohol and NoLo drinkers.” To assess difference in demographic and behavioral characteristics between these groups, multinomial regression analyses were performed. Three separate multinomial analyses were performed combining (1) demographic characteristics, (2) substance use and rules about use, and (3) psychosocial problems. In all three analyses, we controlled for age. In the first step, non-drinkers were the reference group. To identify differences between “NoLo only drinkers” and “alcohol-only”/“alcohol and NoLo drinkers” we re-analyzed the effects with “NoLo only drinkers” as reference group. A stricter significance level of $p > 0.01$ was used to account for the relatively large sample size and to account for multiple testing (Benjamini–Hochberg critical p value = 0.03).

Results

Mapping Review

The mapping review resulted in an overview of studies capturing different domains: (1) prevalence and characteristics of adolescent and young adults “NoLo only drinkers”, (2) parental rules and attitudes of NoLo consumption among youth, and (3) regulations and marketing (see Table 1).

The Prevalence of NoLo Consumption and Purchase Among Adolescents

The literature search revealed three studies on prevalences of NoLo consumption among adolescents and young adults. These studies were carried out in Japan and Taiwan. Although these were large-scale studies, information was lacking about the representativeness of these samples with respect to the national context of study. In one study, national survey data (e.g., randomly selected Japanese high schools) was used for estimating the prevalence of NoLo consumption (Kubo et al., 2015).

In a Japanese large-scale cross-sectional study among youth ($N = 101,134$; 13–19 years), the relationship between alcohol use and NoLo consumption was explored (Kinjo et al., 2017). Findings revealed that around 2% of the 13–16 year olds have consumed NoLo beverages once in their lives. For the older adolescents (16–19 years), this percentage increased to 31.7% for girls and 28.8% for boys. Girls drank more NoLo beverages compared to boys. This study was conducted in 2012, after concerns about the rise in NoLo consumption among youth in Japan. Adolescents were more likely to initiate alcohol consumption first, followed by NoLo consumption. The percentage of adolescents who initiated NoLo beverages first was higher among younger compared to older adolescents. In the second study, 3121 Taiwanese high school students (15–19 years) reported on their NoLo consumption (Hou et al., 2023). This study differentiated between drinking and purchasing and found that 14.22% of girls and 15.83% of boys purchased NoLo beverages, and 18.66% of girls and 18.35% of boys consumed NoLo beverages in the past year. In the third study, 9775 Japanese high school students (15–18 years) were asked about their NoLo consumption (Kubo et al., 2015). Similar percentages of adolescent “NoLo only drinkers” were found to the two other studies, with 25.8% for boys and 26.1% for girls. The consumption for NoLo beverages increased the odds for alcohol consumption including the current use and frequency of drinking.

Table 1 Included studies in the mapping review

Authors, year	Measurement	NoLo definition	Method	N	Sample population	Findings
Hou et al., 2023	Effect of marketing and NoLo beer consumption on intentions of adolescents to purchase and drink alcohol	Non-alcoholic beer or cocktails	Cross-sectional online self-administered survey (during the Covid-19 pandemic in 2022)	3121	Taiwanese high-school students aged 15–18 years old	Adolescent exposure to influencer marketing of non-alcoholic beer and alcoholic drinks is common and is positively associated with non-alcoholic beer/alcohol consumption and purchase Drinking non-alcoholic beer was associated with increased odds of drinking alcohol
Kinjo et al. 2017	NoLo consumption rates and order of drinking NoLo and alcohol	Non-alcoholic, alcohol free, alcohol zero beverages	Cross-sectional national representative school-based study (survey)	100,050	Japanese adolescents aged 13–19 years old (38,494 junior high and 61,556 senior high)	The NoLo consumption was positively associated with alcohol use in high school students. Among all age groups, alcohol was more commonly consumed before NoLo beverages for both males and females
Kubo et al., 2015	NoLo consumption and association with alcohol consumption	Non-alcoholic beverages with less than 1% of alcohol	Cross-sectional Japan Youth Risk Behavior Survey (2011)	9775	Japanese adolescents in 10–12th grade	The NoLo consumption was positively associated with alcohol use in high school students. Higher odds for alcohol use were found among adolescents who consumed NoLo beverages compared to those who had never consumed NoLo beverages

Table 1 (continued)

Authors, year	Measurement	NoLo definition	Method	<i>N</i>	Sample population	Findings
Bartram et al. (2024)	Associations with NoLo beverage provision	Non-alcoholic wine, bottled virgin apple cider, or other similar drinks with no alcohol or an alcohol content of less than 0.5% alcohol by volume	Online cross-sectional survey	1197	Australian parents of adolescents aged 12–17 years old	Factors significantly associated with parents' provision and future intentions to provide zero-alcohol beverages included: (1) beliefs that NoLo is a beneficial substitute for alcohol for adolescents, (2) actual provision of alcoholic beverages, and (3) incorrect understanding of alcohol guidelines for adolescents
Harrison et al., 2024	Parents' views on zero-alcohol beverages and their provision to adolescents	Alcohol-free beer, wine and spirits	Semi-structured interviews	38	Australian parents of adolescents aged 12–17 year old	Parents reported conflicting and cautious views on zero-alcohol beverage provision to adolescents

Parental Rules and Attitudes Towards Adolescents' NoLo Consumption

Two studies—both among Australian parents—examined the attitudes of parents with respect to the provision to and the consumption of NoLo beverages by their child (12–17 years). In the first study—a survey study among 1197 participants with children aged 12–17 years—parents were asked about the provision and context of provision of NoLo to their child. With respect to the provision of NoLo beverages, the majority of parents (87.9%) reported not buying non-alcoholic beverages for their adolescents. Overall, a little bit more than half of the parents (58%) had no intentions to provide non-alcoholic beverages to their adolescent before the age of 18; the other half either had intentions (22%) or were not yet sure about their intentions (20%) to buy non-alcoholic beverages before their adolescent turned 18 years. In contrast to parents who had intentions to provide NoLo beverages to their adolescent in the future, parents without such intentions were more likely to believe that NoLo beverages would increase alcohol consumption among adolescents (Bartram et al., 2024). In semi-structured interviews with 38 parents with adolescents aged 12–17 years, parents were asked about attitudes and perceptions regarding NoLo consumption. Parents highlighted concerns about possible gateway and normalization effects of NoLo beverages in relation to alcoholic beverages (Harrison et al., 2024). At the same time, some parents reflected on the possible harm minimization effects of NoLo beverages and the possible benefits of drinking NoLo beverages as a strategy or tool to navigate through the social challenges such as peer pressure and learning how to drink alcohol.

The Impact of Marketing and Regulations Regarding the Selling of NoLo to Adolescents

According to a Taiwanese study, self-reported exposure to non-alcoholic marketing was associated with the intention to buy NoLo beverages among youth (15–18 years); (Hou et al., 2023). Exposure to marketing of NoLo beverages was associated with increased odds of consuming NoLo beverages as well as the intention to purchase and drink NoLo beverages among adolescents who did not consume NoLo beverages yet. NoLo consumption was associated with increased odds of purchasing and drinking alcoholic beverages among adolescents (Hou et al., 2023).

Cross-Sectional Study

Demographic Characteristics Nolo Drinkers

In total, 2176 (46%) of the adolescents between 12 and 16 years reported that they had consumed non-alcoholic beverages at least once in their lives. Three hundred sixty-eight (7.8%) of these adolescents reported weekly NoLo use. Table 2 provides an overview of the characteristics of the “non-drinkers,” “NoLo only drinkers,” “alcohol-only drinkers,” and “alcohol and NoLo drinkers” groups of adolescents. Results indicate that the distribution of boys-girls is similar for all types of drinkers (e.g., non-drinkers, NoLo only, alcohol-only drinkers, and alcohol and “NoLo only drinkers”). With respect to educational level, “NoLo drinkers” do not significantly differ from the “non-drinkers” group. Adolescents who do drink “alcohol only” or drink “both” were more likely to be on the vocational tracks when compared to non-drinkers (an odd below zero indicates a lower educational

Table 2 Multinomial regressions for group differences in demographic characteristics of non-drinkers (reference group), NoLo only drinkers, alcohol-only drinkers, and adolescents who drink alcohol and NoLo beverages ($N = 4746$)

		Non-drinkers (reference group, $n = 2186$) Percentage	NoLo only drinkers ($n = 1344$)		Alcohol-only drinkers ($n = 376$)		Alcohol and NoLo drinkers ($n = 832$)	
			Odds ratio (OR/95% confidence interval)	Percentage	Odds ratio (OR/95% confidence interval)	Percentage	Odds ratio (OR/95% confidence interval)	Percentage
Sex			.997 (.869–1.145)		1.050 (.833–1.323)		1.081 (.912–1.282)	
	Boy	51.2		51.1		52.1		50.7
	Girl	48.8		48.9		47.9		49.3
Educational level			.890 (.774–1.022)		.598** (.472–.756)		.647** (.545–.768)	
	Vocational	46.3		48.5		59.5		57.1
	Pre-university	53.7		51.5		40.5		42.9
Age			1.062 (1.002–1.126)		2.722** (2.438–3.039)		1.982** (1.841–2.133)	
	12	26.6		24.0		2.9		7.3
	13	28.6		28.0		9.4		14.7
	14	22.0		25.2		21.0		24.9
	15	18.0		18.8		39.5		37.6
	16	4.7		4.1		27.1		15.5
Migration background			.425** (.358–.503)		.485** (.369–.638)		.300** (.240–.375)	
	No	67.8		82.9		77.1		85.0
	Yes	32.1		17.1		22.9		14.9
Family composition			.906 (.767–1.069)		.677** (.523–.875)		.642** (.530–.778)	
	In 1 house	77.2		77.0		68.9		69.1
	Not in 1 house	22.6		22.9		31.1		30.8

adjusted significance level * $p < .01$, ** $p < .001$

track). With respect to age, “NoLo only drinkers” are similar in age to “non-drinkers,” while “alcohol-only drinkers” and “alcohol and NoLo drinkers” are a bit older compared to “non-drinkers.” Within the group of “NoLo only drinkers,” consumption of NoLo beverages appears to be higher among the 12–14 year olds (e.g., 12 years = 24%) and much lower among 16-year olds (14%). In contrast, drinking “alcohol only” is rare among the younger groups (12 years = 2.9%) and becomes more popular among the older adolescents (16 years 27.1%).

In the second step, “NoLo only drinkers” were compared to “alcohol-only” and “alcohol and NoLo drinkers”. “NoLo only drinkers” were more likely from pre-university tracks compared to both alcohol drinking groups (OR = 0.672 (0.53–0.86), $p = 0.001$ and OR = 0.727 (0.61–0.87), $p < 0.001$); were younger (OR = 2.562 (2.29–2.87), $p < 0.001$ and OR = 1.865 (1.73–2.02), $p < 0.001$); and more likely lived with both parents compared to the “alcohol and NoLo drinkers” group (OR = 0.709 (0.58–0.87), $p < 0.01$).

Parental Rules and Smoking Behavior

Differences in parental rules about substance use and differences in substance use among the four different groups are presented in Table 3. The three drinking groups experienced less strict parental rules on alcohol, compared to the “non-drinkers,” visible by the odds higher than 1. This difference was the largest for the “alcohol-only” and “alcohol and NoLo drinkers” groups. For parental rules about smoking, no significant differences between the four groups emerged. Regarding the use of other substances, smoking or vaping was not higher among the “NoLo only drinkers” when compared to the “non-drinkers,” but the “alcohol-only” and “alcohol and NoLo drinkers” more often smoked and vaped compared to the non-drinkers.

In the second step, “NoLo only drinkers” were compared to “alcohol-only” and “alcohol and NoLo drinkers.” “NoLo only drinkers” reported stricter parental rules for alcohol consumption compared to “alcohol-only” and “alcohol and NoLo drinkers” (OR = 3.603 (2.56–5.08), $p < 0.001$ and OR = 4.611 (3.62–5.88), $p < 0.001$); reported less smoking behavior (higher odds indicate more smoking) (OR = 8.782 (5.65–13.66), $p < 0.001$ and OR = 5.761 (3.83–8.66), $p < 0.001$); and less vaping (higher odds indicate more vaping OR = 2.044 (1.81–2.31), $p < 0.001$ and OR = 3.526 (2.25–5.52), $p < 0.001$).

Psychosocial Problems

In Table 3, differences in psychosocial problems between the four groups are presented. Compared to non-drinkers, the three drinking groups experienced fewer peer problems—visible in the odds below zero—but more hyperactivity problems. In addition, the “alcohol-only” and the “alcohol and NoLo” groups reported more behavioral problems. Finally, the alcohol-only group reported fewer emotional problems, compared to the non-drinkers.

In the second step, NoLo only drinkers were compared to alcohol-only and “alcohol and NoLo drinkers.” “NoLo only drinkers” reported more emotional problems than “alcohol-only drinkers” (OR = 0.906 (0.86–0.96), $p < 0.001$); fewer behavioral problems than “alcohol-only” and “alcohol and NoLo drinkers” (OR = 1.370 (1.27–1.48), $p < 0.001$ and OR = 1.185 (1.12–1.26), $p < 0.001$); and fewer hyperactivity problems than the “alcohol-only” and “alcohol and NoLo drinkers” (OR = 1.109 (1.05–1.17), $p < 0.001$ and OR = 1.078 (1.03–1.12), $p < 0.001$).

Table 3 Multinomial regression for group differences in parental rules about alcohol and smoking, adolescents' smoking and vaping behavior, and controlled for age for NoLo only drinkers, non-drinkers, alcohol-only drinkers, and adolescents who drink alcohol and NoLo beverages ($N = 4746$)

			Non-drinkers (reference group) $n = 2186$	NoLo only drinkers ($n = 1.344$)		Alcohol-only drinkers ($n = 376$)		Alcohol and NoLo drinkers ($n = 832$)	
			Percentage/mean	Odds ratio (OR/95% confidence interval)	Percentage/mean	Odds ratio (OR/95% confidence interval)	Percentage/mean	Odds ratio (OR/95% confidence interval)	Percentage/mean
Parental rules alcohol				2.871** (2.442–3.375)		10.342** (7.362–14.528)		13.236** (10.428–16.801)	
	Not allowed	75.2			54.4		14.9		14.9
	Allowed	24.5			45.6		84.5		85.1
Parental rules smoking				0.753 (.591–.960)		1.004 (.735–1.371)		0.959 (.749–1.229)	
	Not allowed	90.7			87.9		61.2		67.5
	Allowed	9.1			12.0		38.8		32.5
Smoking				1.743 (1.043–2.913)		15.306** (9.494–24.676)		10.041** (6.421–15.704)	
	No	98.5			97.2		60.9		74.5
	Yes	1.4			2.7		39.1		25.2
Vaping				1.259 (.776–2.044)		5.837** (3.540–9.625)		4.440** (2.817–7.000)	
	Yes	98.0			97.4		77.3		84.6
	No	1.9			2.5		22.7		15.2
Psychosocial problems									
	Emotional	2.87		1.015 (.985–1.046)	3.12	0.919* (.873–.968)	3.00	1.002 (.966–1.040)	3.44
	Behavioral	1.88		1.065 (1.013–1.119)	2.10	1.459** (1.351–1.577)	2.82	1.261** (1.190–1.337)	2.55

Table 3 (continued)

	Non-drinkers (reference group) <i>n</i> = 2186	NoLo only drinkers (<i>n</i> = 1,344)		Alcohol-only drinkers (<i>n</i> = 376)		Alcohol and NoLo drinkers (<i>n</i> = 832)	
		Percentage/mean	Odds ratio (OR/95% confidence interval)	Percentage/mean	Odds ratio (OR/95% confidence interval)	Percentage/mean	Odds ratio (OR/95% confidence interval)
Peer	2.06		0.909** (.869–.952)	1.92		0.854** (.789–.924)	2.05
Hyperactivity	4.27		1.111** (1.076–1.147)	4.93		1.232** (1.166–1.301)	5.56
							1.198** (1.151–1.246)

adjusted significance level * $p < .01$, ** $p < .001$

Discussion

There are increasing societal concerns about the potential hazardous effects of NoLo beverages as a gateway to alcohol for young people (Miller et al., 2022). Moreover, very little is known about the characteristics of adolescents drinking NoLo (Booth et al., 2024). The aim of this study was twofold: (1) providing an overview of the literature regarding NoLo consumption among adolescents between 12 and 25 years and (2) evaluating the extent NoLo drinkers differ from or are more similar to non-drinkers or alcohol drinkers, in terms of demographics, parental rules, substance use, and psychosocial problems in a national representative sample of Dutch adolescents ($N = 4746$).

Mapping Review

The literature review yielded an overview of empirical studies identified three different themes: (1) the prevalence of NoLo purchase and consumption among adolescents; (2) parental rules and attitudes towards adolescents' NoLo consumption and the link to their offspring's NoLo consumption; and (3) the impact of regulations and marketing regarding the selling of NoLo to adolescents. With respect to the purchase and prevalence of NoLo consumption, three studies from Japan and Taiwan found that between 20 and 30% of the adolescents aged 13–19 years consumed NoLo in their lives/past year. Consumption of NoLo beverages was more popular among the older adolescents (15 + years) than among younger adolescents. Particularly older adolescents first initiated alcohol and consumed NoLo afterwards or in combination with alcohol (Kinjo et al., 2017). Due to the relatively recent introduction of NoLo, initial indications exist that the order of use (alcohol first then NoLo) may be different for younger drinkers and could lead in that age group as a gateway to alcohol (Kinjo et al., 2017; Kubo et al., 2015). Nevertheless, it should be noted that these results were cross-sectional of nature, and two out of three studies did not include a national representative sample. Any conclusions about possible gateway effects of NoLo beverages are therefore premature and require longitudinal research.

Regarding parental rules and attitudes, two Australian studies found that parents are concerned about the possible gateway effects of NoLo consumption (Bartram et al., 2024; Harrison et al., 2024). This concern of parents was associated with a reduced likelihood of providing NoLo beverages to their offspring (Bartram et al., 2024). Most parents did not purchase (88%) NoLo beverages for their minor adolescent, or had no intention to that in the future (58%). With respect to marketing strategies, findings suggest that exposure to NoLo marketing can affect the current and future intentions of NoLo consumption among youth (Hou et al., 2023).

These initial results provide a first indication of the purchase and prevalence of NoLo consumption among youth and its possible association with alcohol use. However, the results are too scarce to draw general conclusions about the dangers of NoLo consumption and the effects of marketing on adolescent drinking behavior. Prevalence studies including adolescents from Western societies, are particularly needed to assess the extent to which these prevalences of NoLo consumption can be translated to other adolescent populations, and longitudinal research is pivotal to draw conclusions about possible gateway effects of NoLo beverages on future alcohol consumption. Moreover, future research could benefit from the inclusion of research designs that can disentangle cause and effect, such as experiments, to evaluate the impact of marketing. Beer brands for instance promote NoLo beverages as harm reduction alternative for alcoholic beverages (Nicholls, 2023). Although NoLo beverages have the potential to reduce (problematic) alcohol use, it is questionable

whether this harm reduction claim is applicable to young people (Miller et al., 2022). Research on vaping underscores the need for restrictive policies with regard to the marketing of substances towards youth; the promotion of vapes targeting adolescents specifically has led to increase in vaping among youth (van Zyl-Smit et al., 2024). As long as uncertainties exist about the potential harming effects of adolescents' NoLo consumption, it may be advisable to be restrictive with the marketing of NoLo beverages targeted at youth.

Cross-Sectional Study

With respect to the differences and similarities between adolescent “NoLo only drinkers,” “non-drinkers”, and “alcohol drinkers,” we found that NoLo only drinkers are quite similar in demographic characteristics compared to “non-drinkers”. We did not find any significant differences between NoLo only drinkers and “non-drinkers”, on demographics such as sex and family composition. Yet, “NoLo only drinkers” were less likely to have a migration background as compared to “non-drinkers”. Alcohol-only drinkers and adolescents who drank NoLo and alcohol more likely attended vocational education and were older when compared to “non-drinkers”. This is in line with previous research indicating that early alcohol use among adolescents is higher among vocational students (Berten et al., 2012; Schmengler et al., 2022). That “NoLo only drinkers” are often younger compared to “alcohol-only” and “alcohol and NoLo drinkers”, could suggest that NoLo consumption is a way of the young group of adolescents to experiment with “new” forms of risk behavior. Underlying reasons for adolescents to do this could be to confirm to peer group norms, to receive status (Balsa et al., 2011; Bartram et al., 2024) or because of sensation seeking tendencies to try out something new (Booth et al., 2024). Due to the similarities with alcohol beverages, NoLo beverages could retain “a maturity status” (Dijkstra et al., 2015) as a substance without negative effects of alcohol may particularly attract young drinkers. Future research could investigate the motives and reasons for NoLo use among adolescents in more detail—for instance with qualitative research—to explore to what extent peers influence the consumption of NoLo beverages. In addition, it would be relevant to explore to what extent peer processes in relation to adolescent drinking behavior (Henneberger et al., 2021) can be translated to or interact with NoLo consumption.

With respect to parental rules about alcohol and smoking, NoLo adolescent drinkers reported less restrictive rules about drinking when compared to “non-drinkers”. This could indicate that it is important that parents have separate rules about NoLo consumption, as the rules for alcohol use appear inefficient in preventing NoLo consumption. It should be noted however that we did not ask about NoLo regulations. Previous findings indicate that parental rules are an important leverage point for the prevention of underage regular drinking (Koning et al., 2011). Future research could explore to what extent rules for alcoholic drinks could be extended to non-alcoholic drinks. Previous findings indicate that parental rules are an important leverage point for the prevention of underage regular drinking (Koning et al., 2011). The lack of clear and consistent laws and regulations, in combination with the idea that consuming NoLo beverages may seem less harmful and less unhealthy than consuming alcoholic beverages (Bartram et al., 2024), could motivate parents to be less strict in enforcing the prevention of NoLo consumption among their children.

“NoLo only drinkers” engaged in smoking and vaping to a similar extent as “non-drinkers”. Furthermore, they were less likely to have peer problems but more likely to have hyperactivity problems, compared to “non-drinkers”. For NoLo drinkers who also drank alcoholic beverages, the differences with nondrinkers were even larger. Common known risk factors

for problematic alcohol use such as hyperactivity and other substance use (Halladay et al., 2020; Patrick & Schulenberg, 2014) appear to be lower among the “NoLo only drinkers” group, and therefore more likely appears to resemble the behavior of “non-drinkers” than of adolescent alcohol drinkers.

Limitations

This study presents several limitations that must be acknowledged. First, the mapping review provides only a first indication of the available research on NoLo consumption of adolescents and does not represent an extensive systematic search and critical evaluation of the quality of included studies. The primary purpose of this study was to provide a preliminary overview of the available research on NoLo consumption which can be best done by performing a mapping review (Grant & Booth, 2009). Given the limited amount of existing literature, a systematic review would not have been feasible at this stage. There is an urgent need for more empirical research focused on NoLo consumption among adolescents. So far, prevalence studies are completed in South-East Asian societies, and it is unclear to what extent laws and regulations and the drinking culture are similar to other high-income societies. Second, the cross-sectional study only included prevalences on non-alcoholic beverages and did not include low-alcoholic beverages. For the literature review, we also screened for papers including low-alcoholic beverages although we only found studies including non-alcoholic beverages—though with varying amounts of alcohol allowed within alcohol-free beverages. For future research, it would be good to differentiate between these kind of beverages as for the Dutch context, for example, the amount of alcohol is 0.1% for non-alcoholic versus 1.2% for low alcoholic beer (Groefsema et al., 2024), while in Japan drinks below 1% alcohol are considered as non-alcoholic (Kubo et al., 2015). Surprisingly, in the Netherlands, there are no laws that differentiate between low- and non-alcoholic beverages; only agreements exist regarding beer. This illustrates the complexity and diversity that currently exists around the definition of NoLo beverages within and between countries. Since it is difficult to differentiate between the two beverages, it is possible that some of the adolescents in our study indicated that they consumed non-alcoholic beverages while they actually consumed low alcoholic beverages. However, both drinks are offered as alternatives to the alcohol variant with the aim of offering a low-alcohol drink that represents the taste of the original alcoholic drink. Lastly, the cross-sectional study is restricted to the Dutch context and only provides indication for associations between concepts central in our study. To gain a more comprehensive understanding of NoLo consumption trends and behaviors, representative longitudinal studies in other countries are necessary. Expanding the scope of research will help elucidate the nuances of NoLo consumption across diverse cultural and social landscapes.

Conclusion and Implications

Our findings suggest that “NoLo only drinkers” comprise a distinct group of adolescents who, to a large extent, resemble “non-drinkers” but to some extent, also resemble alcohol drinkers. Specifically, “NoLo only drinkers” do not share the health risk profile (e.g., other use of substances, behavioral problems, single parenthood) that is associated with early and problematic use of alcohol (Dawson et al., 2008; Halladay et al., 2020) and also visible

among the alcohol drinkers group in this study. However, longitudinal research is needed to examine whether NoLo use at an early age is indicative of alcohol use at a later age; in other words, whether or not it functions as a gateway to alcohol for early adolescents.

While worries exist about adolescent NoLo use as it might serve as a gateway to alcohol, international peer-reviewed literature on adolescent NoLo use is remarkably scarce. Definitions and regulations differ across countries; parents have hardly any guidelines on what to do with NoLo consumption. Meanwhile, many adolescents are drinking NoLo beverages. Previous research on underage alcohol drinking reveals that parental rule setting (Koning et al., 2011) and reducing availability through marketing and sales (Finan et al., 2020; Jernigan et al., 2017) are promising leverage points for prevention. Prevention strategies could therefore focus on supporting parents in setting rules for NoLo drinks and reduce the exposure to and/or regulate marketing strategies (Miller et al., 2022). Banning the sale of non-alcoholic beverages to minors and thereby aligning with policy for alcohol sales could support parents in setting rules. In addition, stricter regulations regarding marketing strategies could prevent alcohol brands from using their non-alcoholic variant as a tool for marketing their alcoholic brands (Bury et al., 2024). Until we know the outcomes: be restrictive. It is crucial that we avoid finding out in retrospect—as we did with vaping (van Zyl-Smit et al., 2024)—that NoLo consumption has significant (health) risks for adolescents.

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Data Availability HBSC data used in this study is available upon request at the HBSC Data Management Centre. Scripts of data cleaning, and all analyses are publicly available at <https://osf.io/5akh8/>.

Declarations

Conflict of interest The authors declare no competing interests.

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