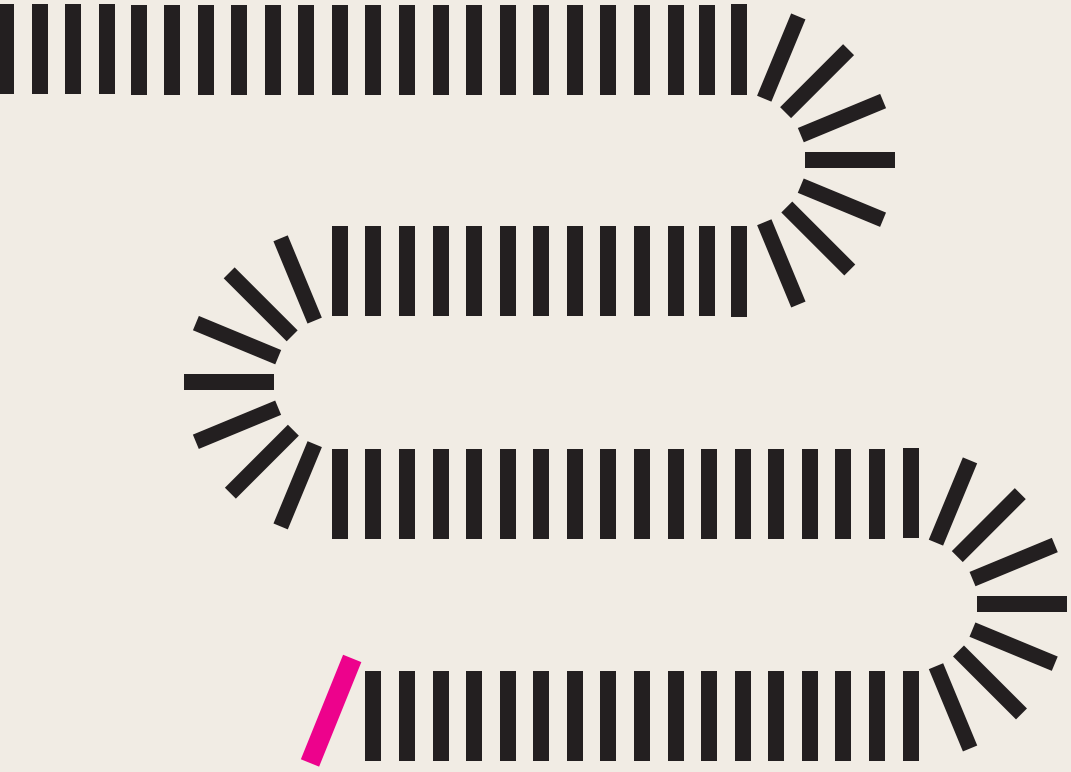
Beyond Legislation

Gaining insight into impact of raising the minimum legal drinking age



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/Contents

General introduction

Underage drinking leads to short- and long-term health damage and costs for society. To curb underage drinking, many countries have established a minimum legal drinking or purchasing age (MLDA) that is expected to protect minors from drinking and related harm. Additionally, countries (or states/provinces) have raised their MLDA to expand the impact of the measure. Yet, debate persists in research and politics whether such a raise in an age limit effectively expands the protection of minors from drinking and related harm. Also, insights into the implementation and the role of unintended impact of raised MLDA are still unclear. More insights could inform us how to best implement such a measure to improve the effectiveness, also taking into account the intended as well as unintended impact of raised MLDA. The main research question I will address in this PhD thesis is: *how can the implementation of a raised MLDA be improved to optimize impact?* In the current chapter, I will introduce alcohol policy and the MLDA, and discuss current evidence for the effectiveness of raised MLDA. Also, factors important for the implementation of a MLDA are discussed, including current gaps in scientific literature. This chapter ends with the central purpose, secondary research questions and a general outline of this thesis.

1. Alcohol policy and the MLDA

In general, alcohol policies are implemented using laws, rules, regulations and measures that aim to prevent and reduce alcohol-related harm on a global, national or regional level [1,2]. The central purpose of alcohol policies is to serve the interest of public health and social wellbeing through their impact on health and social determinants, such as drinking patterns, the drinking environment and the health services available to treat problem drinkers [2]. Effective alcohol strategies incorporate a multilevel, multicomponent approach, targeting multiple determinants of drinking (e.g., physical availability or price of alcohol) and alcohol-related harms (e.g., car crashes/fatalities due to drunk-driving behaviour) [1,2].

Evidence for the regulation of the physical availability of alcohol designed to effectively prevent easy access is strong [2]. Therefore, the World Health Organization (WHO) has called restrictions on the physical access of alcohol a 'best buy', deeming them as (cost) effective [1]. By restricting the physical access to alcohol, policymakers can reduce overall exposure to alcohol's intoxicating and toxic effects and thereby reduce alcohol-related problems [1] . Examples of this are restricting hours, days and locations for the sale of alcohol, restricting the density or concentration of on-premise and retail drinking establishments, or prohibiting the eligibility to purchase and/or possess alcohol [1].

One policy measure to prohibit eligibility to purchase and/or possess alcohol for a specific underage target population, is the establishment of a MLDA. According to the WHO, in 2016, worldwide, 152 countries (93%) reported a national or subnational MLDA for on-premise beer and wine sales, 151 (92%) for spirits [1]. The minimum ages range from 13 years to 25 years, the most common MLDA is 18 years [1]. The general intention of implementing a MLDA for the purchase and/or possession of alcohol is to decrease the availability of alcohol for minors (e.g., for adolescents younger than 18 or 21-year-olds). Preventing underage drinking is important, because early alcohol use is associated with harmful direct effects (e.g., violence, delinquent behaviour, alcohol poisoning or risky sexual behaviour) and long term effects (e.g., impaired liver functions, increased odds for alcohol abuse or dependence later in life) [3–5]. Also, initiating alcohol use at a young age has shown to impair brain development (executive functioning) and related learning abilities, because brain development is still ongoing until the age of approximately 24 years [6,7]. Implementing a MLDA is expected to reduce alcohol use and its associated harm among adolescents and their environment [2,8–11].

2. Raising a MLDA

In order to further decrease alcohol availability for minors (and in turn, further reduce alcohol use and associated harm [2,10,11]), some countries, states, provinces or regions have decided to raise the age of their MLDA. In North America (after 29 states reduced their existing MLDA between 1970 and 1975 from 21 to 18 [12]), by 1988, all states had returned to some form of an age-21 MLDA [12]. In Canada (after lowering the MLDA from 21 to 18 in the 1970's) the provinces of Saskatchewan and Ontario raised their MLDA from 18 to 19 in 1976 and 1979, respectively [13,14]. By 2008, other countries started raising their MLDA as well. For instance, Thailand and Malaysia have recently raised their MLDA from 18 to 20 in 2008 and from 18 to 21 in 2018, respectively [15–17]. Furthermore, in Europe, by 2009, ten countries have raised their MLDA, mostly from 16 to 18 years [18]. The Netherlands is one of these European countries that have raised their MLDA from 16 to 18 years in 2014 [19].

3. Evidence for the effectiveness of raising a MLDA

An extensive body of evidence, predominantly found in the United States, shows that raising a MLDA has had a positive impact on various behaviours by the target population [11,13,20–24]. Several literature reviews have presented effects of MLDA increases on reduced drinking and alcohol-related societal harm. In an early review in the United States conducted in 1982, Wagenaar [20] reported the effects of raised MLDA on automobile crashes. The author found significant reductions in drinking-driving behaviour or alcohol-related automobile crash involvement after states raised their MLDA [20]. In another early review from the United States conducted in 1984, Vingilis and De Genova [13] found that increasing an MLDA may have had some effect in reducing consumption, alcohol-related problems and collisions. A more recent review in 2001 by Shults et al. [21] concluded, based on multiple studies in the United States and other Established Market Economies, that raising a MLDA results in decreases of roughly 10% to 16% in alcohol-related traffic crash outcomes for the targeted age groups. Wagenaar and Toomey [11] searched and summarized all research published from 1960 to 1999 in another review published in 2002, investigating multiple effects. They found that compared with a wide range of other programs and efforts to reduce drinking among teenagers, increasing the MLDA for the purchase and consumption of alcohol to 21 appears to have been the most successful effort to date in the United States. They argued that, although the magnitude of effects may appear small, these effects apply to the entire population of youth and therefore result in very large societal benefits. Reaching a comparable conclusion in 2009, Hingson [22] pointed in his commentary to the preponderance of evidence indicating that increasing MLDA laws in the United States reduced alcohol consumption and alcohol-related traffic crashes and deaths among adolescents. Focusing on trends in alcohol consumption and alcohol-related crashes among people younger than 21 in the United States in 2010, McCartt et al.,[23] concluded that highway safety benefits of MLDA-21 have been proven, and the cause-effect relationship between MLDA and highway crashes is clear. According to the authors, deaths go down when the drinking age is raised. Lastly, in 2014, DeJong and Blanchette [24] provided an updated review of the literature on research on the age 21 MLDA since 2006 in the United States. They concluded that in addition to short-term effectiveness, the evidence in the included studies show that the raise of a MLDA protects drinkers (who were underage at the time of the increase of a MLDA) from long-term negative outcomes they might experience in adulthood.

To sum up, previous evidence has indicated that raising the MLDA reduces underage drinking and alcohol-related societal harm, protecting minors from short- and long-term negative consequences of early alcohol use.

Although a MLDA is in place in most countries worldwide (or even raised in some of the countries), adolescents are still able to obtain and drink alcohol. For example, in the United States, having a uniform age-21 MLDA since 1988, the 'YRBS' survey from 2019 showed that 29% of high school students consumed alcohol at least once during the past 30 days [25]. Also, the prevalence of binge drinking behaviour (i.e., consuming at least four or more alcoholic drinks in one occasion during the past 30 days) was 14% [25]. In Europe, having different MLDA of 16 or 18 between countries, the 'ESPAD' survey from 2019 (a survey among 16-year-old students in secondary school) showed that on average, 47% of the students reported last 30-day drinking [26]. An an average of 13% of these students reported having been intoxicated in the last 30 days [26]. Furthermore, in the Netherlands, the 'ESPAD' results show that the drinking prevalence of 16-year-old students in secondary school in 2019 appears to be above average: 51% of reported last 30-day drinking (47% on average in Europe), and 15% reported intoxication in the last 30 days (13% on average in Europe) [26].

When looking at this drinking prevalence of minors, we may conclude that the effectiveness of the MLDA is not optimal, because minors are still able to obtain and drink alcohol. It appears that a top-down introduction of MLDA legislation is not enough for it to be effective. Indeed, implementation is essential in order to make alcohol policy effective [27]. Elements of implementation that determine effectiveness, are 1) the level of compliance with the measure (e.g., compliance by alcohol sellers), 2) the level of enforcement of the measure, and 3) the level of public support for the specific policy measure or change [28–33]. In this thesis, focus will be on compliance and enforcement. There is scientific research investigating the compliance and enforcement of an *existing MLDA* and how this may influence its impact on underage alcohol use and related harm (e.g., [18,34–37]). Up to now, insights into implementation processes of *a raise in a MLDA* are still scarce. To address this gap in knowledge and contribute to optimizing impact, I will focus on the implementation processes involved with a raised MLDA (i.e., compliance with and enforcement during the raise of the MLDA in the Dutch setting). The main research questions I will address in this thesis is: *How can the implementation of a raised MLDA be improved to optimize impact?*

4. What do we know: compliance and enforcement of existing MLDA

We know from the literature that compliance and enforcement potentially determine the effectiveness of an existing MLDA (e.g., [18,34–37]). More specifically, a MLDA can only be effective if alcohol sellers comply to it [2,30,38–41]. Also, to reduce alcohol sales to minors, substantial benefits of enhanced enforcement have been found and shown to be effective [34,42,43]. Even moderate increases of enforcement can reduce sales of alcohol to minors by as much as 35–40% [44,45]. Within a community-wide prevention uptake, increased enforcement can even reduce adolescent heavy drinking and related harm [35,36,46]. Furthermore, we know that responsible beverage training can teach bar personnel to: 1) recognize false age identification, 2) to refuse sales to underage or obviously intoxicated patrons, and 3) to offer food and non-alcoholic beverages to reduce intoxication [47]. However, studies have shown that the effectiveness of these trainings are limited without additional enforcement efforts [18,35]. Multi-component strategies appear most effective into increasing compliance and the effectiveness of the MLDA [2,18,48]. For example, the Stockholm STAD project (combining intensified enforcement, staff training and general education to the public) has resulted in an increase in compliance with the MLDA by alcohol sellers from 55% to 68% [48].

Compliance and enforcement in the Dutch setting

The Dutch setting is suitable and relevant for investigating compliance and enforcement of raised MLDA because of three reasons: 1) the MLDA was recently increased in the Netherlands (in 2014), 2) compliance levels by alcohol sellers with the MLDA are low, and 3) enforcement efforts are limited in the Netherlands. Regarding the first reason, the MLDA in the Netherlands for the sale of all alcoholic beverages was raised from 16 to 18 years in 2014 [19]. In addition, in 2014, the possession of alcohol in public places has become punishable by law for minors [19]. Furthermore, prior to the raise of the MLDA, the enforcement of the Dutch MLDA was decentralized to municipalities in 2013 [19]. The abovementioned legislative changes provide the possibility to gain more insight into processes or factors that are important for improving implementation and in turn, optimize the impact of raised MLDA.

The second reason involves low overall compliance rates with the MLDA in the Netherlands. Results from a national representative mystery shopping study (using 17-year-old mystery shoppers to perform actual purchase attempts of alcohol at all

types of alcohol sellers) showed that the national average compliance rate including all types of sellers was 35.8% in 2016 [49].

The third reason involves the limited enforcement efforts in the Netherlands. Between 2009 and 2010, in the Netherlands, the likelihood of apprehension resulting from enforcement efforts was 28% [36]. This low percentage was likely caused by the enforcement-strategy that officers were allowed to use to inspect retailers' compliance [36]. Only red-handed observations of noncompliance were allowed and proof of noncompliance is needed to impose a warning or fine [36]. Although resulting in a higher likelihood of apprehension, during that time, no decoy operations or pseudo patrons were allowed for compliance monitoring activities [50]. Pseudo patrons are younger-looking mystery shoppers who have reached the legal age to buy alcohol [50]. More recently, a guide is developed for municipalities on how to use pseudo patrons to inspect compliance with the MLDA [51]. Also, as part of the decentralization in 2013, municipalities are allowed to prohibit the sale of alcohol for off-premise alcohol sellers (i.e., supermarkets, take-away restaurants, liquor stores and night shops) [19]. This prohibition can last up to 12 weeks when these sellers are unable to comply with the alcohol age limit measure during three enforcement-inspections within one year (the so-called 'three-strikes-out' policy) [19]. However, despite abovementioned developments, only a limited number of municipalities in the Netherlands use pseudo patrons in their enforcement-strategy, and enforcement efforts are limited [51,52]. Findings from telephone interviews with Dutch local policy workers showed that, on average and per municipality, only 20.4 warnings, 2.3 fines and 0.0 'three-strikes-out' were imposed on alcohol sellers [52]. When asking for the reasons behind these low figures, 54% of the interviewed policy workers indicated a shortage of time (47%), budget (46%) and personnel (34%) as the main hindering factors [52].

These low compliance rates and limited enforcement efforts are problematic and could undermine the potential and effectiveness of MLDA policy in reducing alcohol availability for minors [8,9,11]. This is indicated by the above average drinking prevalence of Dutch minors compared with European minors. Furthermore, with the research presented in this thesis, an important gap in knowledge is addressed by gaining more insight into the processes of implementation of a raised MLDA. Additionally, not much research has been conducted on MLDA policy in Europe. The majority of research has been conducted in the United States. However, the drinking prevalence of minors in Europe is higher compared with the United States: the average last 30-day drinking prevalence of minors in 2019 was 48% in Europe compared to 22% in the United States [25,26]. This indicates that research on MLDA policy in Europe is certainly relevant and needed, as is conducted in this thesis. The

secondary research questions I will address in this thesis are:

- Which processes or factors can influence compliance regarding the raise of a MLDA?
- Which processes or factors can influence enforcement regarding the raise of a MLDA?

Responses of alcohol sellers to developments in the Dutch setting

There are particular responses by alcohol sellers that are caused by the legislative developments in the Dutch setting followed by a substantial increase of attention for underage alcohol availability in media and politics. Supermarkets- and liquor store chains have voluntarily formulated and implemented self-regulated age limit control measures. Self-regulation in the Dutch setting means that the central government has set objectives for complying with the MLDA. The government does not prescribe specific procedures for observing the age limit for alcohol sellers, leaving proper execution to the discretion of parties in the field. To the best of our knowledge, no scientific literature on specific self-regulated MLDA-measures exists. However, we do know from the literature that there is no evidence for the effectiveness or safety of general self-regulation measures [43,53,54]. More specifically, in the alcohol market, the development or promotion of a (new/existing) voluntary code or other form of self-regulation is used to reduce political pressure [55,56] on happy hours [57], advertisement [58–60], marketing campaigns [56,61–64] and alcohol health warning labels [65]. In addition, the alcohol market is known to argue that their own self-regulation is working well or is working better than formal regulation [61,62,66,67], arguing that existing regulation is satisfactory [58,61], or more extensive than necessary [61,68]. These insights underline the importance of a critical assessment and evaluation of these self-regulated age limit control measures, because strict compliance to the MLDA may conflict with economic interests. Furthermore, a critical assessment and evaluation could potentially improve compliance and by focusing on self-regulation in this setting, address a gap in knowledge.

As an extension of these self-regulated age limit control measures, supermarkets- and liquor store chains have introduced age verification systems (AVSs). These are systems that, by 'keying on' the date of birth of costumers, or by 'swiping' the ID card of costumers, calculate and/or verify the age of the costumer for the cashier. Previous research has shown that requesting ID increases compliance (e.g., [69,70]). Yet, limited to the work listed below, little is known about the effectiveness of AVSs on ID reques-

ting rates and compliance. We know that research investigating comparable AVSs in the United States made it easier for cashiers to request customers' IDs, however, the AVSs did not increase the actual frequency of age verification [71]. Furthermore, in a Dutch study based on 24 purchase attempts of alcohol, it was found that the cashier used the AVS 12 times (50.0%) and complied to the age limit in 11 of these 12 times (91.7%) [72]. In another Dutch study, compliance rates of 96% where found for remotely operated AVS, compared with 12% compliance for regular AVSs [73]. Because of the inconsistent results presented above (and the lack of previous research regarding most of the AVSs implemented in supermarket- and liquor store chains), a critical assessment and evaluation is important and needed and could improve compliance.

Other factors influencing underage alcohol availability

In addition to minors buying alcohol themselves directly from alcohol sellers, there are other ways for them to obtain alcohol. Research indicates a development in many Western countries (also in the Netherlands) in which alcohol is mainly available for minors through secondary or social supply [74–76]. Secondary or social supply occurs when an adult furnishes an alcoholic product to a minor in an on- or off-premise outlet. In Dutch law, the individual selling the alcohol and the minor possessing the alcohol are liable, not the person supplying the alcohol [19]. In order to fully curb alcohol availability for minors, all modes of supply (i.e., supply directly from alcohol sellers and supply from secondary or social sources) need to be addressed. Any form of supply represents a conceivable treat to the general intention of MLDA policy, which is to decrease the availability and in turn lower alcohol use and associated harm [2,8–11]. Indeed, successful strategies to reduce access to alcohol need to address both commercial and social availability of alcohol, especially to youth [2]. Up to now, there is no methodology developed or tested for measuring compliance of alcohol sellers with the secondary or social supply of alcohol.

5. The intended and unintended impact of raised MLDA

In addition to the problem of adolescents still being able to obtain and drink alcohol (despite having a MLDA in place), there is another problem that the drinking prevalence of minors shows us. The 'YRBS' survey from 2019, measuring the prevalence of last 30-day drinking by high school students in the United States, show differences in prevalence ranging from 10% and 18% in Utah and Georgia versus 33% in Kansas and Montana, respectively [25]. Also in Europe (although only small differences in MLDA between countries exist [18]), even larger differences in drinking prevalence of minors between countries are noticeable. The 'ESPAD' survey from 2019, measuring the last 30-day prevalence of drinking by 16-year-old students in secondary school, also show differences in prevalence, ranging from 10% and 11% in Kosovo and Iceland versus 74% and 65% in Denmark and Germany, respectively [26].

Although most regions have a (roughly) uniform MLDA in place (i.e., 18 years old in most countries in Europe and 21 years old in all states in the United States), the drinking prevalence of minors differs between states and countries. This fragmented effectiveness of the measure indicates that each situation in which a MLDA is implemented, differs. Additionally, current evidence on the effectiveness of raised MLDA is predominantly focused on the intended impact (i.e., the desired output of the measure, focused on, for example, changes in underage drinking or alcohol-related harm) of the changed policy. Yet, in addition to the intended impact and in order to fully understand how changes in legislation affect all dynamics in society, an evaluation on unintended impact is important and should be investigated as well. Responsive and realism evaluation (theories used for the general evaluation of legislation) remind us of the importance of this perspective when changes in legislation occur [77–80]. Both theories consider the sometimes complex, capricious and unintended relationship between legislation on the one hand and reality on the other, when changes in legislation occur. These theories show that all forms of knowledge, actions and processes (and not only the most general) should be investigated and used to fully understand how the impact of legislation works [77–80]. Furthermore, Wolfson and Hourigan [81] described how legal changes appear to have affected law enforcement practices concerning youth tobacco and alcohol use in the United States. They underline the importance of more situational information by arguing that impact from this perspective is an important issue for professionals involved in advocating, developing, implementing and evaluating public policy concerning substance abuse [81].

To our knowledge, no studies have been conducted on both the intended and unintended impact regarding raised MLDA. Yet, more insight is important and needed, because both seem to influence effectiveness (as indicated by the fragmented drinking prevalence between different states and countries). Furthermore, current evidence on impact of raised MLDA are predominantly found in the United States. However, other countries, with varying situational processes of implementation and drinking-cultures [82], have raised their MLDA as well. Because of this, it is perceivable to assume that current US-based evidence may be difficult to apply to the European, Asian or African situation. Legislators in these particular regions could base their decision-making on evidence that is not appropriate for their specific setting. Therefore, more research is needed regarding intended as well as unintended impact regarding the raise of a MLDA (preferably from a broad and international orientation). Because opposition against higher MLDA persists in research and politics, this could further enrich the debate regarding this particular subject [12,23,24,28,83–85]. The last secondary research question I will address in this thesis is:

- Which processes or factors are involved with the intended and unintended impact of the raise of a MLDA?

6. Outline of this thesis

This thesis describes six studies, an overview is presented in Table 1. The main research question I will address in this thesis is: *how can the implementation of a raised MLDA be improved to optimize impact?* The secondary research questions I will address are:

- Which processes or factors can influence compliance regarding the raise of a MLDA?
- Which processes or factors can influence enforcement regarding the raise of a MLDA?
- Which processes or factors are involved with the intended and unintended impact of the raise of a MLDA?

Firstly, we focused on implementation and compliance of alcohol sellers regarding the raise of a MLDA. We used empirical data to investigate ways to improve compliance of alcohol sellers in the Dutch setting of raised MLDA. Using mystery shopping and based on a total of 1770 alcohol purchase attempts, we investigated whether raising

Table 1 Overview of the studies presented in this thesis

Chapter	Research question	Subject	Participants	Design and data	Time period data collection
2	Which processes or factors can influence compliance regarding the raise of a MLDA?	The effect of the raise of the MLDA in the Netherlands from 16 to 18 years old on the compliance of alcohol retailers using 15-year-old mystery shoppers	Alcohol sellers (on- and off-premise)	Mystery shopping (cross-sectional)	2013, 2014 and 2016
3	Which processes or factors can influence compliance regarding the raise of a MLDA?	Differences between three liquor store chains in their style of self-regulation and how that affects compliance with the MLDA	Alcohol sellers (cashiers), liquor store owners and chain managers	Mixed methods, combining mystery shopping with surveys and qualitative interviews	2015
4	Which processes or factors can influence compliance regarding the raise of a MLDA?	Effectiveness of AVSs on requesting a valid age verification (ID) and sellers' compliance with the MLDA	Alcohol sellers (cashiers) and managers of chain supermarkets	Mixed methods, combining mystery shopping with qualitative interviews	- qualitative interviews in 2012 and 2013 - mystery shopping in 2015
5	Which processes or factors can influence compliance/enforcement regarding the raise of a MLDA?	Developed and field tested a novel methodology, measuring compliance of alcohol sellers with secondary (or social) supply	Alcohol sellers (on- premise)	Mystery shopping	2016
6	Which processes or factors can influence enforcement regarding the raise of a MLDA?	A risk-oriented ranking of alcohol seller types in the Netherlands based on the prevalence of minors purchasing alcohol (using survey data) and the success-rate of minors based on actual purchase attempts of alcohol (using mystery shopping data)	Alcohol sellers and minors	Multi-method, combining survey data and mystery shopping data	2015
7	Which processes or factors are involved with the intended and unintended impact of the raise of a MLDA?	Intended and unintended impact regarding the raise of a MLDA	-	Scoping review	2019 and 2020

the MLDA for the sale of alcohol has influenced compliance rates among Dutch alcohol sellers (chapter two). Also, in a combination of mystery shopping, survey- and qualitative data, we investigated differences between three liquor store chains in their style of self-regulation and how that affects sellers' compliance (chapter three). By combining mystery shopping and qualitative data, we investigated the effectiveness of AVSs implemented in 400 Dutch supermarkets on requesting a valid age verification (ID) and sellers' compliance (chapter four). Secondly, we focused on implementation and enforcement regarding the raise of a MLDA. In order to improve effectiveness of the raise of the MLDA occurring in the Dutch setting, we presented a novel method and a new risk-oriented approach for prioritizing alcohol enforcement and prevention efforts. From existing mystery shopping protocols, we developed and field tested this novel methodology, measuring compliance of alcohol sellers with secondary (or social) supply in on premise outlets (chapter five). Furthermore, a risk-oriented ranking of alcohol seller types in the Netherlands was introduced. This ranking was based on the prevalence of minors purchasing alcohol (using survey data) and the success-rate of minors based on actual purchase-attempts of alcohol (using mystery shopping data) (chapter six). Thirdly, from an international orientation, we conducted a synthesis (scoping review) of what is known from the available literature on intended and unintended impact regarding the raise of a MLDA. This overview is conducted in order to more fully understand the impact of changes in legislation on multiple situational aspects of society and how we can make it more effective (and to avoid overlooking existing insights). The outcome of this scoping review is an empirically based overview of impact (chapter seven). Lastly, the discussion of this thesis (chapter eight) provides a summary and general discussion, in which the research questions are reviewed and reflected upon. Additionally, methodological considerations and possible implications will be discussed.

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Increased minimum legal age for the sale of alcohol in the Netherlands as of 2014: The effect on alcohol sellers' compliance after one and two years

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/Abstract

Background

As of January 2014, the Dutch minimum legal age for the sale and purchase of all alcoholic beverages has increased from 16 to 18 years of age. The effectiveness of a minimum legal age policy in controlling the availability of alcohol for adolescents depends on the extent to which this minimum legal age is complied with in the field. The main aim of the current study is to investigate, for a country with a West-European drinking culture, whether raising the minimum legal age for the sale of alcohol has influenced compliance rates among Dutch alcohol vendors.

Methods

A total of 1,770 alcohol purchase attempts by 15-year-old mystery shoppers were conducted in three independent Dutch representative samples of on- and off-premise alcohol outlets in 2013 (T0), 2014 (T1), and 2016 (T2). The effect of the policy change was estimated controlling for gender and age of the vendor.

Results

Mean alcohol sellers' compliance rates significantly increased for 15-year-olds from 46.5% before to 55.7% one year and to 73.9% two years after the policy change. Two years after the policy change, alcohol vendors were up to 3 times more likely to comply with the alcohol age limit policy.

Conclusion

After the policy change, mean alcohol compliance rates significantly increased when 15-year-olds attempted to purchase alcohol, an effect which seems to increase over time. Nevertheless, a rise in the compliance rate was already present in the years preceding the introduction of the new minimum legal age. This perhaps signifies a process in which a lowering in the general acceptability of juvenile drinking already started before the increased minimum legal age was introduced and alcohol vendors might have been anticipating this formal legal change.

Keywords

Minimum legal drinking age / Compliance of alcohol sellers / Mystery shopping / Underage alcohol sales

Introduction

The risks associated with excessive drinking at a young age, such as increased risk of injuries, violence, premature mortality and in the long run possible permanent cognitive damage or addiction [1–6], underline the importance of implementing effective alcohol prevention policies. Setting a minimum age for selling and purchasing alcoholic beverages is one of the strategies to reduce harmful alcohol use among young people. Availability of alcoholic beverages has been found to be an important determinant of young people's drinking behaviour [7–10]. A systematic review including studies conducted between 1960 and 1999 and investigating the effects of the legal minimum drinking age on related health and harm showed that a higher minimum legal drinking age in the U.S. of 21 years (by 1988, all states had established an age-21 minimum legal drinking age) has led to a reduction in alcohol consumption among adolescents, as well as a reduction in alcohol-related harm, including road fatalities, crime, violence and drunkenness convictions [11]. In New Zealand, the lowering of the legal drinking age for alcohol from 20 to 18 years has led directly to a higher number of emergency admissions and traffic accidents caused by alcohol consumption among 15- to 19- year olds [12–14], as well as to a higher prevalence of alcohol-related road accidents among 18- and 19-year-olds in the long term [15]. An increase in the alcohol minimum legal age could well decrease the availability of alcohol for underage adolescents, which in turn could reduce alcohol-related health and societal harm for adolescents. However, the extent to which this minimum legal age policy is complied with and the extent to which social sources (e.g., older friends or parents) will not substitute for the reduced alcohol availability via commercial sources will most likely influence its effectiveness in reducing alcohol availability for adolescents [9,16]. Dutch figures on compliance and adolescents purchase attempts indeed showed that a doubling of the compliance rates for 15-year-old buyers between 2011 and 2013 (28% to 56%) co-occurred with an 89% decrease in self-reported purchases by 14-15- year-olds (9% to 1%) [17,18].

The Dutch context; adolescent alcohol use and alcohol policy

Although alcohol consumption of Dutch teenagers has been relatively high in the past two decades, in recent years the proportion of 12- to 16-year-olds "ever users" of alcohol dropped substantially from 84% in 2003 to 45% in 2015 [19]. Nevertheless, of the 12- to 16-year-olds who have reported to drink alcohol, around two thirds have

reported binge drinking (5+ units per occasion) in the past month.

Between 2007 and 2013, parental awareness of the harmful effects of their adolescent children's alcohol use has increased and parents became stricter when it comes to their children's drinking in specific situations and under the age of 16 [19]. Also the support for a higher legal purchase age for alcohol increased from 79% in 2011 to 83% in 2013 [19]. After several attempts by consecutive Dutch governments to raise the minimum legal age, the Dutch parliament eventually accepted raising the minimum legal age to 18 years for all alcoholic beverages in March 5, 2013, to be become effective as of the 1st of January 2014. Dutch law now requires alcohol vendors to determine the age of buyers by checking a valid identity card, in case this person is not unmistakably over 18 years of age. Since 2005, all Dutch citizens over 14 years of age are required by law to carry an official identity card in public.

From 2011 onwards, the Dutch Ministry of Health commissioned mystery-shopping research to estimate national compliance rates with the minimum legal age for selling alcohol. In this mystery-shopping research, adolescents one year younger than the minimum legal age made purchase attempts at all the different type of alcohol outlets. Compliance with the minimum legal age in the Netherlands was low, prior to the introduction of the new minimum legal age. A mean compliance estimate in 2011 revealed that in only 28% of the underage purchase attempts by 15-year-olds the minimum legal age of 16 years for light alcoholic beverages (<15 Vol%) and 18 years for strong alcoholic beverages was complied with [20]. Although alcohol vendors' compliance rates had significantly increased to an average of 47% in 2013 [20,21], still more than half of the 15-year-old mystery shoppers could purchase alcohol. The observed increase in compliance before 2014 may have resulted from several developments in the Netherlands, some of which may also have contributed to the co-occurring drop in adolescent drinking. For example, in the past decade, media attention for the risks associated with adolescent drinking increased which spurred the necessity for a higher minimum legal age [22], and for a better compliance with alcohol laws. In the same period, certain alcohol policy measures were taken, such as curtailing alcohol advertising by Dutch law in 2009 and the criminalisation of underage possession of alcohol in public places on the 1st of January 2013. Alcohol law enforcement regulations were decentralized to the municipal level in 2013. The decentralisation has created possibilities for (stricter) measures on local alcohol price promotions, noncompliance in off-premise outlets (supermarkets) and on setting access ages for on-premise retailers based on their opening hours. The proposed possibility for local governments to impose stricter measures for vendors and the uncertainty about how this would be put into practice by local governments, may have

increased vendors' motivation to comply with the legal age for alcohol between 2012 and 2013. However, recent research has shown that just few Dutch municipalities made use of these stricter measures for vendors between 2013 and 2016, tempering the potential effect of this measure [23].

The current study

Although there is ample evidence from U.S. studies that a higher minimum legal age for alcohol results in less juvenile alcohol consumption and harm (e.g., [11,24]), this has not yet been investigated in countries with a Western-European drinking culture in which juvenile drinking is more socially integrated than in the U.S. Adolescents from Western-European countries (e.g., Belgium and the Netherlands) show above average drinking rates compared with adolescents from other European countries and the U.S. [25], emphasizing the importance to investigate the effectiveness of alcohol policy measures in these regions. Besides the influence of planned prevention control policies, alcohol consumption might also be influenced by unplanned complex changes in a series of phenomena, such as social, cultural, economic, demographic, religious or political factors, also referred to as a "period effect" [26,27]. In a study including longitudinal data between 1960s-2008 of 12 European countries, socio-demographic and economic factors (e.g., urbanisation, increased income and older mother's age at their childbirths) were better able to explain the observed changes in alcohol consumption than planned control policies (availability restrictions and drink-driving limitations) [26]. However, the degree to which the control measures were enforced and/or complied with were not taken into account in these studies.

The main aim of this study is to investigate the effect of the planned increase of the minimum legal age for the sale of alcohol in the Netherlands from 16 to 18 years old on the compliance of alcohol retailers (on- and off-premises) using 15-year-old mystery shoppers. In other words, the question is raised whether the compliance with the minimum legal age for selling alcoholic beverages via on-premise (sport bars, public bars, café's and disco's) and off- premise outlets (take-away restaurants, supermarkets, liquor stores, and alcohol home delivery outlets (AHDOs)) significantly has increased for 15-year-olds after the minimum legal age was raised. This is important knowledge, because the availability of alcohol for adolescents can directly impact drinking, which in the long run could reduce alcohol-related health and societal harm for adolescents (e.g., [11,24]).

Methods

Research design and sampling

Cross-sectional data collection took place in November and December (not during holidays) of 2013 (T0), in November and December of 2014 (T1) and in May and June of 2016 (T2) in the Netherlands. To increase the national representativeness of the sample, purchase attempts were conducted in four Dutch regions covering the complete country geographically and each consisting of one or two large cities and rural areas in each data wave. Selection of on- and off-premise alcohol outlets in each geographic unit was based on their presumed popularity among youth (so-called hotspots; outlets in the city centre's going out are and in proximity of high schools) and on logistical feasibility. Outlet categories formed the strata with evenly distributed purchase attempts (Table 1). A balanced design based on gender of the mystery shoppers was used for each alcohol outlet category, meaning that half of the purchase attempts were conducted by girls and the other half by boys. In 2013, 1399 alcohol purchase attempts were conducted by 51 mystery shoppers, followed by 361 purchase attempts conducted by 19 different mystery shoppers in 2014, and 398 attempts conducted by 17 again different mystery shoppers in 2016 in on- and off-premise

Table 1 Number and percentages of alcohol purchase attempts in different outlets for each data collection year

	Off-premise outlets				On-premise outlets	
	Take away restaurants	Super-markets	Liquor stores	Home delivery outlets	Sport bars	Bars/café/ disco
2013	103	408	410	50	102	326
	7.4%	29.2%	29.3%	3.6%	7.3%	23.3%
2014	27	98	101	15	26	94
	7.5%	27.1%	28.0%	4.2%	7.2%	26.0%
2016	28	111	112	22	31	94
	7.0%	27.9%	28.1%	5.5%	7.8%	23.6%

outlets. A financial incentive was given to each mystery shopper and supervisor for every data-collection day. All outlets were visited once in all data waves. In 2013, the number of purchase attempts per type of outlet was set by the Dutch Ministry of Health (commissioning party). Because of limited budgets, a lower number of purchase attempts was used in the measurements of 2014 and 2016. The number of purchase attempts in 2014 and 2016 was based on a sample size calculation comparing proportions of two independent samples to detect a minimal increase in total compliance (two-sided test) of 10% (95% confidence interval;
alpha = 0.5) [28].

Procedure

Alcohol purchase attempts were conducted by 15-year-old mystery shoppers, always accompanied by an adult trained research assistant. Mystery shoppers would wear regular clothing; neither hats nor sunglasses were allowed. Girls were not allowed to wear extreme make-up and boys had to be shaved (remove facial hair). In all purchase attempts, interaction between mystery shoppers and the vendor consisted of lying once about one's age if asked ("yes, I'm 18 years old"), and, upon request by the vendor, of showing their (true) personal and valid ID (carrying date of birth). Outcome measures were ID check and refusal/compliance rate. In off-premise outlets, one mystery shopper entered the outlet alone and s/he picked a can of beer/mix/wine/spirits from the shelves or asked one, challenging the 16 or 18 y/o minimum legal age. In on-premise outlets, two mystery shoppers (boy and girl) entered the premise together for safety reasons. The mystery shopper who was to purchase the alcohol ordered a beer (boy) or wine (girl) at the bar. The side-kick mystery shopper made use of the restroom whenever the purchase took place. The research assistant supervised the process from a discrete distance, but no interaction between the mystery kids and research assistant took place. For AHDOs, the same research procedure was used. An order was placed online by the researchers or by telephone by the mystery shopper. The mystery shopper received the delivery at a different address than their home address.

Within off-premise outlets, when alcohol was sold, this was paid and the cans/bottles were taken outside of the outlet and given to an adult research assistant directly. Within on-premise outlets, the mystery shoppers would leave the bar, leaving the purchased alcohol untouched. For AHDOs, the ordered cans or bottles were taken into the house and given to an adult research assistant. Directly after every purchase attempt, a checklist was completed including whether the vendor had requested a valid ID (no/yes) of the mystery shopper, and whether the alcoholic beverage was sold

(no/yes). Gender and estimated age of the vendor were also noted. The vendors were not aware of the period and time during which the purchase attempts were carried out.

Ethics

Data collection took place in accordance with validated protocols for mystery shopping research, including the ethical and legal aspects regarding this type of research, as described and conducted in previous mystery shopping studies [29–32]. The method used in this study is not deemed to be medical research, subjects are not manipulated or adversely affected in any way, and is for this reason exempted under the Dutch WMO-law which is the legal charter of the Helsinki Declaration [33]. The mystery shoppers were accompanied by experienced and trained supervisors, who oversaw the entire purchase process from a distance in an unobtrusive way. To avoid being punishable by law, mystery shoppers never touched the alcohol that was sold to them in on-premise outlets and immediately transferred the closed alcohol to the supervisor after leaving the off-premise outlets. Furthermore, the procedure secured the anonymity, privacy, and legal integrity of the mystery shoppers, supervisors and vendors. The outcomes resulting from this procedure will never be used for penalizing vendors. Study results are not reducible to individual supervisors, minors, vendors and employees. If purchase attempts interrupt enforcement efforts, the enforcement-officer will be informed by the supervisor.

Analyses

Univariate analyses (Chi-square) were conducted to explore changes in compliance one and two years after the increased minimum age was introduced. A single logistic regression analysis was conducted to estimate the effect of the policy change on compliance (no/yes) of alcohol sellers, controlling for the passage of time (T1, T2, with T0 as reference). The gender and estimated age of the vendor (<20, 20-40, >40) were included as covariates. The gender of the Mystery Kid and the degree of urbanisation were not added as covariates, because these factors did not significantly added information to the explanation of compliance rates.

Furthermore, it was explored whether male or female vendors or younger and older vendors are differently affected by the policy change by testing interaction effects with policy change. For instance, female vendors might have increased their compliance rates after the policy change, whereas men did not (or vice versa). Only significant effects will be reported.

Results

Descriptive results

Changes in compliance one and two years after the introduction of the new minimum legal age

Almost one year after the new minimum legal age was introduced the total average ID requests and compliance rates involving all alcohol outlets significantly increased by 7.2% ($p<0.05$) and 9.2% points ($p<0.01$), respectively (Table 2). Compared with the 2013 situation, approximately two years after the new minimum legal age was introduced the total average ID requests and compliance rates including all alcohol outlets even significantly increased by 23.3% ($p<0.001$) and 27.4% points ($p<0.001$), respectively. One year after the new minimum legal age was introduced, purchase attempts at supermarkets showed only a significant increase in compliance, not a significant increase in ID requests. Purchase attempts at liquor stores showed neither an increase in vendors requests for ID, nor in compliance to alcohol laws after one year. The strongest increase after one year in ID requests and compliance was found for bars, café's and disco's (on-premise outlets); plus 17.6% points for ID requests and up 26.7% points for compliance. Two years after the minimum legal age was introduced, supermarkets, liquor stores and bars, café's and disco's all showed significant increases for ID requests and compliance. For the remaining outlets, no reliable statements about changes in ID requests or compliance over time could be made, because their individual sample sizes were too small.

Effects on compliance in the years after the policy change

Controlling for sex and gender of the vendors, the logistic regression analysis showed a significant effect for the policy change one and two years after the new minimum legal age came into effect. After one year of implementing the new minimum age, vendors were 1.5 times ($p<0.01$) more likely to comply with the minimum legal age regulations whenever 15-year-olds attempted to purchase alcohol (Table 3). The effects of the new minimum legal age two years after its introduction, doubled compared with the effect after one year; vendors were 3.24 times more likely to comply compared with before the policy change. The increase in compliance between T0 (2013, right before the policy change) and T1 (2014, almost one year after the policy change) of 9.2% points did not (yet) stand out from the increase in the years preceding the policy change (2011-2013; mean increase of 9.15% points a year) (Figure 1). However, the

Table 2 Mean percentages of ID requests and compliance [95% BI] for 2013, 2014 and 2016 regarding 15-year-old mystery shoppers [a]

	2013			2014			2016		
	Mean % ID requests	Mean % compliance	N	Mean % ID requests	Mean % compliance	N	Mean % ID requests	Mean % compliance	N
Total	54.1 [51.5; 56.7]	46.5 [43.9; 49.1]	1399	61.5 * [56.4; 66.4]	55.7 ** [50.5; 60.7]	361	77.4** [73.0; 85.2]	73.9** [69.3; 77.9]	398
TA restaurants	21.4 [14.5; 30.2]	14.6 [9.0; 22.6]	103	40.7 [24.5; 59.3]	33.3 [18.6; 52.2]	27	39.3 [23.6; 57.6]	39.3 [23.6; 57.6]	28
Supermarkets	78.9 [74.7; 82.6]	55.4 [50.5; 60.1]	408	79.6 [70.6; 86.4]	66.3* [56.5; 74.9]	98	94.6** [88.7; 97.5]	89.2** [82.0; 93.7]	111
Liquor stores	75.1 [70.7; 79.1]	68.0 [63.4; 72.4]	410	74.3 [65.0; 81.8]	70.3 [60.8; 78.3]	101	87.5** [80.1; 92.4]	85.7** [78.0; 91.0]	112
AHDOs	0.0 [0.0; 7.1]	0.0 [0.0; 7.1]	50	26.7 [10.9; 52.0]	20.0 [7.0; 45.2]	15	18.2 [7.3; 38.5]	18.2 [7.3; 38.5]	22
Sport bars	14.7 [9.1; 22.9]	14.7 [9.1; 22.9]	102	11.5 [4.0; 29.0]	11.5 [4.0; 29.0]	26	61.3 [43.8; 76.3]	58.1 [40.8; 73.6]	31
Bars/café's/ Disco's	27.6 [23.0; 32.7]	35.6[b] [30.6; 40.9]	326	54.3 ** [44.2; 64.0]	53.2 ** [43.3; 63.0]	94	75.5** [66.0; 83.1]	70.2** [60.3; 78.5]	94

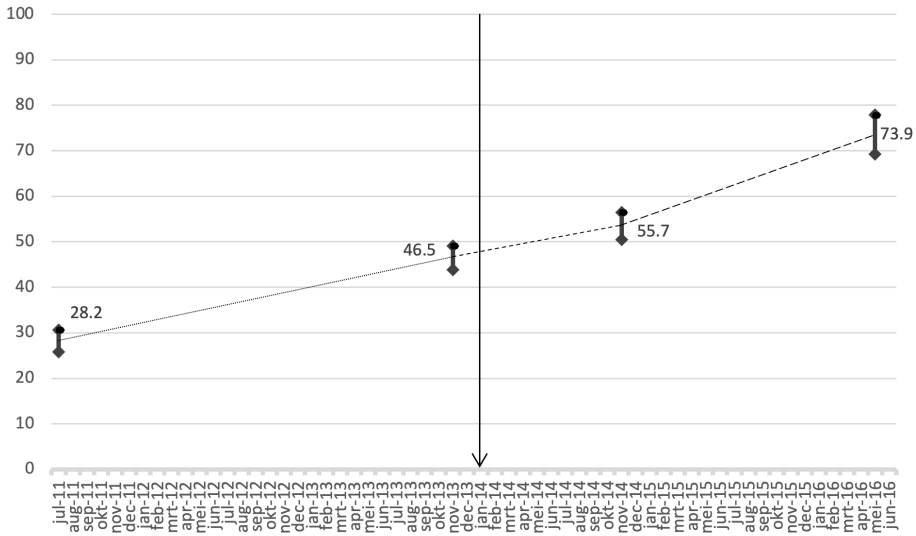
Footnote: TA = Take away; AHDOs = Alcohol home delivery outlets; [a] Sample sizes within TA restaurants, AHDOs, and Sport bars are too small to make reliable statements about changes in compliance over time for each of these alcohol premises separately; [b] In 26 cases compliance was due to an 18+ years door policy and the mystery shopper was immediately refused by the doorman (no ID requested); * $p<0.05$; ** $p<0.01$.

Table 3 Logistic regression analyses: number of years after the policy change predicting overall compliance (no = 0/yes = 1)

			95% C.I. for EXP(B)	
	df	Exp (B)	Lower	Upper
Gender alcohol seller (male = 0; female = 1)	1	1.28*	1.07	1.53
Estimated age alcohol seller (indicator = <20)	2			
Estimated age alcohol seller (20-40)	1	1.02	0.80	1.31
Estimated age alcohol seller (>40)	1	1.08	0.84	1.39
Years after policy change (indicator = before policy change)	2			
One year after policy change	1	1.46**	1.16	1.84
Two years after policy change	1	3.24***	2.53	4.15
Constant	1	0.74*		

Footnote: * p<0.05; ** p<0.01; *** p<0.001; Model Chi-Square = 103.94 (df = 5, p = 0.000); Hosmer and Lemeshow sign = 0.34; Nagelkerke R-Square = 0.063

Figure 1 Mean compliance rate [95% CI] with the alcohol age limit over time for Dutch on- and off-premise retailers selling alcohol to 15-year-old mystery shoppers



Footnote: *The arrow indicates the timing of the introduction of the new age limit; 2011 data come from previous research [20]; in 2012 and 2015 no measurement was conducted

increase in vendors' compliance between November/December of 2014 and May/June of 2016, a similar period of time after the minimum legal age was raised, is higher than the increase in compliance between 2011 and 2014 measurement (27.4%-points vs. 18.3%-points). The logistic analysis showed that the effect (i.e. odds ratio) of each consecutive year of implementation of the new minimum legal age on compliance also slightly increased from an OR of 1.5 after one year to an OR of 1.8 after two years of implementation.

The results also showed a significant effect for gender: female vendors were 1.28 ($p<0.05$) times more likely to comply with the minimum legal age than male vendors. No significant interaction effects were found. Also, although the predictors in our model showed a significant effect on the outcome (Model Chi-square = 103.94, df = 5, $p<0.001$), they only accounted for approximately 6.3% (Nagelkerke R-Square) of the estimated explained variance of sellers' compliance.

Discussion

The main aim of the current study was to investigate whether raising the minimum legal age from 16 to 18 years old has influenced compliance rates among Dutch alcohol vendors. Results showed that vendors requested more frequently an ID (significant overall increase of 7.4% points after one year and 23.3% points after two years) of the 15-year-old mystery shoppers after the policy change. Mean compliance rates including all alcohol outlets increased significantly by 9.2% points after almost one year and 27.4% points after two years and 5 months compared with before the policy change, even after controlling for the gender and age of the vendor. It can be concluded that it became more difficult for 15-year-old adolescents to purchase alcohol after the minimum legal age for alcohol was raised from 16 to 18 years and its effect on compliance seems to increase over time (18.3%-points increase between 2011 and 2013 vs. 27.4%-points increase between 2014 and 2016). Nevertheless, it might be naïve to believe that the effect found in this study can entirely be attributed to the implementation of the increased minimum legal age for alcohol. Several other changes occurred in the years preceding the raise of the minimum legal age, which might have contributed to the observed effect on compliance, such as the increased media attention considering the harmful effects of adolescents' alcohol use and the need for a better compliance or the changes in parental norms considering underage drinking (became stricter) [19].

Although compliance rates with the alcohol minimum legal age have raised up to 73.9% for 15-year-old mystery shoppers in 2016, our prior research shows that compliance rates for 17-year-old mystery shoppers are much lower in 2016 (35.8%) [17,34]. Other previous research underlines that, as the age of adolescents gets closer to the minimum legal age for alcohol, it becomes easier for them to purchase alcohol (e.g., [19,35]). This may indicate that the minimum legal age for alcohol use has an increased effect on adolescents' access to alcoholic drinks well below the legal drinking age, most likely due to a more restrictive general norm for selling alcohol to these adolescents.

Results of the current study and results from the national representative mystery shopping study conducted in 2015 and 2016 [17,34] showed that the availability of alcohol via on- and off-premises reduced for 15- and 17-year-olds after adaptation of the minimum legal age in the Netherlands. This reduced alcohol availability via commercial sources for these adolescents, may, in turn, reduce alcohol-related harm for adolescents (e.g., [11]). This study indicates that increasing the minimum legal age for alcohol is also effective in a country with a Western-European drinking culture. From a prevention point of view, this is a promising result, because adolescents in these countries show above average drinking rates (ESPAD, 2015). Nevertheless, still more than 25% of the 15-year-olds and more than 60% of the 17-year-olds [17] could purchase alcohol themselves two years after the new minimum legal age was introduced.

Although the effect of the raised minimum legal age for alcohol as of 2014 on vendors' compliance showed to increase over time, the size of this effect might still be disappointing. This may be due to several reasons. Firstly, in 2014 Dutch municipalities showed low enforcement efforts [36]. Because of the decentralization of enforcement of the minimum legal age for alcohol as of January 2013, most Dutch municipalities still had to determine a so-called "prevention and enforcement policy plan" in 2014 [36]. Effects of the increase in minimum legal age may have been more pronounced if local alcohol policies and enforcement efforts would have been more adjusted to the alcohol policy changes; a process which may take longer than one year. Indeed, after two years, the effect of the new minimum legal age on compliance rates is much greater than after one year.

Secondly, because only two measurements of mean compliance rates are available before the new minimum legal age was introduced, it is difficult to determine the exact slope of the increase in compliance. This may have caused a possible over- or underestimation of the increase in compliance with alcohol laws between 2011 and 2013, which could have biased the interpretation of our results.

Lastly and most importantly, because this study is conducted in a natural setting, there may have been many other factors influencing compliance rates of alcohol vendors, which is also suggested by the low explained variance of 6.3%. This could imply that results found in the current study might not entirely be attributable to the change in policy, however, might be due to unplanned complex changes in a series of phenomena (e.g., social, cultural or economic changes) during this period of time ("period effect") [26,27]. A study by Allamani et al. (2001) indeed showed that unplanned socio-demographic and economic changes had a stronger impact on alcohol consumption than changes in planned control policies considering a 48-year period [26]. Nevertheless, within the limited time frame (only 5 years) of the current study, we do not believe that such pronounced socio-demographic or economic changes occurred. Still, it can be questioned whether the effect of changing the minimum legal age is only observed after the policy change has been put into place or whether the effects of such policies are the result of dynamic changes within several societal dimensions.

The results perhaps do signify a process in which a lowering in the general acceptability of juvenile drinking (social norms cultural change) already started before the new minimum legal age was introduced. Previous research indeed indicates that parental awareness about the harmful effects of their adolescent children's drinking has increased and parents became stricter regarding their children's drinking between 2007 and 2013 [19], before the actual minimum legal age for alcohol was raised. This would then set the stage for a change in policy, in creating sufficient political support for a more restrictive alcohol policy. Policy endogeneity is the term referring to the situation when a policy change is the result of a wider societal or cultural change [37].

Limitations and suggestions for further research

In this study, only few cross-sectional data waves were included and, because it was a natural setting, no control region/country was included. To be able to determine a trend in compliance rates, it would have been necessary to include more data collection waves before and after the policy change was introduced (e.g., time series design). Also, the number of purchase attempts in 2014 and 2016 was considerably lower than in 2013, which produced larger error variation within the 2014 and 2016 results. Furthermore, results of this study do not give information about how relevant the different alcohol outlets are for adolescents themselves. Social sources, which previously have shown to play an important role in the availability of alcohol for adolescents (e.g., [19,35]), are not considered in the current study. It is thus not known which part of the consumed alcohol by adolescents comes from commercialized or social

sources. The impact of the different sources on adolescents' health can therefore not be determined. Further research should therefore, besides commercialized sources, also take social sources into account and, ultimately, the alcohol use of adolescents.

Finally, the rather low explained variances of the predicted logistic regression models evaluating the policy change effect on overall mean compliance indicate that many other, still unknown, factors are influencing sellers' compliance. Future studies should therefore include a much wider range of factors (e.g. social, cultural, economic, or demographic factors) when investigating the effects of new policies. However, knowing that such a national policy change is a distal factor affecting individual behaviour of alcohol vendors where the complete population is exposed to, it could still have large effect on the availability of alcohol for adolescents.

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Conflict of interests

None.

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Can vendors' age limit control measures increase compliance with the alcohol age limit? An evaluation of measures implemented by three Dutch liquor store chains

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/Abstract

Background

Dutch liquor store (off license) chains have voluntarily developed and implemented age limit control measures to increase compliance with the Licensing and Catering Act (LCA), aimed at prohibiting vendors from selling alcohol to minors (<18 years old). This study investigates differences between three liquor store chains in their style of self-regulation and how that affects compliance with the LCA in four domains (capturing processes in age verification, instructing staff, monitoring performance/providing feedback and imposing consequences).

Methods

A mixed-method design was used. In depth-interviews (n = 3) were conducted with chains' head office managers, gaining insight into control measures. Survey (n = 372) research was conducted to measure liquor store owners' perceptions of implementation. Mystery shop (n = 387) research was conducted to measure compliance of store owners with the LCA. Survey and mystery shopping data was linked (n = 179) for the indicated perceived risk of inspection.

Results

The interviews indicated that control measures differ across chains in comprehensiveness and degree of implementation, survey results showed corresponding differences across the chains. Linked results showed that liquor store owners who perceive a very high risk of inspection, showed higher ID requesting rates (chain 2 and 3: 93% and 99%) and compliance rates (chain 2 and 3: 77% and 86%), respectively. This effect may be amplified by a set of measures (e.g., by implementing age verification systems, increasing training, monitoring performances and/or imposing consequences) and could result in higher ID request rates (chain 1: 54% versus chain 2 and 3: both 95%) and compliance rates (chain 1: 35% versus chain 2 and 3: both 80%).

Conclusion

A comprehensive and systematic implementation of specific combinations of control measures in all four domains resulted in high compliance rates up to 80%. Nevertheless, the expectation is that this effect can only be attained when complemented by external government enforcement efforts.

Keywords

Alcohol availability / Alcohol sources / Liquor store chains / Underage alcohol sales / Legal age limit / Compliance / Control measures / Self-regulation / Enforcement / Prevention / Mystery shopping

Introduction

Several studies have concluded that the extent to which alcohol is available for young people influences their use and related health impacts, and that access to alcohol can be reduced by setting age limits [1–7]. The effectiveness of age limits depends, however, on the degree to which they are complied with [1,8]. The Dutch liquor store (off license) sector showed a compliance rate of 61.8% in 2016 [9]. Although above the national average compliance rate of 35.8% for all alcohol sellers (on and off premise), still over 38.2% of the 17-year-old mystery shoppers could buy alcohol at liquor stores [9]. This high noncompliance is especially a concern, because only liquor stores are allowed to sell spirits (drinks concentrated with >15% pure alcohol) in the off-premise sector in the Netherlands [10].

Dutch legislation and the liquor store sector in context

According to the Dutch Licensing and Catering Act (DLCA), vendors are prohibited to sell alcohol to minors, and are obliged to determine the age of the potential buyer (if the buyer is not unmistakably over 18 years of age) by requesting a formal identification document (ID) [10]. In January 2013, the enforcement for the sale of alcohol was decentralized to local municipalities, and in January 2014, the legal age limit for the sale and purchases of all alcoholic beverages was increased from 16 to 18 years [10]. These changes were accompanied by a substantial increase of attention in politics and the media regarding underage alcohol availability and triggered liquor store chains to voluntarily formulate self-regulated age limit control measures. Regarding the enforcement of age limits, the DLCA does not specify any statutory or mandatory requirements regarding the enforcement of age limits. This means that the responsibility for implementation and enforcement of age limit control measures are left with vendors. The setting of statutory drinking age limits cannot be considered self-regulation in the strict sense of the word, i.e., voluntary regulation by societal parties and stakeholders (such as the industry). The Dutch government, however, has decentralized enforcement of this law as a municipal task (each council is obliged to create an enforcement plan), and has put responsibility for proper execution of the ban with the sellers of alcoholic drinks (and to a small degree to juvenile individuals). Self-regulation here means that the central government has only set objectives and does not prescribe specific procedures for observing these limits for sellers, leaving proper execution to the discretion of parties in the field.

From a broad perspective, literature on self-regulation focusing on tobacco, alcohol and the ultra-processed food and drinks industries show that there is no evidence for the effectiveness or safety of self-regulation [11–13]. Furthermore, focusing on the alcohol market, the development or promotion of a (new/existing) voluntary code or other form of self-regulation is used to reduce political pressure [14,15], regarding happy hours [16], advertisement [17–19], marketing campaigns [15,20–23] and alcohol health warning labels [24]. In addition, the alcohol market is known to argue that their own self-regulation is working well or is working better than formal regulation [20,21,25,26], arguing that existing regulation is satisfactory [17,20], or more extensive than necessary [20,27]. Because of this, a critical assessment and evaluation of these self-regulated measures is important, as strict control on age limits may conflict with economic interests.

Liquor store chains and age limit control measures; the present study

Off-premise alcohol in the Netherlands is sold by liquor stores, cafeterias (snack bars and/or small diners), supermarkets, convenience/night shops and home delivery outlets. Only liquor stores are allowed to sell spirits (>15% proof) off-premise [10]. In 2016, 2442 liquor store permits were issued allowing the sale of spirits [28]. Approximately 30% of all liquor stores are chain-organized. Dutch liquor store chains consist of affiliated liquor stores (liquor stores owned by the chain) and/or franchise liquor stores (liquor stores owned by the liquor store owner). One of the differences between the two are the legal consequences chains can impose on store managers and employees. For instance, within a franchise collaboration, the chains can only impose on store owners, not employees. In an affiliated collaboration, both parties (the store manager and employees) work for the chain and agree to possible consequences in their contract. From 2012 onward, all stores affiliated with the trade organization VDN, together with the Dutch supermarket affiliation (CBL), agreed on a voluntary code of conduct to request a valid and original ID for all individuals appearing younger than 25 years [29]. Furthermore, all affiliates committed themselves to a systematic, four-step approach on age verification in the purchasing process, which aims to increase compliance: 1) age estimation, 2) request for a valid ID for those estimated up to 25 years of age, 3) review the ID, and 4) decide whether to sell the product, or not. In addition to these collective measures, liquor store chains have individually implemented age limit control measures, aiming to self-regulate age verification to increase compliance.

Four types of policy domains indicated by the Dutch Food and Product Safety Authority (NVWA) are, when addressed systematically, important for achieving high compliance rates [30]. The first one is capturing processes in age verification, and involves the systematic, four- step approach on age verification in the purchasing process. Previous research has shown that requesting ID increases compliance [31,32]. Furthermore, the supportive usage of age verification systems (AVSs), calculating and confirming whether the customer reached the legal purchase age, significantly increases the odds for compliance [29,33]. Logically, this measure should be implemented as a start. Secondly, instructing staff could possibly increase compliance. For instance, responsible beverage service training, designed to reduce disorder and alcohol related harm, have shown potential [34–36]. Presumably, the training and/or instruction of off-premise alcohol vendors can have a similar positive effect on compliance. The instruction of staff can only be properly executed when processes in age verification are captured and implemented in the organization, therefore, instructions should be sequential to the first measure. Thirdly, monitoring performance/giving feedback could be important to achieve high levels of compliance because of its ability to change and improve unwanted outcomes [37–41]. Performance feedback is successfully used in a variety of organizational settings (e.g., alcohol establishments, university hockey teams, electric utility industries, textile factories). A similar positive effect on compliance in the liquor store chain organization structure could be expected [37–41]. Monitoring performance/giving feedback is only feasible if employees are instructed properly and age verification processes are in order. Lastly, regulations and laws seem to be ineffective when they are not enforced [8]. Therefore, in addition to monitoring and feedback, imposing consequences based on noncompliance with the age limit is needed to achieve high compliance rates.

In this study, differences are investigated between liquor store chains in their style of self-regulation and how that affects compliance with legal requirements concerning alcohol sales to minors. Control measures are analysed in four regulatory domains, followed by the perceived implementation at shop floor level and an evaluation on compliance with the alcohol age limit.

Methods

A mixed-method design was used. In-depth interviews were conducted with managers of the liquor store chains for gathering insights into control measures. Using surveys, liquor store owners were asked about the implementation of their chain's

control measures. Mystery shopping was used to measure compliance. Survey and mystery shopping data was linked for the indicated perceived risk of inspection.

In-depth interviews

Population and sampling

In 2015, managers of the three liquor store chains (all males) were invited via email to participate to an in-depth interview, all accepted the invitation. The interviews were done before the survey data collection started, all managers were interviewed separately and face to face. During two interviews, a total of three public relation colleagues also participated (two females and one male).

Measures

Semi-structured in-depth interviews (approximately one hour) were conducted in which the managers were asked to describe their age limit control measures within four domains: 1) *capturing processes in age verification*, 2) *instructing staff*, 3) *monitoring performance/giving feedback*, 4) *imposing consequences*.

Analyses

The interviews were transcribed and independently analysed by two researchers [42]. The transcripts and preliminary results were all sent to the managers for feedback (member checks). All inconsistencies in coding were resolved through discussions between two researchers.

Surveys

Participants

In the fall of 2015, cross-sectional data were collected over a six-week period on store-level implementation of control measures in the four domains. Liquor store owners or shop managers of three liquor store chains were included (the same chains also used in the interviews and mystery shopping study). A total of 721 store owners were invited to complete the survey (104 out of 825 stores (12.6%) could not receive an invitation caused by technical defects). Within a two-week period, a total of 298 (41.3%) online surveys were retrieved. After two weeks, a reminder was sent to the remaining liquor store owners, resulting in an additional response of 74 (10.3%), summing up to a total response of 51.6% (n = 372). Table 1 describes characteristics of participants. To avoid identification, the number of stores per chain will not be mentioned.

Table 1 Descriptive data regarding participants in the survey

	Chain 1	Chain 2	Chain 3
% of participants working as affiliates of a chain (in a chain-owned liquor store)	15	100	68
% males	83	90	88
Average age (min-max)	48 (28-63)	40 (27-62)	46 (20-64)
Average number of years affiliated with chain (min-max)	13 (1-36)	15 (1-40)	16 (< 1-50)
% of stores with >1 staff	78	100	96
Average number of staff members (min-max)	2.0 (1-6)	5.3 (2-8)	3.9 (1-25)

Note: To avoid identification of chains, the total number of stores and the total response per chain is not mentioned in this table.

Procedure

All 721 store owners received a link in their inbox or a link was placed on their personal portal-page (intranet). The introduction page explained the organizations involved, the goal of the study, ethical considerations (anonymity of the liquor store and the liquor store owner), the approximate length of the survey (between 10 and 15 minutes), and contact details of researchers for questions or remarks. If surveys could not be completed at once, the participant could close it and resume at any other time.

Measures

1) *Capturing processes in age verification*. Due to social desirability bias, store owners were not asked about their own performance. All the necessary steps (compliance, ID requests, and the use of an AVS) were measured with the use of mystery shopping research. 2) *Instructions for staff*. Store owners were asked which training/instruction type they used: individual oral training, group oral training, giving written information, E-learning module or practical training using age verification systems. 3) *Monitoring performance/giving feedback*. Perceived risk of inspection by the liquor store chain was measured on a Likert-type scale (1 = very low – 5 = very high) as indicator for the degree of monitoring. 4a) *Imposing consequences on staff by liquor store owner/manager*. Liquor store owners were asked in 7 multiple response questions to indicate which specific types of consequences were applied to their staff whenever noncompliance with the age limit was found: personally addressing staff member, a

written warning, obligatory additional training, a note in the personnel file, mandatory interview with the head office manager, suspension or dismissal). 4b) *Imposing consequences on liquor store owners by chains' head office*. Liquor store owners were asked to indicate which types of consequences applied to themselves or the store whenever noncompliance with the age limit was observed in their store: personally addressed by chains' head office, written warning from head office, obligatory additional training, obligatory additional training of their staff members, and mandatory interview with the head office manager.

Analyses

Comparisons between the three chains were made on the above described control measures: 1) applying different types of training/instructions for their staff, 2) indicating the perceived risk of inspection by their head office (monitoring performance), and 3) indicating various consequences for themselves and their staff (imposing consequences). Chi-square tests were conducted analysing possible differences between the chains.

Mystery shopping

Population and sampling

In the fall of 2015, cross-sectional data were collected over a four-week period in the liquor stores of the three chains. Sample sizes were calculated assuring a 95% confidence level ($\alpha = .05$) for each individual chain separately (total n = 825). Sampling was stratified by liquor chain, region (the North, East, South or West) and population density, assuring a regionally representative sample for each individual chain. Based on these strata, a total of 387 liquor stores were selected randomly, and visited by 17-year old boy or girl-mystery shoppers (balanced design for gender). At each store, one underaged mystery shopper performed one purchase attempt of a >15% alcohol product (n = 194; spirits), or a <15% alcohol product (n = 193; e.g., beer or wine). The selected liquor stores were not aware of the specific period and time in which the purchase attempts would be carried out.

Ethics in mystery shopping

Data collection took place in accordance with validated protocols for mystery shopping research, including ethical and legal aspects regarding this type of research, as described and conducted in previous mystery shopping studies [29,31,43]. The method used in this study is not deemed to be medical research, subjects are not manipulated

or adversely affected in any way, and is for this reason exempted under the Dutch WMO-law which is the legal charter of the Helsinki Declaration [44]. All mystery shoppers were accompanied by experienced adult mentors trained and assigned by the research institute, who oversaw the entire procedure from a distance in a discrete way. The procedure secured the anonymity, privacy and legal integrity of the liquor store's employees, mentors and mystery shoppers. Study results are not reducible to individuals and will never be used for penalizing vendors. If purchase attempts interrupt enforcement efforts, the enforcement-officer will be informed by the mentor. Lastly, according to the DLCA, buying and the possession of alcohol is not illegal for adolescents in liquor stores, as long as the beverage container is not taken out of the store [10]. By handing the alcohol to an adult research supervisor, mystery shoppers avoid breaching the DLCA.

Procedure

The mystery shopper enters the liquor store and takes a can of alcohol from the shelves (wine/beer or spirits). Interaction with the vendor consists of showing a personal and valid ID if this is requested and lying about one's age ("I am 18 years old"). All mystery shoppers are trained to interact in this way and to recognize the presence and possible use of AVS. When a purchase is allowed by the vendor, the mystery shopper pays for the product, and discreetly hands over the beverage container to the mentor during exit. After each purchase attempt, observations are recorded and the alcohol securely stored and sealed by the mentor. The alcohol was not consumed and all alcohol products were destroyed by the research institute.

Measures

The mystery shoppers assessed compliance, ID requests, and the use of an AVS by the cashier. Covariates were estimated age (<20, 20-40 or >40) of the cashier, and the gender of the cashier and mystery shopper.

Analyses

Results are presented for the complete data set (showing all data) and the linked data set (showing data from liquor stores who are tested using mystery shopping and have filled out the survey). Comparisons using Chi-square analysis are made between the three chains as to 1) requesting ID rates, 2) the total compliance rate and 3) the total compliance rate and requesting ID rates for several contextual variables (gender of vendors and mystery shoppers and the perceived age of vendors). In addition, differences between the complete and linked data sets on ID requesting and compliance rates are analysed using Chi-square calculations.

Linked survey- and mystery shopping results

Data from liquor stores who have filled out the survey and are tested using mystery shopping are linked for the indicated perceived risk of inspection. Linking other domains (different types of training and consequences) with mystery shopping results was not feasible due to a limited cell-count and interpretability of categories within these domains. Chi-square test were conducted analysing possible differences between the chains regarding the perceived risk of inspection (survey results) and the ID requesting and compliance rates for the "very high" perceived risk of inspection category.

Results

Interview results; analysis of age limit control measures

Key differences between the chains on domains are presented in Table 2, regarding capturing processes in age verification, instructing staff, monitoring performance/ giving feedback and imposing consequences.

Capturing processes in age verification

Key differences. During age verification, employees of chain 2 are obligated to do a more thorough or detailed inspection of ID's (they have to physically obtain the ID of the adolescent buyer and are obligated to perform a photo check). Also, chain 2 and 3 have fully implemented age verification systems (AVS provides sellers with a physical notification of the current date minus 18 years). The AVS used by these chains resembles the digital pop-up window AVS used in Dutch supermarkets [29].

Corresponding measures. All three liquor store chains indicated they are committed to the rules in the DLCA [10], the code of conduct, and the four-step systematic approach of age verification, and all have captured age limit control measures in a plan or manual.

Instructing staff

Key differences. Chain 2 and 3 instruct their staff in a way that is more diverse and more intensive, compared with chain 1. For instance, new employees of chain 2 must pass an alcohol e-learning exam, if they succeed, they receive a certificate and are

Table 2 Interview results; key differences between the chains on domains

	Chain 1	Chain 2	Chain 3
Capturing processes in age verification			
Obligated additional checks on IDs	-	+	-
Fully implemented age verification system (AVS)	-	+	+
Instructing staff			
E-learning exam during application (with certificate)	-	+	-
Employees receive a rulebook after application	-	-	+
Magazine for employees, covering the age limit subject from various perspectives	-	-	+
Reminders of mandatory age verification steps (a reading confirmation is required)	-	+	+
Monitoring performance and feedback			
Audits using underaged and adolescent mystery shoppers testing age verification	-	+	+
Audits using underaged mystery shoppers testing the home delivery of alcohol	-	-	+
In most cases, feedback is delivered directly after the audit	-	+	+
Obligated additional checks by region/rayon manager	-	+	-
Imposing consequences (affiliate liquor stores)			
Neglecting processes could lead to a salary reduction	+	-	-
Employees receive a personal letter from management	-	+	+
Employees receive an official warning (this warning is included in their personnel file)	-	-	+
All employees in the store receive a notification of the incidents	-	+	-
An additional training is obligated	-	+	+
Employees will have a stern conversation with the region/rayon manager and a work suspension	-	-	+
Neglecting processes could lead to dismissal	-	+	+
Imposing consequences (franchise liquor stores)			
Consequences for the liquor store owner are included in the franchise agreement*	+	-	+

* The specific content of consequences included in the agreement is unknown.

allowed to work in the store. New employees of chain 3 receive a rulebook, containing all the mandatory steps during age verification. Also, approximately five of six times a year, a magazine is published by chain 3, with a discussion of the age limit subject from various perspectives. Furthermore, on a weekly basis, reminders of age verification rules and other age limit related information is published on the intranet portal of chain 2, and on a yearly basis, employees of chain 3 receive a personal letter containing the mandatory steps during age verification. In both cases (for both chains), a reading conformation by the employee is required.

Corresponding measures. All three chains indicated that the first age limit instructions are provided by the store manager or owner during the job application; the rules in the code of conduct are discussed here. In addition, all new employees on store level must read, understand and sign (providing a reading confirmation) the steps mandatory during age verification (their stated age limit control measures) as part of their employment conditions/contract. All chains remind their employees of these mandatory steps and general rules regarding age verification at least once a year on their intranet-systems, in staff meetings or during general meetings with all the liquor store owners, discussing research findings (sometimes based on internal audits, enforcement efforts and other developments on the subject).

Monitoring performance/giving feedback

Key differences. Chain 2 and 3 monitor the performance of every liquor store using mystery shopping audits, chain 1 does not. Four times a year, chain 2 uses underaged mystery shoppers (<18 years), measuring compliance at every liquor store. In addition, they use adolescent shoppers once a year, measuring ID requests. Chain 3 uses underaged and adolescent shoppers, each once a year, monitoring every liquor store. In addition, chain 3 also uses underaged mystery shoppers to monitor age verification during the home delivery of alcohol. In most cases, both chains use external firms for executing the audits, and feedback is delivered directly after the audit (permission is unequivocally granted by all employees of both chains). Additionally, the region/rayon managers of chain 2 (managers overviewing a certain number of liquor stores in a specific region) are specifically instructed to check the dates on the AVSs (they should be set on the current date), and check security cameras for the execution of age verification in previous days.

Corresponding measures. The chains stated unanimously that the visits their region/rayon managers bring to the liquor stores are important in monitoring the performance of age verification. The region/rayon managers of all the chains pay these visits on a (approximately) weekly basis, visiting all of their assigned liquor stores.

Imposing consequences

The chains can legally impose consequences on store managers and employees of an *affiliated liquor* store (both parties work for the chain and agree to possible consequences in their contract), in franchise liquor stores, the chains can only impose consequences on the store owners, not the employees.

Key differences. The affiliate liquor stores of chain 1 have included the possibility of a salary reduction measure in the employment contracts if processes in age verification are neglected. The consequences imposed on by chain 2 and 3 are based on results obtained from the mystery shopping audits. In chain 2 and 3, employees who neglected processes in age verification (after the first negative audit) receive a personal and formal letter from management. Employees of chain 3 also receive an official warning, which is included in their personnel file. If negative audits occur in a chain 2 store, all employees of that store receive a notification from the incident (improving team-spirit). Furthermore, employees of chain 2 have to pass the e-learning exam again and update their certificate, the employees of chain 3 are required to follow a mandatory training with the store manager at the head office of the chain. After a second negative audit, consequences for employees of chain 3 are a stern conversation with the region/rayon manager and a work suspension if necessary. After a third negative audit, dismissal could be a consequence for employees of chain 2 and 3. Employees can be dismissed after three errors when monitored by a mystery shopper. Store managers in chain 2 will be dismissed whenever they personally make an error. The franchisers of chain 1 and 3 (the store owners) are free in composing his or her own team of employees and possible consequences to impose on employees. In the franchise agreement is included that not complying to the law in general could lead to consequences for the liquor store owner, the specific content of consequences is unknown.

Corresponding measures. The consequences that chains could impose on store managers and owners are captured in their general age limit control measures and in employment contracts.

Survey results; the perceived implementation of age limit control measures

Instructing staff

The number of liquor store owners/manager who apply individual oral trainings for their staff members did not differ between the chains (between 90% and 97%). The

Table 3 Survey results; differences between the chains on domains

	Chain 1	Chain 2	Chain 3	Chi-sqaure		
	%	%	%	X^2	df	p-value
Percentage of store owners in each chain applying different types of training for staff (n = 318)						
Individual oral training	97	90	96	3.657	2	.161
Group oral training	15	28	51	21.158	2	.000
Giving written information	35	62	67	12.846	2	.002
E-learning module	0	100	29	94.245	2	.000
Practical training AVSs	3	21	25	8.443	2	.015
Percentage of store owners in each chain indicating perceived risk of inspection by their head office (n = 347) *						
Very low	6	0	0			
Low	13	0	0			
Not low/not high	23	0	0			
High	40	16	12			
Very high	19	84	87			

Percentage of store owners in each chain indicating policies concerning consequences for store owners (n = 345)						
Personally addressed by head office manager	49	89	86	37.247	2	.000
Written warning from head office	15	55	51	21.957	2	.000
Obliged additional training	2	13	39	31.447	2	.000
Obliged to additionally train staff	0	47	36	27.855	2	.000
Mandatory interview with head office	4	32	33	16.203	2	.000
Percentage of store owners in each chain indicating policies concerning consequences for staff (n = 325)						
Personally addressed by liquor store owner/manager	59	42	59	3.859	2	.145
Written warning	32	63	69	18.515	2	.000
Obligated additional training	5	24	68	70.145	2	.000
Note in personnel file	22	45	65	28.134	2	.000
Obligated interview with head office manager	5	45	61	41.428	2	.000
Suspension	5	18	43	25.228	2	.000
Dismissal	8	66	39	26.405	2	.000

Note: To avoid identification of the chains, only percentages are presented and the total number of participants per domain.
Due to social desirability bias, store owners were not asked about their own performance regarding processes in age verification.
*X2 =155.1;df=8;p=.000

application of all other types of training did significantly differ (p<.05) between the chains, with chain 1 applying these training types to a lower degree (Table 3).

Monitoring performance/giving feedback

A majority of liquor store owners from chain 2 and 3 perceived a very high risk of inspection (84% and 87%, respectively) by their head office compared to store owners from chain 1 (19%; Table 3).

Imposing consequences

Comparing the control measures between chains, it becomes clear that liquor store owners from chain 1 experience significantly fewer (p<.000) consequences in case of noncompliance (all types) from their head office, compared to chain 2 and 3. Similarly, chain 1 store managers/owners are significantly less likely (p<.000) to impose consequences on their own staff, with one exception; personally addressing staff.

Mystery shopping results; analysing compliance with the alcohol age limit

Table 4 shows the descriptive results for purchase attempts of alcohol products per liquor store chain for the complete and linked data sets. In total, in 255 of the 387 attempts, vendors refused the sale of alcohol to the mystery shopper (66% full compliance). In 317 out of the 387 attempts (82%) vendors asked for the ID of the mystery shopper. Not all ID requests resulted in refusal of sale, resulting in 80% compliance after ID requests. Furthermore, after ID requests, AVSs were used 77 times (24%). This resulted in compliance after use of 91%. When comparing the chains, all compliance rates of chain 1 were lower compared to chain 2 and 3 in the complete and linked data set (p<.01). No significant differences were found between the complete and linked data sets regarding total ID requesting rates and total compliance rates. Lastly, regarding contextual variables, vendors estimated between 20 and 40 years of age comply significantly more often compared to vendors estimated younger than 20 years old or vendors estimated above 40 years of age (77% compliance versus 50% and 59%, respectively; $X^2 = 15.7$, df = 2, p = .000).

Table 4 Requesting ID[a] rates, AVS[b] usage, compliance after usage/ID requests and total compliance per chain for the complete and linked data sets

	Requesting ID	AVS used after requesting ID	Compliance after using AVS	AVS not used after requesting ID	Compliance after not using AVS	Total compliance after requesting ID	Total compliance
% complete data set							
Chain 1	54[c]	18	75	82	63	65	35[d]
Chain 2	95[c]	27	100	73	78	84	80[d]
Chain 3	95[c]	26	93	74	82	85	80[d]
Total (n = 387)	**317 (82%)[e]**	**77 (24%)**	**70 (91%)**	**240 (76%)**	**185 (77%)**	**255 (80%)**	**255 (66%)[f]**
% linked data set							
Chain 1	50[c]	24	75	77	54	59	29[d]
Chain 2	95[c]	26	100	74	81	86	81[d]
Chain 3	98[c]	29	90	71	83	85	83[d]
Total (n = 179)	**158 (88%)[e]**	**44 (28%)**	**40 (91%)**	**114 (72%)**	**90 (79%)**	**130 (82%)**	**130 (73%)[f]**

Note: To avoid identification of the chains, only percentages and total results are presented.

[a] ID = Identification Document.

[b] AVS = Age Verification System.

[c], [d], [e], [f] Testing the differences between:
requesting ID rates between chains (X^2 complete = 97.1, df = 2, p = .000; X^2 linked = 59.7, df = 2, p = .000);
total compliance between chains (X^2 complete = 76.8, df = 2, p = .000; X^2 linked = 39.5, df = 2, p = .000);
total requesting ID rates between the complete and linked data set (X^2 = 3.7, df = 2, p = .056);
total compliance between the complete and linked data set (X^2 = 2.6, df = 2, p = .110), respectively.

Linking survey and mystery shopping results; analysing the perceived risk of inspection on compliance rates.

The results from the linked data set (Table 5) show that a majority of the liquor store owners of chain 2 and 3 perceive a very high risk of inspection (83% and 86%, respectively) compared with store owners from chain 1 (23%). The corresponding ID requesting rates (93% and 99%, respectively) of store owners of chain 2 and 3 who perceive a very high risk of inspection are significantly higher than the ID requesting rates of store owners of chain 1 (71%). Likewise, the corresponding compliance rates of store owners of chain 2 and 3 who perceive a very high risk of inspection are significantly higher (77% and 86%, respectively), compared with store owners of chain 1 (43%). It appears that liquor store owners (in general) who perceive a very high risk of inspection, show higher ID requesting and compliance rates.

Discussion

Th aim of the present study was to investigate the differences between liquor store chains in their style of self-regulation and how that affects compliance with legal requirements concerning alcohol sales to minors. The general conclusion is that if chains implement a specific combination of age limit control measures comprehensively, higher compliance rates with the alcohol age limit can be achieved.

Looking at specific measures, chain 2 and 3 have fully implemented AVS, chain 1 has not. The vendors in chain 2 and 3 showed higher ID requesting rates (as high as 95% versus 54% for chain 1) and a relatively higher use of AVSs (up to 27% versus 18% for chain 1). The combined effects of these measures resulted in higher compliance rates for chain 2 and 3 after using AVSs (100% for chain 2 and 93% for chain 3). Other studies investigating similar AVSs in Dutch supermarkets (the digital pop-up window AVS) show less optimistic results when analysing this specific AVS [29]. Liquor store chains could possibly benefit from an application of a more advanced AVS, which calculates and confirms whether the customer has reached the legal purchase age (e.g., keying-on-date-of-birth or ID swiper/checker AVSs), because these more advanced systems are proven effective in a supermarket context [29].

Another control measure that might contribute to a higher compliance rate in chains 2 and 3 (up to 80% compliance versus 35% for chain 1), is the systematic monitoring of vendors' behaviour, leading to a significant high perceived risk of

Table 5 Linked data; survey results (liquor store owners in each chain indicating perceived risk of inspection) and mystery shopping data

	% survey results (n = 166)[a]			% mystery shopping data (n = 166)[b]							
				Chain 1		Chain 2		Chain 3		**Total**	
	Chain 1	Chain 2	Chain 3	ID req. rates	Compl.	ID req. rates	Compl.	ID req. rates	Compl.	**ID req. rates**	**Compl.**
Very low	3	0	1	0	0	0	0	100	100	**50**	**50**
Low	16	0	0	20	20	0	0	0	0	**20**	**20**
Not low/ not high	19	0	1	33	17	0	0	100	100	**43**	**29**
High	39	17	12	58	33	100	100	92	67	**80**	**60**
Very high[c]	23	83	86	71	43	93	77	99	86	**96**	**81**

Note: To avoid identification of the chains, only percentages are presented and the total number of participants per data set.
a $X^2 = 66.8$; df = 8; p = .000. b due to a limited cell-count, Chi-square analyses between the chains were only feasible in the "very high" category.
cX^2 ID req. rates = 13.0; df = 2; p = .001. X^2 Compl. = 8.3; df = 2; p = .015.

inspection for vendors of chain 2 and 3. Our linked data on this domain cautiously demonstrates that, in general, a very high perceived risk of inspection improves ID requests and compliance rates and this effect may be amplified by a set of measures (increased training, monitoring and strict consequences in case of noncompliance) imposed by liquor store chains on their store owners. However, despite clear differences between the chains in their perceived risk of inspection and mystery shopping results, it was not possible to estimate the direct effect of specific control measures on compliance, due to a limited cell-count of linked data (data from liquor stores who have filled out the survey and are tested using mystery shopping). If the cell-count is too low, this can lead to invalid results in analyses. In future studies, a larger sample is needed of sellers who fill out the survey **and** are tested by mystery shoppers (linked data). This creates the ability to perform multivariate analyses on the linked data set with sufficient cell-count and controlling for relevant covariates (other measures) or combinations of measures that are performed. Additionally, in future studies, data collection of survey data should not be limited to store managers or store owners, but should be performed in several levels of the organizations (e.g., front-end staff and region/rayon managers). Another limitation arises due to the cross-sectional nature of the data, not ruling out reversed causation (a better compliance inspires a more elaborate control measure implementation). Furthermore, the low survey response rate of 52% and the likelihood of respondent bias (e.g., given the presence of public relation employees during the in-depth interviews) are limitations of this study that should be considered when interpreting the results.

Despite these limitations, this study shows that certain age limit control measures are linked to higher compliance rates. These results can offer chain managers and store owners guidelines when trying to improve compliant behaviour at the shop level. Additionally, chain organizations could use these results as a blueprint for introducing and implementing age limit control measures in their organization. Further research is needed for a more thorough investigation of differences in the implementation and enforcement of control measures between franchise or affiliate chain-organizations, and how control measures are evaluated within different layers in the chain organization. Of interest are, for example, the communication of control measures from the head office to the region/rayon managers to the alcohol vendor in the liquor store. In future research, stores not organized in chains or on- premise locations should not be ignored.

Despite measuring compliance rates up to 80% in this study, there is still much room for improvement. Even though it seems that age limit control measures increase compliance, it is quite likely that high compliance rates are only possible when the

perceived risk of inspection is not only stressed from within the organization, but also from outside of the organization by external government enforcement efforts. Further research should additionally focus on the way government enforcement efforts influence the effectiveness of age limit control measures.

Implications and contribution

This study investigates differences between liquor store chains in their style of self-regulation, and how that affects compliance with legal requirements concerning alcohol sales to minors, using in-depth-interviews, surveys and mystery shopping research in a mixed design. If measures are implemented comprehensively in specific combinations, higher compliance rates are achievable.

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Alcohol and tobacco sales to underage buyers in Dutch supermarkets: Can the use of age verification systems increase seller's compliance?

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/Abstract

Purpose

Age limits is an effective measure for reducing alcohol-related harm, however, their effectiveness depends on the extent to which they are complied with. This study aimed to investigate the effectiveness of different age verification systems (AVS) implemented by 400 Dutch supermarkets on requesting a valid age verification (ID), and on sellers' compliance.

Methods

A mixed method design was used. Compliance was measured by 800 alcohol and tobacco purchase attempts by 17-year-old mystery shoppers. To analyse the effectiveness of AVSs, logistic regression analyses were performed. Insight into facilitating and hindering factors in the purchase process was obtained by 13 interviews with supermarket managers.

Results

Only a tendency toward a positive effect of the presence of the keying-on-date-of-birth AVS or ID swiper/checker was found on ID request for both alcohol and tobacco purchase attempts. The use of the keying-on-date-of-birth AVS or ID swiper/checker significantly increased the odds for compliance after an ID was requested, for both alcohol and tobacco purchase attempts. Managers indicated that ID requests and compliance could be facilitated by providing cashiers with sufficient managerial support, technical support, and regular training about the purchase process and use of the AVS.

Conclusions

The usage of AVSs calculating and confirming whether the customer reached the legal purchase age for cashiers significantly increases the odds for cashiers to comply with age limits of alcohol and tobacco. Future research should gain insight into how usage of effective AVSs can be improved and explore the feasibility of implementation and effectiveness in other outlets.

Keywords

Compliance of age limits / Mystery shopping / Age verification systems / Underage alcohol and tobacco sales / Age restrictions / Adolescents

Introduction

It is undisputed that the use of alcohol and tobacco in adolescence is harmful to health [1–7]. The extent to which alcohol and tobacco are available for young people influences the use and related health impacts (e.g., [1,8,9]). The availability of these products can be reduced by setting age limits [1,8–15]. However, the effectiveness of an age limit also depends on the degree of compliance [1,16].

The implementation of age verification systems (AVSs) could possibly ease the difficulty in age recognition and increase compliance, hence minimizing the availability of alcohol and tobacco products for young people. However, little is known about the actual effectiveness of the variety of AVSs used by cashiers in the purchase process of supermarkets. This study investigates the effectiveness of three main AVSs used in Dutch supermarkets in increasing compliance with the alcohol and tobacco age limit.

The Dutch context

In the Netherlands, vendors are by law required to determine the age of potential buyers based on a formal identification document (including date of birth). In the Netherlands, a number of policy changes concerning legal age limits for alcohol and tobacco have been implemented since 2013 in the Dutch Licensing and Catering Act and the Tobacco Act. In January 2013, enforcement for alcohol sale was decentralized to local authorities (municipalities) by national politicians; reasoning that enforcement can be deployed more efficiently and tailored at the local level. Nevertheless, tobacco sales restrictions are still enforced at the national level. In January 2014, the legal age limit for the sale of all alcoholic beverages and tobacco products was increased from 16 to 18 years. In addition, next to vendors selling alcohol or tobacco to underage buyers, also the possession of alcohol in public places (excluding stores where alcohol is sold to consume elsewhere, such as supermarkets) has become punishable by law for persons younger than 18 years [17]. The changes in policy were accompanied by substantial attention in media and politics [18]. These developments may all have contributed to the significant increase in average national compliance rates regarding alcohol sales in on- and off-premise outlets from 28.2% in 2011 to 46.5% in 2013, resulting from two national Dutch mystery shopping studies [18,19]. These two national studies had, to a large extent, comparable methodologies and defined compliance rates as the number of times the vendor did not sell alcohol to under aged buyers [18,19]. In addition, supermarkets significantly increased in average alcohol compliance rates from 29.6% in 2011 to 55.4% in 2013 [19].

Compliance-enhancing activities and age verification systems used by Dutch supermarkets

From 2012 onwards, all supermarket chains affiliated with the Dutch trade organization for supermarket chains and other food services (CBL) agreed in a code of conduct to request a valid and original age verification (ID) for individuals appearing younger than 25 years. In this code, all CBL-affiliated supermarket chains also commit to a four-step systematic approach of age verification in the purchasing process (age estimation, requesting a valid ID up to 25 years, reviewing the ID, and decision to sell) aimed at increasing compliance [20].

In addition, as of 2012, supermarket chains have individually introduced self-regulatory activities, such as using mystery shoppers to monitor compliance and the development and implementation of AVSs, to increase or support cashiers' compliance. Three main types of AVSs have been integrally implemented in Dutch supermarkets. The first one is the pop-up window, a digital window appearing within the cash register screen when an age-related product is scanned, showing the current date minus 18 years. The second one is the keying- on-date-of-birth, the cashier must enter the date of birth into the cash register system, which then performs the calculation and indicates whether the product may or may not be sold. The third one is the ID swiper/checker, the cashier swipes/inserts the ID card through or into a device which then reads the age on the ID. The ID swiper/checker was not developed to verify the authenticity of IDs.

Evaluation of the effectiveness of age verification systems on compliance with age limits

Previous research has shown that requesting ID increases compliance (e.g., [18,19]). However, little is known about the effectiveness of AVSs on cashiers' ID requests and compliance. Krevor et al. [20] investigated the effectiveness of an electronic AVS comparable to the ID swiper/checker, using adult mystery shoppers in the U.S. Although vendors from that study reported that ID swiper/checkers made it easier for them to request customers' IDs, ID swiper/checkers did not increase the actual frequency of age verification. Statements about the effectiveness of ID swiper/checkers on compliance could not be made in the study by Krevor et al. [20] because vendors never needed to stop the sale because they may legally sell alcohol to these adult mystery shoppers.

Another study explored the effectiveness of the ID swiper/checker in Dutch supermarkets, in which the AVS was already implemented (natural setting) [21]. Regarding the 24 purchase attempts of alcohol performed by under aged mystery shoppers

who had to show a valid ID when requested by the cashier, it was found that the cashier used the AVS 12 times (50.0%), and complied to the age limit in 11 of these 12 times (91.7%) using the AVS.

Van Hoof et al. [22] explored the effectiveness of a remote AVS by comparing it with traditional age verification by cashiers, using under aged mystery shoppers attempting to purchase tobacco products. They found compliance rates of 96% for the remote AVS compared with 12% for the traditional age verification. Regardless of the evidence for effectiveness of the remote AVS, this system is barely used in supermarkets [23].

The present study

This study evaluates the effectiveness of the presence and use of three AVSs on cashiers' ID requests and compliance with the alcohol and tobacco age limits in Dutch supermarkets. In addition, hindering and facilitating factors of AVSs in the purchase process will be examined. The present study uses a natural setting and therefore only focuses on AVSs that are already implemented and institutionalized in Dutch supermarkets.

Method

This study uses a mixed method design, using quantitative and qualitative data. The quantitative data were obtained using mystery shop research, the qualitative data were obtained from in-depth interviews with supermarket managers. In addition, field research registered the functionality of various AVSs.

Quantitative research

Population and sampling.

Cross-sectional data was collected over a four-week period in the autumn of 2014. All existing supermarket chains in the Netherlands (n = 19) were included in our study, accounting for approximately 75% of the total number of supermarkets (chain and nonchain) in the Netherlands. Sampling was stratified by chain, region (the North, East, South and West of the Netherlands), and population density, assuring a representative Dutch sample of chain supermarkets. The degree supermarket chains are represented in the sample corresponds with the total number of stores of the chain (with a minimum of 10 stores for small-scaled supermarket chains). At 400 supermarket stores from these 19 different supermarket chains, 800 purchase attempts (one

alcohol and one tobacco purchase attempt at each store) were conducted by 17-year-old mystery shoppers. A balanced design for gender was used. The selected stores were not aware of the period and time in which the purchase attempts were carried out.

Ethics

Data collection took place in accordance with validated protocols for mystery shopping research, including ethical and legal aspects regarding this type of research, as described and conducted in previous mystery shopping studies [24]. The method used in this study is not deemed to be medical research, subjects are not manipulated or adversely affected in any way, and is for this reason exempted under the Dutch WMO-law which is the legal charter of the Helsinki Declaration [25]. The mystery shoppers were accompanied by experienced mentors trained and assigned by the research institute, who oversaw the entire procedure from a distance in a discrete way. Furthermore, the procedure secured the anonymity, privacy and legal integrity of the supermarkets' employees. Finally, under Dutch law, buying and the possession of alcohol and tobacco is not illegal for adolescents in supermarkets.

Mystery shopping procedure

Two mystery shoppers separately enter the supermarket. One takes a can of alcohol from the shelves and approaches the regular checkout lines, the other approaches the service desk/tobacco register (when applicable) and asks for a pack of cigarettes. Interaction with the cashier in both cases consists of showing their personal and valid ID card if this is requested and lying about one's age ("I am 18 years old"). All the mystery shoppers deployed for research are trained to recognize the various AVSs and the use of the AVSs. When a purchase attempt is successful, the mystery shopper pays for the product, takes the product outside of the supermarket, and gives it directly to the adult research supervisor. After each purchase attempt, the observations were registered.

Measures

All variables were assessed by the mystery shopper. Compliance (no/yes) indicated whether the product was sold or not, ID requests (no/yes) indicated whether the cashier requested the ID, use (no/yes) indicated whether the cashier used the AVS. Covariates included were estimated age (<20, 20-40 or >40) of the cashier, gender of the cashier and mystery shopper, the number of cash registers opened during purchase attempts, the total number of cash registers in the supermarket and product type (alcohol/tobacco).

Analyses

Descriptive analyses (frequencies, chi-square tests) and logistic regression analyses were conducted [26] for alcohol and tobacco purchase attempts separately. At first glance, multilevel analyses, controlling for the clustering of supermarket chains, may seem more appropriate to use in this study. However, this cannot be estimated in the current study because the presence of the AVSs is fully determined by type of supermarket chain and, evidently, the presence of an AVS is a precondition for the use of a particular AVS. Chi-square tests were used to compare requesting ID rates of supermarkets with and without AVSs and to compare compliance rates of purchase attempts where the use of three AVSs was compared with not using an AVS. Logistic regression analyses were used to investigate the effect of the presence of AVS on ID requests and the use of the AVSs (no/yes) on compliance. In the logistic regression analyses on compliance, only those purchase attempts were included in which the cashier requested the ID because requesting ID is a precondition for compliance and whether an AVS is used. In all regression analyses, estimated age, gender of the cashier and mystery shopper, product type, number of cash registers opened, and the total number of cash registers were included as covariates. In the logistic regression analysis on compliance, also the presence of the AVS was controlled for.

Qualitative research

Population and sampling

In 2012 and 2013, data was obtained from in-depth interviews with supermarket chain managers responsible for age verification. Via email, 18 managers of the 19 existing supermarket chains (one manager is responsible for two chains) were invited to participate. Five managers refused to participate because they were not allowed to share internal policy with external parties or saw no additional value in the subject. A total of 13 managers (response rate 72.2%, including eight males) representing 14 different supermarket chains participated. During four interviews, a total of five assistant managers (four males) also participated.

Measures

Semi structured interviews (duration approximately 1 hour) were conducted in which managers of the supermarket chains were asked to describe facilitating and hindering factors at the operational and managerial level considering age verification in the purchase process within six characteristics; setting age limit controls, instructing staff, informing the public, monitoring the performance, risk analysis and evaluation

methods [27]. According to the Dutch Food and Product Safety Authority, these six characteristics are assumed to have a positive impact on compliance when addressed systematically [27].

Analyses

The interviews were transcribed and independently analysed by two investigators [28]. A deductive coding scheme (based on the previously mentioned characteristics) in combination with axial coding was used. All inconsistencies in coding were resolved through discussion between the two researchers.

Field research

In the field study, all 19 different supermarket chains were visited over a 1-week period in the winter of 2015. On the shop floor, the supervisor available at the time of the visit was asked for information about their AVS, focusing on the functioning when an age-related product was scanned. Information of this field study was used to determine which AVSs are present in which supermarket chain and how they are used in practice. Some chains combine AVSs integrated across all of their operating cash register systems. For instance, there are chains which use the pop-up window in combination with the ID swiper/checker. In those cases, the AVS on which the supermarket policy is mainly focused will be categorized and measured as such.

Results

Descriptive results

The correlation (phi) between the ID requests of alcohol and tobacco purchases at the same shop is .199 ($p < .01$), and the correlation (phi) between the compliance of alcohol and tobacco purchases at the same shop is .224 ($p < .01$). Table 1 shows the overall results for purchase attempts of alcohol and tobacco products. Within 84.5% of the alcohol and tobacco attempts, there were AVSs present. Re questing ID was performed by cashiers in 81.3% of the alcohol attempts and in 86.3% of the tobacco attempts. Compliance after ID requests for alcohol and tobacco attempts (74.5% and 72.8%, respectively) were significantly higher compared with the mean (total) compliance for alcohol and tobacco attempts (60.5% and 62.8%, respectively). The AVSs were used in 45.5% of the alcohol and tobacco attempts (after requesting ID). Compliance resulting from using AVSs was 91.2% and 91.1% for alcohol and tobacco attempts, respectively, which showed to be significantly higher compared with compliance when not using an AVS for alcohol (60.5%) and tobacco attempts (57.4%).

Table 1 Number and percentage for presence AVSs, requesting ID, compliance after requesting ID, AVS use, compliance after using or not using AVSs and total compliance

	Presence AVS	Requesting ID	Compliance after requesting ID	AVS used after requesting ID	AVS not used after requesting ID	Compliance after using AVS	Compliance after not using AVS	Total compliance
Purchase attempts alcohol (n = 400)	338	325	242	148	177	135	107	242
	84.5%	81.3%	74.5%	45.5%	54.5%	91.2%	60.5%	60.5%
Purchase attempts tobacco (n = 400)	338	345	251	157	188	143	108	251
	84.5%	86.3%	72.8%	45.5%	54.5%	91.1%	57.4%	62.8%

Alcohol purchases: compliance after ID requests compared with the mean (total) compliance; chi-square = 15.750, df = 1, $p < .001$). Compliance after using AVS compared with compliance after not using AVS; chi-square = 40.116, df = 1, $p < .001$).
Tobacco purchases: compliance after ID requests compared with the mean (total) compliance; chi-square = 8.434, df = 1, $p < .01$). Compliance after using AVS compared with compliance after not using AVS; chi-square = 48.830, df = 1, $p < .001$).
AVS = age verification system; ID = age verification

Table 2 shows the chi-square analyses for the presence of AVSs versus requesting ID and the use of AVSs versus compliance for alcohol and tobacco purchase attempts. Firstly, presence of the keying-on-date-of-birth AVS is significantly associated with higher ID requests for tobacco purchase attempts (92.9%) compared with no AVS present (79.0%). Although not significant, a similar result was found for alcohol purchase attempts where the keying-on-date-of-birth AVS was present (requesting ID in 87.7% versus 79.0% when no AVS was present) and the alcohol and tobacco purchase attempts where the ID swiper/checker was present (requesting ID in 86.2% and 87.4% respectively vs. 79.0% when no AVS was present). Requesting ID rates within the presence of the pop-up window for alcohol purchase attempts (68.0%) were lower compared with no AVS present (79.0%); however, this difference was not significant. Furthermore, the use of the keying-on-date-of-birth AVS showed significant higher compliance rates for alcohol and tobacco purchase attempts (98.8% and 98.9%, respectively) compared with not using an AVS (60.5% and 57.4%, respectively). A similar result was found for the use of the ID swiper/checker AVS for alcohol and tobacco attempts (87.8% and 83.3%, respectively) compared with not using an AVS (60.5% and 57.4%, respectively). Use of the pop-up window compared with no AVS used showed no significant difference in compliance.

Logistic regression results

Descriptive analyses showed a limited variation in compliance rates when using the keying- on-date-of-birth AVS for both alcohol and tobacco purchase attempts. Because the presence and use of the keying-on-date-of-birth AVS and ID swiper/checker showed to have the same effect on ID requests and compliance, these two AVSs were combined into one category in the logistic regression analyses, to increase the stability of these analyses.

The logistic regression models predicting ID requests for alcohol and tobacco purchase attempts separately (Table 3) only showed significant overall effect for the presence of AVSs in alcohol purchase attempts. The presence of the keying-on-date-of-birth or ID swiper/checker AVSs (combined variable), compared with no AVS present and controlling for covariates, did show a tendency towards a significant effect on ID requests in both alcohol (odds ratio = 2.19; p = .069) and tobacco (odds ratio = 2.30; p = .070) purchase attempts. The estimated age of the cashier was significantly related to ID requests for both alcohol and tobacco purchase attempts, cashiers aged above 40 years requested IDs more frequently than cashiers aged under 20 years. The predictors in the model regarding alcohol purchase attempts account for approxima-

Table 2 Number and percentage for the presence of AVSs versus requesting ID and the use of AVSs versus compliance (after ID requests)

	Alcohol (n = 400) Requesting ID			Tobacco (n = 400) Requesting ID		
	No	Yes		No	Yes	
No AVS	13 21.0%	49 79.0%	62	13 21.0%	49 79.0%	62
Pop-up window	31 32.0%	66 68.0%	97	20 20.6%	77 79.4%	97
	44	115	159	33	126	159
No AVS	13 21.0%	49 79.0%	62	13 21.0%	49 79.0%	62
Keying-on-date-of-birth	19 12.3%	135 87.7%	154	11 7.1%	143 92.9%[1]	154
	32	184	216	24	192	216
No AVS	13 21.0%	49 79.0%	62	13 21.0%	49 79.0%	62
ID swiper/ checker	12 13.8%	75 86.2%	87	11 12.6%	76 87.4%	87
	25	124	149	24	125	149
	Alcohol (n = 325)[b] Compliance			**Tobacco (n = 345)[b] Compliance**		
	No	**Yes**		**No**	**Yes**	
No AVS used	70 39.5%	107 60.5%	177	80 42.6%	108 57.4%	188
Pop-up window used	6 33.3%	12 66.7%	18	5 23.8%	16 76.2%	21
	76	119	195	85	124	209
No AVS used	70 39.5%	107 60.5%	177	80 42.6%	108 57.4%	188
Keying-on-date-of-birth used	1 [a] 1.2%	80 98.8%[2]	81	1 [a] 1.1%	87 98.9%[3]	88
	71	187	258	81	195	276
No AVS used	70 39.5%	107 60.5%	177	80 42.6%	108 57.4%	188
ID swiper/ checker used	6 12.2%	43 87.8%[4]	49	8 16.7%	40 83.3%[5]	48
	76	150	226	88	148	236

[1] $p < .05$; chi-square = 8.554. [2] $p < .001$; chi-square = 40.896. [3] $p < .001$; chi-square = 49.589. [4] $p < .001$; chi-square = 12.817. [5] $p < .01$; chi-square = 10.958. [a] Count < 5. [b] Purchase attempts after ID requests.

Table 3 Logistic regression analyses; presence of AVSs predicting overall requesting ID (no/yes) for alcohol and tobacco purchases separately

		Alcohol purchases			Tobacco purchases		
	df	Exp (B)	95% CI for EXP(B)		Exp (B)	95% CI for EXP(B)	
			Lower	Upper		Lower	Upper
Gender cashier (male = 0; female = 1)	1	.868	.393	1.914	1.126	.537	2.361
Age cashier (<20; indicator)*	2						
Age cashier (20-40)	1	.824	.464	1.462	1.037	.546	1.969
Age cashier (>40)	1	2.860*	1.143	7.161	2.729*	1.051	7.083
Gender Mystery Shopper (boy = 0; girl = 1)	1	.878	.516	1.494	.933	.517	1.683
Number of cash registers opened	1	1.195	.949	1.503	1.019	.784	1.324
Total number of cash registers	1	.921	.788	1.075	1.105	.919	1.328
No AVS available (indicator) [1]	2						
Pop-up window available	1	.686	.308	1.528	1.132	.486	2.636
Keying-on-date-of-birth or ID swiper/checker available	1	2.190[2]	.939	5.106	2.302[3]	.933	5.675
Constant	1	3.411*			1.651		

* $p < .05$;
[1] The overall effect of the presence of AVSs regarding alcohol purchases is significant ($p < .01$),
[2] $p = .069$;
[3] $p = .070$;
Model chi-square (alcohol purchases) = 28.472 (df = 8, $p < .001$); n (alcohol purchases) = 398;
Model chi-square (tobacco purchases) = 18.944 (df = 8, $p < .05$); n (tobacco purchases) = 398;

Nagelkerke R Square (alcohol purchases) = .112; Nagelkerke R Square (tobacco purchases) = .084.
AVS = age verification system; CI = confidence interval; ID = age verification.

tely 11.2% (Nagelkerke R Square) of the estimated explained variance of ID requests by cashiers; for tobacco purchase attempts, this is approximately 8.4%.

The logistic regression models predicting overall compliance for alcohol and tobacco purchase attempts (Table 4) showed significant results for the use of the keying-on-date-of-birth or ID swiper/checker AVS (combined variable), controlling for covariates. When using the keying-on-date-of-birth or ID swiper/checker AVS, cashiers were 11.6 times more likely to comply with alcohol purchase attempts, and 13.3 times more likely to comply with tobacco purchase attempts, compared with when not using an AVS. The predictors in these models account for approximately 23.3% (Nagelkerke R Square) of the estimated explained variance of cashiers' compliance regarding alcohol purchase attempts; for tobacco attempts, this is approximately 24.5%.

Table 4 Logistic regression analyses; use of AVSs predicting compliance (no/yes) after ID requests for alcohol and tobacco purchases separately

		Alcohol purchases			Tobacco purchases		
	df	Exp (B)	95% CI for EXP(B)		Exp (B)	95% CI for EXP(B)	
			Lower	Upper		Lower	Upper
Gender cashier (male = 0; female = 1)	1	.795	.352	1.796	1.110	.558	2.209
Age cashier (<20; indicator)	2						
Age cashier (20-40)	1	.993	.520	1.897	1.080	.584	2.001
Age cashier (>40)	1	.893	.425	1.872	.661	.323	1.354
Gender Mystery Shopper (boy = 0; girl = 1)	1	1.010	.580	1.758	.748	.440	1.271
Number of cash registers opened	1	.873	.692	1.100	.980	.785	1.222
Total number of cash registers	1	1.110	.928	1.328	1.067	.904	1.261
No AVS available (indicator)	2						
Pop-up window available	1	.889	.367	2.154	.634	.274	1.465
Keying-on-date-of-birth or ID swiper/ checker available	1	.880	.365	2.123	.499	.209	1.191
No AVS used (indicator)*	2						
Pop-up window used	1	1.364	.431	4.313	2.526	.801	7.965
Keying-on-date-of-birth or ID swiper/ checker used	1	11.643*	4.797	28.262	13.253*	5.819	30.184
Constant	1	1.783			1.745		

* $p < .001$;
Model chi-square (alcohol purchases) = 55.782 (df = 10, $p < .001$); n (alcohol purchases) = 324;
Model chi-square (tobacco purchases) = 63.676 (df = 10, $p < .001$); n (tobacco purchases) = 343;

Nagelkerke R Square (alcohol purchases) = .233; Nagelkerke R Square (tobacco purchases) = .245.
AVS = age verification system; CI = confidence interval; ID = age verification.

Qualitative results regarding facilitating and hindering factors in the purchase process

Table 5 shows all facilitating and hindering factors in the purchase process mentioned by the managers of the different supermarket chains, including illustrative quotes. Hindering factors mentioned are a positive evaluation of juvenile drinking and smoking, a negative position on age limits, difficulty calculating age, and the inability to handle stressors. On the other hand, managers indicated that the hindering factors at the operational level could be cancelled out at the managerial level by

Table 5 Facilitating and hindering factors in the purchase process and illustrative quotes from managers

		Age estimation	Requesting ID	Reviewing ID	Decision to sell
Hindering factors	Operational level	• **It is difficult to estimate someone's age** "The biggest bottleneck I think is to estimate if someone is 25 or not." • **External factors** o **Too many options and rules at the register** "(Describes that there are too many options and rules to comply with when using the register) … cashiers do no longer see the age verification button..." o **Stress, busyness** "Cashiers are busy, long lines, all those external factors play a role as to whether they comply or not."	• **Cashiers fearful to request ID's** "Asking customers for ID is the biggest fear of cashiers."	• **Calculation of the correct age is difficult for cashiers** "The most difficult part seems to be the calculation of the correct date, whether the customer has reached the legal age limit." • **Escapes (bypassing AVSs) in the cash register system can lead to a reduction in use** "Everything can be circumnavigated with escapes."	• **Cashiers are fearful to say and sell no to an underage customer** "Around 14% does not have the courage to sell no to a young customer, especially if it is an acquaintance of the young cashier."
		• **Negative attitude cashiers towards age limits** "Cashiers in general do not see the importance of complying to age limits, maybe because they are usually underage themselves."			
	Managerial level	• **Difficult to institutionalize the steps in the purchase process** "Asking for ID should be just as self-evident as to ask the customer if they want a receipt. That is also a part of the culture, which should be learned. However, that requires a cultural shift which does not happen overnight."			
Facilitating factors	Operational level		• **Providing managerial support/backup in the store in case of difficult situations with customers** "From practice we know that it is important for young cashiers to know that a manager is present at the shop floor as backup."	• **Providing technical support (AVSs) to review ID** "If you want to prevent mistakes in age verification, then you have to use a device… It makes it easier, because cashiers do not have to review the ID themselves; this is done by the machine."	• **Providing cashiers with AVSs which make the decision whether to sell the product or not for them** "The best thing is to use a device which shows whether you can sell it or not. It makes it easier for the cashier, the decision is not up to them, and the device makes the decision for them." "If you use the device, it is not you who refuses the sale, however, it is the device: "I cannot sell it to you, look, the device turned red."
		• **More regular training about the purchase process and practical steps to take (including how to use the AVSs) for cashiers** "The most important thing is repetition of the message."			
	Managerial level	• **Stronger communication from the manager about the importance of complying to age limits.** "The manager needs to more strongly communicate the importance to comply with age limits, to prevent youth from drinking/smoking and, second, to prevent sanctions from local authorities." • **Stronger supervision of the correct use of the steps in the purchase process (e.g., by internal audits using mystery shoppers).** "The magic word is repetition, either through more frequent internal audits, or more frequent training to remain focused." • **Higher internal sanctions for cashiers, but also managers, in case of noncompliance.** "Higher sanctions are needed; one needs to know you can lose your job if you do not ask for ID."			

providing cashiers with sufficient managerial support, technical support for calculating the age of the customer, and regular training about the purchase process and practical use of the AVS. Especially, AVSs calculating and confirming whether the customer reached the legal purchase age for the cashier were considered important by managers in reducing cashiers' fear of having to ask for ID and/or declining the sale. Stronger managerial supervision on compliance of their staff and introducing internal sanctions for cashiers and managers not complying with the age limits (in addition to the three-strikes-out policy local authorities are able to enforce) were mentioned as factors to increase overall compliance rates. Finally, some supermarket chains allow the cashier to bypass the AVS that is incorporated in the cash register system by entering a predetermined code or shortcut. According to the managers, the accessibility and usability of these escapes seemed to influence the use of an AVS negatively.

Discussion

The aim of the present study was to investigate as to whether the presence and use of AVSs increase cashiers' ID requests and compliance with the age limits of alcohol and tobacco. The presence of AVSs did not significantly increase the odds for cashiers to request customers' IDs regarding alcohol and tobacco purchases. Only a tendency towards a positive effect was found for the presence of AVSs calculating and confirming whether the customer reached the legal purchase age for the cashier on cashiers' ID requests ($p = .069$ and $p = .070$ for alcohol and tobacco purchases, respectively). Whenever cashiers requested the customers' ID, the use of AVSs calculating and confirming whether the customer reached the legal purchase age for the cashier significantly increased their odds to comply, with 11.6 and 13.3 times for alcohol and tobacco purchases, respectively. Furthermore, the descriptive results showed that the use of the keying-on-date-of-birth AVS is even more effective in increasing compliance (98.8% and 98.9% for alcohol and tobacco purchase attempts, respectively) than the ID swiper/checker (87.8% and 83.3% for alcohol and tobacco purchase attempts, respectively). These promising results are comparable with remote AVS compliance rates of 96% [22].

The qualitative results supported the quantitative findings for the keying-on-date-of-birth AVS and the ID swiper/checker on ID requests and compliance, respectively. Providing cashiers with AVSs calculating and confirming whether the customer reached the legal purchase age for the cashier seems to reduce their fear of having to ask for ID and/or declining the sale.

Nevertheless, still a large part of the variances of the outcomes remained unexplained in the logistic regression analyses, especially the variance of cashiers' ID requests. In the qualitative interviews, managers indicated that the biggest bottleneck not to request ID was the difficulty to estimate if someone is under the age of 25 years. The effectiveness of the age of 25 years, to which supermarkets agreed to request ID for persons appearing younger than this age, should be critically reviewed, and more insight is needed in which factors are important to correctly estimate someone's age. In addition, future research should gain insight into how the usage of effective AVSs can be improved.

Results from the qualitative interviews with managers also indicated that individual characteristics of cashiers (e.g., attitudes towards age limits) and the role of the floor manager (e.g., the degree of support provided to cashiers) could, next to the presence and use of AVSs, influence ID requests and compliance rates of alcohol and tobacco sales. Managers also indicated that the way in which AVSs are incorporated in the cash register system could influence the use of AVSs. To increase cashiers' ID requests and compliance, it was suggested by managers to 1) intensify instructions regarding age estimation, 2) increase cashiers' age verification skills systematically by using mystery shoppers and imposing sanctions based on these confrontations and 3) increase managers' support for cashiers at shop floor level.

Furthermore, possible variations in supermarket chain's internal policies regarding age limits and differences in the frequency of enforcing age limits by national or local authorities could also have influenced the odds of ID requests and compliance. More research is needed to investigate in which way the implementation of different internal supermarket chain's policies and enforcement efforts of national or local authorities influence ID requests and compliance rates regarding alcohol and tobacco sales.

Limitations and implications for practice

Firstly, this cross-sectional study cannot give insight into long-term effectiveness of the use of AVSs. Secondly, observing the use of the pop-up window AVS might be difficult is some cases, resulting in underestimation of its use. Thirdly, the timing of the interviews (before the policy change) may have had an effect on the incentive supermarket chain managers experienced for ensuring compliance. Nevertheless, the fines/penalties for violating the age limits did not change/increase in this period.

Regardless of these limitations, the significant findings of this study strongly indicate the effectiveness of AVSs regarding compliance in supermarkets, and show promising results, especially compared with the results when no AVS is used. The results of this study showed that the use of AVSs can increase compliance in different age-related products (alcohol and tobacco) through similar processes. This implies that effectiveness of AVSs on compliance might also be generalizable to other age-related products, such as video games or fireworks. In addition, other vendors in the Netherlands or even other countries using similar cash register systems (e.g., liquor stores, gas stations, etc.) could possibly benefit from using certain AVSs.

Implications and contribution

The study explores the effectiveness of age verification systems in Dutch supermarkets in a natural setting using a mixed method design. The use of age verification systems to calculate and confirm whether the customer has reached the legal purchase age significantly increases odds of compliance.

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Editor's Note

Following publication of Roodbeen RTJ, Schelleman-Offermans K, Lemmens PHHM, Alcohol and Tobacco Sales to Underage Buyers in Dutch Supermarkets: Can the Use of Age Verification Systems Increase Seller's Compliance? J Adolesc Health 2016;58:672-678. DOI: 10.1016/j.jadohealth.2016.03.005, the editors received the following information clarifying the relationship between the author's employer and one of the products studied: Nuchter initiated efforts to develop a product called ID-Swiper in 2011, but ended those efforts and released its interest in the product to a third party in 2012. According to the Benelux Trademark Register, Nuchter registered a trademark for "ID-Swiper" in 2011, and the trademark was cancelled in 2014.

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Could you buy me a beer? Measuring secondary supply of alcohol in Dutch on-premise outlets

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/Abstract

Objective

Alcohol is largely available for Dutch minors through on-premise secondary supply, which occurs when an adult furnishes an alcoholic drink to a minor in an on-premise outlet. Vendors allowing this secondary supply on their premises are in violation of the Dutch Licensing and Catering Act (legal age limit is 18 years old for the sale and possession of alcohol). Using existing mystery shopping protocols as a standard, our study objective was the development and field testing of a novel procedure, measuring vendors' compliance with secondary supply.

Method

Using a newly developed mystery shopping procedure, transfers of alcohol between young adult buyers and minors were staged in 109 Dutch on-premise outlets (cafes and bars) to measure vendors' compliance with secondary supply.

Results

In accordance with the Dutch Licensing and Catering Act, 29% of the vendors disallowed the secondary supply of alcohol to minors (32 out of 109 attempts). During 40 attempts (of 109 attempts; 37%), the vendor asked for the identification document (ID) of the minor. Compliance after the ID was requested was 80% (32 of 40 attempts). During 8 attempts (20%), the minors were served, even after the ID was requested.

Conclusions

Mystery shopping is a suitable methodology for measuring compliance with secondary supply. Results show that alcohol is largely available for Dutch minors through secondary supply. Governments that intend to formulate and evaluate enforcement policies aimed at curbing high alcohol availability for minors are advised to use this novel procedure for monitoring compliance and to use these results for agenda setting and benchmarking.

Introduction

In Western drinking cultures, minors who drink obtain their alcohol primarily via social sources, such as older friends or parents, instead of buying it themselves. For example, in Australia, friends (41.9%) and parents (30.5%) were reported as the main sources of alcohol for 13- to 17-year-old risky drinkers [1]. In the United States, most of the 12th graders who reported drinking alcohol, obtained their alcohol via friends (72.4%), at parties (60.0%) and from others (52.5%) [2]. Also, in the Netherlands, the majority of 14- to 17-year-olds who drink alcohol did not report buying alcohol themselves (90%); they reported obtaining it through others (75%), including older friends (76%) and/or parents (41%) [3]. Thus, although minors obtain their alcohol much more often from social sources (secondary supply) instead of buying it themselves, this type of supply has received little attention in research on compliance.

The role of on-premise outlets in obtaining alcohol by Dutch minors

Next to social alcohol sources, of all commercial alcohol sources, on-premise outlets seemed to be the most prevalent source for Dutch minors [3,4]. Among 12- to 16-year-old drinkers, only 16% reported buying alcohol at cafes/bars and only 19% reported buying alcohol at disco/clubs, whereas a much larger percentage (35%) reported drinking on the premise of a disco/club [4]. This difference suggests that not all of those who reported drinking alcohol in an on-premise outlet purchased the alcohol themselves. Considering the importance of social sources to obtain alcohol for minors [1–3], it is most likely that these minors are provided with alcohol by other (adult) social sources in on-premise outlets (secondary supply).

Dutch legislation

According to the Dutch Licensing and Catering Act, vendors are prohibited from selling alcohol to minors and are obliged to determine the age of the potential buyer (if the buyer is not unmistakably 18 years old) based on a formal identification document (ID) [5]. Vendors are also prohibited from selling alcohol if the alcohol is meant for another person (not unmistakably 18 years old) whose age is not yet confirmed based on a valid ID. If on-premise secondary supply (i.e., whenever an adult furnishes an alcoholic drink to a minor in an on-premise outlet) occurs, the minor possessing the alcohol, not the person supplying the alcohol (secondary supplier), is liable [5].

In other Western countries (e.g., Australia and the United States), the secondary supplier of alcohol is also liable [6–9].

Present study

To examine vendors' compliance with the minimum legal age for the sale of alcohol, mystery shopping is a frequently used methodology, wherein minors independently and unobtrusively try to buy alcohol following predetermined procedures. This allows the examination of compliance in a quasi-real-life situation that is less susceptible to social desirability bias [10– 12]. In 2016, the Dutch overall national average compliance was 35.8% for all alcohol sellers (on and off premises), with on-premise outlets (cafes and bars) indicating lower compliance (26.6%) than supermarkets (63.3%) [13].

Other mystery shopping procedures were developed for a) measuring vendors' compliance with serving alcohol to pseudo-intoxicated guests [14–16] and b) adults' compliance with secondary supply in case adults are approached by adolescents outside off-premise outlets asking them to purchase alcohol [17–20]. To the best of our knowledge, the mystery shopping methodology has not yet been developed or tested for measuring vendors' compliance with secondary supply of alcohol in on-premise outlets. Nevertheless, because most Dutch minors obtain alcohol via secondary supply and consume alcohol in on-premise outlets, such compliance rates are important knowledge for policy makers and prevention workers.

Using existing mystery shopping protocols as a standard [10–12], our study objective was the development and field testing of a novel research procedure, measuring compliance with secondary supply of alcohol in on-premise outlets.

Method

Ethics

In previous mystery shopping procedures, minors perform purchase attempts of age-related products in a real-life setting without interference by the adult supervisor. Minors check whether vendors request an ID and correctly verify the date of birth [10–12]. In our novel procedure, minors (17-year-olds) are also used. However, the crucial difference is that the supervisor interferes with the purchase process, and he or she buys the alcohol and attempts to supply it to the minor. The ethical and legal aspects of the developed research procedure are in accordance with approved protocols for mystery shopping research [10–12]. The methodology is not deemed to be medical research (subjects are not manipulated or adversely affected in any way)

and therefore it is exempted under the Dutch WMO law (i.e., the legal charter of the Helsinki Declaration [21]). The minors performed all purchase attempts in association with a trained adult supervisor. Minors never touch the alcohol that is transferred in their proximity by the supervisor, avoiding being punishable by law. The anonymity and legal integrity of the supervisors, minors, vendors, and employees are secured, and study results are not reducible to individuals. The outcomes resulting from this procedure will never be used for penalizing vendors. If purchase attempts interrupt enforcement efforts, the enforcement officer will be informed by the supervisor.

Recruitment requirements of mystery shopping teams

Measurements are performed by male and female teams (each team consists of one supervisor and one minor). This particular composition of teams is based on the ethical consideration that an adult male supervisor is not allowed to work independently with an underaged female. The age range for supervisors is 25-30 years and is chosen to convince vendors that the minor is having a night out with an older friend who is at least older than underage (≥18 years), but not old enough to be his or her parent. All minors are instructed to wear non-explicit clothes (jeans, T-shirt/sweater). Girls are not allowed to wear excessive make-up, and boys are asked in advance to shave [11,12].

Procedure

Entering the premises

The adult supervisor and minor enter an outlet together and head toward the bar. They sit or stand next to each other at the bar and wait for the vendor to take their order. If the bar area is too crowded, both of them take a seat at a table or booth, and purposefully engage in friendly conversation, pretending that they are friends having a night out.

Placing the order

If the vendor asks the supervisor and minor for their order, the supervisor will look at the minor and ask, “What would you like to drink?” The minor is instructed to answer, “Could you buy me a beer/wine?” (among Dutch minors, the most popular alcoholic drinks are beer for males and wine for females [4]). The supervisor agrees and confirms the order by saying “Okay” while turning to the vendor and placing

the order. The supervisor emphasizes that one of the drinks is meant for the minor by acknowledging, "So, one beer/wine for me, and one beer/wine for him/her please." At this point, the vendor may ask about age and/or for the ID of the supervisor and/or minor. If the vendor initially only asks for their ages, the minor is instructed to lie once about age ("I am 18 years old"). This prompts the vendor to request the minor's ID to verify his or her age. If the vendor requests the ID of the supervisor or minor, both show valid IDs.

Paying and leaving the premises

If the vendor decides to refuse to serve to the supervisor and/or the minor, both should leave the location without discussion. If the vendor accepts the order and returns with the beverages, the supervisor must actively take them and clearly place one drink unmistakably near the minor, emphasizing that one of the drinks is meant for the minor. This gives the vendor a clear opportunity to perform age verification. However, the minor cannot touch the beverage in order to avoid being punishable by law. Directly after receiving the alcohol, the supervisor pays for the drinks and both discreetly leave the premise, with an excuse if necessary (e.g., "We forgot to lock our bikes at the station."). The drinks remain untouched and unconsumed by both parties. After each measurement, observations are registered by the supervisor out of the line of vision of the vendors. If bouncer(s) are positioned at the entrance of the outlet checking IDs of individuals attempting to enter (i.e., door policy), the procedures are similar to the placement of a regular order.

Population and sampling

Cross-sectional data were collected during four consecutive weekends in 2016. A random sample of 109 on-premise outlets was drawn from a Dutch municipality, including a large Dutch city (with approximately 350,000 inhabitants). Outlets were not aware of the specific period and time in which measurements were carried out. A balanced design for gender was used for the teams; 55 measurements were performed by male teams (using two male supervisors and four underaged males) and 54 by female teams (using one female supervisor and two underaged females). The measurements were conducted on Friday and Saturday nights, prevalent times for Dutch minors to go to bars [3].

Measures

Compliance (no/yes) rates of secondary supply indicated that the vendors disallowed the secondary supply of alcohol to minors by the adult buyers. Vendors' ID requests

(no/yes) and/or asking for age (no/yes) indicated whether the vendor performed age verification and were recoded in three types of interventions: asking for age and requesting ID, only requesting ID, and requesting ID total (all ID requests with or without asking for age). Intervening by the vendor after the purchase/serving of alcohol had no influence on the registration of noncompliance. If access was denied to the minor by the bouncer(s), compliance was registered. Gender and estimated age (<20 years, 20-40 years, or >40 years) of the vendor and the number of visitors at the bar (1-5, 6-10, or >10) were observed.

Analyses

Descriptive statistics are presented for compliance rates and the interventions vendors performed, split by gender. Chi-square tests were conducted to analyse differences (a) in compliance rates and ID requests between male and female supervisors/minors, (b) between the total compliance rate and the compliance rate after requesting ID (because not all ID requests resulted in refusal of service), and (c) between several contextual variables (gender of vendors, day of measurements, perceived age of vendors, and the number of visitors at the outlets). Only significant results of contextual variables will be mentioned.

Results

In 32 of 109 attempts (29% total compliance), vendors disallowed the secondary supply of alcohol to minors (Table 1). During 69 of 109 attempts (63%), vendors did not perform age verification. In 11% (n = 12) of attempts, vendors asked minors for their age and ID; in 26% (n = 28), they asked minors only for their ID. In total, during 40 attempts (of 109 attempts; 37%), the vendor asked for the ID of the minors. In 38 of these cases (95%), age verification was performed before the team received drinks; in 2 cases, it was after they received drinks but before they paid. Whenever vendors requested ID (n = 40), compliance was 80% (in 32 of 40 attempts; not all ID requests resulted in refusal of service). This compliance rate after ID was requested (80%) was shown to be significantly higher compared with total compliance (29%), $\chi^2(1) = 30.627$, $p < .000$. No significant difference was found between underage males and females regarding total compliance (31% vs. 28%), $\chi^2(1) = 0.129$, $p = .720$, or requesting ID (36% vs. 37%), $\chi^2(1) = 0.005$, $p = .942$, nor was there a significant difference between male and female supervisors regarding requesting ID (27% vs. 37%), $\chi^2(1) = 1.192$, $p = .275$. During 13 of 109 attempts (12%),

vendors verified the age of the minors but did not verify (or only partly verified) the age of the supervisor. In no cases was age verification only performed on the supervisor. During four attempts, bouncer(s) were located at the entrance of the outlet. In two attempts, the bouncer(s) performed age verification (asked for the ID of the minor and supervisor in both cases). During one attempt, the minor and supervisor were not allowed to enter, therefore, compliance was registered.

Table 1 Interventions (asking for age/requesting ID [a]), compliance after requesting ID total and total compliance for supervisors and minors (male/female) during secondary supply of alcohol

Variable	No intervention	Asking for age [b] and requesting ID	Only requesting ID	Requesting ID total [c]	Compliance after requesting ID total	Total compliance
Male supervisors (n = 55)	40 73%	0 0%	15 27%	15 27% [d]	-	-
Female supervisors (n = 54)	34 63%	3 6%	17 31%	20 37% [d]	-	-
Supervisors total (n = 109)	74 68%	3 3%	32 29%	35 32%	-	-
Underaged males (n = 55)	35 64%	5 9%	15 27%	20 36% [e]	17 85%	17 31% [f]
Underaged females (n = 54)	34 63%	7 13%	13 24%	20 37% [e]	15 75%	15 28% [f]
Minors total (n = 109)	69 63%	12 11%	28 26%	40 37%	32 80% [g]	32 29% [g]

Notes:
[a] ID = identification document.
[b] The intervention only asking for age has not occurred in this study.
[c] All ID requests with or without asking for age.
[d] Testing the difference between the requesting ID rate of male and female supervisors;
$\chi^2(1) = 1.192$, $p = .275$.
[e] Testing the difference between the requesting ID rate of underaged males and females;
$\chi^2(1) = 0.005$, $p = .942$.
[f] Testing the difference between the total compliance rate of underaged males and females;
$\chi^2(1) = 0.129$, $p = .720$.
[g] Testing the difference between the total compliance rate and the compliance rate after requesting ID;
$\chi^2(1) = 30.627$, $p < .000$.

Discussion

The main aim of the current study was the development and testing of a novel mystery shopping procedure measuring compliance with the legal age limit through secondary supply of alcohol in on-premise outlets. It seems that the mystery shopping methodology is also suitable when measuring compliance with secondary supply because of the proven veracity (i.e., no teams were exposed as researchers) and practicality of the procedure in the field. The consistency found between compliance of male and female field teams indicates that the procedures were similarly performable, and this adds to the confidence that the procedures are suitable. To further examine the reliability and validity of the procedure, more research is needed to investigate inter-rater and test-retest reliability of the procedure more fundamentally.

This novel procedure might have generated an overestimation of compliance because of the approach used (i.e., the transaction occurs in a setting where the vendor gets to see the minor). Perhaps, in real-life situations, minors deliberately avoid exposure to vendors when drinks are transferred. However, we chose this approach so compliance results, which can be used for agenda setting and confronting sellers, cannot immediately be rejected by vendors. After all, the secondary supply took place directly in their sight. Further research should investigate whether secondary supply compliance rates differ if minors avoid exposure.

From the results, we may conclude that more than 70% of the vendors did not comply with the Dutch Licensing and Catering Act when secondary supply occurred. In comparison, using procedures where minors buy alcohol themselves, 73% of Dutch vendors in on-premise outlets do not comply [13]. Perhaps most of the on-premise vendors are unaware that the secondary supply of alcohol is illegal or are insufficiently motivated or skilled to perform age verification (63% did not even request ID). Vendors should be stimulated to ask for IDs because the results of this study show that compliance with the ban regarding secondary supply is highest (80%) whenever vendors request an ID. Further research is needed to examine underlying reasons for noncompliance. In addition, penalizing the adult supplier of alcohol - as is applicable in, for instance, Australia or the United States [6–9] - could perhaps reduce alcohol availability for minors through secondary supply.

Governments that intend to formulate and evaluate enforcement policies aimed at curbing high alcohol availability for minors are advised to use this novel procedure for monitoring compliance and use results for agenda setting and benchmarking. Furthermore, this novel procedure can be used to support enforcement efforts.

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/6

The right time and place: A new approach for prioritizing alcohol enforcement and prevention efforts by combining the prevalence and the success rate for minors purchasing alcohol themselves

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/Abstract

Objective

In the Netherlands, enforcement of the alcohol age limit is low and inconsistent because of limited resources. A solution is to optimize the efforts of enforcement officers by prioritizing ways in which they regulate commercial alcohol availability. This could increase compliance by sellers, curbing commercial availability. The objective of this study is to present the development of a commercial alcohol availability estimate (CAAE) for all vendor types selling alcohol and to propose a priority ranking.

Methods

A multi-method design was used, combining data (collected in 2015) from national studies reporting behaviour of underage youth purchasing alcohol themselves and the success rate (noncompliance) of alcohol vendors (interviewing 510 minors by telephone and conducting 1,373 purchase attempts of alcohol by minors, respectively). Descriptive data and the development of the CAAE are presented.

Results

Compared with other vendor types (e.g., sports bars or supermarkets), bars/cafes/discos scored highest on the CAAE, indicating that 7.7% of 16- to 17-year-olds in the survey reported successfully purchasing their own alcohol at this vendor type.

Conclusions

To control commercial alcohol availability efficiently for minors in the Netherlands, our estimates suggest that enforcement and prevention efforts should prioritize bars/cafes/discos. However, local authorities should also consider local circumstances and maintain a base amount of attention for all vendor types. Ultimately, the CAAE has the potential to improve enforcer capacity and efficiency in policing commercial alcohol regulation, and prevention workers could align their interventions or campaigns to high-ranked vendor types.

Keywords

Alcohol availability / Alcohol age limit / Compliance / Government enforcement / Prevention / Mystery shopping research

Introduction

It is generally accepted that increased enforcement of alcohol age limits improves effectiveness of the measure. In previous research, substantial benefits of enhanced enforcement have been found and shown to be effective to reduce alcohol sales to minors [1,2]. Even moderate increases of enforcement can reduce sales of alcohol to minors by as much as 35–40% [3,4]. Furthermore, and within a community-wide prevention uptake, increased enforcement can even reduce adolescent heavy drinking and related harm [5–7].

In Western countries such as the United States and the Netherlands, levels of enforcement of the alcohol age limit are low and inconsistent [8–10]. When mentioning enforcement in this study, focus is on the strategy of imposing fines and/or license suspensions/revocations by government on alcohol vendors selling alcohol to underage youth. This study is set in the Netherlands, in which municipalities are responsible for enforcement (including enforcement capabilities for alcohol vendors selling to minors), and the alcohol age limit is set at 18 years for sale and possession of alcohol [11].

When Dutch policy workers were asked about reasons behind low and inconsistent levels of enforcement, 54% indicated a shortage of time (47%), budget (46%) and personnel (34%) as the main hindering factors [9]. Furthermore, the likelihood of apprehension resulting from enforcement efforts is low (28%) in the Netherlands [6]. This limited enforcement is problematic because it undermines potential and effectiveness of the alcohol age limit policy in reducing commercial availability for minors [8,12,13], which in turn increases odds for minors to be exposed to immediate and long-term risks of using alcohol early in life [14–18].

One way of increasing possible enforcement effects without using additional resources is to prioritize enforcement efforts toward those alcohol vendors who are popular among minors and where compliance rates are low. Thus, valid indicators for prioritizing enforcement efforts could be compliance rates of alcohol vendors with the alcohol age limit and popularity of vendors among underage youth. In the Netherlands, alcohol home delivery outlets (AHDOs; 2.8% compliance on average) and sports bars (11.1% compliance on average) are two vendor types which showed lowest scores on compliance [19,20]. Regarding popularity of vendors among underage youth in the Netherlands, findings showed that cafes/bars/discos (9%) and supermarkets (7%) are places mentioned most often by minors for purchasing their own alcohol [21].

It could be concluded, by solely looking at compliance rates, that commercial

alcohol availability for minors is highest in AHDOs and sports bars. However, cafes/bars/discos are the most prevalently used sources of alcohol for minors when it comes to buying their own alcohol. This raises the question which of these alcohol vendor types should have priority for enforcement officers. In this study (based on a Dutch report by [22]), we try to answer this question by combining data on purchasing behaviour of minors using survey research [23] and compliance data using mystery shopping research [24]. The aim of this study is to present the development of a commercial alcohol availability estimate (CAAE) for all vendor types selling alcohol. This is the first scientific study, to the best of our knowledge, that combines prevalence of adolescents' use of a certain vendor type with compliance rates of the same vendor type into one estimate (CAAE). Development of such an estimate provides important information for enforcement officers to regulate commercial alcohol availability more efficiently and for prevention workers to align their campaigns regarding self- purchasing (and drinking) behaviour of minors.

Method

Methods used in this study were not deemed to be medical research (subjects are not manipulated or adversely affected in any way), and, for this reason, were exempt from Dutch WMO law (Medical Research Involving Human Subjects Act), which is the legal charter of the Helsinki Declaration [25]. Methods secured anonymity, privacy and legal integrity of participants, vendors, employees, mentors and mystery shoppers.

Survey (random digit dialling)

Between May and June of 2015, cross-sectional and nationwide representative survey data were collected over an 8-week period, asking 16- to 17-year-olds for their actual drinking and alcohol-purchasing behaviour (performed by research institute Breuer&Intraval and previously published in a Dutch report [23]). Data were gathered by calling selected households on their landline or mobile telephone connection. In total, 510 minors (16- to 17-year-olds) were successfully questioned, with a final response rate of 42.3%. Descriptive results were presented, with overall drinking and purchasing behaviour of minors. The total number of minors reporting purchasing alcohol themselves (or attempting to self-purchase), the reported number of self-purchase attempts in the preceding month, and the calculated and estimated number of self-purchase attempts were presented per vendor type. Supplementary materials A-C appear as online-only addenda to this article on the journal's website:

https://www.jsad.com/doi/suppl/10.15288/jsad.2020.81.719. Appendix A provides a full description of methods.

Mystery shopping

Data collection and processing (performed by research institute Nuchter and previously published in a Dutch report [24]) took place in accordance with validated protocols, including ethical and legal aspects regarding this research, as described and conducted in [19,26]. Between March and May of 2015, cross-sectional and nationwide representative data were collected by conducting alcohol purchase attempts by 17-year-old mystery shoppers. A random stratified sample of vendors was drawn, weighted according to population density. In total, 1,373 purchase attempts were successfully performed. The primary outcome measure was refusal/compliance rate (vendors not selling alcohol to mystery shoppers). In other words, in this study, compliance was valid when a mystery shopper attempted to purchase alcohol directly from the vendor and the vendor refused to sell alcohol. Descriptive results were presented, with compliance rates and success rate (percentage in which minors were able to purchase alcohol) for every vendor type. Confidence intervals (95%) using Wilson's score [27] were calculated. Appendix B provides a full description of methods.

Combined data

Combining, merging and performing initial analysis on both data sets were performed by authors K.S.-O., A.K., R.R., and B.B. in a Dutch report [22]. Independent supermarkets were excluded from the data set, because different definitions for independent supermarkets were applied in two combined studies and therefore, not comparable between the two data sets. Only purchase attempts of 16- /17-year-olds were used from survey data (excluding data from 14-/15-year-olds) to ensure comparability with 17-year-old mystery shoppers.

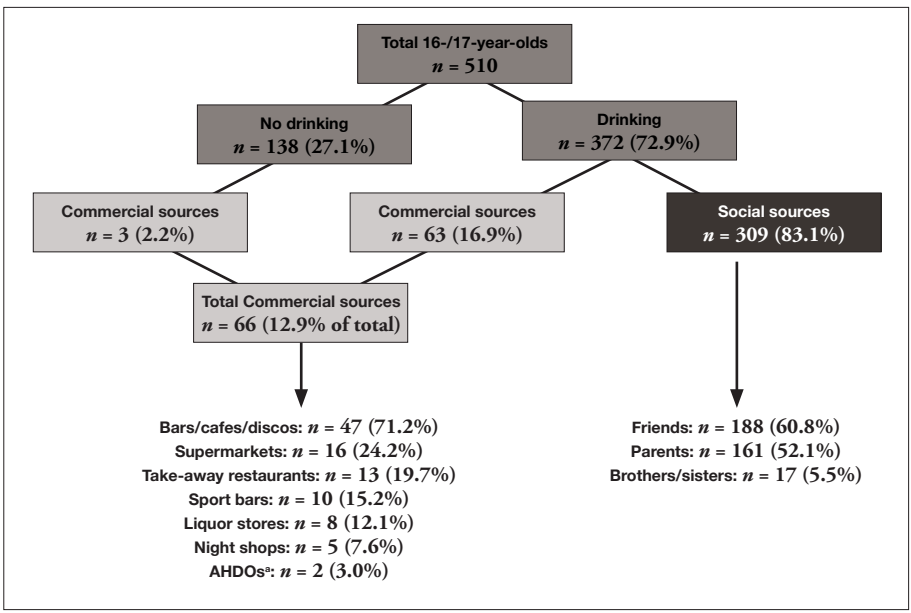
Combined measures

To construct the CAAE for each vendor type, the number of minors that reported attempts (successful and unsuccessful attempts) of purchasing their own alcohol at a specific vendor type in the preceding year (derived from survey results) were multiplied by the success rate at the same specific vendor type (derived from mystery shopping results), divided by 100. The outcome of the CAAE is an estimated success rate for minors purchasing alcohol, combining prevalence of self-purchase attempts by the minor and the actual success rate for different vendor types.

Results

Figure 1 presents overall drinking behaviour of 16- to 17-year-olds and their sources of alcohol. Of all minors, 72.9% reported drinking alcohol in the preceding year. Within this group of drinkers, 16.9% reported purchasing (or attempting to purchase) alcohol themselves in commercial sources. A small number of non-drinkers (2.2%) reported self-purchase attempts of alcohol for others. In sum, 66 minors (12.9% of all 510 minors in the survey) reported attempting to purchase alcohol themselves and did this mostly at bars/cafes/discos (71.2%). The group of minors attempting to self-purchase alcohol in commercial sources was not asked about the frequency that alcohol was given to them by social sources. Furthermore, 83.1% of minors drinking alcohol reported never attempting to purchase alcohol themselves, but rather obtaining alcohol through social sources. This group of minors reported obtaining their alcohol mostly from friends (60.8%).

Figure 1 Overall drinking and purchasing behaviour of 16-/17-year-olds



Notes: Multiple answering was allowed for reporting commercial and social sources. Adolescents reporting purchase attempts at commercial sources (vendors) were not asked about the frequency social sources supplied them with alcohol. Data presented in this figure are derived from survey results performed by Breuer&Intraval. [a] AHDOs = alcohol home delivery outlets

Table 1 presents purchase attempts, success rate and the CAAE per vendor type. A total of 9.2% of all minors in the survey reported buying their own alcohol in bars/cafes/discos, followed by supermarkets (3.1%), take-away restaurants (2.5%), sports bars (2.0%), liquor stores (1.6%), night shops (1.0%) and AHDOs (0.4%). Success rate results showed that in the Netherlands, sports bars (91.5%) scored the highest success rate for 17-year-old mystery shoppers. Compared with other vendor types, supermarkets significantly scored the lowest success rate (confidence intervals with a success rate of 47.5% [42.7%, 52.4%] show no overlap with other vendor types).

Based on these results, the CAAE was calculated, showing that 7.7% of all 16-/17-year-olds in the survey successfully purchased their own alcohol (or attempted to purchase their own alcohol) in bars/cafes/discos (meaning that sellers do not comply). The ranking in Table 1 was based on these results, with bars/cafes/discos on top. In the next column, reported number of self-purchase attempts represents reported responses of participants in the survey. To calculate the number of times minors purchased (or tried to purchase) their own alcohol in the preceding month, the number of participants in the survey who responded to each measure are recoded (using midpoints of categories) into estimated frequencies (i.e., "1 to 3 times a month" category corresponds to 24 purchase attempts a year [2 times a month * 12 months a year]).

To the highest category, "1 or more times a week," 25% of total number of weeks in a year (rounding up to approximately 14 weeks) was added because of framing ("or more") of the question (52 purchase attempts a year + 14 purchase attempts). Following these estimated frequencies (and assuming that self-purchasing behaviour of minors was constant throughout the year), in the year preceding the survey, a total estimated number of 1,632 self-purchase attempts were performed in bars/cafes/discos by minors who completed the survey (51.3% of all attempts). On average, minors performed an estimated 24.7 self-purchase attempts of alcohol in the preceding year in bars/cafes/discos. The CAAE, in estimated average number of successful self-purchase attempts per minor per year at bars/cafes/discos, was 20.7.

Using bars/cafes/discos as an example, the general equation for calculating the CAAE was: (9.2 x 83.8) / 100 = 7.7; (35 x 24) + (12 x 66) = 1,632; 1,632 / 66 = 24.7; (24.7 x 83.8) / 100 = 20.7. Supplemental Appendix C provides a more elaborate description of underlying calculations in the CAAE using bars/cafes/discos, followed by hypothetical examples of high- and low-ranking percentages, further explaining the interpretation of ranking percentages.

Table 1 Purchase attempts, success rate, and CAAE per vendor type

	% of minors reporting self-purchasing (or attempting to self-purchase) their alcohol (n = 510)[a]	Success rate (non-compliance) [95% CI]	CAAE in % for all minors successfully self-purchasing alcohol	Reported no. of self-purchase attempts in the preceding month[a]			Calculated & estimated no. of self-purchase attempts in a year (n = 66)	Calculated & estimated average no. of self-purchase attempts per minor, per year	CAAE in average no. of successful self-purchase attempts per minor, per year	Ranking
				Never	1 to 3 times a month	1 or more times a week				
Bars/cafes/discos	9.2	253 (83.8%) [79.2, 87.5]	7.7	19	35	12	1,632 (51.3%)	24.7	20.7	1
Take-away restaurants	2.5	95 (89.6%) [82.4, 94.1]	2.3	53	11	2	396 (12.5%)	6.0	5.4	2
Sports bars	2.0	86 (91.5%) [84.1, 95.6]	1.8	56	9	1	282 (8.9%)	4.3	3.9	3
Supermarkets	3.1	190 (47.5%) [42.7, 52.4]	1.5	50	15	1	426 (13.4%)	6.5	3.1	4
Liquor stores	1.6	208 (67.1%) [61.7, 72.1]	1.1	58	7	1	234 (7.4%)	3.5	2.4	5
Night shops	1.0	38 (66.7%) [53.7, 77.5]	0.7	64	4	1	162 (5.1%)	2.5	1.6	6
AHDOs	0.4	50 (90.9%) [80.4, 96.1]	0.4	64	2	0	48 (1.5%)	0.7	0.7	7

Notes: Example of calculations for bars/cafes/discos: (9.2 x 83.8) / 100 = 7.7; (35 x 24) + (12 x 66) = 1,632; 1,632 / 66 = 24.7; (24.7 x 83.8) / 100 = 20.7. Multiple answering was allowed for the percentage of minors reporting self-purchasing (or attempting to self-purchase) their alcohol. Data presented in this table are derived from survey results performed by Breuer&Intraval and mystery shopping results performed by Nuchter, Centre for Research on Age Restrictions. CAAE = commercial alcohol availability estimate; no. = number; AHDOs = alcohol home delivery outlets; CI = confidence interval. a These columns represent reported responses of participants in surveys.

Discussion

Prior work has documented benefits of enhanced enforcement in reducing alcohol sales to minors, drinking behaviour and associated harm (e.g., [1,3,6]). However, previous studies have not offered tools or information on how to prioritize enforcement efforts without using additional resources. Based on a Dutch report [22], this is the first scientific study that provides such a tool by the development of the CAAE for all vendor types selling alcohol, in which data on purchasing behaviour of minors [23] and compliance data [24] are combined into one estimate. The general benefit of using the CAAE, instead of solely using compliance or survey rates, is that it indicates which vendor types are being used successfully by underage people to purchase their own alcohol. Prioritizing enforcement and prevention efforts to these popular and low-complying vendors optimizes the effects of these efforts without using additional recourses.

The CAAE showed that 7.7% of all 16-/17-year-olds in the survey reported purchasing their own alcohol at bars/cafes/discos and are expected to be successful in doing so. Compared with other outlet types, bars/cafes/discos scored highest on the CAAE. This finding could provide enforcement authorities with additional support and substantiation for optimizing deployment of their already limited enforcement facilities. Prevention workers could align their campaigns or interventions with this result, discouraging purchasing and drinking behaviour focused on bar/cafe/disco settings. Furthermore, they could offer alcohol sellers recommendations for increasing compliance, and, in addition, local regulators could use the CAAE as a basis for determining their alcohol hotspots. Although the CAAE presented in this study based on national data offers a solid starting position for municipalities aiming to prioritize their efforts, local authorities should also consider local circumstances in defining priority. Furthermore, all vendor types, regardless of priority, should receive a basic amount of structured attention.

In calculating the CAAE, we have focused on minors purchasing their own alcohol (not on social supply), because local authorities in the Netherlands only have enforcement capabilities with respect to these occurrences and can only be effective in these areas. However, in future research, with regards to curbing alcohol availability from more than one viewpoint, social or secondary supply of alcohol should be investigated as well, because alcohol is available to minors in several ways (e.g., obtaining alcohol from friends or parents [28–30]).

Limitations

Regarding the development of the CAAE, we only have nationwide survey and mystery shopping data available from 2015; using more recent data could provide us with a more present-day priority setting and is recommended. In this study, national data sets are used to give insight into a nationwide situation. Nevertheless, local differences in compliance and purchasing behaviour could exist. Therefore, future research should include local data and could provide a more specified and locally tailored priority setting. The total number of minors who indicated buying (or attempting to buy) their own alcohol was limited (n = 66). In addition, coding used to operationalize monthly self-purchase attempts consists of an approximate estimate. In future research, a larger sample and more detailed categories measuring monthly purchasing behaviour could facilitate a more accurate priority setting. We have merged bars, cafes and discos into one category. Despite homogeneous compliance results between on- and off-premise outlets, in future research, we suggest to separately examining bars, cafes and discos because differences in nightlife settings are conceivable between these subtypes.

Conclusions

Ultimately, the CAAE has the potential to improve enforcer capacity and efficiency in policing commercial alcohol regulation. By using the CAAE, prevention workers could align their interventions or campaigns to high-ranked vendor types that are being used successfully by underage youth to purchase their own alcohol. This could contribute to increased compliance and, subsequently, help curb commercial alcohol availability to minors [8,12,13] and associated harm [14–18]. Development of the CAAE can be applied to different countries/cultures within a range of settings (e.g., using national or local data) and can easily be calculated for other restricted (addictive) products (e.g., tobacco products, as is performed in a Dutch report [31]).

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Restrictions (Kerkenbos 1033, 6546 BB, Nijmegen, NL; info@nuchter.nl; https://nuchter.nl/). K. Schelleman-Offermans, A. Kruize, R. Roodbeen and B. Bieleman combined/merged these data sets, performed initial analysis on this data and published results in a Dutch report [22]. The authors thank Breuer&Intraval and Nuchter for facilitating data.

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Conflict-of-interest statement

There are no conflicts of interest for all named authors.

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Examining the intended and unintended impact of raising a minimum legal drinking age on primary and secondary societal harm and violence from a contextual policy perspective: a scoping review

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/Abstract

Raising a minimum legal drinking age (MLDA) has generated interest and debate in research and politics, but opposition persists. Up to now, the presentation of impact focussed on effectiveness (i.e., intended impact); to our knowledge, no literature syntheses focussed on both intended and unintended impact. A systematic scoping review was conducted in which a a search strategy was developed iteratively and literature was obtained from experts in alcohol research and scientific and grey databases. Ninety-one studies were extracted and analysed using formative thematic content analysis. Intended impact were reported in 119 units of information from the studies (68% positive), forming four paths: implementation, primary and (two) on secondary societal harm and violence. Unintended developments were reported in 43 units of information (30% positive), forming five themes. Only eight studies reported on implementation. Furthermore, a division between primary and secondary paths and the use of a bridging variable (drinking patterns in analyses or methodology) was discovered. These results provide an insight into how well legislation works and can be used to discover or implement new means of curbing underage drinking and alcohol-related violence and harm. They also offer valuable starting points for future research and underline the importance of considering unintended developments.

Keywords
Minimum legal drinking age / Alcohol policy / Policy impact / Societal harm / Societal violence / Public health / Underage youth / Minors / Environmental Research / Scoping review

Introduction

Raising the minimum legal drinking age (MLDA) has generated much interest and debate in research and politics over the past decades due to the conduct of numerous investigations, the multiplicity of impact that have been found and the moral sensitivity surrounding the debate. The general intention of raising an MLDA (e.g., from 18 to 21 years of age) is to further decrease the availability of alcohol for minors which, in turn, is expected to reduce alcohol use and its associated harm to adolescents and their environment [1–5]. Despite confirmed evidence of the effectiveness of raising the MLDA found in multiple studies and literature reviews (e.g., [5,6]), opposition to a higher MLDA persists, especially in the United States [6–10].

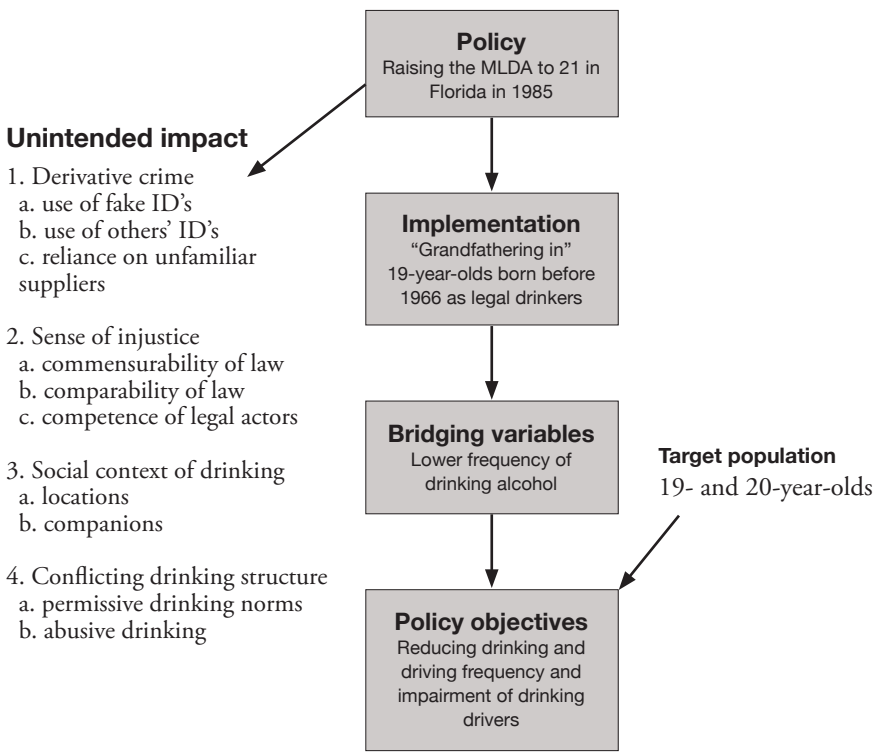
An extensive body of literature exists in reviews on the impact of increased MLDA [5,6,9,11–14]. These reviews have presented the effects of an increase in the MLDA on reduced drinking patterns and other alcohol-related harm and violence. Reviews have also indicated that an increase in the MLDA protects underage drinkers from short-term negative outcomes (e.g., being involved in an alcohol-related traffic crash [13]) as well as long-term negative outcomes (e.g., alcohol and other drug dependence in adulthood [6]). Furthermore, it is argued that although the magnitude of effects may appear small, these effects apply to the entire population of youth and therefore result in very large societal benefits [5]. Up to now, the approach to presenting the impact of an increase in the MLDA has mainly focussed on the effectiveness of the changed policy (i.e., the intended impact). To our knowledge, no literature synthesis of previous studies has focussed on the intended as well as the unintended impact of a raised MLDA. Moreover, the use of a comprehensive theoretical model to present this information and give more insight into the contextual aspects is lacking.

Responsive and realism evaluation (theories used for the general evaluation of legislation) indicate the importance of a contextual perspective when changes in legislation occur [15–18]. Both theories consider the sometimes complex, capricious and unintended relationship between legislation, on the one hand, and reality, on the other, when changes in legislation occur. They show that all forms of knowledge, action and process (and not only the most general or intended effects) should be investigated and used to understand the true impact of legislation [15–18]. Therefore, unintended impact and the processes or developments that in reality occur after an increase in the MLDA should be considered as well. Any form of impact should be taken into consideration during the evaluation and justification of changes in legislation, whether this is a positive change resulting in attainable benefits or a negative

change showing an opposite impact. In this study, intended impact of raised MLDA is defined as a direct decrease in the availability of alcohol for minors and the sequential reduction of alcohol use and associated harms to adolescents and their environment. Unintended impact refers to all additional processes, developments or occurrences in reality caused by raised MLDA.

A good starting point to further substantiate the perspective needed in this study is the conceptual model for raising an MLDA introduced by Lanza-Kaduce and Richards [19]. According to these authors, the most important value of their model (see Figure 1) is the ability to present the unintended as well as the intended impact that a change in policy can have.

Figure 1 A conceptual model for explaining the impact of raising an minimum legal drinking age (MLDA) [19]



The authors started their model with a "policy", which was the increase in 1985 of the MLDA in Florida from 19 to 21 years. They assumed that the primary policy objective of this increase (the last step in the model) was to reduce the frequency of youthful drink-driving behaviour and/or the level of impairment of youthful drinking-drivers (for the target population of 19- to 20-year-olds) [19]. Two directions were then possible. Starting with "unintended impact", they examined whether the increase in the MLDA led to derivative lawbreaking, whether the change engendered a sense of injustice and whether the social context of drinking was altered. "Implementation" described the process for 19- and 20-year- olds in Florida born before 1966 that were "grandfathered in", meaning that this specific group of minors were allowed to drink during the year that the higher MLDA was introduced. Furthermore, according to the authors, if increasing an MLDA is to affect drinking-driving behaviour, it must deter drinking and/or restrict the opportunity to drink so that individuals drink less. Therefore, they constructed a "bridging variable" that measured drinking patterns of respondents and preceded the primary policy objective of the increase (the last step in the model) [19].

Although this model is acceptable for the presentation of intended and unintended impact of a change in policies, the individual aspects were unidimensional and were only focused on the Florida setting. Yet, policy objectives or implementation processes from other settings could be relevant as well. In addition to drink-driving behaviour, alcohol-related traffic crashes could be an example of an important type of additional societal impact. Furthermore, "implementation" should not be limited to "grandfathering in" effects but should include all processes or developments after an increase in the MLDA that aid implementation and change impact in reality.

Our aim is to present a broad spectrum of intended as well as unintended units of information derived from the literature relative to the impact of a raise in the MLDA on primary and secondary societal harm and violence using the conceptual model proposed by Lanza-Kaduce and Richards [19]. The outcome of this study is a novel and empirically-based overview of all impact after an MLDA was raised. By presenting impact this way, we are able to provide insight into how well legislation works and use this to discover new means of curbing underage drinking and alcohol-related violence and harm. Also, these insights offer valuable starting points for future research and underline the importance of considering unintended developments. Furthermore, this overview could further help calibrate the ways in which professionals advocate, develop, implement, evaluate and legitimise changes in policy aimed at curbing alcohol availability [20]. A scoping review will be conducted synthesising what is known from relevant literature.

Methods

Aim, purpose and design

Scoping reviews are an ideal tool to determine the scope or coverage of a body of literature on a given topic, providing an overview (broad or detailed) of the literature's focus [21]. The purpose of our study matches two generally accepted purposes for conducting scoping reviews [21–24] and follows the protocol proposed by Arksey and O'Malley [24] and using the additional advancements of this protocol by Levac, Colquhoun and O'Brien [23].

Search strategy

Phase 1

The scientific databases of the Web of Science, Sociological abstracts, PubMed, PsycINFO and Embase were searched using different strategies for an initial scope of the scientific literature (May and June of 2019). No timespan was selected for the search. Search strategies were developed iteratively per database. When applicable, the initial search started with categorisations developed by the database (e.g., using MeSH terms in PubMed, or using Emtree in Embase). In addition, free text terms were applied iteratively, searching the literature more broadly. When applicable and in line with the research question of our study, Boolean operators (AND, OR, NOT), parenthesis, truncation (e.g., raise*, increase*) or additional proximity searching was used in order to facilitate the search strategy. Supplementary materials S1-S5 appear as online-only addenda to this article on the journal's website: https://www.mdpi.com/1660-4601/18/4/1999/s1. The final search strategies are included in appendix S1.

Phase 2

The finalised strategies used in phase 1 were adapted for searching grey literature databases (e.g., theses, reports, policy documents) using OAIster, GLIN, Opengrey and Google Scholar (July of 2019). The final search strategies are included in appendix S2.

Phase 3

National and international experts in the field of alcohol research were invited to indicate relevant literature (scientific or grey) in English or Dutch languages. In August of 2019, an invitation was sent to the members of the Kettil Bruun Society

(https://www.kettilbruun.org/ accessed on 11 October 2019 [25]), who are specialised in social, epidemiological and cross-cultural research on alcohol policy and use (the invitation is included in appendix S3).

Selection process

All literature was uploaded into Endnote software and, after merging data, duplicates were removed [26,27]. The literature was screened and selected by one author (R.R) based on title (e.g., excluding titles containing the word "tobacco" or titles describing medical laboratory studies). The same author then conducted an initial screening in which all literature was reviewed more thoroughly based on title and abstract. Independently, another author (R.D) reviewed a randomly selected 10% of all studies (77 of 740 studies) using initial criteria. For three of the 77 studies (4%), disagreements had to be resolved through discussion between the authors. There was no need to change the initial criteria. Thereafter, the second author (R.D) screened the other 90% of studies (663 studies) and final disagreements were resolved for 23 out of 663 studies (3%) in a meeting between both authors (R.R, R.D). During all steps in the process described above, co-authors were repeatedly consulted to resolve differences (K.S.O, R.F, D.v.d.M). The inclusion criteria had been finalised in consultation with all authors.

During the selection of studies, literature reviews were set aside. After completing the selection, a full-text evaluation of reviews was conducted by one author (R.R). Reviews were deemed relevant if they (partially) focused on the impact of a raised MLDA. The studies included in the reviews regarding the impact of a raised MLDA (and meeting the criteria listed below) were added to those included in this study [5,6,9,11–14]. References from search results obtained from databases and studies generated from key reviews were hand-searched by one author for additional relevant studies and added to the included studies when relevant (R.R).

General criteria for exclusion

The selection of studies and the development of criteria followed an iterative process. Post-hoc additions of criteria are a central element to the scoping review process, as it is unlikely that researchers will be able to identify parameters for exclusion at the beginning [23]. Because the general aim of this study is a comprehensive overview of intended and unintended impact, a selection criteria solely based on the methodological quality of studies (e.g., as is performed by Wagenaar and Toomey [5]) is, in our view, incomplete. Adhering solely to these criteria could unwillingly exclude studies with methodological disadvantages that may have relevant contextual information.

Therefore, inclusion criteria for quality selection used in realist reviews were implemented in the development of criteria in this study. These criteria assess studies for their relevance (i.e., whether the study addresses the theory under test) and for their rigour (i.e., whether an interference has sufficient weight to make a methodologically credible contribution) [28,29].

In general, studies were excluded when they did not target or were not related to increases in an MLDA. For example, studies only focused on outlet density (e.g., [30]) or only focused on reducing BAC (Blood Alcohol Concentration) levels (e.g., [31]) were excluded. Furthermore, in general, studies were excluded when they were performed in areas smaller than a state or province (e.g., [32]), or only targeted a specific subgroup in society (e.g., college students, military [33,34]). A full description of definitive exclusion criteria is included in appendix S4.

Data extraction

One author (R.R) performed a full text assessment of the included literature. Details were extracted and recorded regarding: 1) the aim of the study; 2) the design used (target population); 3) the policy measures or interventions under investigation; 4) the measured policy effects (type of impact and statistical significance or relevance); 5) the reflection on policy and other occurrences by authors; and 6) the data source used (when applicable). Studies were also checked and extracted by the co-authors when one of them (K.S.O, R.F, D.v.d.M) had doubt regarding the precision of the extraction, leading to an approximate 10% of double extracted studies by co-authors. Differences in extracted data were adjusted or added to the extraction.

Regarding the fourth category (measured policy effects), in quantitative studies, impact was recorded if an effect was found to be statistically significant in the measured association at hand. In qualitative studies, a realist perspective was used using relevance and rigour criteria for recording impact in this category [28,29]. Furthermore, for every type of impact extracted, the existence and/or type of "bridging variable" was recorded (alcohol use of minors). Criteria for deciding whether studies had used these bridging (intervening) variables were: 1) that studies controlled for/mediated for this behaviour in their analysis; 2) that studies used data selection tactics to account for intervening behaviour; or 3) that studies used actual BAC-levels (e.g., [35,36]). Studies that used police-reported indicators for drinking or that selected single vehicle nighttime accidents as proxies for alcohol use when investigating alcohol-related motor vehicle accidents among young drivers (e.g., [37–39]) were not recorded as bridging variables due to the unreliability of these proxies for drinking [40–42].

Formative thematic content analysis

For all included studies, the fourth and fifth categories of the extracted data were analysed using formative (deductive as well as inductive) thematic content analysis [43]. The pieces of material that represented intended or unintended impact (e.g., the significant or relevant policy effect) or a reflection on policy and other occurrences related to the policy effect, were defined as "units of information".

All the extracted data within the fourth and fifth categories were read carefully by one author (R.R), and initial coding's were applied to the units of information, using the model proposed by Lanza-Kaduce and Richards [19] as a starting point. During coding, multiple forms of societal impact were identified (e.g., not only drinking-driving behaviour, but also, for example, alcohol-related traffic crashes) and not all studies were consistent in using "bridging variables" that, according to Lanza-Kaduce and Richards [19], precedes the policy objective of the increase. These findings have initiated the need for extending the model by adding multiple paths that allow the presentation of all forms of impact found in the included literature. This resulted in an overview of four paths that present the multiple forms of impact (including the division between primary and secondary societal impact) and one path presenting themes of unintended impact. During all steps described above creating this overview, as well as the finalization of naming, positioning and describing themes and paths, co-authors of this study were consulted in meetings (R.D, K.S.O, R.F, D.v.d.M). In these meetings, the findings were checked, adjusted and supported following an iterative pathway through this type of thematic analysis.

Results

Flowchart

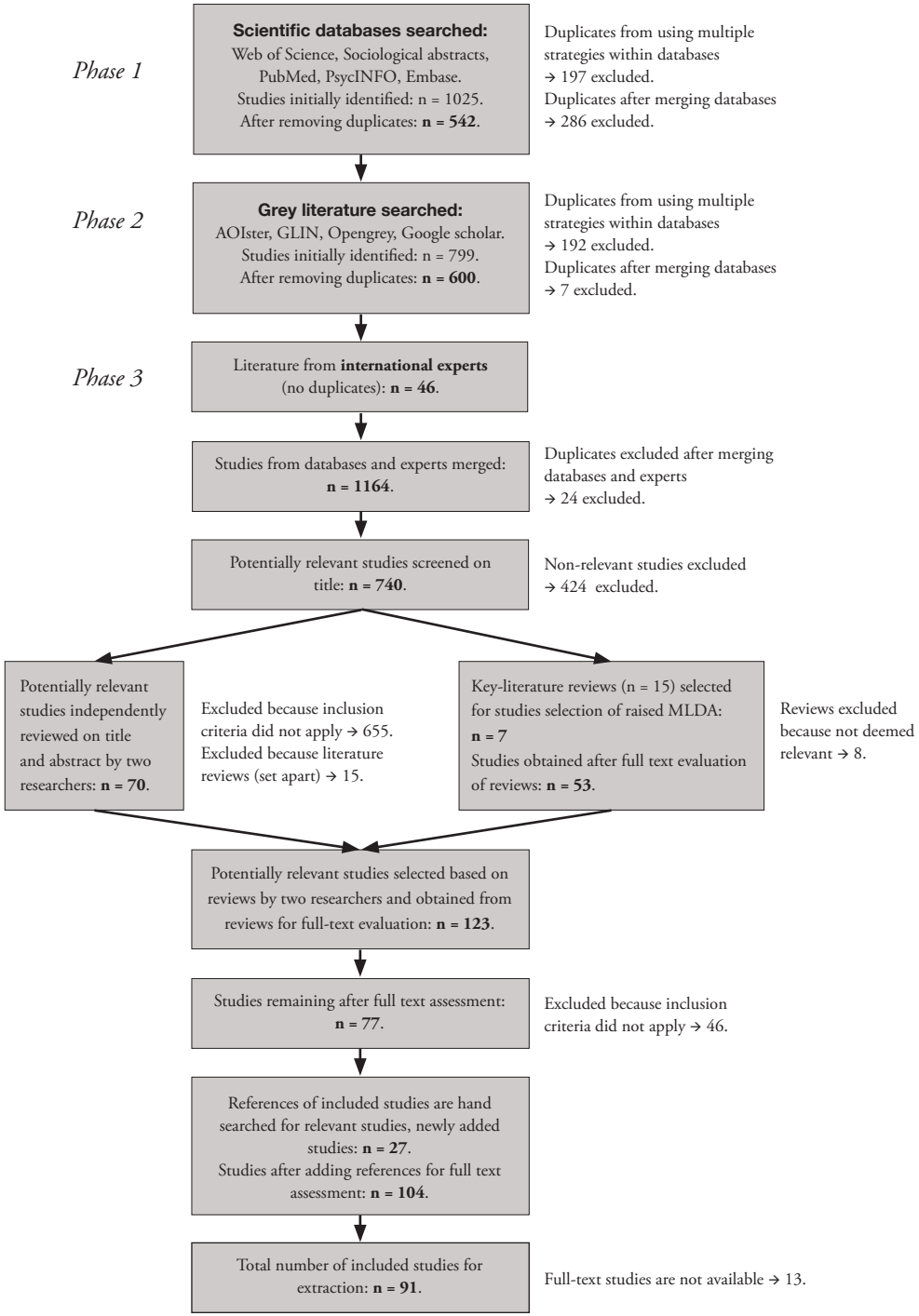
A total of 1025 studies were identified from the scientific databases (see Figure 2). The grey search resulted in the identification of 799 studies. Forty-six studies provided by experts were additionally included. Merging studies from databases and experts after removing duplicates resulted in a remainder of 1164 studies. After the first title-screening, 740 studies were selected. An independent review of the titles and abstracts of these 740 studies by two researchers resulted in a remaining 70 studies for full-text assessment. From the 15 literature reviews that had been set aside, seven key reviews were selected, from which 53 relevant studies were obtained, resulting in 123 relevant studies for full-text evaluation. Seventy-seven studies were deemed relevant and 46 were excluded because inclusion criteria did not apply. After hand-searching the references of 77 included studies, 104 studies were selected for extraction. Although we consulted the main authors of studies that were missing, as well as a professional librarian, and requested studies through interlibrary networks, 13 studies were not available in full text, resulting in 91 studies for extraction.

Significant and relevant impact found in studies after an increase in MLDA

Building on the conceptual model described by Lanza-Kaduce and Richards [19], Figure 3 presents the significant and relevant unintended and intended impact found in the included studies. The number of units of information found in the 91 included studies that reported intended impact was 119, forming four paths. In 81 units of information, positive impact was reported (68.1%), marked with a plus sign in Figure 3. Some studies were used in more than one path (and sometimes more than once within a path), because in some cases these studies investigated or reported on multiple types of impact (e.g., [44,45]). Information on significant/relevant positive impact was reported on:

- 1st path: implementation (eight units of information, four times positive impact; 50%);
- 2nd path: primary societal impact (on drinking/purchasing patterns; 37 units of information, 24 times positive impact; 64.9%);

Figure 2 Flow chart of search strategies and results



- 3rd path: secondary societal harm and violence without bridging variable (48 units of information, 35 times positive impact; 72.9%);
- 4th path: secondary societal harm and violence with bridging variable (26 units of information, 18 times positive impact; 69.2%).

Forty-three units of information that reported unintended impact were found; in 13 units of information, positive impact was reported (30.2%). Five themes were reported.

The most important addition to the current model was the division between primary societal impact (drinking, possession or purchasing patterns) and secondary societal harm and violence (i.e., sequential impact on primary drinking behaviour, e.g., alcohol-related traffic accidents) and the division between secondary societal harm and violence measured with or without the preceding bridging variable (i.e., without consideration of drinking patterns in analyses or methodology). All paths were described, presenting impact and relevant study characteristics. Extracted data per study can be found in appendix S5, in order of appearance in this results section.

First path: Implementation

Eight included studies reported information (eight units of information) on processes or developments that occurred after an increase in an MLDA that helped implementation [44–51]. Five studies were conducted in the United States, two in the Netherlands, one in Canada. Six studies used survey research, one study conducted statistical analysis on existing databases and one study used mystery-shopping to gather the information on implementation. One study found that an increase in the strength of "False ID Use Laws" (as part of the increase in the MLDA) was associated with a significant 7.3% reduction of younger-than-age-21 drivers involved in fatal crashes who had a positive BAC [46]. Another study—measuring compliance by alcohol sellers using 15-year-old mystery shoppers—found that after the increase of the MLDA from 16 to 18 years, mean alcohol compliance rates significantly increased when 15-year-olds attempted to purchase alcohol [47]. In two separate studies in which high school principals and prevention workers in addiction-care were interviewed, results showed that both groups perceived no changes in underage drinking, alcohol-related problems or illicit drug use since the increase in the MLDA [45,50]. In two studies, interviews with enforcement officers indicated that the intensity of enforcement was low, sporadic and varied, caused by the lack of personnel, competing priorities and minimal support for the increased MLDA [44,51]. Lastly, after the increase in the MLDA, the perceived parental approval of alcohol use for minors decreased and

appeared to correspond to the drinking status (i.e., illegal or legal) instead of age of the respondent [48,49].

Second path: Primary societal impact

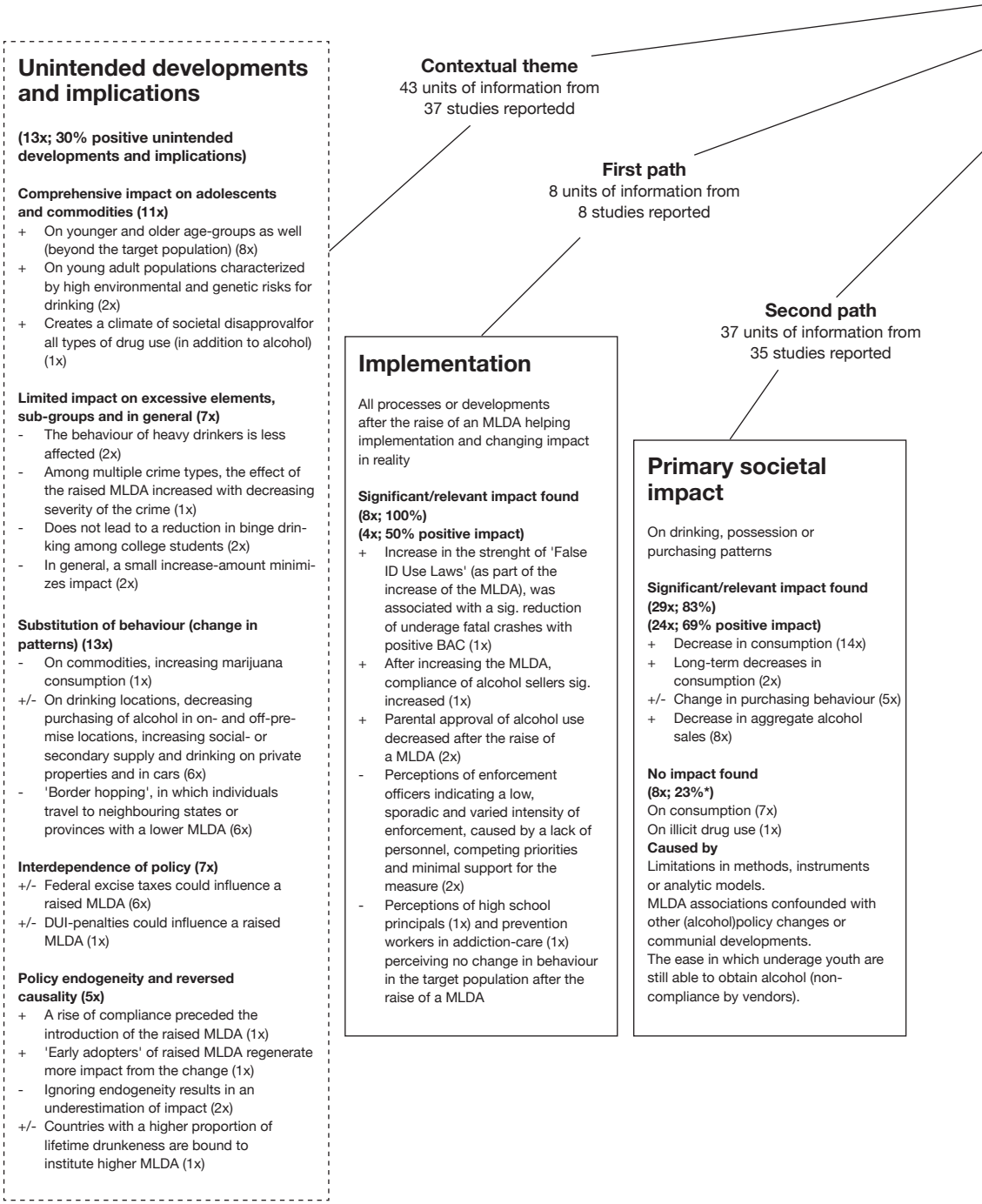
Thirty-five studies were found which reported information (37 units of information) on the impact of an increase in an MLDA on primary societal impact (i.e., drinking, possession and purchasing patterns of alcohol) [44,45,57–66,49,67–76,50,77–81,51–56]. Thirty-seven units of information were found, because two of the 35 studies reported information on multiple types of primary societal impact, finding significant/relevant impact in some cases and finding no impact in others. In total, 29 studies were conducted in the United States, three in Canada, one in Belgium, one in the Netherlands and one that focused on several European countries. Twenty-seven studies used surveys to gather information on primary societal impact, seven studies conducted statistical analysis on existing databases and one study used a qualitative survey.

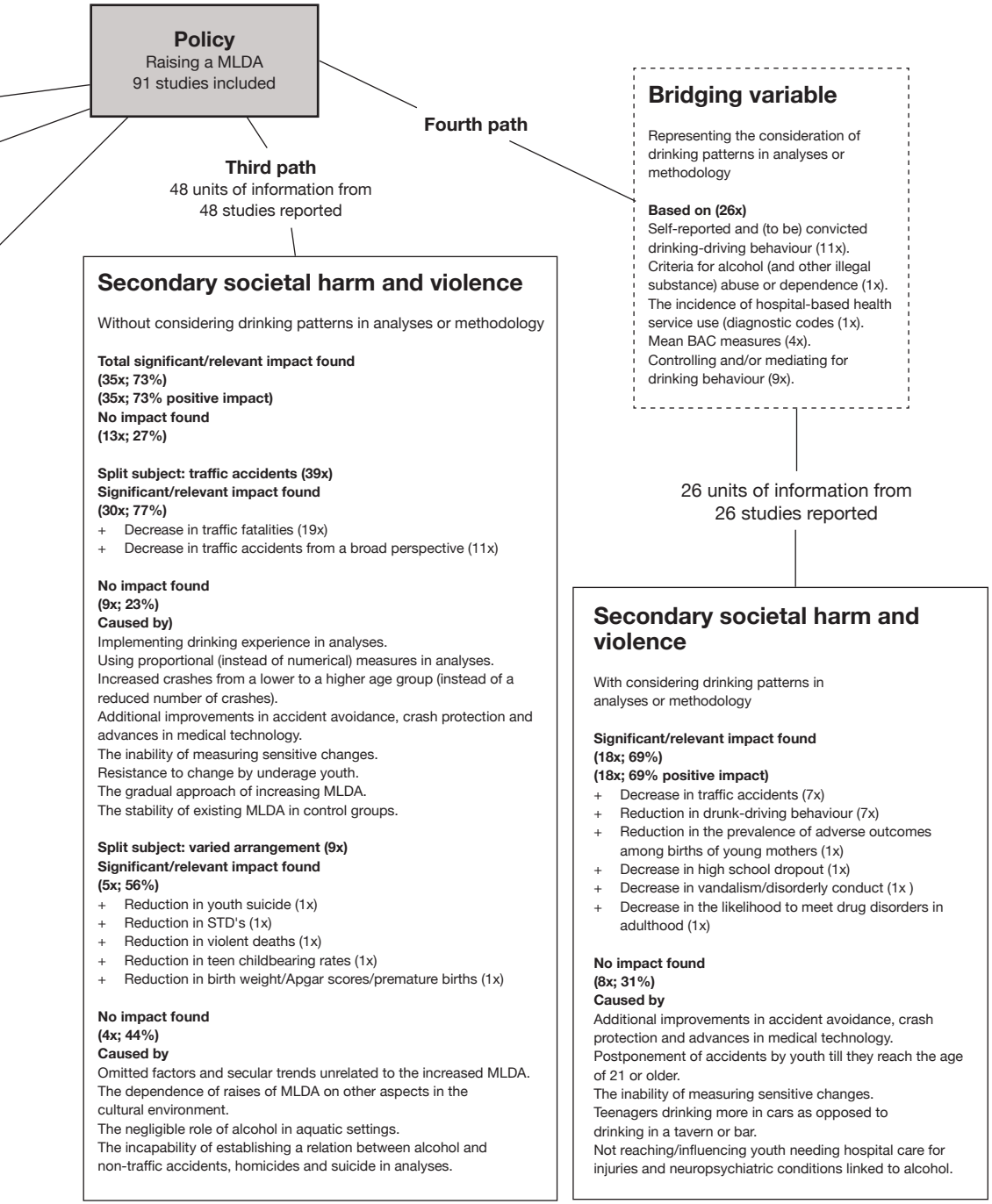
Of these 35 studies, 29 (82.9%) found a significant and relevant impact from an increase in the MLDA on primary societal impact [44,45,59,61–65,67,68,70,71,49,72–74,76–81,51–56,58]. More specifically, of these 29 studies, 14 found a negative (protective) impact on various short-term output measures of drinking patterns (i.e., alcohol consumption for minors) after the increase in the MLDA [45,53,71,74,76,79,54–56,58,61,62,64,65]. Short-term impact was reported on:

- past month alcohol use [45,53,55,56,62,71];
- the number of drinking occasions in the past week, month, year or lifetime (lifetime includes age of onset) [54,61,64,76];
- binge-drinking, heavy/frequent episodic drinking (i.e., drinking five or more drinks in a row in the last two weeks or per occasion) [53,55,58,61,62,65,71,74,79].

Also, in four of the 14 studies mentioned above, a joint impact on drinking patterns was found with increase in the MLDA and the real prices of beer [71,76], Zero Tolerance-laws [53] and excise taxes, mass media campaigns, grassroots movements and variations in the implementation of policies over time [54]. Furthermore, out of the 29 studies, two studies reported a negative (protective) impact on long-term decreases in drinking patterns after the MLDA was raised [49,77].

Figure 3 Overview of the impact of raised MLDA as found in current literature





Notes: * Some studies were used in more than one path (and sometimes more than once within a path), because in some cases these studies investigated or reported on multiple types of impact (and thereby causing the sum of percentages not to be 100%). Also, part of the studies included in the "primary societal impact" versus "bridging variable" categories are similar studies. | + and - indicate the perceived positive or negative societal impact caused by an increase in MLDA. | The paths described are not restricted, they only present an overview of impact as found in current literature.

Long-term impact was reported on:

- past month alcohol use ten years after the enactment of the 21 MLDA [49];
- frequent heavy weekend drinking ten years after the enactment of the 21 MLDA [49];
- proportion, use and (days of) binge drinking in the past months for adults who were 18- to 20-years-old when the MLDA-environment changed [77].

Furthermore, five of the 29 studies found that the increase in the MLDA was associated with significant changes in alcohol purchasing behaviour by teenagers; declines were reported in the frequency of teenagers' alcohol purchases in on- and off-premise outlets or public places [44,51,67,73,80]. Increases were reported in the frequency of teenagers' obtaining alcohol at parties and having others purchase alcohol for them [44,51,67]. Additionally, eight of the 29 studies found that raising an MLDA had a significant decrease on aggregate or per capita alcohol sales [52,59,63,68,70,72,78,81].

Compared to the abovementioned studies which presented impact, eight of the 35 studies found no significant or relevant impact on drinking patterns associated with an increase in the MLDA [44,50,51,57,66,69,75] (one additional study found no significant impact on illicit drug use associated with an increase in the MLDA [60]):

- estimated average drinks on a daily basis [51];
- the number of drinking (and illicit drug use) occasions in the past week, month or year [44,60,66,75];
- the number of binge-drinking days or occasions in the past month (i.e., drinking five or more drinks per occasion) [57,66,75];
- proportion of weekly, lifetime and binge drinkers [69];
- perceived drinking of minors by prevention workers in addiction care [50].

Reasons for not finding any impact may include limitations in methods, measuring instruments or robustness in analytic models such that they are not able to capture the complexities of multiple alcohol-control policies or relevant risk factors in adolescents that determine relevant output measures [66,69,75]. Other studies point to the lack of impact regarding raised MLDA due to the influences by other (alcohol) policy changes or communal developments (e.g., Zero Tolerance-laws, age-of-majority laws for birth control access or improved car safety measures) [44,51,57,60]. Lastly, one study indicated that the lack of impact might be due to the ease with which minors are still able to obtain alcohol when going out due to noncompliance by alcohol sellers or

secondary supply [50].

Third path: Secondary societal harm and violence without the bridging variable

Forty-eight studies were found which reported information (48 units of information) on the impact of an increase in the MLDA on secondary societal harm and violence (i.e., sequential impact on, for instance, drinking-driving behaviour or traffic accidents) without the bridging variable (i.e., without a consideration of drinking patterns in analyses or methodology) [37,38,71,74,77,79,80,82–86,39,87–96,40,97–106,42,107–114,44,45,51,62,67]. Forty-seven studies were conducted in the United States and one in Canada. For gathering information on secondary societal harm and violence, all 48 studies conducted statistical analysis on existing databases (e.g., data on fatal traffic accidents from the Fatality Analysis Reporting System (FARS)). Of the 48 studies, 35 (72.9%) found significant and relevant impact from an increase in the MLDA, reporting that raising an MLDA was associated with a significant or relevant decrease [37,38,84,85,87–90,92–94,96,40,97–106,71,107–111,74,77,79,80,82,83]. Thirteen out of 48 studies (27.1%) found no significant or relevant impact associated with an increase in the MLDA [39,42,112–114,44,45,51,62,67,86,91,95]. Thirty-nine studies investigated secondary societal harm and violence on traffic accidents [37,38,74,77,80,82–88,39,89–98,40,99–107,42,44,45,62,67,71] and 9 studies investigated a variety of indicators [51,79,108–114].

Of the 39 studies investigating traffic accidents, 30 studies (76.9%) found significant and relevant impact from an increase in the MLDA, reporting that raising the MLDA was associated with a significant or relevant decrease in traffic accidents [37,38,85,87–90,92–94,96,97,40,98–107,71,74,77,80,82–84]. Different types of traffic accidents were investigated; 19 studies reported impact on traffic fatalities [71,74,96–99,101–103,106,107,77,82,84,85,87,92–94], while 11 studies analysed traffic accidents from a broader perspective (i.e., looking at all alcohol-related crashes including property damage instead of just fatal crashes [37,38,106,40,80,83,88–90,100,105]. A joint impact with other alcohol control policies was found in some studies, for example, an increase in the MLDA accompanied by the impact of beer taxes, seatbelt laws or dram-shop laws [71,87,98,104,107]. Furthermore, although most studies focused on minors (sometimes using older age groups as a control, e.g., [85]), some studies focused on the effects on the entire age-population, investigating multiple age categories [40,71,82,93,101,104]. Also, three studies only investigated or only found impact from the increase of an MLDA on traffic accidents for males and not for females [77,105,106]. Lastly, two studies reported impact on long-term decreases in traffic accidents after an increase in the MLDA [77,89], finding a significant 16% lower rate

of involvement in traffic accidents over a 6-year period [89] and a significantly lower degree of night-time traffic fatalities for male adults who had not been able to legally drink when the MLDA-environment changed while they were adolescents [77].

Nine out of 40 studies (22.5%) found no significant or relevant impact on traffic accidents associated with an increase in the MLDA [39,42,44,45,62,67,86,91,95]. Reasons for not finding an impact related to variables in the analyses included implementing drinking experience in analyses [39,91], using proportional (instead of numerical) measures in analyses when investigating traffic accidents [42] and controlling for a corresponding shift in increased crashes from a lower to a higher age group [86]. According to the authors of these studies, raising an MLDA seems to primarily postpone fatalities [91] and additional attention should be directed to the role of driving experience instead of alcohol [39,86,91]. Furthermore, landmark improvements in the accident avoidance and crash protection of cars and advances in medical technology [62], the inability to measure sensitive changes [45] and the resistance to change of 18- and 19-year-olds after an increase in an MLDA (who had previously been allowed to drink) were recognised as reasons for not finding impact [44]. The gradual approach of increasing an MLDA in New York (increasing their MLDA from 18 to 19 in 1982 and from 19 to 21 in 1985, in contrast to a state such as Michigan, which abruptly increased its MLDA from 18 to 21 in 1978) was recognised as a reason for not finding impact [95]. Lastly, reasons for not finding an impact after an increase in an MLDA from 18 to 20 in Massachusetts (in comparison to the existing MLDA of 18 in New York) was believed to be due to the stability of the drinking age in New York over several decades [67].

The impact on secondary societal harm and violence without a consideration of drinking patterns (bridging variable) on a varied arrangement of subjects other than traffic accidents was investigated in nine studies [51,79,108–114]. Five out of nine studies (55.6%) found significant and relevant impact from an increase in the MLDA, reporting that the raise was associated with a significant and relevant reduction in youth suicide [108], sexually transmitted disease rates [109], categories of violent death (e.g., suicide, homicide) [110], teen childbearing rates [111] and the prevalence of low birth weight, Apgar scores and premature births [79]. Four out of nine studies (44.4%) found no impact from an increase in the MLDA concerning birth outcomes [112], accidental injury other than traffic accidents [51], homicide or suicide [51,113] and drowning [114]. Reasons for not finding an impact were related to omitted factors and secular trends unrelated to changes in an MLDA that affected outcomes [112], the dependence of an increase in the MLDA on other aspects in the cultural environment [113], the possibility of a negligible role of alcohol in aquatic settings [114] and the incapability of esta-

blishing a relation between alcohol and nontraffic accidents, homicides and suicide in analyses [51].

Fourth path: Secondary societal harm and violence with the bridging variable

Twenty-six studies were found which reported information (26 units of information) on the impact of an increase in the MLDA on secondary societal harm and violence with the bridging variable (i.e., with a consideration of drinking patterns in methodology or analyses) [35,36,69,80,82,100,115–120,44,121–126,45,46,49,55,62,64,67]. Twenty-four studies were conducted in the United States, one in Canada and one in Belgium. Twenty studies conducted statistical analysis on existing databases and six studies used surveys to gather information. The bridging variable included in the analyses is based on:

- self-reported and (to be) convicted drinking-driving behaviour measured on an individual level [44,45,125,49,62,67,80,100,119,120,123];
- criteria for alcohol abuse or dependence (and other illegal substances) on an individual level [117];
- the incidence of hospital-based health service use (diagnostic codes) linked to alcohol use on an individual level [69];
- mean BAC mostly on an individual level [35,82,116,122];
- controlling and/or mediating for drinking-driving behaviour mostly on a population-level [36,46,55,64,115,118,121,124,126].

Out of 26 studies, 18 (69.2%) found significant and relevant impact from the increase in the MLDA [36,44,117–122,125,126,46,49,64,67,80,82,115,116]. Of these 18 studies, seven found a significant or relevant decrease in traffic accidents [36,46,64,82,121,122,126] and four of these discovered a joint impact of an MLDA with other alcohol control policies (e.g., mandatory seat belt laws, Zero Tolerance-laws, 55-mph maximum speed limit) in significantly reducing traffic fatality rates [36,121,122,126]. Of the 18 studies, 11 found impact on a varied arrangement of subjects [44,49,125,67,80,115–120]. Seven studies found a significant reduction in drinking-driving behaviour (e.g., driving after drinking or drunk-driving convictions) by young adults due to increased MLDA policies [44,49,67,80,119,120,125]. One of the studies found that changes in the MLDA were significantly related to prenatal drinking, and, in this context, an MLDA of 18 (instead of a higher MLDA) was associated with a significantly higher prevalence of adverse outcomes among births of young mothers (e.g., low birth weight, premature births)

[115]. Lastly, three studies found impact from the increased MLDA on high school dropout [118], the occurrence of vandalism and disorderly conduct [116] and the likelihood to meet criteria for alcohol or illicit drug disorders in adulthood [117].

Out of 26 studies, eight (30.8%) found no significant or relevant secondary societal harm and violence associated with an increase in the MLDA [35,45,55,62,69,100,123,124]. Four of these studies [45,55,62,124] did find significant or relevant primary societal impact, with a decrease in drinking patterns in the target population associated with an increase in the MLDA. Furthermore, three out of these eight studies involved the investigation of traffic accidents [35,62,124]. Some reasons for not finding an impact were the additional landmark improvements in the accident avoidance and crash protection of cars, advances in medical technology [62] and a postponement in accidents by youth in the 18–20 category until they reached the age of 21 or older (i.e., postponing traffic deaths, not avoiding them) [124]. Three studies measured arrest data of DUI-offenders [45,100,123]. Two of them identified reasons for not finding an impact to the inability of measuring sensitive changes in the larger context which influences drinking-driving behaviour, precluding simple before–after comparisons [45,100]. The third study argued that no impact was found due to teenagers drinking more in cars as opposed to drinking in a tavern or bar [123]. Lastly, one reason for not finding an impact after the increase of an MLDA on the incidence of hospital-based health service use linked to alcohol was that the MLDA-policy was not directed at or did not influence youth needing hospital care for injuries and neuropsychiatric conditions linked to alcohol [69].

Unintended developments and implications

Thirty-seven studies reported information (43 units of information) on unintended developments and implications [35,38,57,58,61,62,65,67–69,71,73,40,82–84,87,92,93,95,97,98,102,44,104,110,115–118,123,45,47,49–51,56]; 33 were conducted in the United States, two in the Netherlands, one in Canada and one in Belgium.

Comprehensive impact on adolescents and commodities

The impact of raising the MLDA seems to be widespread and substantive, going beyond the target population affected and commodities focused on by the increase [35,47,118,56,58,73,92,93,110,115,117]. Firstly, studies show that raising an MLDA not only impacts the target population (e.g., youths directly affected by the increase in the MLDA) but has a wide-ranging impact on younger and older age groups as well [35,47,58,73,92,93,110,115].

These studies show that raising an MLDA appears to initiate an additional protective mechanism for young adolescents under an MLDA (i.e., 18-year-olds). For instance, after a raise in the MLDA to 21, 18-year-olds show significantly lower long-term prevalence rates of alcohol consumption and purchasing rates compared to 19- and 20-year-olds [73]. In another study, raising an MLDA showed an additional protective effect on young adult populations characterised by high environmental and genetic risks for drinking from all aspects of their lives (e.g., problematic alcohol use by their parents) [117,118]. Furthermore, results from another study indicated that an increased MLDA not only helps to create a climate of societal disapproval for alcohol use but also for all types of drug use [56].

Limited impact on excessive elements, subgroups and in general

Problematic drinkers and heavy crimes as excessive elements in society seem unaffected from impact generated by an increase in the MLDA. The findings from one study showed that the drinking-driving behaviour of heavy drinkers is less affected by an increase in the MLDA than the drinking-driving behaviour of moderate drinkers [38]. In another study, which measured the incidence of hospital-based health service use for adolescent injuries and neuropsychiatric conditions linked to alcohol (i.e., problematic drinkers), time trends were not found [69]. Furthermore, one study found that among multiple crime types, the effect of the increase in the MLDA increased with decreasing severity of the crime [116]. Two studies pointed out that an increased MLDA does not lead to a reduction in binge drinking among college students [57,65]. Associated with limited impact in general, a small increase amount (e.g., increasing an MLDA from 18 to 19) could minimalize impact in contrast to a more abrupt increase from 18 to 21 [45,95].

Substitution of behaviour (change in patterns)

The impact of raising an MLDA seems to have substitution effects on commodities, drinking locations and sources of supply used. Firstly, one study found that an increased MLDA had the unintended impact of increasing the prevalence of marijuana consumption [56]. Also, three studies found a decrease in minors obtaining alcohol in on- and off-premise locations after raising an MLDA [44,51,67] and a doubled social or secondary supply of alcohol. Furthermore, another study found an increase in the number of alcohol-related arrests among people under 20 after an increase in the MLDA [123]. The authors argued that this could be due to teenagers not honouring

the new law by drinking more in cars as they were unable to legally drink in a tavern or bar. This substitution effect is also mentioned in a Dutch study, indicating that 16- and 17-year-olds engaged in more drinking out-of-sight on private property after the MLDA was raised [50]. In another study, authors argued that youth cannot use alcohol at home in the presence of their parents after an increase in the MLDA and therefore might use alternative drinking locations such as at their friends' houses where parents may be absent [49]. Furthermore, "border hopping" was identified in multiple studies [40,61,71,83,84,102]. Border hopping occurs when individuals travel to neighbouring states or provinces with a lower MLDA than their own. More specifically, for counties more than 25 miles from a lower MLDA border, raising the drinking age within a state showed a negative and statistically significant effect on the likelihood that an underage driver is involved in a fatal accident [84]. Farther from such a border, results showed that restrictions caused by an increase in the MLDA were effective in reducing accident fatalities [84].

Interdependence of policy

Changes in federal excise taxes or stricter DUI penalties could influence (or could be influenced by) an increase in the MLDA. One study found that the price sensitivity for youth alcohol use fell after the change to a uniform MLDA of 21 in the United States [61]. Similarly, another study argued that after an increase in an MLDA, the tax-instrument had less impact on youth drinking and fatalities [87]. From a more general viewpoint, the authors formulated that communities with relatively strong existing policies might expect smaller impact, while communities with weak current regulations might expect larger benefits from identical policy initiatives [87]. On the other hand, some authors have proposed that alcohol policies may interact advantageously. Multiple studies reported that increasing an MLDA appeared to proportionately reduce more accidents when taxes were high compared with when taxes were low, suggesting that alcohol policies may work synergistically [68,71,97]. One of these studies proposed that the additional benefit of combining an increase in the excise tax with an increase in the MLDA is to affect a wider age group (i.e., affecting youths between 15–17 and 21–24 as well) [71]. As a potential downside, the authors argued that a tax increase may greatly stimulate the demand for illegally produced beer [71]. Another study argued that another downside of an increase in the MLDA and beer tax is the exposure of people who drink responsibly to punitive action (i.e., increased taxes) [104]. Lastly, one study suggested that an increase in the MLDA and the imposition of stricter DUI penalties were both responsible for a decline in fatal crashes

among underage drivers [82].

Policy endogeneity and reverse causality

The impact of an increase in the MLDA seems to be influenced by policy endogeneity and reverse causality. One study, which investigated the compliance of alcohol vendors, noticed that a rise in compliance was already present in the years preceding the introduction of the increased MLDA [47]. According to the authors, this could signify a process in which the general acceptability of juvenile drinking had already started to lower before the increased MLDA was introduced [47]. In addition, the impact of the inducement of the federally mandated transition to a uniform MLDA of 21 in 1986 in the United States could reveal the occurrence of policy endogeneity. Results of one study suggested that the greatest reduction in traffic fatality rates of youth between 18 and 20 years old occurred in states that adopted the policy on their own (without federally mandated inducements) [62]. These "early adopters" may have enacted a higher MLDA in response to grassroots concerns about drinking-driving behaviour or may have devoted significant resources to enforcement [62]. This underlines the importance of local support for a successful implementation of federally mandated law. Also, two studies argued that ignoring the process of endogeneity results in an underestimation of impact [98,104]. Furthermore, while reflecting on mixed results from the analyses of the impact of an increase in the MLDA, the authors point to reverse causality as a possible cause, arguing that countries with a higher proportion of lifetime drunkenness are bound to institute a higher MLDA [69].

Discussion

Prior work has presented evidence for the effects of MLDA increases on reduced alcohol consumption and other alcohol-related harm and violence, protecting underage drinkers from short- and long-term negative outcomes [5,6,9,11–14]. Up to now, the impact of an increase in the MLDA has mainly been presented by focussing on intended impact. To our knowledge, there is no literature synthesis that focusses on intended as well as unintended impact by using a comprehensive theoretical model to present this information and give more insight into contextual aspects. For this reason, the aim of this study is to synthesise exactly that, presenting a novel and empirically based overview of all impact after an MLDA has been increased.

Building on the conceptual framework described by Lanza-Kaduce and Richards [19], we identified four paths of intended impact, in which 119 units of

information were found in the 91 included studies (positive impact was reported in 68% of the units of information). Our results show a gap in current literature: only eight studies reported information on the implementation process of an increase in an MLDA. This is unexpected given the importance of implementation in allowing changes in legislation to function in society [18]. Furthermore, the importance of implementation is underlined in key reviews on the subject of existing MLDA [5,6,13], by implications voiced by authors in the studies included in this review (e.g., [44,47,49,81]) and in prior research showing that increased enforcement and compliance improves the effectiveness of existing MLDAs [44,127–130]. In addition, implementation involves more than instruments deployed by governments; it involves all the processes or developments within all levels of society that occur in reality after the increase in an MLDA. This could additionally involve, for instance, the emergence of self-regulation among alcohol sellers [131,132], the handling of social or secondary supplies of alcohol by alcohol sellers [133], or the development of a risk-oriented approach of deploying enforcement and prevention efforts more effectively [134]. Future research should try to address this gap in knowledge and focus on the implementation process surrounding an increase in an MLDA.

A division between primary and secondary societal impact was made in order to organise the impact found in the included studies. Furthermore, a division between studies on secondary societal harm and violence was made with and without the bridging variable. This addition follows the reasoning of Lanza-Kaduce and Richards [19] for adding a bridging variable to their model. In our review, we found that 48 studies reported information on secondary societal harm and violence without a bridging variable, that is, without taking drinking patterns into account. Limitations on the availability of data have mostly forced the researchers of these included studies to omit drinking patterns or use proxies in their analysis and methodology. In some cases, studies used potentially unreliable proxies as bridging variables for drinking patterns (e.g., [40–42]) and were therefore included in the path without a bridging variable. It is thus important that research evaluating an increase in an MLDA (possibly commissioned by governments) starts before the new policy is introduced so that future research relevant to alcohol outcome measures can be included when assessing the processes of secondary societal harm and violence. In this study, we identified five bridging-variable categories representing drinking patterns in analyses or methodology when assessing secondary societal harm and violence. Future research should try to investigate the possible influence of different categories of bridging variables on impact. For instance, it is not unlikely that the methodological validity of alcohol-related traffic-fatality measures will improve when, as a bridging variable, alcohol use is

mediated for (e.g., [126]) instead of controlled for (e.g., [36]) in analyses.

We identified five themes of unintended developments using 43 units of information from the 91 studies (30% of the units of information reported positive impact). Using these themes, we provided an additional approximate expectancy of occurrences when an MLDA is raised. For instance, we may predict that when an MLDA is raised, not only the target population is affected but also older or younger individuals. It is also likely that when an MLDA is raised, problematic drinkers as a vulnerable group in society remain unaffected. Furthermore, in the context of an increase in the MLDA, the substitution of other sources of supply or the potential of border hopping to neighbouring provinces, states or countries with a lower MLDA is likely. From a more general perspective, we have learned that policy endogeneity has the potential to affect the impact of an increased MLDA in a positive way and that interdependence with existing alcohol-control policy is possible.

Our comprehensive literature search, theory-driven approach and rigorous methods can be seen as strengths of our paper. However, some methodological considerations need to be discussed. Firstly, in this review, in quantitative papers, we have recorded impact if an effect was found to be statistically significant in the measured association at hand. Although we have also included relevant results from qualitative studies from a realist perspective [28,29], we cannot rule out the reflection and reproduction of publication bias. However, because our units of information not only consisted of significant or relevant policy impact, but also on additional observations by the authors of included studies on other policy and occurrences related to impact, this broad perspective might have reduced publication bias. Secondly, although we have searched for grey literature using the appropriate search engines, insights on raised MLDA in local results using native language are perhaps omitted and therefore absent in our review. Part of this is prevented by inviting national and international experts in the field of alcohol research to indicate relevant literature. Thirdly, in this review, the majority of results (and conclusions) are based on data from the United States, because most research on MLDA policy is conducted in this region. This could have created an incline towards results from a homogeneous context. We believe that the context in which a MLDA is raised matters, and therefore, more evidence on raised MLDA policy from other contexts is needed (e.g., the European context). Lastly, we have focused on raised MLDA policy to investigate impact when changes in alcohol policy occur. Yet, MLDA are lowered as well. Future research should additionally address impact of lowered MLDA to further substantiate the findings in this review.

The information gained from this scoping review not only more accurately supports the assessment of impact and offers valuable starting points for future rese-

arch, but also provides insight into how well legislation works. This underlines the importance of considering unintended processes surrounding legislation instead of solely focussing on intended effectiveness. Also, these insights can be used to discover or implement new means of curbing underage drinking and alcohol-related violence and harm and could additionally aid legislators to further calibrate the ways in which they advocate, develop, implement, evaluate and legitimise changes in policy aimed at curbing alcohol availability [20]. For instance, if an area with neighbouring regions aspires to raise the MLDA, legislators should foresee border hopping [84] and prioritise enforcement activities to these regions. Also, after an increase in an MLDA, legislators can expect modifications of impact to be generated by their tax-instrument [61].

Conclusions

This study has provided a novel and empirically-based overview of intended as well as unintended impact after a raise in the MLDA. This overview offers the possibility of considering any type or form of impact during the evaluation and justification of changes in legislation. Whether this involves impact following the paths or unintended impact, all can be considered and used to estimate how legislation will function in society. As a consequence, positive impact can be emphasised and negative impact can be toned down to ultimately protect adolescents and their environment from alcohol-related harm and violence.

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Conflicts of interest

The authors declare no conflicts of interest.

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General discussion

Prior work has demonstrated that raising a MLDA reduces underage drinking and alcohol-related societal harm, protecting minors from short- and long-term negative consequences of early alcohol use [1–7]. Despite this, adolescents are still able to obtain and drink alcohol. This indicates that the effectiveness of the MLDA is not optimal decreasing the capability of MLDA to reduce the availability of alcohol [4,8–13] and in turn, exposing minors to the immediate and long-term risks of using alcohol early in life [8,14–19].

Although the intended effects of raising a MLDA have been studied rather extensively (e.g., the effects on societal harm [1–7]), the role of implementation and unintended impact of a MLDA has hardly been studied up to now. Yet, implementation is essential in order to make alcohol policy effective [20]. Key-elements for an effective implementation of a MLDA are the level of compliance, enforcement and public support [20–26]. In addition, the consideration of the sometimes complex, capricious and unintended relationship between legislation on the one hand and reality on the other is essential when changes in legislation occur [27–31]. This is an important issue for professionals involved in advocating, developing, implementing and evaluating public policy concerning substance abuse [31]. Furthermore, the unintended impact of raising a MLDA, because current drinking prevalence of minors show fragmented results between different countries and states with comparable (and raised) MLDA. In this PhD thesis, the main research question I will address is:

How can the implementation of a raised MLDA be improved to optimize impact?

The secondary research questions I will address are:

- Which processes or factors can influence compliance regarding the raise of a MLDA (chapter two, three and four)?
- Which processes or factors can influence enforcement regarding the raise of a MLDA (chapter five and six)?
- Which processes or factors are involved with the intended and unintended impact of the raise of a MLDA (chapter seven)?

The first three studies in this thesis (chapter two, three and four) used empirical data to investigate ways to improve compliance of alcohol sellers with the raised MLDA in the Netherlands. The next two studies (chapter five and six) used empirical data to investigate ways to improve enforcement of a raised MLDA in the Netherlands. In chapter seven, an international orientation is chosen. A scoping review is conducted of what is known from the available literature (grey and scientific) on intended and unintended impact after the raise of a MLDA. In the current chapter, I will provide

a summary and general discussion, and will review and reflect upon the research questions of this thesis. Additionally, methodological considerations and possible implications will be discussed.

1. Main findings

Chapter two

Using mystery shopping for measuring compliance of alcohol sellers in chapter two, we investigated whether raising the Dutch MLDA for the sale of alcohol has influenced compliance rates. We concluded that it became more difficult for 15-year-old adolescents to purchase alcohol after the MLDA was raised from 16 to 18 years. Results showed that alcohol sellers requested an ID more frequently of the 15-year-old mystery shoppers after the policy change (significant overall increase of 7.4%-points after one year and 23.3%-points after two years). Mean compliance rates including all alcohol outlets increased significantly by 9.2%-points after almost one year and 27.4%-points after two years and five months compared with before the policy change. Nevertheless, a rise in the compliance rate was already present in the years preceding the raise of the MLDA. This might signify a process (i.e., policy endogeneity) in which a lowering in the general acceptability of underage drinking already started before the raised MLDA and alcohol sellers might have been anticipating on this formal legal change. Also, several other (policy) changes occurred in the years preceding the raise of the MLDA, which might have contributed to the observed effect on compliance. Examples of this could be an increase of underage drinking in the media, or other social, cultural or economic changes during this period of time.

Chapter three

Using a combination of mystery shopping, survey- and qualitative data in chapter three, we investigated differences between three Dutch liquor store chains in their style of self-regulation and how that affects sellers' compliance with the MLDA. The results showed that if liquor store chains implement a specific combination of self-regulated age limit control measures comprehensively, higher compliance rates with the alcohol age limit can be achieved. Two of the three liquor store chains implemented self-regulated age limit control measures. The two liquor store chains with these measures showed ID requesting rates as high as 95% versus 54% for chains without control measures, and user rates of age verification systems (AVSs) as high as 27% versus 18% for chains without control measures. This resulted in total compliance

rates of 80% for chains with age limit control measures versus 35% for chains without control measures. Control measures that influenced compliance were: 1) a full implementation of AVSs, 2) the systematic monitoring of sellers' behaviour (leading to a high level of perceived risk of inspection), which can be amplified by 3) increased training, monitoring and strict consequences in case of noncompliance imposed by liquor store chains on their store owners.

Chapter four

By combining qualitative and mystery shopping data in chapter four, we investigated the effectiveness of AVSs implemented in 400 Dutch supermarkets on requesting a valid age verification (ID) and sellers' compliance. Mystery shopping results showed that the presence of AVSs in Dutch supermarket chains did not significantly increase the odds for cashiers to request customers' IDs. However, if cashiers did request the customers' ID, the use of AVSs that calculated and confirmed the legal purchase age of the customer for the cashier significantly increased their odds to comply. These odds increased 11.6 and 13.3 times for alcohol and tobacco purchases, respectively. Qualitative results supported these findings. According to the managers of supermarket chains that were interviewed for this study, these AVSs seemingly reduced the fear of cashiers' having to ask for ID and/or declining the sale to minors. Yet, the difficulty to estimate if someone is under the age of 25 (to which Dutch supermarket chains agreed to request ID for individuals appearing younger than this age) was mentioned by managers as one of the main reasons why cashiers do not request ID. Furthermore, according to the managers, next to the presence and use of AVSs, other factors that could influence ID requesting rates and compliance were: 1) the individual characteristics of cashiers, 2) the role of the floor manager, and 2) the degree of implementation of AVSs in store policy.

Chapter five

Instead of minors buying alcohol themselves directly from alcohol sellers, secondary or social supply (when an adult furnishes an alcoholic drink to a minor) is highly prevalent among minors in Western countries. Until now, there was no methodology developed or tested for measuring secondary supply. Yet, this is important and needed in order to curb alcohol availability for minors from this prevalent alcohol source. In chapter five, using existing mystery shopping protocols, we developed and field tested a novel methodology, measuring compliance of alcohol sellers with secondary supply in on premise outlets. In this study, the veracity and practicality of the developed

method was demonstrated in the field. In addition, the study results showed that alcohol was largely available through secondary supply for minors, since more than 70% of Dutch on-premise alcohol sellers in our sample did not comply with Dutch law when secondary supply occurred.

Chapter six

Limited resources lead to inconsistent and minimal enforcement activities of the Dutch MLDA. Optimizing the efforts of enforcement officers by prioritizing ways in which they regulate commercial alcohol availability (i.e., regulating youth buying alcohol themselves directly from alcohol sellers) could be a solution. This could increase compliance by sellers and curb commercial availability. In chapter six, a risk-oriented ranking of all alcohol seller-types in the Netherlands is presented. This ranking is based on the prevalence of minors purchasing alcohol (using survey data) and the success-rate of minors based on actual purchase-attempts of alcohol (using mystery shopping data). This commercial alcohol availability estimate, or CAAE, is able to prioritize enforcement and prevention efforts. Estimates from the CAAE showed that 7.7% of all 16-/17-year-olds in the survey reported purchasing their own alcohol at bars/cafes/discos and are expected to be successful in doing so. Compared with other outlet types, bars/cafes/discos scored highest on the CAAE.

Chapter seven

The presentation of impact of raised MLDA in previous work has mainly focused on effectiveness (i.e., intended impact), largely omitting unintended impact. Yet, the consideration of the sometimes complex, capricious and unintended relationship between legislation on the one hand and reality on the other is important when changes in legislation occur [27–31]. This marks an important issue for professionals involved in advocating, developing, implementing and evaluating public policy concerning substance abuse [31]. To our knowledge, no literature syntheses has focused on both intended and unintended impact regarding raised MLDA. In chapter seven, a systematic scoping review was conducted in which a search strategy was developed iteratively. Literature was obtained from experts in alcohol research and scientific and grey databases. Ninety-one studies were included investigating impact of raised MLDA. Intended impact was reported in 119 units of information from the studies (68% positive), forming four paths: 1) implementation, 2) primary societal impact, 3) secondary societal harm and violence, and 4) secondary societal harm and violence with bridging variable. The need for a division between primary and secondary paths and the use of a bridging variable (i.e., including drinking, possession or purchasing

patterns in analyses or methodology) was discovered. Only eight (out of 91) studies reported information on the implementation process of a raised MLDA. Unintended impact was reported in 43 units of information (30% positive), forming five themes: 1) comprehensive impact on adolescents and commodities, 2) limited impact on excessive elements, subgroups and in general, 3) substitution of behaviour (change in patterns), 4) interdependence of policy and 5) policy endogeneity and reverse causality.

2. Answering the secondary research questions

Which processes or factors can influence compliance regarding the raise of a MLDA?

The raise of the MLDA (from 16 to 18 years) has positively influenced compliance of alcohol sellers in the Netherlands. Results showed (chapter two) that it became more difficult for 15-year-old mystery shoppers to purchase alcohol after the policy change. Furthermore, our results showed (chapter three) that a specific and comprehensive implementation of self-regulated age limit control measures can positively influence compliance of Dutch liquor store chains. Also, the use of AVSs that are integrated in the age limit control measures of Dutch supermarket chains and calculate and confirm whether the customer reached the legal purchase age, can positively influence compliance after the raise of the MLDA (chapter four).

Which processes or factors can influence enforcement regarding the raise of a MLDA?

The substitution of behaviour shown by Dutch minors to obtain alcohol, for instance through secondary supply, or to self-purchase alcohol using different alcohol-seller types, subverts enforcement efforts after the raise of a MLDA. In order to reduce this problem of substitution (which is another example of unintended impact of a raised MLDA), governments are advised to add the novel procedure (chapter five) and priority-setting using the CAAE (chapter six) to their enforcement and compliance monitoring efforts. This may increase the likelihood of apprehension of alcohol sellers, which can improve compliance. In turn, this may optimize impact by addressing alcohol availability to minors more comprehensively. Also, limited enforcement faci-

lities are deployed more effectively without using additional resources, and prevention workers will be able to align their campaigns or interventions. Additionally, local regulators could use the CAAE as a basis for determining their alcohol hotspots.

Which processes or factors are involved with the intended and unintended impact of the raise of a MLDA?

Two types of processes or factors are involved in attaining the intended and unintended impact of the raise of a MLDA: Implementation and unintended developments. The results of our scoping review (chapter seven) showed a total of six of such processes or factors involved with the impact of raising a MLDA:

1. Implementation, defined as processes or developments that occur after the raise of a MLDA, include elements of compliance, enforcement and public support. Examples of public support are parental approval of alcohol use after the raise of a MLDA, or perceptions of enforcement officers about the raised MLDA.
2. Comprehensive impact on adolescents and commodities. The impact of raising the MLDA seems to be widespread and substantive, going beyond the target population affected and commodities focused on by the increase (also reflected in the findings of chapter two).
3. Limited impact on excessive elements and subgroups in society. Heavy crimes as excessive elements and problematic drinkers as subgroups seem unaffected from impact generated by an increase in the MLDA.
4. Substitution of behaviour (change in patterns). The impact of raising an MLDA seems to lead to a substitution of commodities (e.g., using other drugs substituting the effects of alcohol), drinking locations and sources of supply used (also reflected in the findings of chapter five and six).
5. Interdependence of policy. Changes in federal excise taxes or stricter DUI penalties could influence (or could be influenced by) an increase in the MLDA.
6. Policy endogeneity and reversed causality. An increase in compliance may precede the raised MLDA (also reflected in the findings of chapter two, three and four), and countries with a higher proportion of drunkenness are bound to institute a higher MLDA.

These six processes or factors can be used to provide an additional approximate expectancy of occurrences when a MLDA is raised. Also, they offer valuable starting points for future research and underline the importance of considering unintended developments (instead of solely focusing on intended effectiveness).

3. Answering the main research question

How can the implementation of a raised MLDA be improved to optimize impact?

Elements of implementation that determine the effectiveness of alcohol policy, are the level of compliance by alcohol sellers, enforcement and public support [20–26]. In this thesis, focus in the empirical results was on compliance by alcohol sellers and enforcement. Firstly, our empirical evidence showed that alcohol sellers can play a key role in improving compliance by implementing self-regulated age limit control measures (including AVSs). This in turn improves the implementation of a raised MLDA. Secondly, our empirical evidence showed that prioritizing enforcement efforts on prevalent strategies that minors use to obtain alcohol can improve the implementation of a raised MLDA. Thirdly, to further improve implementation of raised MLDA, six processes or factors from the literature should be considered. When indicating positive impact, these processes or factors can be emphasized, when indicating negative impact, they can be toned down.

Three of these processes or factors from the literature match the empirical insights found in this thesis. Firstly, we found comprehensive impact after the MLDA was raised from 16 to 18 years in the Netherlands. It became more difficult for 15-year-old adolescents to purchase alcohol (compared to 17-year-old adolescents; chapter two). Secondly, we found a substitution of behaviour regarding sources of supply used by minors (chapter five and six). Thirdly, we found indications of policy endogeneity, because a rise in the average compliance rate was already present in the years preceding the raise of the MLDA (chapter two). This might indicate that the process of implementation started before the raise of the MLDA by: 1) a lowering in the general acceptability of underage drinking (i.e., increasing public support) and 2) the implementation of self-regulated age limit control measures by alcohol sellers (i.e., increasing compliance; chapter three and four).

4. A further developed conceptual model

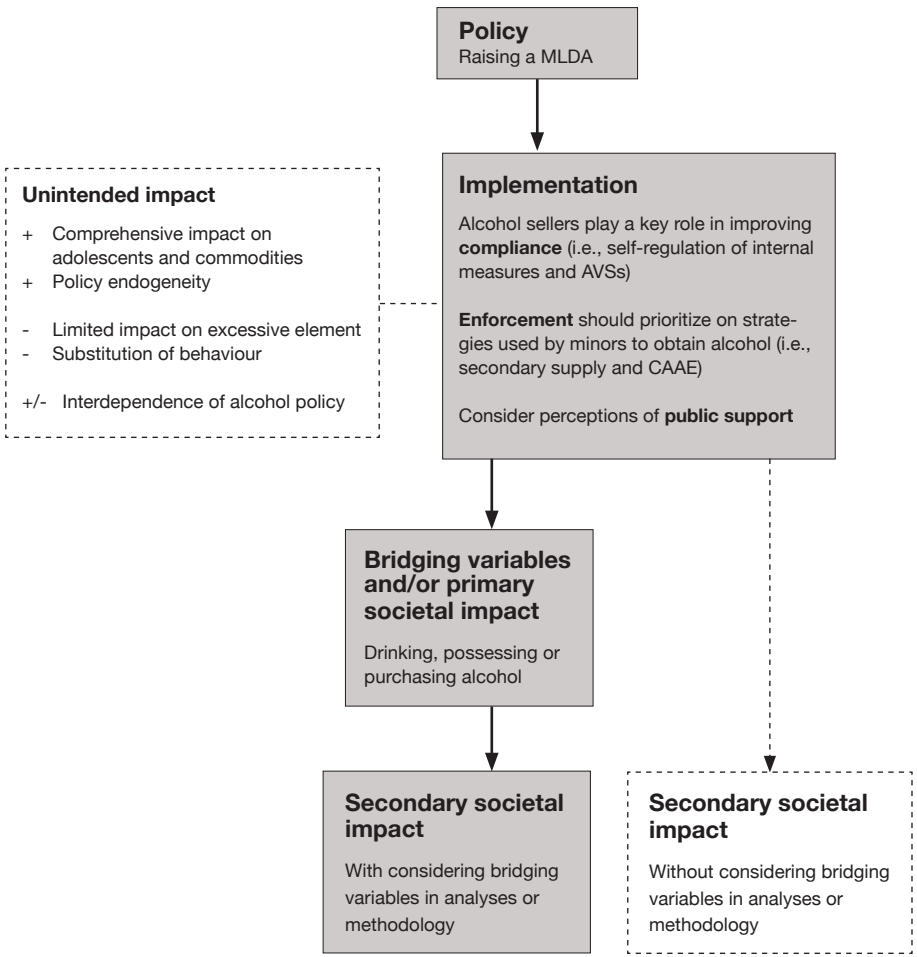
From a more fundamental perspective, these insights can be summarized by adding them to the conceptual model explaining the impact of raising a MLDA presented by Lanza-Kaduce & Richards [32], as displayed in chapter seven of this thesis. This provides a more up-to-date and comprehensive fit with current evidence, as presented in Figure 1. Additions in the model are the division between primary societal impact (drinking, possession or purchasing patterns) and secondary societal impact (i.e., impact on sequential consequences of the primary behaviour, e.g., alcohol-related traffic accidents). Also, the division between secondary societal impact measured with or without preceding bridging variable (i.e., drinking, possession or purchasing patterns in analyses or methodology) is added. Lastly, three additions that improve implementation and unintended impact that should be considered are added in the model to further improve implementation of raised MLDA.

5. Strengths and methodological considerations

Specific strengths and methodological considerations for the studies in this thesis are discussed in chapters two to seven. In this paragraph, I will focus on general considerations. This thesis adds empirical evidence on impact of MLDA policy in Europe, which is a strength, because not much research has been conducted on MLDA policy in Europe. The majority of research has been conducted in the United States. However, the drinking prevalence of minors in Europe is higher compared with the United States: the average last 30-day drinking prevalence of minors in 2019 was 48% in Europe compared to 22% in the United States [33,34]. This indicates that research on MLDA policy in Europe is certainly relevant and needed, as is conducted in this thesis. Another general strength of this thesis is that insights regarding compliance of alcohol retailers are gathered in a realistic and natural setting in which the actual behaviour of alcohol sellers were measured using mystery shopping research. This allowed for investigating and understanding the impact of legislation in a realistic way, providing insights in other factors or processes that might play a role [27–30]. However, the impact found in this thesis might not unambiguously be attributable to an

increased MLDA. Also, the purchasing procedures that mystery shoppers where trained to conduct in most of our research do not necessarily represent the actual behaviour of minors when purchasing or obtaining alcohol. Furthermore, some of the research conducted in this thesis was not focused on prominent sources of alcohol for minors at that moment. For instance, alcohol is mainly available for minors through secondary or social supply [35–37] and in on-premise outlets [37,38]. Yet, in all chapters of this thesis except five and seven, the mystery shopping procedure used, focused on minors trying to buy alcohol themselves. Also, chapters three and four are solely

Figure 1 An adjusted model for explaining the impact of raising a MLDA



focused on off-premise and chain-organized retailers, not on on-premise outlets. Therefore, it is possible that not all relevant factors were considered. Additionally, another consideration of this thesis is that we have not included the perceptions of enforcement-officers, prevention workers and parents. Although we have presented perceptions of these populations by citing relevant studies, these insights represent important elements of implementation that could have further substantiated the findings of this thesis [20–26].

6. Implications

Chapters two to seven of this thesis have demonstrated examples of impact of raised MLDA. What stands out from this, is the versatility of impact found that goes beyond the general intention (i.e., to further decrease the availability of alcohol for minors, as is found to be evident in previous studies [1–8,11]) of raising a MLDA. This indicates that unexpected manifestations of impact in society are bound to occur when a MLDA is raised, and aligns with the theories of responsive and realism evaluation of legislation [27–31]. Because of the insights that have resulted from this thesis, some of these occurrences are now foreseeable implications, and can be anticipated upon when a MLDA is raised.

Anticipation on unintended impact: implications for policy and prevention

The results of this thesis showed positive and negative unintended impact that could be either increased or anticipated on through prevention or policy. Negative unintended impact includes the limited effects of raising the MLDA on excessive elements and substitution of behaviour or changing patterns. Our results (chapter 7) showed that the impact of raising a MLDA on excessive elements (i.e., individuals conducting heavy crimes) and heavy drinking sub-groups in society is limited. Therefore, prevention, healthcare providers in addiction-care and policy makers should increase their attention towards heavy drinking sub-groups in society. In addition, interventions aiming to prevent onset of harmful patters in settings such as vulnerable families, schools and communities, might additionally reduce the attractiveness of substance use for these excessive sub-groups [39]. Another negative unintended effect could be the substitution of behaviour by minors on commodities (i.e., using other drugs instead of alcohol), drinking locations (e.g., through 'border hopping') and sources of

supply. In addition to optimizing enforcement efforts by prioritizing, as indicated in this thesis, both policy makers and enforcement officers could anticipate on this by, for instance, introducing a partial earlier-closing bar policy on cross-border drinking when 'border hopping' occurs [40,41].

Interdependence of policy (raising an MLDA could affect other alcohol-control policies and vice versa) could include positive or a negative unintended effect. For instance, studies included in our scoping review (chapter seven) have found a decrease on impact of tax-instruments in combination with raised MLDA, yet others have found a synergistical effect of both policies [42–45]. It is therefore important for policy makers to monitor these interdependencies.

Positive unintended impact of raising a MLDA could include the comprehensive impact of raising a MLDA and policy endogeneity. These unintended positive processes can be used as arguments by policy makers and prevention workers to propagate and emphasize positive unintended impact of raised MLDA when facing opposition of higher MLDA [6,7,21,46–49]. For instance, public support represents an element of implementation that determines the effectiveness of alcohol policy [20–26]. In chapter seven, we found a decrease in parental approval of underage alcohol use after a raised MLDA [50,51]. This example of positive unintended impact can be propagated and emphasized by prevention to increase support and in turn, optimize impact.

Implications for implementation of raising a MLDA

The need to focus more on implementation (compliance, enforcement and public support) is an insight that stands out in this thesis. Results of this thesis showed that compliance can be increased by self-regulated measures. Although it may be harder for alcohol sellers not organized in chains (e.g., on-premise retailers) to implement self-regulated measured, there could still be ways to increase self-regulation for them. For example, in on-premise settings, the authority responsible for enforcement, (i.e., municipalities in the Netherlands) could use different modes and intensities of communication to alcohol sellers, including announcements of upcoming enforcement efforts. This could be combined with different compliance monitoring efforts by enforcement officers using mystery shoppers or pseudo patrons (i.e., younger-looking mystery shoppers who have reached the legal age to buy alcohol [52]). These different monitoring efforts could increase the likelihood of apprehension on compliance of alcohol sellers.

Furthermore, a new method is developed in the scope of this thesis to measure secondary supply in the Netherlands. This newly developed method is specifically

relevant, because the law on secondary supply is being adapted and expanded in the Netherlands. In addition to the alcohol seller and minor possessing the alcohol, the secondary supplier of alcohol will also be liable [53]. Municipalities and enforcement officers can use the procedure of measuring compliance of alcohol sellers with secondary supply developed in this thesis (chapter five) to monitor and enforce the adapted and expanded law on secondary supply.

Although this thesis has shown the importance of implementation for the impact of raising the MLDA, implementation processes have not always been included in previous research. Multi-component strategies appear most effective to increase compliance with and the effectiveness of the MLDA [8,54,55]. For example, combining intensified enforcement, staff training and general education to the public in the Stockholm STAD project has resulted in an increase in compliance with the MLDA by alcohol sellers from 55% to 68% [54]. The social ecological paradigm, presenting multiple levels of influence, could be used for the development of interventions that incorporate multiple levels [56–58]. However, it is important to, next to gaining insight in impact, also gain insight in the implementation processes when new policy measures or interventions are introduced. Formative process evaluations including qualitative research could give more insight into implementation processes and additionally, improve them during the process of implementation.

Implications for policy

Because of the versatile impact found in this thesis going beyond the general intention of raising MLDA, we have additionally provided insights into potential limits of raised MLDA. It is not unlikely to presume that, in society, all measures implemented by governments have certain limits. Evasion strategies or noncompliance are perceivable in practically any given situation. However, it is important to think about the position of these limits in society in order to implement policy as effective as possible, to enforce it being at the right time and place and to know where additional measures or interventions are needed. We have been able to indicate some of these limits, and have found foreseeable impact that can now be anticipated on after MLDA are raised. For example, as presented in this thesis, raised MLDAs have limited impact on heavy crimes and problematic drinkers in society, indicating the need for additional measures or interventions for these particular elements. In another example, the impact of raised MLDA seem to lead to a substitution of behaviour on sources of supply used by minors, and can be anticipated upon by prioritizing the enforcement efforts to these developments.

Implications for future research

The overview of impact of raised MLDA presented in chapter seven of this thesis clearly indicate gaps in literature. It shows that more research is needed to uncover additional processes or factors, especially related to implementation and unintended impact, that could expand or increase impact of raising a MLDA. Also, when investigating secondary societal impact (e.g., alcohol-related traffic accidents) in future research, alcohol use should be included as a bridging variable. Although previous research investigating secondary societal impact without bridging variables (the dashed path in Figure 1) has offered us valuable insights, it represents a methodological limitation in the majority of results on impact of raised MLDA. Furthermore, in addition to the foreseeable impact found in this thesis, unforeseeable impact remains expected after a MLDA is raised. Future research should focus on insights from other comparable changes in legislation (e.g., on lowering the MLDA, or on raising the tobacco age limit) that could be used in future research to come to an even more complete overview of impact. This could help turn unforeseeable impact in foreseeable anticipations.

Regarding compliance, a continuation of research is needed to systematically evaluate whether the self-regulated measures by chain-organized alcohol sellers remain effective, and to identify supportive factors for maintaining compliance. The interplay between external government enforcement and self-regulated measures implemented by organization should be included in future research. The use of multi-component research designs to investigate all levels in organizations and society are recommended, including formative process evaluations. Also, the implementation and applicability of self-regulated measures for stores not organized in chains, or on-premise alcohol sellers, should not be ignored in future research.

To gain more insight into the effects of enforcement, future research should investigate the perceptions of officers and policy makers on what could further facilitate and optimize their efforts. More specifically, future research should ask for their opinions on the tools or ways that could increase enforcement efforts and the likelihood of apprehension for retailers (i.e., using mystery shoppers or pseudo patrons, the CAAE or the new procedure for measuring secondary supply).

7. In conclusion

Implementation of raising a MLDA can be improved by using a multi focus approach including optimizing compliance, enforcement and public support. Also, there is no linear pathway from a raised MLDA towards intended impact. Yet, there is versatile unintended impact that suggest limits to and foreseeable anticipations on raised MLDA that should be considered. The observations from this thesis are useful for policy makers and the research agenda in alcohol policy. Regarding all subjects addressed, there is sufficient room for future research to improve the capability of MLDA to effectively reduce the availability of alcohol for adolescents [4,8–13]. This in turn decreases the exposure of minors to the immediate and long-term risks of using alcohol early in life [8,14–19].

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/Summary

Prior work has demonstrated that raising a minimum legal drinking age (MLDA) has intended impact on underage alcohol use and its consequences. It reduces underage drinking and alcohol-related societal harm, protecting minors from short- and long-term negative consequences of early alcohol use. However, despite raising a MLDA, some adolescents are still able to obtain and drink alcohol. This indicates that the effectiveness of the MLDA and its capability to reduce the alcohol availability for minors is not optimal.

Although the intended effects (i.e., reducing underage drinking and alcohol-related societal harm) of raising a MLDA have been studied rather extensively, the role of *implementation* and *unintended impact* of a MLDA has hardly been studied up to now. Yet, more knowledge on the implementation (i.e., compliance, enforcement and public support as key-elements) and unintended impact (i.e., the complex, capricious and unintended relationship between legislation and reality) is essential for an effective and optimized alcohol policy. In this PhD thesis, I focus on *how the implementation of a raised MLDA can be improved to optimize its impact*. To do so, three research questions are answered, focusing on 1) processes or factors on compliance with the MLDA (chapter two, three and four), 2) ways to optimize enforcement of the MLDA (chapter five and six) and 3) the involvement of processes and factors with *intended and/or unintended impact* after a raise of the MLDA (chapter seven). Regarding chapters two to six, empirical evidence within the Dutch setting is gathered. This setting is suitable and relevant, because in the Netherlands, the MLDA was increased from 16 to 18 years in 2014. Regarding chapter seven, an international literature review was conducted.

Starting with compliance, in chapter two, we investigated whether raising the Dutch MLDA for the sale of alcohol from 16 to 18 years (in 2014) has influenced compliance rates of different types of alcohol sellers (e.g., supermarkets, liquor stores, sports bars, cafes, etc.) for 15-year-old adolescents. Mystery shopping, a method in which minors (15-year-olds) are instructed to try to purchase alcohol in a real-life setting, was used to see whether sellers complied (no/yes) with the MLDA before and after the MLDA was raised. Results showed that it became more difficult for 15-year-old adolescents to purchase alcohol after the MLDA was raised. After the raise, mean compliance rates including all types of alcohol sellers significantly increased by 9.2%-points after almost one year and 27.4%-points after two years and five months, compared with before the policy change. Nevertheless, a rise in the overall compliance rate was already present in the years preceding the raise of the MLDA. This indicates policy endogeneity, in which a lowering in the general acceptability of underage drinking already started before the policy change. As an example of unin-

tended and positive impact, Dutch alcohol sellers might have been anticipating on this formal legal change.

To get a better understanding of the role of liquor store and supermarket chains in the implementation of this legislation, we investigated the influence of self-regulation measures by these off-premise alcohol sellers on compliance (chapter three and four). We combined qualitative, survey, and mystery shopping data in chapter three to investigate differences between three liquor store chains in their style of self-regulation and the effectiveness of these measures on compliance. We examined the control measures implemented by the chains' head office, the perceptions of liquor store owners on the implementation of measures and compliance with the MLDA of individual liquor stores, respectively. Two of the three liquor store chains had implemented self-regulated age limit control measures. The results showed that if liquor store chains implemented a specific combination of self-regulated age limit control measures comprehensively, compliance rates of 80% were achieved versus a 35% compliance rate for chains without such control measures. The first control measure that influenced compliance was a full implementation of age verification systems (AVSs). AVSs are tools that can be used by the cashier to determine whether the customer has reached the legal purchase age to buy alcohol. AVSs used by alcohol sellers are: 1) a pop-up window (used by the liquor store chains in this study), showing the current date minus 18 years in case of an alcohol product, 2) an AVS in which the date of birth is entered into the cash register system, or 3) an ID swiper/checker. Secondly, the systematic monitoring of sellers' behaviour (leading to a high level of perceived risk of inspection by the seller) was found to influence compliance, which can be amplified by increased training, monitoring and strict consequences in case of noncompliance imposed by liquor store chains on their store owners.

By using a combination of mystery shopping and qualitative data in chapter four, we investigated the effectiveness of AVSs implemented in 400 Dutch supermarkets. Nineteen Dutch supermarket chains were included. We examined compliance with the MLDA of individual supermarkets (i.e., cashiers) and the implementation of AVSs by the chains' head office, respectively. The results showed that if cashiers did request the customers' ID when purchasing alcohol and used an AVS that calculated and confirmed the legal purchase age of the customer (i.e., the keying on date of birth AVS or ID swiper/checker AVS), their chance to comply increased 11.6 times.

In chapter five, we address the issue of secondary supply. Secondary or social supply occurs when an adult (18+ years) furnishes an alcoholic drink to a minor. The substitution of behaviour regarding sources of supply used by minors from self-buying their alcohol towards obtaining it through secondary supply (especially in

on-premise outlets; e.g., sports bars, cafes, etc.) is an example of unintended negative impact after raising an MLDA. Although off-premise alcohol sellers do account for some of the alcohol availability of minors, the prevalence of secondary or social supply especially in on-premise outlets is high among Dutch minors, which is comparable to other Western countries. Until now, there was no methodology developed or tested for measuring secondary supply in on-premise settings. Yet, having a methodology to measure secondary supply is important and needed in order to decide on measures to curb this type of alcohol availability for minors from this prevalent alcohol source. Based on existing mystery shopping protocols, in chapter five, we developed and field tested a novel methodology measuring compliance of alcohol sellers with secondary supply in on-premise outlets. Results demonstrated the veracity and practicality of the method in the field and showed that more than 70% of Dutch on-premise alcohol sellers in our sample did not comply with Dutch law when secondary supply occurred.

To further decrease the availability of alcohol to minors in a more efficient way, enforcement efforts, with mostly limited resources available, should be optimized. For instance, enforcement efforts should focus on alcohol sellers and situations that are often used as a source of alcohol by minors and where compliance with the MLDA is low. In chapter six, a risk-oriented ranking of all alcohol seller-types in the Netherlands (on- and off-premise) was developed: the Commercial Alcohol Availability Estimate (CAAE). The CAAE is based on the prevalence of minors purchasing alcohol (using survey data) and the success-rate of actual purchase attempts by minors (using mystery shopping data). Estimates from the CAAE showed that 7.7% of all minors in the survey reported purchasing their own alcohol at bars/cafes/discos and are expected to be successful in doing so. Compared with other outlet types (e.g., sports bars or supermarkets), bars/cafes/discos scored highest on the CAAE.

Prior work has demonstrated that raising a MLDA has shown the intended effect on decreasing underage alcohol use and its consequences. Nevertheless, such a policy change may also cause, or go together with, unintended impact. In chapters two to six in this thesis, we already came across some of the unintended effects that could occur after a raise in the Dutch MLDA. Nevertheless, no study up to now has investigated the intended and unintended impact of a raise in MLDA in a more systematic way and with a worldwide scope. In order to develop a comprehensive overview of intended as well as unintended impact and more fully understand the impact of raised MLDA on multiple situational aspects of society, a systematic scoping review was conducted in chapter seven. Literature was obtained from scientific and grey databases and from experts in alcohol research, 91 studies were included. Unintended

impact of raised MLDA was reported within five themes: 1) comprehensive impact on adolescents and commodities (matching the insights gained from chapter two), 2) limited impact on excessive elements, subgroups and in general, 3) substitutions of behaviours (matching the insights gained from chapter five and six), 4) interdependence of policy and 5) policy endogeneity and reverse causality (matching the insights gained from chapter two, three and four). Only eight studies reported information on the implementation process of a raised MLDA, indicating a gap in current literature.

To conclude, the results of this thesis indicate that the implementation of raising a MLDA can be improved by optimizing compliance, enforcement and public support (this last element is a result from the literature review). More specifically, our empirical evidence showed that alcohol sellers can play a key role in improving compliance by implementing self-regulated age limit control measures (including AVSs). Also, prioritizing enforcement efforts and using new methodologies on those sources of alcohol that minors use most commonly (i.e., on-premise secondary supply), may optimize impact and address alcohol availability to minors more comprehensively. Furthermore, the results of this thesis indicate that there is no linear pathway from a raised MLDA towards intended impact. Yet, there is versatile unintended impact that suggest limits to and foreseeable anticipations on raised MLDA that should be considered (e.g., comprehensive impact of raised MLDA on younger age groups, policy endogeneity, or substitutions of behaviours to obtain or purchase alcohol). In order to optimize impact of a raised MLDA, factors or processes that unintendedly result from a raised MLDA that are expected to decrease minors' alcohol availability and use (e.g., self-regulatory actions of alcohol sellers) should be emphasized. Factors or processes that unintendedly result from a raise in MLDA that are expected to increase minors' alcohol use (e.g., the prevalence of secondary supply) should be toned down.

In the future, more research is needed to uncover additional processes or factors, especially related to *implementation* and *unintended impact*, that could expand or increase impact of raising a MLDA. This could help turn unforeseeable impact in foreseeable anticipations. The observations from this thesis are useful for policy makers and the research agenda in alcohol policy. There is room to improve the capability of MLDA in effectively reducing the availability of alcohol for adolescents. This in turn could decrease the exposure of minors to the immediate and long-term risks of using alcohol early in life.

/Samenvatting

Wetenschappelijk onderzoek laat zien dat het verhogen van de leeftijdsgrens voor alcohol de beoogde impact heeft: het alcoholgebruik van minderjarige jongeren gaat omlaag. Ook blijkt deze verhoging jongeren te beschermen tegen de negatieve gevolgen van het vroegtijdig beginnen met drinken op de korte en lange termijn. Echter, ondanks dat meerdere landen en staten in de U.S.A. hun leeftijdsgrens verhoogd hebben, zijn minderjarigen nog steeds eenvoudig in staat om alcohol te verkrijgen en te drinken. Dit geeft aan dat de effectiviteit van de leeftijdsgrens voor alcohol en het vermogen van deze maatregel om de beschikbaarheid van alcohol voor minderjarigen te verminderen niet optimaal is.

De beoogde effecten van de verhoging van de leeftijdsgrens (i.e., het alcoholgebruik en gerelateerde gevolgen hiervan voor minderjarige jongeren verminderen), zijn uitgebreid onderzocht. Echter, de mogelijke rol van de implementatie van de verhoging, met als kernelementen de naleving, handhaving en het draagvlak voor deze maatregel, zijn tot nu toe nauwelijks onderzocht. Hetzelfde geldt voor de niet-beoogde impact die kan ontstaan na een verhoging door de complexe, grillige en soms onverwachte relatie die kan bestaan tussen wetgeving en realiteit. Daarom is meer kennis hierover essentieel voor een effectieve en optimale werking van een verhoging van de leeftijdsgrens.

In dit proefschrift onderzoek ik *hoe de implementatie van het verhogen van de leeftijdsgrens verbeterd kan worden om de impact te optimaliseren.* Hiervoor beantwoord ik drie onderzoeksvragen, gericht op:

1. processen of factoren die van invloed zijn op de naleving van de leeftijdsgrens (hoofdstuk twee, drie en vier),
2. processen of factoren die van invloed zijn op de handhaving van de leeftijdsgrens (hoofdstuk vijf en zes),
3. de beoogde en niet-beoogde impact na de verhoging van een leeftijdsgrens (hoofdstuk zeven).

In hoofdstuk twee tot en met zes wordt empirisch bewijs gebruikt dat verzameld is in Nederland. De Nederlandse setting is relevant, omdat in 2014 een verhoging plaatsvond van de leeftijdsgrens van 16 naar 18 jaar. Hoofdstuk zeven bevat een review van de internationale literatuur.

In hoofdstuk twee is onderzocht of het verhogen van de leeftijdsgrens voor de verkoop van alcohol in Nederland (verhoging van 16 naar 18 jaar in 2014) invloed heeft gehad op de naleving door alcoholverkopers voor de verkoop van alcohol aan 15-jarige adolescenten. Hiervoor is de mystery shopping methode toegepast, een

methode waarbij minderjarigen (in deze studie waren dit 15-jarigen) worden geïnstrueerd om een aankooppoging van alcohol te ensceneren in een real-life setting. Met deze methode was de naleving door alcoholverkopers te bepalen (product wel/niet verkocht aan de mystery shopper) vóór en na de verhoging van de leeftijdsgrens. Deze alcoholverkopers zijn gecategoriseerd in locaties waar de alcohol ter plaatse geconsumeerd kan worden (bijvoorbeeld in cafés en sportkantines) en waarbij de alcohol buiten de locatie geconsumeerd kan worden (bijvoorbeeld supermarkten, slijterijen en cafetaria's). Uit de resultaten van dit onderzoek bleek dat het voor 15-jarige adolescenten moeilijker werd om alcohol te kopen nadat de leeftijdsgrens was verhoogd. Vergeleken met de gemiddelde nalevingspercentages van vóór de verhoging van de leeftijdsgrens, zijn de gemiddelde nalevingspercentages één jaar en ruim twee jaar na de verhoging met 9,2%-punten en 27,4%-punten significant gestegen. In deze studie werden alle soorten alcoholverkopers in Nederland geïncludeerd. Afgezien van deze significante stijging in het nalevingspercentage na de verhoging van de leeftijdsgrens, was er in de jaren voorafgaand aan de verhoging ook al een stijging zichtbaar in het gemiddelde nalevingspercentage. Dit kan een deel uitmaken van zogenoemde beleidsendogeniteit. Dit is een proces waarin al voor de verandering in wetgeving wijzigingen te zien zijn in het gedrag dat men beoogd te veranderen met de desbetreffende wet. In de context van de verhoging van de leeftijdsgrens ging dit onder andere gepaard met een proces waarin al vóór de verhoging door alcoholverkopers geanticipeerd werd op een verlaging van de algemene aanvaardbaarheid van alcoholgebruik door minderjarigen. Dit proces is een voorbeeld van een niet-beoogde maar wel gewenste vorm van impact van de verhoging van een leeftijdsgrens. Immers, de wet richtte zich op een verandering ná verhoging van de leeftijdsgrens en op de leeftijdsgrens van 16 jaar.

Eén van de initiatieven die genomen zijn door alcoholverkopers, zijn zelfreguleringsmaatregelen voor het naleven van de leeftijdsgrens. In het derde en vierde hoofdstuk is de invloed van deze leeftijdsgrens-controlemaatregelen bij slijterij- en supermarktketens onderzocht op de naleving van de leeftijdsgrens. In hoofdstuk drie zijn interviews en vragenlijsten afgenomen én is mystery shopping onderzoek uitgevoerd om de effectiviteit van deze zelfregulering van drie slijterijketens te onderzoeken. Hierbij is onderzoek gedaan naar de maatregelen die op centraal managementniveau van de keten genomen zijn, de perceptie van slijterijeigenaren over de uitvoering van maatregelen, én de naleving van de leeftijdsgrens van individuele slijterijen. Twee van de drie slijterijketens in het onderzoek hadden zelfregulerende maatregelen geïmplementeerd om de leeftijdsgrens na te leven. De resultaten toonden aan dat als slijterijketens een specifieke combinatie van maatregelen integraal implementeren, nale-

vingspercentages van 80% werden bereikt, versus een nalevingspercentage van 35% voor ketens zonder dergelijke controlemaatregelen. De eerste maatregel die de naleving positief beïnvloedde, was de volledige implementatie van leeftijdsverificatiesystemen (LVSs). LVSs zijn hulpmiddelen die door de caissière kunnen worden gebruikt om te bepalen of de klant de wettelijke leeftijd voor het kopen van alcohol heeft bereikt. LVSs die door alcoholverkopers worden gebruik, zijn: 1) een pop-up venster (gebruikt door de slijterijketens in dit onderzoek), waarbij de huidige datum van de dag minus 18 jaar zichtbaar is na het scannen van een alcoholproduct, 2) een LVS waarbij de geboortedatum wordt ingetoetst in het kassasysteem, of 3) een ID-swiper/checker. Een tweede maatregel die de naleving positief beïnvloedde, was de systematische monitoring van het nalevingsgedrag van medewerkers in de winkel door bijvoorbeeld gebruik te maken van mystery shopping. Deze monitoring resulteerde in een hoog waargenomen risico op inspectie door de medewerkers in de winkel. Verder kan deze maatregel worden versterkt door meer training voor medewerkers gericht op leeftijdsverificatie en de implementatie van strikte consequenties als er geen naleving is, opgelegd door het centrale management van de betreffende slijterijketen.

Door het verzamelen van mystery shopping data en het afnemen van interviews, is de effectiviteit van LVSs onderzocht in 400 Nederlandse supermarkten gespreid over 19 supermarktketens (hoofdstuk vier). De naleving van de leeftijdsgrens van individuele supermarkten (oftewel caissières) werd gemeten, als ook het wel of niet gebruiken van LVSs, die in sommige ketens door het centrale management beschikbaar werden gesteld voor hun supermarkten. De resultaten uit dit onderzoek toonden aan dat als caissières het ID van de klant vroegen en daarbij gebruik maakten van een LVS die de wettelijke aankoopleeftijd van de klant berekende of bevestigde (oftewel wanneer zij gebruik maakten van de intoets-LVS of de ID-swiper/checker), hun kansen op correcte naleving 11,6-voudig toenamen.

In hoofdstuk vijf gaan we in op de sociale (of secundaire) verstrekking van alcohol aan minderjarige jongeren. Deze sociale verstrekking vindt plaats wanneer een volwassene (18+ jaar) een alcoholische drank verstrekt aan een minderjarige. De verplaatsing van gedrag door minderjarige jongeren van het zelf aankopen van alcohol naar het verkrijgen van alcohol via sociale verstrekking (voornamelijk in locaties waar de alcohol ter plaatse geconsumeerd kan worden) representeert een voorbeeld van een niet-beoogde en negatieve vorm van impact na de verhoging van een leeftijdsgrens. De prevalentie van sociale verstrekking van alcohol aan minderjarige jongeren in Nederland is hoog. Een vergelijkbaar beeld is te zien in andere Westerse landen. Tot nu toe was er geen methodologie ontwikkeld of getest voor het meten van deze sociale verstrekking aan jongeren in deze setting (voor consumptie ter plaatse). Toch

is een methode om deze verstrekking te kunnen meten belangrijk en nodig om de juiste keuzes te kunnen maken en deze vorm van alcoholbeschikbaarheid te kunnen beteugelen. Daarom is in het vijfde hoofdstuk een nieuwe methode ontwikkeld en in de praktijk getest om de naleving van alcoholverkopers met betrekking tot sociale verstrekking te meten. Deze nieuwe methode is gebaseerd op bestaande mystery shopping protocollen. Allereerst toonden de resultaten aan dat de methode goed uitvoerbaar en toepasbaar is in de praktijk. Daarnaast is aangetoond dat meer dan 70% van de alcoholverkopers in de sample niet voldeden aan de Nederlandse wet omdat zij sociale verstrekking toelieten.

Om de beschikbaarheid van alcohol voor minderjarigen verder te verminderen met de beperkte middelen die er in Nederland zijn om de leeftijdgrens te handhaven, is het belangrijk om inspanningen te optimaliseren. Men zou daarom handhavingsinspanningen moeten richten op alcoholverkooppunten en situaties die vaak door minderjarigen als bron van alcohol worden gebruikt, en waar de naleving van de leeftijdsgrens laag is. In hoofdstuk zes is een risicogerichte rangschikking van alle typen alcoholverkooppunten in Nederland ontwikkeld, genaamd de Commerciële Alcohol-Beschikbaarheid Schatting (CABS). De CABS is gebaseerd op de prevalentie van alcoholgebruik door minderjarigen (met behulp van enquêtegegevens) en het succespercentage van daadwerkelijke aankooppogingen van minderjarigen (met behulp van mystery shopping gegevens). Schattingen van de CABS lieten zien dat 7,7% van alle minderjarigen in het onderzoek aangaven hun eigen alcohol te kopen in bars/cafés/disco's en hierin succesvol te zullen zijn. In vergelijking met andere typen alcoholverkooppunten (bijvoorbeeld sportkantines of supermarkten), scoorden bars/cafés/disco's het hoogst op de CABS. Dit geeft aan dat handhavingsinspanningen van de leeftijdsgrens prioriteit moeten krijgen in bars/cafés/disco's om het effect van de leeftijdsgrens te optimaliseren.

Eerder wetenschappelijk onderzoek heeft laten zien dat het verhogen van een leeftijdsgrens de beoogde impact heeft en het alcoholgebruik en gerelateerde gevolgen hiervan voor minderjarige jongeren reduceert. Toch kan een dergelijke beleidswijziging ook leiden tot, of gepaard gaan met, niet beoogde effecten. In de hoofdstukken twee tot en met zes van dit proefschrift kwamen we al enkele vormen van deze niet beoogde impact tegen die kunnen optreden na een verhoging van de leeftijdsgrens. Desalniettemin heeft voor zover wij weten geen enkele studie tot nu toe zowel de beoogde als niet beoogde impact van een verhoging van de leeftijdsgrens op systematische wijze onderzocht. Om een uitgebreid en internationaal overzicht te creëren van zowel beoogde als niet beoogde impact van deze verhoging, en om meer inzicht te krijgen in de werking van wetgeving op de samenleving, is in hoofdstuk zeven

een systematische literatuurstudie uitgevoerd. Hierin werd literatuur verkregen uit wetenschappelijke databases en via experts in alcoholonderzoek. In totaal werden er 91 studies geïncludeerd. Niet beoogde impact van verhoogde leeftijdsgrenzen werd gevonden binnen vijf thema's: 1) *omvangrijke impact* op aankoop- en drinkgedrag van adolescenten (bijvoorbeeld een hogere naleving door alcoholverkopers bij jongere adolescenten; overeenkomstig met de inzichten verkregen uit hoofdstuk twee) en op de sociale perceptie van ander middelengebruik dan alcohol door jongeren, 2) *beperkte impact* op kwetsbare subgroepen en op excessieve elementen in de maatschappij, 3) *verplaatsing van gedrag* naar andere middelen of om alcohol te verkrijgen (overeenkomstig met de inzichten verkregen uit hoofdstuk vijf en zes), 4) samenhang met de effecten van ander beleid en 5) beleidsendogeniteit en omgekeerde causaliteit (waarin endogeniteit overeenkomstig is met de inzichten verkregen uit hoofdstuk twee, drie en vier). Slechts acht van de 91 geïncludeerde studies uit het literatuuronderzoek rapporteerden informatie over het implementatieproces van een verhoogde leeftijdsgrens, wijzend op een hiaat in de huidige literatuur.

In conclusie tonen de resultaten van dit proefschrift aan dat de implementatie van het verhogen van een leeftijdsgrens kan worden verbeterd door het optimaliseren van de naleving, de handhaving en het maatschappelijk draagvlak (laatste element is een resultaat uit de literatuurstudie). Meer specifiek toonde het empirisch bewijs aan dat alcoholverkopers een sleutelrol kunnen vervullen bij het verbeteren van de naleving van de leeftijdsgrens door het implementeren van zelfregulerende leeftijdsgrens-controlemaatregelen. Daarnaast kan impact worden geoptimaliseerd door prioriteit te geven aan handhavingsinspanningen gericht op die bronnen van alcoholverkoop die het meest gebruikt worden door jongeren en die de laagste nalevingsresultaten hebben. Door de nieuwe ontwikkelde methode om sociale verstrekking te meten te gebruiken, kan de impact verder worden geoptimaliseerd. Hiermee kan de beschikbaarheid van alcohol voor minderjarige jongeren sterker worden beperkt. Verder tonen de resultaten van dit proefschrift aan dat er geen lineair pad is van de verhoging van de leeftijdsgrens tot aan de beoogde impact. Er is een veelheid van niet beoogde impact zichtbaar die aanvullend overwogen moeten worden. Om de impact van de verhoging van de leeftijdsgrens te optimaliseren, moet de nadruk worden gelegd op factoren of processen die naar verwachting de beschikbaarheid en het gebruik van alcohol bij minderjarigen zullen verminderen. Denk hierbij bijvoorbeeld aan zelfregulerende leeftijdsgrens-controlemaatregelen van alcoholverkopers. Daarnaast moeten factoren of processen die naar verwachting het alcoholgebruik van minderjarigen zullen doen toenemen worden tegengegaan, zoals de verplaatsing naar sociale verstrekking van alcohol aan minderjarige jongeren.

In de toekomst is meer onderzoek nodig om aanvullende processen of factoren te identificeren met betrekking tot *implementatie* en *niet beoogde effecten*, die de impact van het verhogen van de leeftijdsgrens kunnen optimaliseren. Dit draagt bij aan het transformeren van onvoorziene gevolgen in voorzienbare anticipaties bij wijzigingen in alcoholbeleid. De observaties uit dit proefschrift zijn belangrijk voor beleidsmakers en de onderzoeksagenda op het gebied van alcoholbeleid. Dit proefschrift toont aan dat er nog voldoende ruimte is voor een effectiever beleid gericht op het verminderen van de beschikbaarheid van alcohol voor adolescenten.

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/Curriculum Vitae

Curriculum Vitae

Ruud Theodorus Joseph Roodbeen was born on September 24th , 1984 in Boxmeer, the Netherlands. After finishing secondary school, he studied Media & Entertainment Management in Haarlem and obtained his Bachelor degree in Economics (BEc) in 2009. Following his Bachelor's degree, Ruud obtained his Bachelor's and Master's degree in communication sciences (B.A. 2011, M.A., 2012) at Radboud University in Nijmegen, the Netherlands. He started parts of the research included in his PhD-project at Nuchter, which is the Dutch Center for Research on Age Restrictions, where he worked from 2012 to 2018. In 2018, he continued his research at Nivel, the Dutch Institute for Health Services Research, and at Tranzo, Scientific Center for Care and Wellbeing at Tilburg University. Ruud completed his PhD-thesis in 2021 under the supervision of Prof. dr. H. van de Mheen, Prof. dr. ir. R.D. Friele and dr. K. Schelleman-Offermans. Next to his doctoral research, Ruud worked on several research projects at Nuchter, Tranzo and Nivel in the field of addiction, public health policy and communication in healthcare, respectively. His general research interests include the impact of public health policy and communication sciences in healthcare and society.

/List of publications

List of publications

Publications in this thesis

Schelleman-Offermans, K., **Roodbeen, R. T. J.**, & Lemmens, P. H. H. M. (2017). Increased minimum legal age for the sale of alcohol in the Netherlands as of 2014: The effect on alcohol sellers' compliance after one and two years. *International Journal of Drug Policy, 49*, 8–14. https://doi.org/10.1016/j.drugpo.2017.07.016

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Beyond Legislation

Gaining insight into impact of raising the minimum legal drinking age

Although scientific evidence has demonstrated that raising a minimum legal drinking age (MLDA) has the intended impact of reducing underage drinking and alcohol-related societal harm, minors are still able to obtain and drink alcohol. This indicates a nonoptimal effectiveness of raised MLDA to protect minors from the negative consequences of early alcohol use.

In this thesis, the role of implementation and the involvement of unintended impact after a raise in the MLDA is investigated, providing valuable insights to optimize the effectiveness of this policy change. A versatility of impact is found after a raise in MLDAs, indicating potential limits and foreseeable anticipations to consider. Important implications for policy makers, prevention and the research agenda on alcohol policy will be discussed.

About the author

Ruud T.J. Roodbeen (1984) studied communication sciences (B.A., 2011, M.A., 2012) at Radboud University in the Netherlands. He started parts of the research included in his PhD-project at Nuchter, which is the Dutch Center for Research on Age Restrictions, where he worked from 2012 to 2018. In 2018, he continued his research at Nivel, the Dutch Institute for Health Services Research and Tranzo, Scientific Center for Care and Wellbeing at Tilburg University. His general research interests include the impact of public health policy and communication sciences in healthcare and society.