



Effectiveness of a Dutch community-based alcohol intervention: Changes in alcohol use of adolescents after 1 and 5 years



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ABSTRACT

Background: Underage alcohol drinking is a severe public health problem. The aim of this study was to evaluate the short- and long-term effects of a Dutch community-based alcohol intervention on alcohol use of adolescents in the second and fourth grade of high school.

Methods: The community intervention integrated health education, regulation, and enforcement in multiple settings, targeting adolescents as well as their environments. In order to evaluate effectiveness, a quasi-experimental pretest posttest design was used based on three independent cross-sectional surveys in 2003, 2007 and 2011, resulting in an analytical sample of approximately 5700 and 3100 adolescents in the intervention and reference region, respectively. For the main analyses, we compared the change in recent alcohol use and binge drinking in the intervention region with the reference region. Linear regression was used to obtain (adjusted) prevalence of alcohol use.

Results: During the study period, there was an overall decline in the prevalence of alcohol use. After 1 year of intervention, the decline was 11% ($P < 0.01$) and 6% ($P < 0.01$) stronger in the intervention region as compared to the reference region, for recent alcohol use and binge drinking respectively. This effect was restricted to the second grade and remained after 5 years of intervention. No clear subgroup effects or confounding were observed for ethnicity, gender or educational level.

Conclusions: The Dutch community intervention appears to be effective on the short- and long-term in reducing the prevalence of recent alcohol use and binge drinking of (underage) adolescents in the second grade of high school.

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1. Introduction

Underage drinking is a major public health problem in Western society. In the Netherlands, adolescent alcohol use ranks among the highest in Europe. At the age of 14, 39% of Dutch adolescents are recent drinkers, i.e., they had at least one drink in the month prior to investigation (Van Dorsselaer et al., 2010). A young age of onset is associated with a greater risk of alcohol abuse 10 years later (Behrendt et al., 2009). Moreover, there are several risks involved in drinking alcohol at an early age, such as unprotected sex, accidents and brain damage (Bonomo et al., 2001; Hingson et al., 2003a,b; Tapert et al., 2002). Therefore, from a public health viewpoint, prevention of alcohol use in young adolescents is crucial.

Especially in the Dutch Achterhoek region, a rural area in the eastern part of the Netherlands, the prevalence of alcohol use among adolescents was high. Health monitors performed by the Community Health Service in 1997 and 2002 showed a negative trend in the Achterhoek: the age of onset became lower, adolescents drank more often and they drank more alcohol consumptions per occasion (De Rover et al., 1998, 2002, 2003). Drinking alcohol was part of the culture at that time, and drinking alcohol by adolescents was considered normal by the community. Therefore, in 2005, the local authorities and several local organisations decided to develop the community intervention “Alcohol moderation among adolescents in the Achterhoek”. The aim was to promote alcohol moderation among adolescents aged 10–19 years, in order to reduce the harmful effects. This has been the start of one of the first community-based interventions for alcohol reduction among adolescents in the Netherlands.

The effect of the intervention on knowledge, attitude and social norm of parents has already been demonstrated (De Vlaming

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et al., 2008). Moreover, the intervention has been acknowledged by the Dutch Centre of Healthy Living as theoretically well-founded (Database Healthy Living, 2015). However, until now, the effect of the community intervention “Alcohol moderation among adolescents in the Achterhoek” on the drinking behaviour of adolescents has not been examined.

Worldwide, the scientific literature on community-based interventions for prevention and reduction of alcohol use among adolescents is relatively scarce and shows mixed results (Anderson et al., 2009; Bagnardi et al., 2010; Foxcroft et al., 2003; Giesbrecht, 2003; Hallgren and Andreasson, 2013). Evaluation studies of community-based interventions do face difficulties regarding the time frame and scientific standards. For example, community interventions are often initiated by local organisations instead of researchers, which reduces the influence of the researcher in creating a ‘controlled’ setting, and increases the risk of bias. In addition, measuring long-term effects (i.e., 4 years or longer) is important since it takes a long time before community interventions are developed and implemented, and it takes even longer before changes in behaviour or health status can be demonstrated. To this end, it has been argued that more methodically sound research is required, measuring both short- and long-term effects.

Therefore, the aim of this study was to evaluate the effectiveness of the community intervention “Alcohol moderation among adolescents in the Dutch Achterhoek region” on alcohol use by adolescents in the second grade and fourth grade of Dutch high school. It was hypothesised that the community intervention would be superior to the reference condition in reducing the prevalence of recent drinking and binge drinking on the short and long term (1 and 5 years, respectively). Superiority was expected, in particular, in adolescents in the second grade compared to adolescents in the fourth grade of high school, as Dutch adolescents in the second grade are all underage, whereas adolescents in the fourth grade are a mixture of underage adolescents and adolescents who already reached the legal drinking age (16 years at that time). In addition, we performed stratified analyses for age, gender, educational level and ethnicity to gain more insight into possible sources of heterogeneity.

2. Methods

2.1. Design and data collection

In order to evaluate the effectiveness of the community intervention “Alcohol moderation among adolescents in the Achterhoek”, a quasi-experimental (non-randomised) pretest posttest design was used, based on three independent cross-sectional surveys in the intervention and reference region. The change in adolescent alcohol use in the Achterhoek region (intervention region) was compared to the change in the Noord-Veluwe region (reference region) in the same period. The repeated cross-sectional surveys were part of the regular electronic health monitor system (E-MOVO), performed in October/November, 2003, 2007 and 2011 by the Dutch Community Health Service as described elsewhere (Croezen et al., 2009). Data were collected in the second and fourth grade of Dutch high schools using a detailed Internet questionnaire, under supervision of instructed teachers following a standardised protocol.

The questionnaire contained approximately 100 standardised questions concerning social-demographic factors, school, health-status and lifestyle, including alcohol use (Dutch National Health Monitor, 2015). Ethnicity was measured by asking where the parents were born, in accordance with the definition of Statistics Netherlands (2015a). Educational level was measured as type of education that adolescents were following at the time of the survey and classified as low (VMBO) or high (HAVO/VWO). Recent alcohol use was measured by asking how many times adolescents had consumed an alcoholic beverage in the past four weeks, with 13 predefined response categories ranging from 0 times to 20 times or more. Recent binge drinking was measured by asking how many times adolescents had consumed 5 or more alcoholic beverages at one occasion in the past four weeks, with 7 predefined response categories ranging from never to 9 times or more. Self-report measures of adolescents on alcohol use are reliable and valid methods to measure alcohol use (Del Boca and Darkes, 2003), although they might underestimate heavy alcohol consumption (Northcote and Livingston, 2011). We had no data available on the onset of alcohol use.

2.2. Intervention “Alcohol moderation among adolescents in the Achterhoek”

The Dutch community intervention “Alcohol moderation among adolescents in the Achterhoek” was one of the first large-scale, intensive and long-lasting interventions in the Netherlands which aimed to stop the trend of increasing alcohol use in adolescents. This intervention has been described in detail elsewhere (Izeboud et al., 2008). In short, the community intervention was comprised of a range of activities in order to promote alcohol moderation among adolescents aged 10–19 years, targeting their environment and adolescents themselves. Health education, regulation, and enforcement were integrated and implemented in multiple settings, i.e., homes, schools, sport clubs, youth work, bars and dance clubs. The intervention was developed and carried out by the eight municipalities in the Achterhoek region, the regional Addiction Service, the Police and the Public Prosecution Service, under the guidance of the Community Health Service. The Community Health Service and the regional Addiction Service selected evidence-based programmes (such as “Alcohol: another story”) or developed intervention activities based on scientific knowledge in close collaboration with the National Institute of Mental Health and Addiction and local communities. Some examples of intervention activities are mass media campaign (radio broadcast, posters, TV commercials etcetera), parent-child evenings at school, regulations at schools and at sport clubs, instruction of barkeepers of community centres, sport clubs, bars and dance clubs, health education by the school nurse, cartoon battle at high schools and the “fine or chance card” for adolescents who were fined for an alcohol-related crime. Substantial attention was paid to preventing the onset of alcohol use under the age of 16, the legal drinking age at that time. Several prevention strategies were focused on raising awareness among parents on the relation between brain development and alcohol use of adolescents, as well as parenting skills, e.g., rule setting. The implementation of intervention activities started in 2006 and, after two prolongations, ended in December, 2012. The aim of this study was to assess the overall impact of the combined interventions and not the effects of individual strategies. The primary target population consisted of approximately 37,000 adolescents aged 10–19 years living in the eight municipalities of the Achterhoek region in January, 2006 (Statistics Netherlands, 2015b).

2.3. Reference region

The reference region was a rural area west of the intervention region, with enough distance to avoid contamination from the intervention region to the reference region (Fig. 1). In the reference region, which consisted of six municipalities, “regular policy” was continued throughout the study period. This also included the regular national Dutch alcohol legislation and policy of that time (2003–2011), including the development of local initiatives for alcohol prevention. We do not consider this as a threat to the results of our study, as most alcohol initiatives in the Netherlands had a smaller scale, a lower intensity and a shorter time frame than our intervention “Alcohol moderation among adolescents in the Achterhoek”.

2.4. Analyses

Our hypothesis was that the change in alcohol use of adolescents would be significantly larger in the intervention region compared to the reference region. In addition, we expected that the effect would be more prominent in the second grade than in the fourth grade. Therefore, all analyses were stratified by grade. Data were analysed using SPSS, version 21. Overall, the response to the repeated cross-sectional surveys was high. As shown by a response study performed in 2007, 82% of schools participated in the surveys and within participating schools, 95% of the adolescents participated (Croezen et al., 2009). This resulted in an analytical sample of 5881, 5502 and 5920 adolescents in the intervention region and 3122, 3053 and 3211 adolescents in the reference region in 2003, 2007 and 2011 respectively. Missing data varied from 0 to 606 missings (1.5%) per variable and consequently subjects with missing data were not included in the analyses. Descriptive analyses per region were conducted to identify possible differences in gender, educational level and ethnicity. For the main analyses, ‘recent alcohol use’ was defined as at least one drinking occasion in the past four weeks and ‘recent binge drinking’ was defined as at least one drinking occasion with 5 or more alcoholic beverages in the past four weeks, in accordance with national standards (Dutch National Health Monitor, 2015). To this end, the scales were recoded into dichotomous variables 0 = ‘no recent alcohol use’ versus 1 = ‘recent alcohol use’ and 0 = ‘no recent binge drinking’ versus 1 = ‘recent binge drinking’.

For the main analyses, we compared the change in alcohol use in the period 2003–2007 and 2003–2011 in the intervention region with the reference region. Linear regression was used to obtain (adjusted) percentages as the outcome. Although logistic regression is the common method for binary outcomes, we primarily applied linear regression to obtain (adjusted) effect estimates; this enhances straightforward interpretation and it has been argued that this is statistically appropriate for the limited range of percentages and effect estimates in our data (Hellevik, 2009). The model used to obtain (adjusted) effect estimates contained an indicator variable for intervention ($I = 1$ for intervention region, $I = 0$ for control region) and time period (T with subscript for the year 2007 and 2011; 2003 served as reference). The covariates gender, educational level and ethnicity were added as potential confounders as indicated below. In this model, the intervention effect is estimated by the coefficient β_{12} and β_{13} of the product terms region*year, for the short and long term effects,

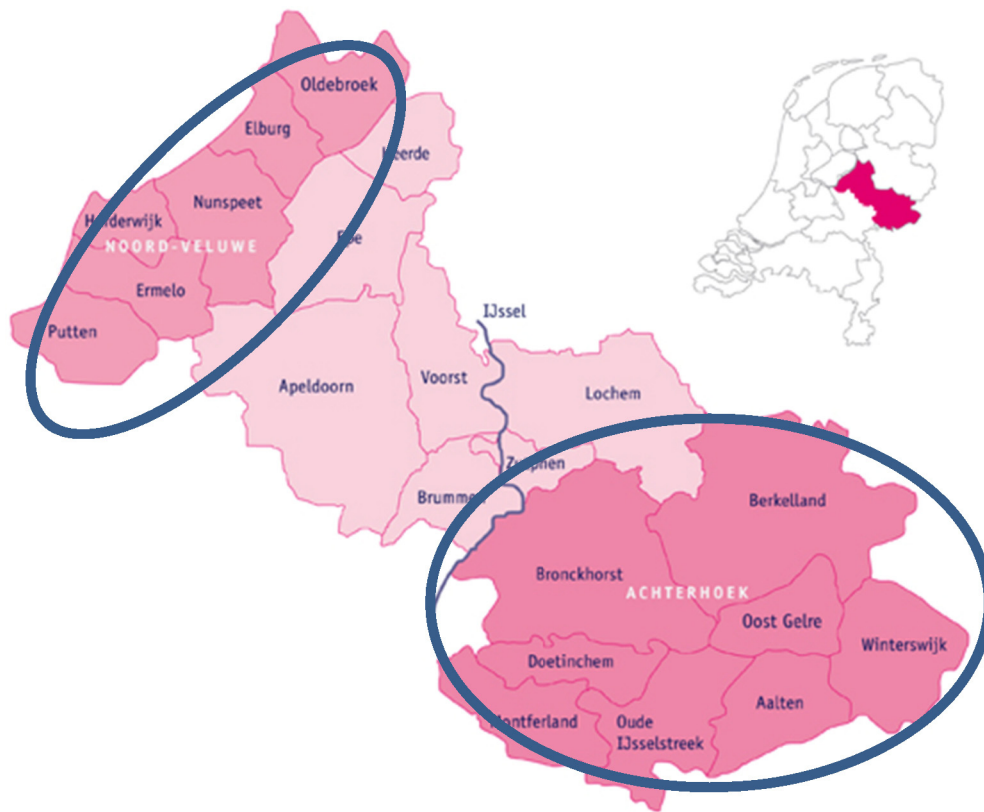


Fig. 1. Geographical position of the intervention region (Achterhoek) and reference region (Noord-Veluwe) in the Netherlands.

respectively:

$$Y = \beta_0 + \beta_1 * I + \beta_2 * T_{2007} + \beta_3 * T_{2011} + \beta_{12} * I * T_{2007} + \beta_{13} * I * T_{2011} + \beta_4 * \text{gender} + \beta_5 * \text{educational level} + \beta_6 * \text{ethnicity}.$$

Crude estimates were obtained using the model without covariates, and stratified analyses were done to obtain adjusted percentages for the second and fourth grade separately. Adjusted estimates were obtained from the predicted values from the model, using the mean values of the confounders as predictors. Logistic analyses were done in similar ways, using the product term region \times year for the intervention effect and adjusting for the same variables. Additionally, to gain insight into possible sources of heterogeneity of effect estimates, the analyses were repeated using strata for age, gender, ethnicity and educational level, adjusting for confounders where appropriate.

3. Results

3.1. Characteristics of the study population

The sociodemographic characteristics of the study population are presented in Table 1. The mean age was slightly over 14 years (SD 1.2), with more than half of the sample in the second grade. In the fourth grade, 41% of adolescents was 16 years of age or older, the legal drinking age of that time. For all three survey years, age, gender, educational level and ethnicity were similar in the intervention and control group; although some of the differences were statistically significant, adjustments for these covariates did not substantially alter the effect estimates and these small

Table 1
Descriptive analyses for intervention (int) and reference (ref) region.

| | 2003 | | 2007 | | 2011 | |
|----------------------------|-----------------|------------|-----------------|------------|------------|------------|
| | Int | Ref | Int | Ref | Int | Ref |
| <i>n</i> | 5881 | 3122 | 5502 | 3053 | 5920 | 3211 |
| Age, years: mean (SD) | 14.4 (1.3) | 14.4 (1.2) | 14.4 (1.2) | 14.4 (1.2) | 14.3 (1.2) | 14.3 (1.2) |
| in 2nd grade | 13.3 (0.5) | 13.4 (0.6) | 13.3 (0.5) | 13.3 (0.5) | 13.3 (0.5) | 13.3 (0.5) |
| in 4th grade | 15.5 (0.7) | 15.5 (0.6) | 15.5 (0.6) | 15.5 (0.7) | 15.5 (0.6) | 15.3 (0.7) |
| Male (%) | 49 | 48 | 49 | 50 | 50 | 50 |
| 2nd grade (%) | 56 | 57 | 52 | 52 | 51 | 49 |
| Low level of education (%) | 56 | 57 | 50 ^a | 54 | 51 | 50 |
| Ethnicity | | | | | | |
| Dutch (%) | 88 ^a | 89 | 90 | 89 | 89 | 89 |
| Turkish/Moroccan (%) | 3 | 3 | 3 | 4 | 3 | 3 |
| Other (%) | 10 | 8 | 7 | 7 | 8 | 8 |

^a $P < 0.05$ compared to the reference region within the same year.

Table 2
Prevalence and change in recent alcohol use and binge drinking; second grade.

| | 2003 | 2007 | 2011 | Change 2003–2007 | Change 2003–2011 |
|---------------------------|------|------|------|------------------|------------------|
| Recent alcohol use (%) | | | | | |
| Crude | | | | | |
| Intervention | 56 | 30 | 17 | –27 | –39 |
| Reference | 45 | 29 | 15 | –16 | –30 |
| Effect estimate | | | | –11* | –9* |
| OR (CI) | | | | 0.65 (0.54–0.78) | 0.77 (0.62–0.95) |
| Adjusted ^a | | | | | |
| Intervention | 57 | 30 | 18 | –26 | –39 |
| Reference | 45 | 30 | 15 | –15 | –30 |
| Effect estimate | | | | –11* | –10* |
| OR (CI) | | | | 0.62 (0.51–0.75) | 0.73 (0.59–0.90) |
| Recent binge drinking (%) | | | | | |
| Crude | | | | | |
| Intervention | 31 | 17 | 11 | –14 | –20 |
| Reference | 26 | 16 | 9 | –9 | –17 |
| Effect estimate | | | | –5* | –4** |
| OR (CI) | | | | 0.79 (0.64–0.98) | 0.96 (0.75–1.23) |
| Adjusted ^a | | | | | |
| Intervention | 31 | 18 | 11 | –14 | –20 |
| Reference | 23 | 14 | 7 | –8 | –15 |
| Effect estimate | | | | –6* | –5* |
| OR (CI) | | | | 0.74 (0.60–0.93) | 0.87 (0.68–1.13) |

* $P < 0.01$.

** $P < 0.05$.

^a Adjusted for gender, ethnicity and educational level.

differences do not raise serious concerns on confounding by these factors.

3.2. Effects on alcohol use

Table 2 and Fig. 2 present the prevalence of recent alcohol use and binge drinking in the second grade in 2003, 2007 and 2011. Generally, a strong decline in alcohol use could be seen. Over the whole period of 2003–2011, the prevalence of recent alcohol use in the intervention region declined from more than 50% to less than 20% (crude percentages). After one year of intervention, the change in the adjusted prevalence of recent alcohol use was significantly stronger in the intervention region (–26%), compared to the reference region (–15%). On the long term, these results remained, but were not strengthened: after five years of intervention, the change in prevalence of recent alcohol use in the intervention region was –39%, which was significantly stronger, compared to the reference region (–30%). The same pattern was seen for recent binge drinking. After one year of intervention, the change in the adjusted prevalence of recent binge drinking was significantly stronger in the intervention region (–14%), compared to the reference region (–8%), and this effect remained until 2011 (albeit non-significant in the logistic analysis). In fact, the high prevalences of alcohol use and binge drinking, which were observed before the start of the community intervention “Alcohol moderation among adolescents in the Achterhoek” in 2003, were ‘normalised’ to the same level as the reference region by the year 2007 and further declined similarly to the reference region until 2011. However when looking at the fourth grade (Table 3 and Fig. 2), the change in the intervention region was not significantly different from the change in the reference region – both regions showed a substantial, but similar decline in recent alcohol use and binge drinking in the period 2003–2011.

3.3. Stratified analyses

Figs. 3 and 4 show the effect estimates of the intervention on recent alcohol use and binge drinking stratified by several variables which are possible sources for heterogeneity. It is clear that the

effect of the community intervention “Alcohol moderation among adolescents in the Achterhoek” is concentrated in the second grade; as mentioned above, in the fourth grade no significant effects can be observed. The picture for age is in line with this. A significant effect can be seen for 13- and 14-year-olds, which is consistent with the effect in the second grade. The picture for 15- and 16-year-olds is, on average, also consistent with the fourth grade: generally no effect can be observed, although the effect estimate for alcohol use of 15-year-olds on the short term seems somewhat increased. For ethnicity, gender and educational level the effect estimates in the strata are similar to the overall effect estimates.

4. Discussion

This quasi-experimental evaluation study provides evidence that the community intervention “Alcohol moderation among adolescents in the Achterhoek” was effective in reducing the alcohol use of adolescents in the second grade of Dutch high school. After one year of intervention, the decline in the prevalence of recent alcohol drinking and binge drinking was 11% ($P < 0.01$) and 6% ($P < 0.01$) stronger in the intervention region as compared to the reference region. This effect was restricted to the second grade and remained, but was not strengthened, after five years of intervention. No clear subgroup effects or confounding were observed for ethnicity, gender or educational level.

During the study period, there was an overall decline in alcohol drinking. This decline in alcohol use over the past years is a well-known phenomenon in the Netherlands. National data of 12- to 18-year-olds, gathered in similar ways as our data and including similar outcome variables, also show a decline in recent alcohol use: from 58% in 2003 to 51% in 2007 to 43% in 2011 (Van Laar et al., 2011; Verdurmen et al., 2012). This is comparable to the decline in our reference region: from 60% in 2003 to 48% in 2007 to 37% in 2011 (crude percentages of the second and fourth grade combined). The decline of alcohol use in the Netherlands in the past decade can be attributed to the Dutch policy towards adolescent drinking. In general, the policy has been lenient and it is only since 2006 has adolescent drinking become an issue on the public health agenda

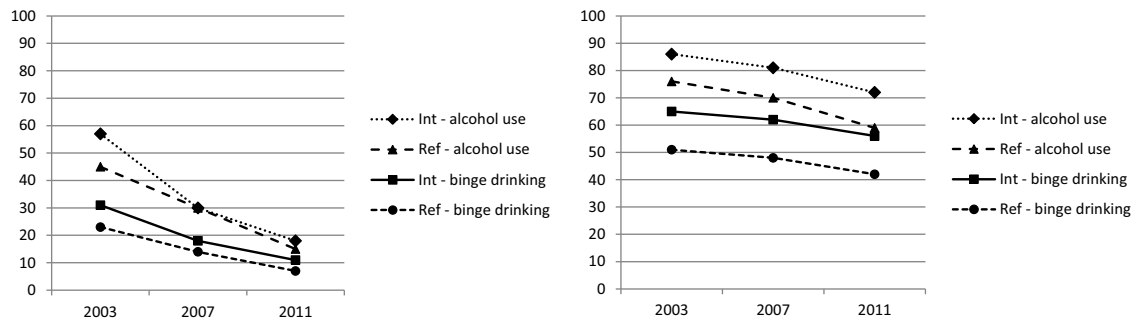


Fig. 2. Prevalence of recent alcohol use and binge drinking in the second grade (left) and fourth grade (right) (adjusted for gender, ethnicity and educational level).

Table 3
Prevalence and change in recent alcohol use and binge drinking; fourth grade.

| | 2003 | 2007 | 2011 | Change 2003–2007 | Change 2003–2011 |
|---------------------------|------|------|------|------------------|------------------|
| Recent alcohol use (%) | | | | | |
| Crude | | | | | |
| Intervention | 86 | 80 | 71 | –6 | –15 |
| Reference | 76 | 69 | 59 | –7 | –17 |
| Effect estimate | | | | 1 ^a | 2 |
| OR (CI) | | | | 0.91 (0.74–1.14) | 0.86 (0.70–1.06) |
| Adjusted ^b | | | | | |
| Intervention | 86 | 81 | 72 | –5 | –14 |
| Reference | 76 | 70 | 59 | –7 | –17 |
| Effect estimate | | | | 2 | 3 |
| OR (CI) | | | | 0.96 (0.77–1.20) | 0.91 (0.74–1.12) |
| Recent binge drinking (%) | | | | | |
| Crude | | | | | |
| Intervention | 66 | 61 | 56 | –5 | –10 |
| Reference | 51 | 48 | 41 | –3 | –10 |
| Effect estimate | | | | –2 | 0 |
| OR (CI) | | | | 0.92 (0.77–1.10) | 0.98 (0.82–1.17) |
| Adjusted ^b | | | | | |
| Intervention | 65 | 62 | 56 | –3 | –8 |
| Reference | 51 | 48 | 42 | –3 | –10 |
| Effect estimate | | | | 0 | 1 |
| OR (CI) | | | | 1.00 (0.83–1.21) | 1.04 (0.87–1.25) |

^a None of the effect estimates reached statistical significance at $P < 0.05$.

^b Adjusted for gender, ethnicity and educational level.

in the Netherlands, and has national policy become more stringent. Our community intervention was initiated as one of the first large initiatives and with our quasi-experimental evaluation study we were able to demonstrate an effect on top of the national trend.

Most evaluation studies on alcohol prevention and reduction describe family- and school-based interventions rather than community-based interventions. A meta-analysis of family interventions on alcohol initiation and frequency of alcohol use (Smit et al., 2008) suggests family interventions to be effective in reducing adolescent alcohol consumption. However, just three of the studies in the meta-analysis reported the long-term effect of the intervention and all studies were conducted in the US. More recently, Foxcroft and Tsertsvadze (2012) reviewed multicomponent alcohol interventions, defined as interventions conducted in multiple settings, for example in both school and family settings. Out of 20 multicomponent alcohol interventions, 12 were effective in preventing alcohol abuse in young people, up to three years of follow-up. Also the majority of these studies (17 out of 20) were conducted in the US. In the Netherlands, the Preventing heavy Alcohol use in Adolescents (PAS) study showed that the combined school- and family-based intervention reduced the likelihood of onset of weekly drinking and the frequency of drinking after 10 and 22 months (Koning et al., 2009). Generally, community-based alcohol interventions tend to be scarce and less well described. Two examples of relatively well described community interventions

are Project Northland, one of the first community interventions which was effective in reducing alcohol use of adolescents (Perry et al., 1996, 2002) and the Italian 'Alcohol, less is better' community project (Bagnardi et al., 2010), which found a reduction of 1–2 drinks per week in the intervention communities compared to the control communities after 2.5 years of intervention activities. Our study is a promising supplement to the current, still modest, evidence on community-based alcohol interventions.

The majority of studies, including the Dutch PAS, found that alcohol interventions are primarily effective in underage adolescents. This is partly in line with our results. As hypothesised, our stratified analysis showed that the effect of the intervention was clearly concentrated in the second grade (13 and 14 year olds) and there was no effect in the fourth grade (15 and 16 year olds). Possibly, underage adolescents in the fourth grade were subject to peer pressure of classmates who had already reached the legal drinking age of that time (16 years). Peer pressure is a well-known factor influencing alcohol use of adolescents (Bot et al., 2005).

In our study, the 1-year effect of the community intervention remained, but was not strengthened, after 5 years. Although in theory a stronger effect could be expected after a longer follow-up time (see also Section 1), the literature shows mixed results. In the above mentioned meta-analysis of Smit et al. (2008), a stronger effect was found after a longer follow-up time. However the opposite has also been reported, e.g., the Dutch PAS study found that the effect on

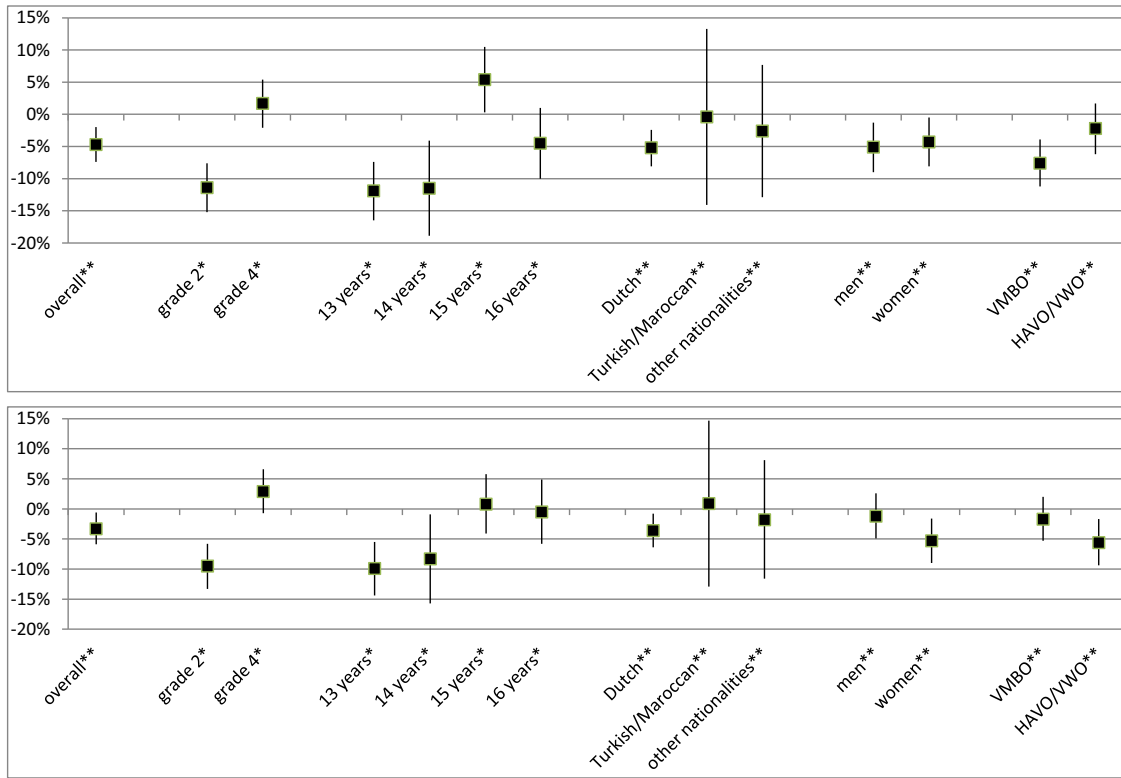


Fig. 3. Effect estimates of the intervention on recent alcohol use in 2003–2007 (above) and 2003–2011 (below). *Adjusted for gender, ethnicity and educational level; **adjusted for grade, gender, ethnicity and educational level.

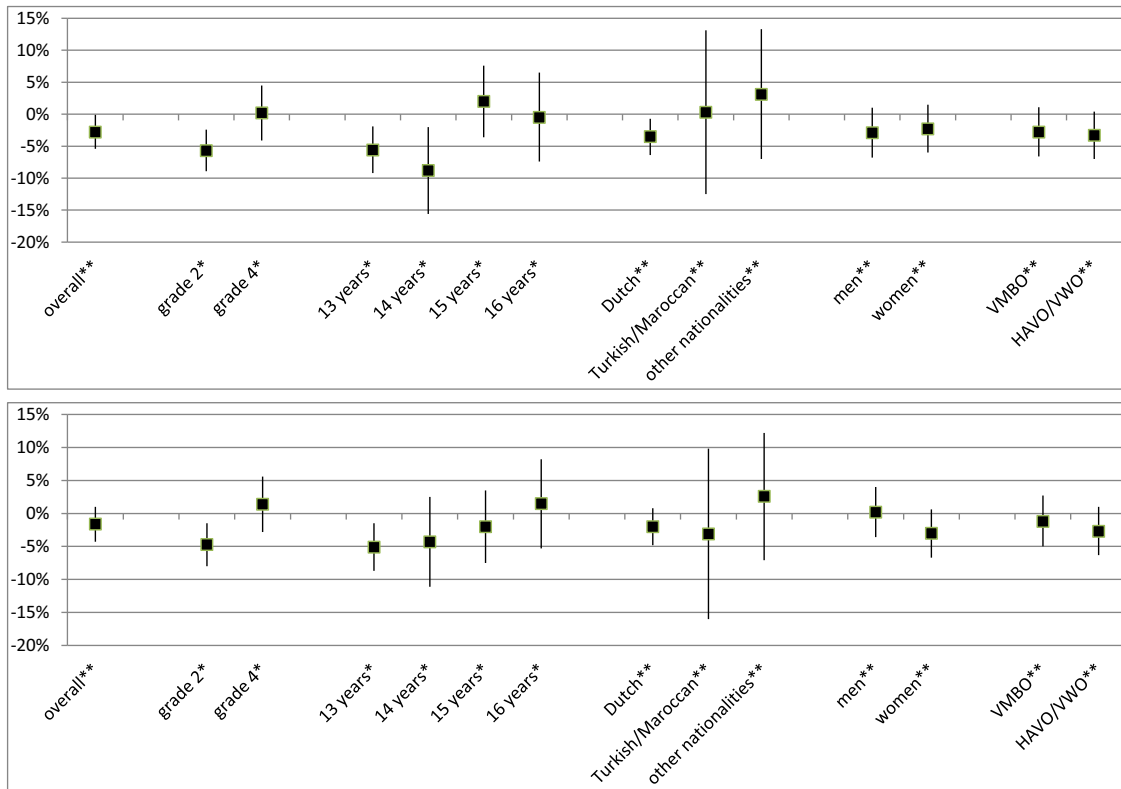


Fig. 4. Effect estimates of the intervention on recent binge drinking in 2003–2007 (above) and 2003–2011 (below). *Adjusted for gender, ethnicity and educational level; **adjusted for grade, gender, ethnicity and educational level.

one of their outcome measures (heavy drinking) disappeared on the longer term (Koning et al., 2009). More research is needed to understand the mechanisms that lead to stability, strengthening or reduction of the effects of alcohol interventions on the longer term.

There are some limitations of our study which should be mentioned. Firstly, the use of existing data of the Dutch regular electronic health monitor system caused a time gap between the baseline measurements in 2003 and the start of the intervention in 2006. Because of this, other factors may have influenced the measurements in 2007, however this is unlikely to be different in the intervention and reference region. Another disadvantageous implication of using existing monitor data is that we did not have all relevant variables available such as alcohol related harms (Hallgren et al., 2012) and the frequency and quantity of specific beverages. The latter is a more specific measure to assess changes in the estimated volume of alcohol consumed and might have been more adequate for demonstrating important changes in the distribution of drinking.

Secondly, our quasi-experimental study design lacks randomisation at the individual level and the community intervention could not be cluster-randomised over more regions. Therefore we are not completely sure that the effects found in this study are due to the intervention, and not to differences (inequivalence) between the intervention and reference region. Various region-level factors of environmental or cultural nature may influence trends in alcohol consumption. However to date, it is well known that randomisation is often unfeasible for community interventions and therefore the use of quasi-experimental designs has been advocated (Des Jarlais et al., 2004; Victora et al., 2004). Moreover in our study, the baseline characteristics of the intervention group and the reference group were very similar and appeared not to be strong predictors or modifiers, therefore we do not expect that bias due to inequivalence has occurred.

Thirdly, a multi-level design was not applied since adolescents in this region are, besides school, part of many other settings where alcohol is consumed i.e. homes, sports, night life and youth work. However by treating each pupil as an independent observation unconnected to the class and school environment, we may have underestimated the standard errors to the estimates.

Fourthly, it is a limitation that our study design did not allow to disentangle the effect of the individual components of the community intervention. This makes it difficult to clarify why the intervention worked and which mixture of intervention activities was most effective.

Finally, there are some potential limitations to the generalizability of our results. The intervention effects as observed in this study may depend on region- or country-specific characteristics such as a highly tolerant drinking culture or a lenient policy towards adolescent alcohol consumption. Therefore, it is unclear to which extent the results would hold for other regions or countries.

There are also some important strengths to our study. Firstly, the use of a reference region made it possible to isolate the effects of the intervention from other influences in the time-period. The selected Noord-Veluwe region is a reliable reference, since 'regular policy' was provided throughout the study period, and the geographical distance to the intervention region was large enough to prevent contamination.

Secondly, the main programme strategies were theoretically well founded; for example, the integration of health education, regulation and enforcement (Alcohol and Public Health Policy Group, 2010), the implementation in multiple settings (Foxcroft and Tsertsvadze, 2012) and the focus on adolescents as well as their environment. Especially strategies for parents were considered important and included knowledge transfer, raising awareness and increasing parenting skills (Van der Vorst et al., 2006; Smit et al., 2008). Although such evidence was scant at the start of

our community intervention (2005), several publications during the past decade have demonstrated the effectiveness of these strategies.

Thirdly, the high response of adolescents in the repeated cross-sectional surveys is a strength, since it yielded a high and representative number of cases for our study.

Fourthly, we measured effects on the short term as well as the long term, after five years of intervention. This is much longer than the time frame of most studies.

Finally, our study was part of a comprehensive evaluation of the community intervention "Alcohol moderation among adolescents in the Achterhoek", which also included an extensive process evaluation (Database Healthy Living, 2015) and an effect evaluation among parents of adolescents (De Vlaming et al., 2008). Our results fit well into the greater picture of these evaluations.

Some processes might have facilitated the favourable outcomes. One of these is the joint decision making between health promoters and local communities. Substantial effort was put in building relationships, lobbying and explaining the new scientific knowledge to the local communities. Although the health promoters initiated most plans, local communities were involved at an early stage, and they implemented and financed a large part of the community intervention.

Our community-based intervention contributes to the growing body of evidence on community efforts aiming at reducing alcohol use. The evidence-base of community approaches for alcohol reduction has been debated in the past (Anderson et al., 2009). However, our study provided evidence that the prevalence of alcohol use and binge drinking can be substantially lowered by such efforts, even in communities where drinking alcohol at a young age is part of the culture and is considered normal. This broadens the perspective to community approaches, i.e., organised bottom-up by the initiative of local authorities or other local organisations, and combining the strategies of health education, regulation and enforcement. As suggested elsewhere, alcohol policy seems to be most effective on behavioural change when the three approaches are mixed and combined integrally (Alcohol and Public Health Policy Group, 2010). Especially in environments where drinking alcohol is the norm, a broad and integrated approach is important in order to be able to turn the tide. Therefore, we think that our results are of great importance for policymakers and local organisations who want to reduce alcohol use of adolescents in an effective and efficient manner.

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Contributors

SCJ conceived the study design and the data analysis plan, and drafted the manuscript. AH contributed to the study design and made major revision to the manuscript, IB performed the data analyses, CI and CdR participated in data interpretation. PvtV had a major contribution to data analysis and interpretation. All authors helped to draft the manuscript and approved the final article.

Conflicts of interest

None.

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