Review

Relationship between characteristics of large national regions and individual alcohol consumption: a systematic review

Sergey A. Maksimov [1]*, Yana V. Danilchenko [2], Darya P. Tsygankova [2], Svetlana A. Shalnova [1] and Oksana M. Drapkina [1]

[1] National Medical Research Center for Preventive Medicine of the Ministry of Healthcare of the Russian Federation, 101990, Moscow, 10 bld. Petroverigskiy lane; www.gnicpm.ru
[2] Research Institute for Complex Issues of Cardiovascular Diseases, Russian Federation, 650002, Kemerovo, 6, Sosnoviy blvd; reception@kemcardio.ru
* Correspondence: m1979sa@yandex.ru; Tel.: +7-985-333-0261

Abstract: The goal of our article was to systematize studies that investigated the impact of living conditions in large national regions on individual alcohol consumption. We sought publications on the research topic in PubMed, Google Scholar, OpenGrey, Crossref and eLibrary databases from the moment they were created until December 31, 2021. After removal of duplicates and unsuitable publications, and full-text review of remaining published sources, the final sample included 81 publications. The majority of ultimately selected papers were published after 2010, represented the United States of America, and considered samples of children and youths, either the younger population or the general adult population. High quality was characteristic for 19 studies, while satisfactory quality was exhibited by 46 publications. The most consistent associations with individual alcohol consumption were revealed for the legislative environment (especially for integral scales and indices), alcohol pricing policy, the prevalence of alcohol consumption and binge drinking in the population, and unemployment rate. Among the shortcomings of the reviewed articles, we should mention the prevailing assessment of the impact of only one type of regional characteristics, as well as the lack of studies analyzing the interaction of environmental influence at the territorial level of different scales. Protocol PROSPERO CRD42021234874.

Keywords: environment; regions characteristics; alcohol; health geography

1. Introduction

The development of socio-ecological concepts of human behavior has determined the inclusion of various components in the causal chain of the individual health condition: biological component (sex, age, genotype), individual social characteristics (educational level, individual wealth, marital status), and, most importantly, the so-called "social production of diseases" [1–2]. The need to understand how the social environment, the infrastructure of living and working environment, and social and legislative norms affect the state of human health is recognized by the scientific community worldwide, which promotes conducting relevant research. In compliance with the socio-ecological model [3–4], human behavior is determined by complex and dynamic relationships between individual, social and physical factors of the living environment. Accordingly, these factors form the lifestyle and level of individual health in the context of their specificity. It should be noted that the living environment, in this regard, is considered in a fairly broad context that includes infrastructure, socioeconomic living conditions, social environment, as well as traditional, legislative and information-based aspects of human life.

To date, an international scientific community has a massive layer of epidemiological data regarding the impact of environmental characteristics on human health. E.g., a systematic review of American research in 1995–2014 on the health condition dependence on the parameters of the residential area infrastructure included 259 publications [5].

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Most of them were published after 2003, and the fastest publication rate over the entire 20-year period was observed since the mid-2000s. Many of these studies were focused on the characteristics of small territories, such as residential areas, zip code areas, census tracts, or city blocks and communities. Several conceptual systematic reviews and meta-analyses were focused on such publications [6–7]. Alternatively, several large international studies, such as European Prospective Investigation into Cancer and Nutrition (EPIC) [8] and Prospective Urban and Rural Epidemiology (PURE) study [9], as well as some systematic reviews [10], presented the differences between the countries. Meanwhile, a number of researchers believe that the effect of the residential area on individual health can manifest itself in different ways at several levels, including not only the macro level (countries) and micro level (districts and communities), but also a certain mezzo level (large regions within countries) [11–12].

Some attention is also paid to the impact of living conditions at the level of large national territories on various health indicators. For example, in a meta-analysis of multilevel studies on the impact of territorial income inequality on mortality and self-assessment of individual health, 13 out of 28 published sources considered large territories: top level national administrative entities (second- and third-level entities in the UK and Scotland) [9]. Contrarywise, a systematic review of 19 studies on the associations of territorial socioeconomic status with individual involvement in neoplasm screening included just one published research considering the level of large territories [11].

Many studies dealt with assessing the impact of living conditions on individual alcohol consumption. A number of systematic reviews considered the impact of certain environmental factors, mainly of a legislative nature [13–15], as well as other features of living environment [16–17]. However, similar to the papers involving other indicators of health status, these systematic reviews were mainly focused on the spatial level of small areas, or else they were focused on exposure from the standpoint of temporal trends rather than from the standpoint of territorial characteristics. Nevertheless, there are many studies encompassing large national territories, which certainly requires their systematization and analytical interpretation. We performed a pilot search of PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews, and the JBI Database of Systematic Reviews and Implementation Reports, and were unable to find current or proposed systematic reviews on this topic.

In the course of the development of the systematic review protocol, our goal was to systematize studies reflecting the impact of living conditions in large national regions on alcohol consumption and smoking at the individual level. By conducting the systematic review and possible meta-analysis, we planned to answer three research questions:

1) What quantitative and qualitative features are inherent in studies of the effect of living conditions in large national territories on the consumption of alcohol and smoking?

2) What are the main associations discovered in these studies? A meta-analysis was planned, if possible, to answer this question;

3) Do the reviewed studies analyze the interaction of the effect of large national territory characteristics with those on other spatial scale levels (between countries and in small territories, such as regions, districts and residential neighborhoods)?

The objectives of the systematic review, the criteria and methods for selecting articles were defined in advance and recorded in the protocol PROSPERO CRD42021234874. The protocol of our systematic review has been published previously [18]. However, in the process of analyzing the publications on the research topic, we concluded that within the framework of one systematic review, it is difficult to provide a high-quality systematization of the characteristics of both alcohol consumption and smoking. Therefore, it was decided to characterize alcohol consumption and smoking separately, in two systematic reviews. The current systematic review presents a systematization of studies that examined the impact of living conditions in large national regions on individual alcohol consumption.

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2. Materials and Methods

2.1 Criteria for inclusion of studies in the review

Our systematic review included studies without restrictions regarding participants, including their gender, age, socioeconomic criteria, and health status. Pertaining to exposure (territorial characteristics), the criteria for inclusion in the review were as follows. (1) The characteristics of living conditions were presented in eligible studies at the regional level from any standpoint: socioeconomic, medical and organizational, industrial, legislative, informational, ethnic, etc. Studies without specified parameters (for example, solely with the names of regions), or considering geographic features alone (e.g., southern regions, northern regions) were excluded from our systematic review. (2) The study area was represented by large national regions, which, as a rule, corresponded to the administrative entities of the top level. For example, state is a top-level entity in the USA, canton is the administrative unit of the kind in Switzerland, while in Canada it is a province, and so on. The choice of administrative entities of the top level was tied with the fact that in each country, the most obvious and variable characteristics of living conditions are observed at the level of such territorial units due to the specificities of their regional management and legislation.

In terms of outcomes, our review involved the studies that investigated individual-level alcohol use: the likelihood of any alcohol consumption pattern, its frequency, amount (volume), and the likelihood of binge drinking. We took into account both quantitative and qualitative outcomes, reported either by study participants or by their parents (in studies on children and adolescents).

There were no restrictions regarding the language of published sources. As for the publication status, we included exclusively original papers that appeared in peer-reviewed journals, while official administrative reports, conference proceedings and theses/dissertations were excluded from our review.

2.2 Strategy for searching and selecting studies for review

Our systematic review was conducted in compliance with the Joanna Briggs Institute methodology for systematic reviews of etiology and risk [19] and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [20]. In accordance with the review protocol, the entire strategy of article searches and selection was initially developed and conducted for two outcomes: alcohol consumption and smoking. The selection of papers for this systematic review (publications on alcohol consumption only) was made after the final selection of all eligible published studies.

Initially, we performed a limited exploratory search in the PubMed to identify eligible articles. Based on the results of a pilot search, the keywords contained in the title and abstracts, as well as the index terms used to describe these publications, were employed to develop a complete search strategy for PubMed [18]. At the next stage, the search strategy, including all identified keywords and index terms, was customized for each database and/or source of information included in our study.

Reviewed databases included PubMed, Google Scholar, OpenGrey, Crossref, and eLibrary (in Russian). All databases were searched from the moment of their creation through December 31, 2020. However, due to the fact that the search and analysis of publications was delayed until 2022, at the beginning of 2022, we performed an additional search for publications from January 01 through December 31, 2021, using the same algorithms. Our decision to prolong the search time was substantiated, among other things, by the fact that the number of publications on the subject of the review was growing fast in recent years, so that each additional considered year yielded a significant increase in the total number of eligible publications.

After the list of publications eligible for the systematic review was compiled, an additional analysis of the bibliography in each selected article was carried out, as well as citations in these articles. Besides, lists of references and citations in all available analytical and systematic reviews on the subject under study were also considered. For addi-

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tional searches, for each published source included in the systematic review, we examined the PubMed database regarding the lists of articles generated by the Similar articles tool. Whenever necessary and possible, we contacted the authors of the publications included in our review to clarify additional published sources (at the discretion of the authors). Furthermore, the International Journal of Health Geographics (BioMed Central Ltd.) and Health & Place (Elsevier Ltd.) were reviewed in full.

All search results were imported into the Systematic Review Data Repository Plus (SRDR+), and duplicate references were removed. At the first screening stage, two staff members (CDP and DYV) independently analyzed the titles and abstracts of all articles. The algorithm for selecting publications according to the inclusion criteria is specified in the protocol of the review [18]. Further, using the same algorithm, a full-text analysis of publications was carried out resulting in the exclusion of articles that did not meet the inclusion criteria. Then, key data were extracted from the articles included in the systematic review in accordance with the developed standard form [18]. The procedure of extraction was performed by two trained researchers (CDP and DYV) independently of each other. Any disagreements were discussed jointly with the third investigator (MSA).

2.3 Assessment of methodological quality of the studies included in the review

The quality of all studies included in the review was assessed by two independent reviewers (CDP and DYV) using the JBI SUMARI critical appraisal checklist [21]. Arising disagreements were resolved via discussion or through the mediation of a third reviewer (MSA). Regardless of methodological quality, all identified publications were included in the systematic review.

2.4 Narrative synthesis of findings

During the development of the systematic review protocol [18], we intended to conduct a meta-analysis. However, since the studies included in the systematic review differed significantly in terms of analyzed territorial characteristics and methods for assessing alcohol consumption, such meta-analysis was not performed. Instead, we carried out a narrative synthesis of the results presented in the studies included in our systematic review.

3. Results

3.1 Identification of published sources for review

Searching in databases for articles published on alcohol consumption and smoking through 2021 yielded 9,717 eligible sources (Figure 1).

After removing duplicates (n=6,615) and ineligible papers (reviews, official administrative reports, conference proceedings, etc., n=2,727), 375 publications remained available for full-text reading. Of these, 27 did not have regional impact characteristics at all, 64 contained impact characteristics of a lower spatial level (district, city, census tracts, etc.), 51 considered behavioral risk factors at the population rather than individual level, and 31 assessed indirect measures rather than alcohol consumption/smoking (e.g., attitude towards smoking or alcohol-related lethality). Accordingly, 202 publications were included in this review. After identifying articles from other sources (reference lists, addressing authors, reviews, Similar articles in PubMed), 35 more publications were added to the pool for the review. Identification of 2021 publications on the review topic yielded 27 more articles (Figure S1). Hence, we reviewed a total of 264 published sources for both behavioral habits.

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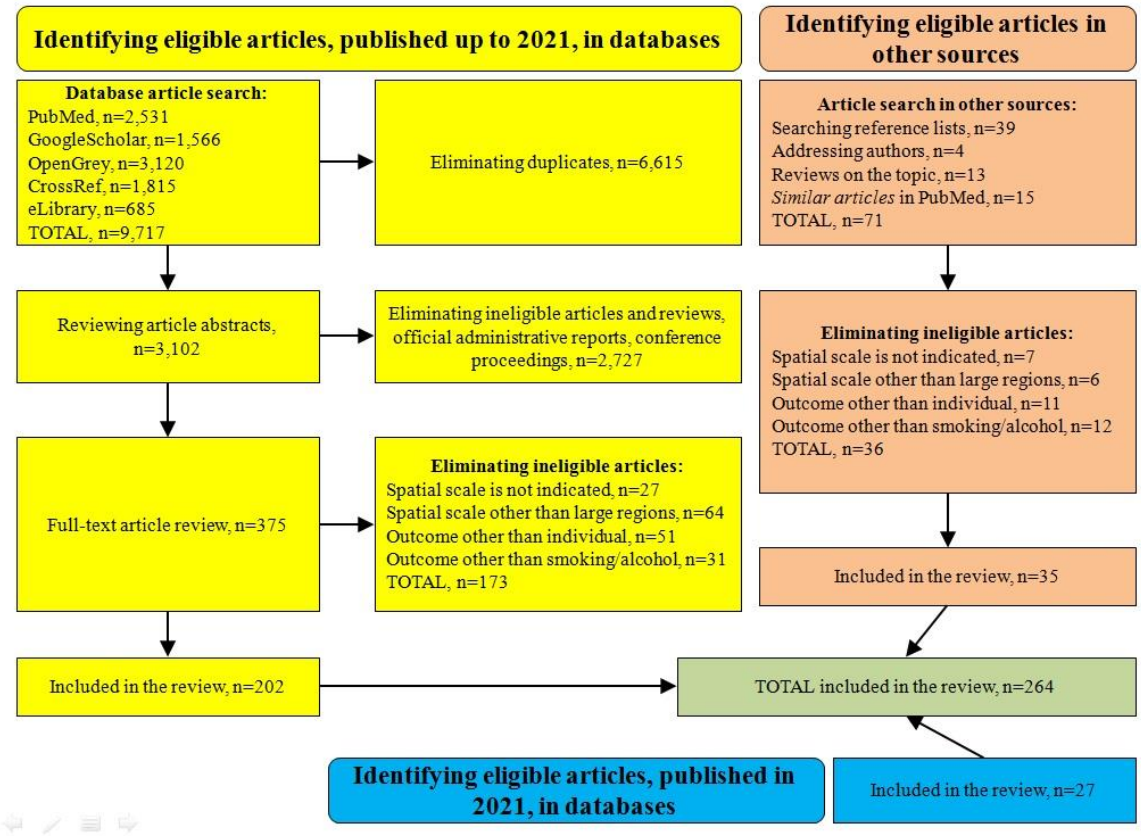

Figure 1. Algorithm for selecting articles on alcohol consumption and smoking for the review.

Of these, 60 publications were on alcohol consumption, 183 on smoking, and 21 on alcohol consumption and smoking. Therefore, our systematic review considered 81 publications on the impact of regional characteristics on individual alcohol consumption.

3.2 General characteristics of publications included in the review

A complete list of publications, their main characteristics and results are presented in Table S1, that comprises 81 publications on the results of 32 studies. In terms of publication time, 5 articles were published before 1996; the periods of 1996–2000, 2001–2005, 2006–2010, 2011–2015 and 2016–2021 were characterized by 6, 6, 8, 22 and 40 articles, correspondingly. Distribution of published sources by country was as follows: the United States of America was represented by 68 publications (82%), Switzerland by 4, Australia by 3, Ireland by 2, and England, Spain, Canada, China, Mexico and Finland by 1 article each. In terms of the study sample features, 21 articles examined children and youths under 18 years old, 18 publications dealt with young people from 18 to 35 years old, 26 characterized the entire adult population, and 2 studied people over 50 years of age. In addition, a number of articles considered specific population groups, such as pregnant women (8), low-income households (5), HIV-positive (1), homosexuals (1), working population (1). The distribution of reviewed publications by sample sizes was as follows: less than 1,000 – 2, 1,000-10,000 (people or person years) – 12, from >10,000 to 50 thousand – 26, from >50,000 to 500 thousand – 23, over 500 thousand – 20.

Most studies (61 studies) used a cross-sectional research design, 7 used a prospective design [22–28], 17 employed the difference-in-differences approach [29–45] measuring differences in the outcomes of control and treatment groups that occur over time. In most publications, the analysis encompassed 10 or more regions, and only 5 studies considered less than 10 regions [46–50].

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No reviewed publication analyzed the interaction of regional characteristics with similar parameters on a different territorial scale (between countries, regions, districts, neighborhoods). A number of studies analyzed the interaction of the regional level with other levels (districts, schools); however, in all these cases, the characteristics differed between levels. For instance, the study by Picone [23] at the regional (state) level assessed the impact of legislative features on alcohol consumption, while at the county/city level, it considered an impact of pricing policies on consumption of alcohol and cigarette sales.

The variety of categories of regional characteristics considered in reviewed publications is presented in Figure 2. The most frequently studied regional feature influencing alcohol consumption was the legislative environment: 30 articles examined the effect of alcohol-related laws, while 26 publications explored the impact of other laws. Other frequently investigated regional features were price of alcohol (in 24 articles) and social characteristics (in 18 articles). In these categories (with the exception of social features), the vast majority of studies covered the United States of America. Other categories of territorial characteristics were represented by many more publications from other countries: e.g., in the social, economic and 'other regional characteristics' categories, the share of such publications reached a third of the total.

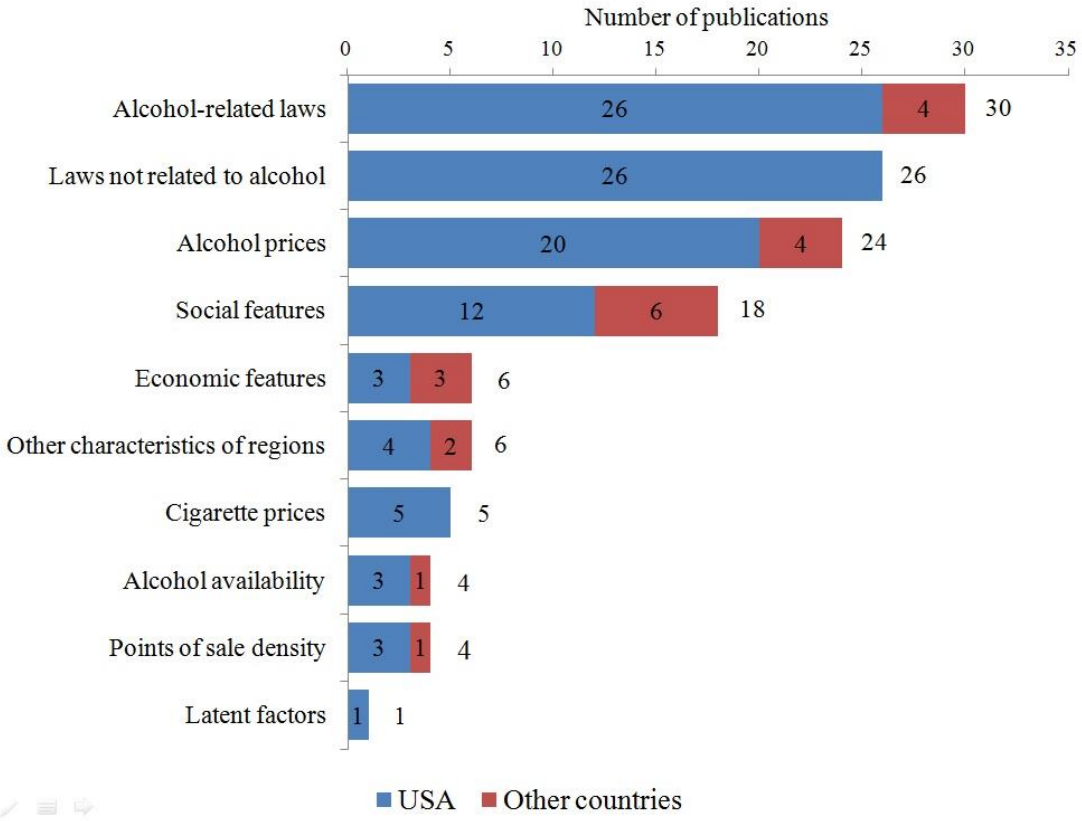

Figure 2. Number of publications for different categories of regional characteristics.

It should be noted that in most publications (59), the impact of any single category of regional characteristics was evaluated. Regional characteristics of several categories were considered in 24 papers (for example, legislative and social characteristics). One study that combined regional characteristics from different categories used exploratory factor analysis with latent factor extraction.

3.3 Quality of studies included in the review

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The assessment of the article quality showed that the highest quality, 8 points, was characteristic for 19 studies (23% of the total number), 7 points for 28 (34%), 6 points for 18 (22%), 5 points for 11 (13 %), 4 points for 5 (6%), and 3 points for 2 publications (2%).

In 13 studies, there were problems with sampling procedure, including: non-random sampling or lacking description of sampling; oversampling for some categories of the population, without subsequent consideration of this issue in the analysis. Besides, in 7 articles, the authors combined several samples into one, while the sampling design varied substantially.

In 41 publications, there was no detailed description of the study subject and setting. Most often, there was no description of the demographic and other characteristics of the study participants, as well as of the territorial units included in the study. Since the hallmark of all these publications was the impact of regional characteristics, at least their brief characterization was necessary. A number of articles lacked sufficient description (source, time period) of regional covariates (if any).

In 16 publications, the exposure to regional characteristics was improperly measured, or there was no information about it. Most often, there was no adequate description (source, time period) of regional characteristics. In some publications, the characteristics of the regions did not match, partially or completely, the years of the data collection (unless this was done for the sake of the study per se, e.g., whenever time lag was stipulated). In one article, for different periods of the study, different sources of exposure were used.

In 8 publications, there was no clear definition of the outcome (alcohol consumption), or indirect data were used to identify it. In 11 articles, insufficient adjustment for individual covariates, potentially affecting alcohol consumption, was performed. However, taking into account the published data on likely impact of individual characteristics on alcohol consumption, it was mandatory to consider the presence of an adjustment for gender and age, as well as at least for any two of such indicators as race (for American studies), educational level, income, and family status.

In 20 publications, we revealed the shortcomings in the analysis of regional characteristics. Most often, this was the use of just one category of regional variables (or the absence of a nominal region variable as a covariate in the regression model). Besides, in a number of panel and pseudo-panel studies, it was possible for individuals to move to other regions (i.e., a change in exposure); however, this issue was not taken into account, most often due to the lack of necessary data.

The shortcomings in the methods of statistical analysis were detected in 22 publications. Since a feature of the studies included in the review was the analysis of the impact of regional variables on individual outcomes grouped by regions, it was important to adjust standard errors to prevent correlation caused by multiple observations in the same region. This was most often achieved via calculating robust standard errors or by clustering errors at the region level. The lack of consideration of these features in statistical analysis was noted in 21 publications. In one other study, a small sample was used without calculating the required power of analysis and, possibly, with erroneous use of multivariate analysis.

4. Main findings of the systematic review

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

4.1 Impact of regional alcohol laws

In 13 articles, their authors examined the impact of integral scales, indices, and the number of laws regarding alcohol. As for the latter, they took into account how stringent

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these laws were and how complete was their implementation. Of these articles, 9 are from the USA, 3 are from Switzerland, and 1 is from Australia. Four of these studies [51–54], all of them based on the BRFSS project, assessed the impact on the adult population and demonstrated that the increase in the stringency of alcohol laws in the region was accompanied by a decrease in the likelihood of binge drinking and excessive drinking. However, Greene [53] demonstrated that such association was characteristic solely for women, but not for men. In addition, Xuan [51] showed the significance of associations for the Caucasian race and for the combined category of other races (Asian, Pacific Islanders, Native Americans), while no statistical significance was established for African Americans and Hispanics. Silver [54] also writes about the lack of such associations among African Americans. In his study, Xuan [51], in addition to the effect of the integral scale of alcohol laws, also discovered a significant impact of all thematic subgroups of laws: laws regarding the adult population focused on alcohol consumption, on driving under the influence of alcohol, on pricing policy, physical availability of alcohol, laws with other mechanisms of impact, as well as rating of the effectiveness of laws. The only subgroup that did not exhibit statistically significant association with the likelihood of binge drinking in the adult population was the subgroup of laws concerning minors.

Two studies focused on youth, CAS (USA, college and university students) [55] and C-SURF (Switzerland, men of military service age, 17-28 years old) [56-58], also demonstrated significant associations of integral scales of alcohol laws with the likelihood of binge drinking. It is worth noting that the Swiss study displayed an association with the likelihood of binge drinking [56] but not excessive drinking [57], along with a significant association with weekend binge drinking but not with alcohol use on workdays [58].

Three American [26,44,59] and an Australian study [47] were devoted to adolescents of older school age. Xuan [59] revealed a reduction in the likelihood of alcohol use and binge drinking with increasing strictness of laws in the region, albeit with some race-dependent differences. Fairman [26] confirmed that more lenient alcohol laws in a region increased the likelihood of occasional drinking, but did not significantly affect the likelihood of periodic, frequent, and very frequent drinking. At the same time, the results of Cavazos-Rehg [44] implied that the more stringent regional laws regarding the sale, possession and consumption of alcohol by minors did not significantly affect the likelihood of alcohol use and abuse. An Australian study [47] found that increasing regional implementation of a group of laws limiting access of youths to alcohol reduced the likelihood of binge drinking, while measures aimed at limiting the sale of alcohol decreased the likelihood of any alcohol drinking. We should emphasize that more complete implementation of the group of laws on the prevention of driving under the influence of alcohol was not associated with alcohol consumption and binge drinking by Australian schoolchildren.

Interesting results were presented by Stout [60] using BRFSS-based data: overall, the passage of restrictive laws at the state level before they are passed at the federal level was statistically significantly associated with a reduction in the likelihood of binge drinking in the adult population.

Other studies examining the legislative environment of the region in relation to alcohol operated with separate laws rather than integral scales. For instance, in 6 American studies, the age-related limitations regarding alcohol, aimed at preventing underage drinking in the region, were evaluated. In general, these studies demonstrated a positive effect of age restrictions on underage drinking, albeit with some nuances. Regional age restrictions were associated with a decrease [61] or an increase [42] in the likelihood of any drinking, decreased frequency of alcohol consumption [62–63], and reduced likelihood of binge drinking [63]. However, a number of studies did not detect statistically significant associations with the likelihood of binge drinking [42,61], or with the likelihood of any alcohol consumption and the volume of consumed alcohol [64]. An interesting study by Plunk [43] involved a prospective analysis showing that living at a younger age (less than 21 years old) in regions, where the sale of alcohol to minors under

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21 years of age is allowed, increased the frequency of binge drinking and reduced the frequency of sobriety in their lives later on.

Four American studies analyzed the impact of individual regional laws on regulating the sale of alcohol and increasing the responsibility of shops and bars for improper sales of alcoholic beverages. Of statistically significant associations, we should mention that permitting grocery stores to sell alcohol in the region, as well as the availability of training requirements for sellers of alcohol and waiters, increased the likelihood of binge drinking [60] or any alcohol consumption [65], respectively. In contrast, the presence of a state monopoly on the sale of alcohol in the region, along with the availability of registration requirements for retail beer kegs, was associated with a reduction in the likelihood of any alcohol consumption [65]. According to Stout [60], the availability of regional laws on the liability of shops and bars for accidents occurring with underage clients or intoxicated customers and liability for harm caused by someone drinking alcohol in the establishment, reduced the likelihood of binge drinking. On the contrary, the availability of a regional law giving the right to intoxicated victim to sue a drinking establishment increased the likelihood of binge drinking. In the group of HIV-infected people [66], the presence of the regional permit allowing grocery stores to sell alcohol, as well as the state monopoly on the sale of alcohol, was associated with an increase in the likelihood of binge drinking. A number of studies noted the lack of association between individual regional laws on alcohol sales and liability of shops and bars for their drunk customers with alcohol consumption [60,66–67].

Six American publications examined the impact of regional laws on drunk driving. According to Farrell [65], the presence of the possibility of revoking a driver's license for drunk driving in the region was associated with a decrease in the likelihood of any alcohol consumption. However, Stout [60] discovered no such associations with the likelihood of binge drinking. For those under 21 years of age, Carpenter [41] and Liang [29] demonstrated a reduction in the likelihood of binge drinking, but not of any drinking, when there was a law in the region requiring zero blood alcohol content in young drivers. No statistically significant associations were revealed for a number of laws [23,42,60,65].

Four American articles discussed regional legislative specificities regarding alcohol consumption by pregnant women. Roberts [68] showed that, in general, a supportive or punitive legislative environment increased the likelihood of any alcohol drinking by pregnant women but not excessive drinking/binge drinking. In another publication, Roberts [69–70] demonstrated that the availability in the region of a ban on criminal prosecution of women exposing their fetus to alcohol, as well as the mandatory warning signs for pregnant women when selling alcohol, reduced the likelihood of binge drinking in pregnant women. At the same time, Cil [32] demonstrated the effect of warning labels on reducing the likelihood of alcohol consumption during pregnancy in NVS study sample, whereas no association with alcohol consumption and binge drinking in the last month of pregnancy was established for BRFSS study sample.

Based on the number and direction of associations between alcohol-related laws in regions and alcohol consumption (Figure 3), it is clear that the most consistent relationships were observed for integral scales and indices. E.g., 40 out of 58 (69%) associations reflected the opposite effect. The impact of specific laws on alcohol consumption was less consistent. In particular, laws regarding drunk driving, shop alcohol selling and liability, and age restrictions were inversely associated with any measure of alcohol consumption in 24%, 33%, and 38% of cases, respectively. At the same time, for the last two categories of laws, the direct relationships were observed as well. Laws regarding alcohol consumption by pregnant women yielded the most conflicting results.

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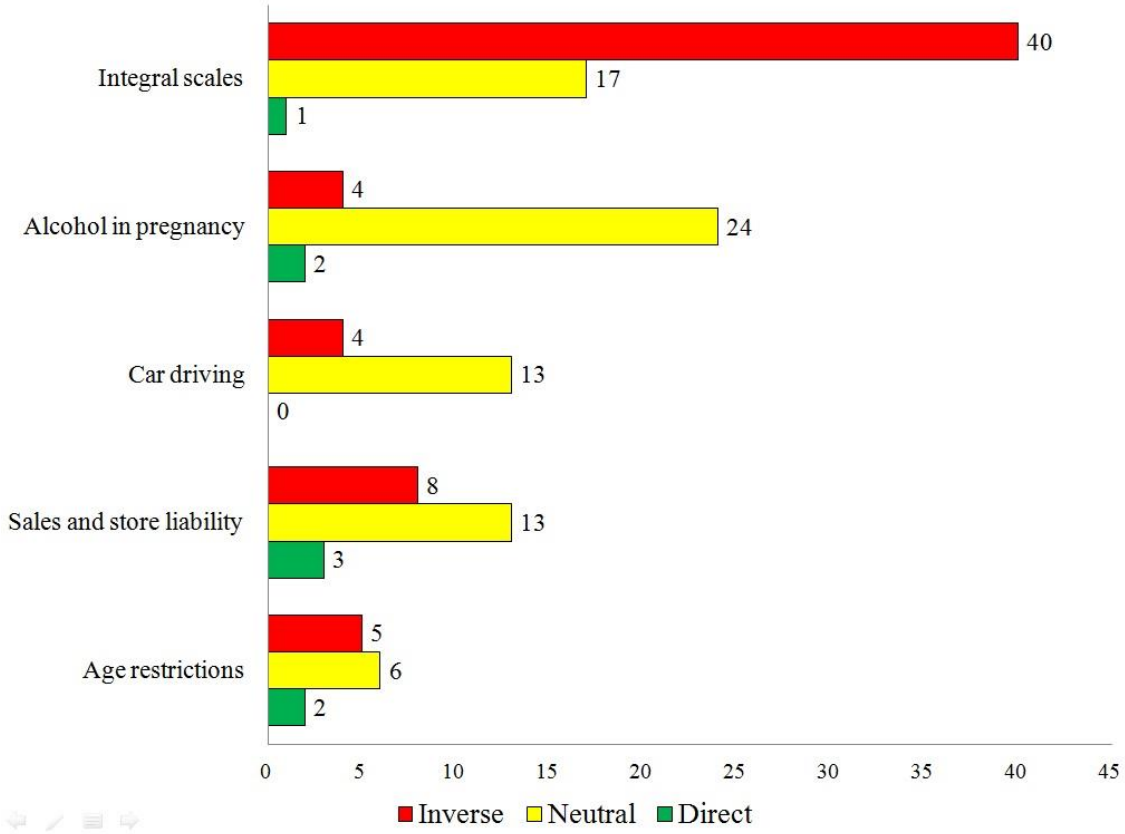

Figure 3. Number and direction of associations of alcohol-related laws in regions with alcohol consumption.

4.2 Impact of regional legislation other than alcohol laws

Regional non-alcohol laws can roughly be grouped into marijuana, smoking, insurance, general civil and tort laws, and equality and discrimination laws. We found 9 articles regarding the impact of regional marijuana laws on alcohol consumption. The results of these studies were ambivalent. E.g., in adolescents under 18 years of age, the legalization of marijuana in the region reduced the likelihood of drinking alcohol but not of binge drinking; in addition, less stringent laws also reduced the likelihood of binge drinking [33]. However, Coley [71] and Cerdá [34] discovered no association of the law in the region with the likelihood of alcohol drinking and its frequency, and with binge drinking, respectively. Among young people aged 18–30 years old, the legalization of marijuana in the region was not associated with the likelihood of alcohol consumption [64,72]. However, in male college students 21–26 years of age, the availability of a regional law legalizing recreational marijuana use was associated with a reduced likelihood of binge drinking [73]. In the general population, the legalization of marijuana reduced the likelihood of any alcohol use [39] and increased the likelihood of binge drinking [74]. At the same time, Anderson [75] demonstrated a reduction in the likelihood of drinking alcohol, binge drinking, along with the number of intoxications, in various age groups.

The effect of legislation regarding smoking restriction (laws on smoking in public places, age restrictions) on alcohol consumption was examined in four studies [23,36,71,82]. All of them showed the absence of statistically significant associations.

Roberts [76] looked at the impact of regional gender equality indices on alcohol consumption. Improved gender equality for women in the region reduced the frequency of alcohol consumption, while men also reduced the volume of alcohol consumption.

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Improved reproductive rights of women in the region, as well as their increased participation in the politics of the region, led to the reduced likelihood of both frequent drinking and risky drinking in women. Indices of improving the socioeconomic status of women, as well as improving the regional laws regarding violence against women, did not demonstrate significant relationships.

We found four articles regarding regional legislation on support for sexual minorities. An increase in the support and/or protection of sexual minorities at the legislative level in the region was associated with a decrease in the likelihood of binge drinking among LGBT people, both youths [77] and those in the general sample [78]. For the latter, the availability of regional laws against discrimination on the basis of sexual orientation was associated with a reduced likelihood of binge drinking among women [53]. The study performed on a small sample (n=119) of homosexual men aged 18-25 years [79] confirmed that legislation in the region regarding the protection of homosexuals was not associated with the likelihood of any alcohol consumption.

Five American papers [31,37–38,40,80] examined the impact of having a legislative expansion of Medicaid health coverage options for low-income childless people in the region. All these studies were performed on samples of adult population represented by childless low-income households. Only one publication unveiled an inverse statistically significant relationship between the availability of health insurance and the likelihood of alcohol abuse [37]. Two other studies also showed an inverse association with alcohol abuse [31] and frequency of alcohol consumption [40] in some stratified subgroups.

Six articles considered the impact of other regional legislative features on individual alcohol consumption. Three articles looked at the impact of a regional law against fake ID when buying alcohol on underage drinking, its frequency and volume, and on the likelihood and frequency of binge drinking. Zheng [35], based on the NLSY study, showed that the availability of such law in the region reduced the number of alcohol drinking days and binge drinking days, as well as the volume of alcohol consumption; however, YRBSS data suggested no such relationship. Examining similar age group, Yörük [45] showed that the availability of such law in the region reduced the likelihood of binge drinking, the number of days of alcohol use and binge drinking, and the volume of consumed alcohol solely in men, but not in women. The reduction in the severity of Graduated Driver Licensing (GDL) laws in the region increases the likelihood of alcohol consumption, binge drinking, and frequent heavy drinking in 12th graders [44]. Other analyzed laws displayed no association with alcohol consumption [30,60,64].

As seen in Figure 4, quantitatively, legislative characteristics of regions not related to alcohol were associated mostly neutrally with indicators of alcohol consumption. However, legal characteristics, such as marijuana legalization in the region, the severity of general laws and contravention laws, along with legally enforced gender and LGBT equality, were often inversely associated with alcohol consumption. Accordingly, 21%, 37% and 27% of such associations were statistically significant. It is worth noting that the vast majority of associations regarding gender equality and LGBT equality were statistically significant exclusively in the subpopulations for which these laws work, i.e., in women and sexual minorities. Laws regarding smoking restrictions and health insurance were not effective pertaining to alcohol consumption.

4.3 Impact of regional differences in price/excise duty on alcoholic beverages

Of 24 papers assessing the effect of price/excise duty on alcohol, 20 papers represented American population, 3 were from Australia, and 1 from Mexico. Thirteen publications assessed different indicators of alcohol use in the age groups of older youths and young adults, 10 did so in the general population, and 1 study examined pregnant women. A decrease in the probability of any alcohol consumption with an increase in the price/excise tax of alcohol in the region was shown in 5 studies on youths [42,44,64, 81-82] and in 3 studies on general population [65,67,82]. Three other studies on youths [71,84–85] and one article covering general population [49] did not reveal such significant effect. Eight publications demonstrated a decrease in alcohol consumption with an in-

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crease in the price/excise duty on alcohol in the region, half of which represented young people [81–82,84–85], and another half encompassed general population [49,67,83,86]. Two studies established no statistically significant change in volume of alcohol consumption, one in youths [64] and another in general population [25]. The reduction in the likelihood of binge drinking caused by the regional alcohol pricing policy was less pronounced than other outcomes of alcohol consumption: the dependence was detected in one study on youths [81] and one study on general population [24], while it was not revealed in four [42,44,62,87] and one [60] of such studies, respectively.

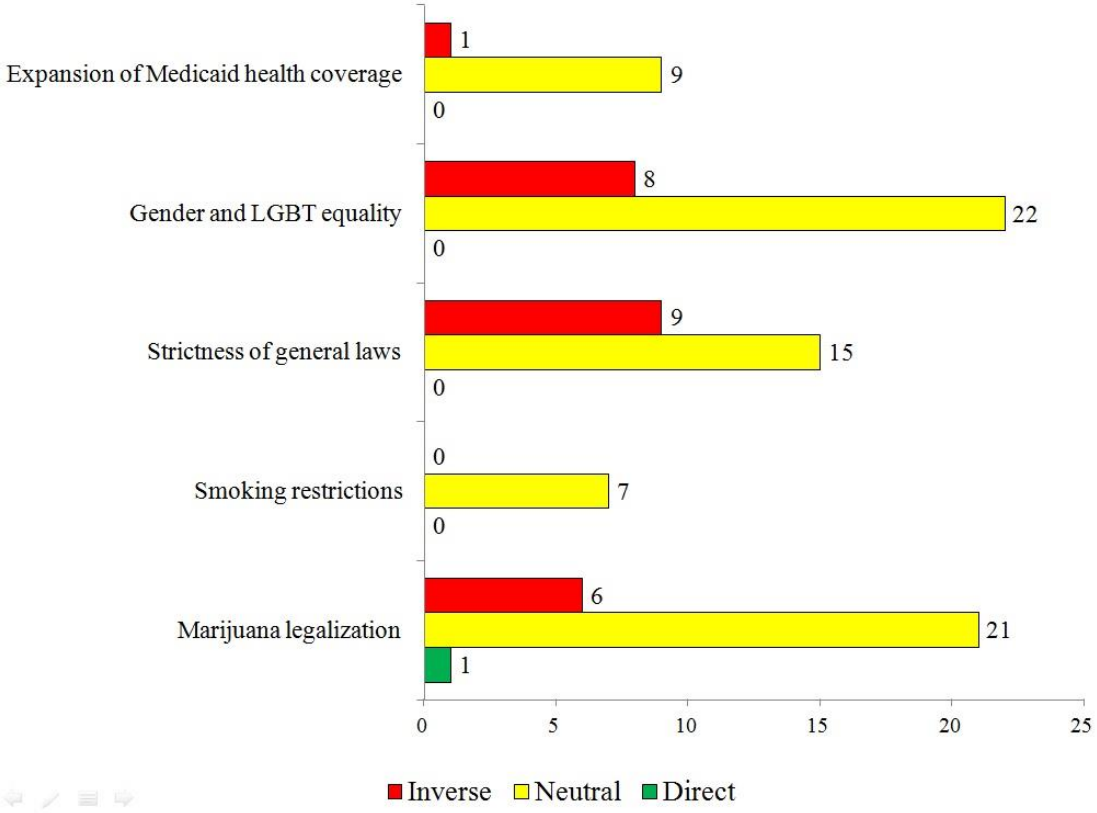

Figure 4. Number and direction of associations of regional non-alcohol legislation with alcohol consumption.

Five more studies looked at the frequency of alcohol consumption. Of these, one article demonstrated a decrease in the frequency of alcohol consumption among young people [63] and another research revealed a similar trend in the adult population [48] caused by an increase in the price/excise tax on alcoholic beverages in the region.

Cavazos-Rehg [44] suggested that an increase in the regional alcohol tax increases the likelihood of frequent alcohol drinking in high school students. Contrarywise, Cowell did not establish similar statistically significant effect in the group of men aged 14–37 years [87]. On a sample of pregnant women, Zhang [88] confirmed that increased regional tax on beer, wine, and all alcoholic beverages combined reduced the likelihood of binge drinking.

In two studies, some calculated indicators rather than price of alcohol per se were used as a regional characteristic. E.g., in the Australian ASSAD study of urban residents aged 12–17, White [47] used the ratio of the alcohol price to prices of consumer goods as an exposure and reported no significant associations with alcohol consumption. In the Mexican ENCODAT study carried out on alcohol drinkers aged 12–65 years, Colchero confirmed that the presence of alcohol prices in a region lower than the national average

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increased the likelihood of periodic and frequent binge drinking without affecting the likelihood of rare binge drinking [89].

Overall, 56% of statistically significant associations of alcohol prices in the region with alcohol consumption were inverse (Figure 5), which characterized them as consistent regional predictors.

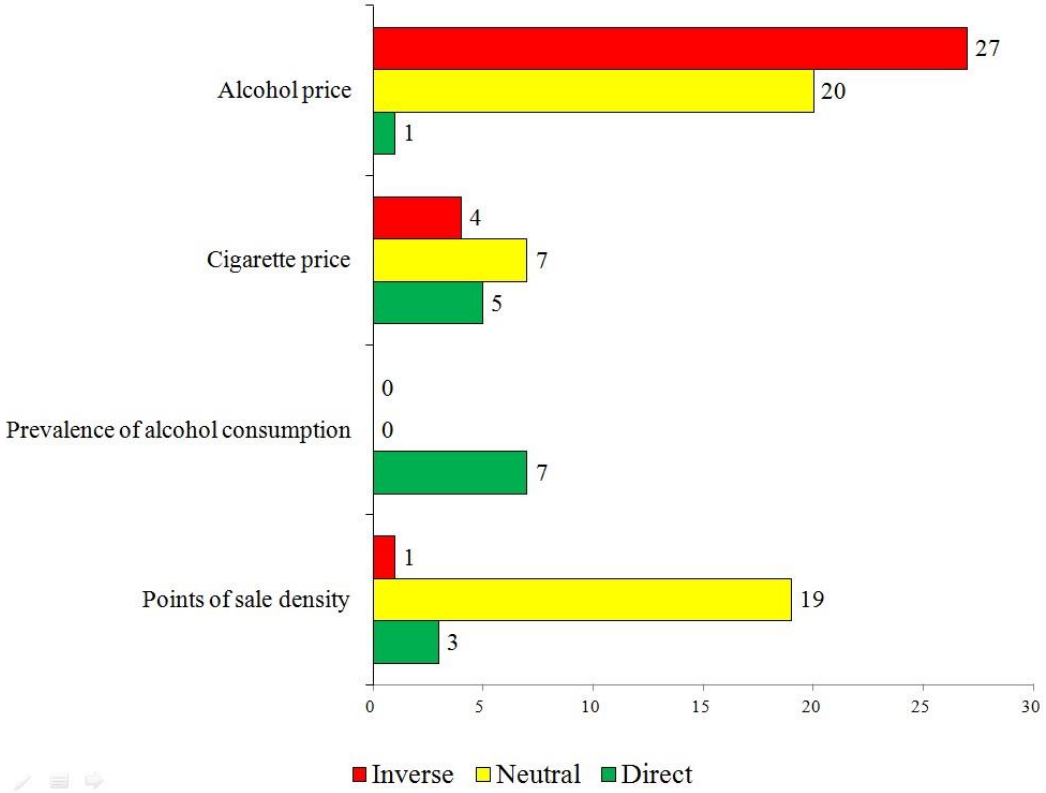

Figure 5. Number and direction of associations of regional pricing policies, prevalence of alcohol consumption and density of alcohol points of sale with alcohol consumption.

4.4 Impact of regional differences in price/excise duty on cigarettes

In addition to evaluating the impact of regional differences in alcohol prices/excise duty, five studies (all of them American) focused on the effect of prices/excise tax on cigarettes. In the general sample of adult population, McLellan [90] found no associations; however, when stratified by age, an increase in the price of cigarettes in the region resulted in reduced likelihood of drinking alcohol at 18–20 years old, increased likelihood of binge drinking and continuous binge drinking in youths 21–29 years of age, increased likelihood of alcohol consumption, and reduced likelihood of binge drinking in people 65 years of age and older. Two studies considered the samples of young adults: Shrestha [82] demonstrated an inverse effect of regional cigarette prices in a sample of youths 18–24 years of age, whereas Pacula [64] showed a direct effect of a cigarette tax on the likelihood of any alcohol consumption in a sample of 19–26-year-old subjects. In another study [87], it was shown on a sample of men aged 14–37 years that an increase in regional cigarette prices reduced the likelihood of binge drinking but increased the likelihood of frequent drinking. In a sample of adolescents aged 14–18 years [71], no associations of excise tax on cigarettes with the likelihood of teetotalism and the frequency of alcohol consumption were detected. Overall, associations of cigarette prices in the region with alcohol consumption are multidirectional, both direct and inverse, and also neutral in 44% of cases, which characterizes them as inconsistent regional predictors (Figure 5).

4.5 Impact of per capita alcohol consumption and availability of alcohol points of sale

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Four studies, including three American and one Australian, were evaluating the impact of population alcohol consumption on individual alcohol consumption. All studies demonstrated statistically significant direct associations. For instance, per capita alcohol consumption in the region was associated with an increase in the individual probability of binge drinking and the number of days of binge drinking in the adult population [24]. In three other publications, the prevalence of alcohol use and binge drinking in the adult population was associated with an increase in the likelihood of any alcohol use [47,91] and binge drinking [47,55,91] among children and youths.

The availability of alcohol points of sale in the region exhibited a different degree of consistency of the association with alcohol consumption, depending on the age of the sample. E.g., in an adult sample, the density of bars [60,67], beer, and strong alcohol outlets outside stores [67] in the region did not demonstrate associations with alcohol consumption. However, an increase in the number of liquor stores per 1,000 residents reduced the likelihood of binge drinking [60]. Two studies performed on samples of young people showed a reduction in alcohol consumption with a decrease in the overall density of all pubs and pubs without licenses in the region [92], as well as with an increase in the proportion of the population living in neighborhoods with no access to alcohol [82].

Overall, all associations of the population prevalence of alcohol consumption with individual alcohol consumption were direct and statistically significant, which characterized these regional characteristics as consistent predictors (Figure 5). The density of alcohol-selling establishments in the region exhibited direct or inverse statistically significant relationships only in 13% and 4% of cases, respectively, which implied the inconsistency of the effect of these predictors.

4.6 Impact of social characteristics in the regions

The effect of social characteristics in regions on individual alcohol consumption was considered in 18 studies, 13 of which examined the impact of the unemployment rate (8 articles from the USA and 1 article from each of the following countries: Finland, China, England, Ireland and Spain). In adult population samples, an increase in unemployment rate in a region reduced the likelihood of any alcohol drinking [93–94] and the amount of consumed alcohol [94–95], but increased the likelihood of binge drinking [24,92] and its frequency [24]. In a number of cases, no associations were found with the likelihood of any alcohol consumption [95] and the volume of its consumption [25,28,93]. On adult population in the UK, Jofre-Bonet [50] demonstrated that an increase in the unemployment rate in a region increased the likelihood of teetotaling and reduced the likelihood of moderate alcohol drinking but did not affect the likelihood of its light and excessive drinking. In studies of adolescents and young adults, rising unemployment did not affect the likelihood of any alcohol consumption [71,96–97] but increased the frequency of drinking [71,96] and was directly associated [98] or not [96] with the likelihood of binge drinking. An Irish study by Briody [27] performed on a sample of pregnant women revealed no association of unemployment with the likelihood of any alcohol consumption and the volume of its consumption. An American study by Lantis conducted on adult sample [22] analyzed the impact of the wage compensation rate with unemployment benefits rather than of unemployment per se. No associations were found in the subgroup of professionally employed subjects, while in the unemployed, an increase in the compensation rate in the region increased the volume of alcohol consumption and the likelihood of binge drinking.

Three publications assessed the impact of indicators related to the work of regional law enforcement on alcohol consumption. Only one study carried out by Thies [72] on a sample of men aged 18-31 years showed that a decreased crime incidence (the ratio of total arrests to arrests for violent crimes) in the region reduced the likelihood of alcohol consumption and the frequency of alcohol consumption. In two other studies, the frequency of crimes based on the number of police officers in the region did not affect the likelihood of any alcohol consumption and the volume of its consumption [64]; and the

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number of police officers and per capita government spending on police did not affect the likelihood of binge drinking [60].

Two papers (from USA and Canada) evaluated the impact of income inequality. The Gini index, which characterizes inequality, was not associated with alcohol consumption in either a Canadian sample of adolescents [99] or an American sample of adults [100]. In American study by Karriker-Jaffe [100], in addition to Gini index, two indicators of inequality were considered as well: the ratio of income inequality in Caucasian population to African Americans and to Hispanics. Both indicators were directly associated with the volume of light alcohol consumption. Besides, the growth of income inequality in Caucasian population relative to African Americans increased the volume of excessive alcohol consumption.

Overall, social characteristics exhibit strong associations with alcohol consumption (Figure 6). The unemployment rate is directly associated with alcohol consumption in 26% of cases, the relationship is inverse in 17% of cases, which in total covers 43% of significant associations. The multidirectional nature of these associations is explained by the peculiarity of this predictor effect: an increase in unemployment rate reduces the likelihood of any or moderate alcohol consumption but increases the likelihood and frequency of binge drinking. The impact of the crime rate and social inequality is also rather consistent: cumulatively, the associations are direct and statistically significant in 38% of cases. However, the paucity of such studies does not allow stating unequivocally the consistency of this effect.

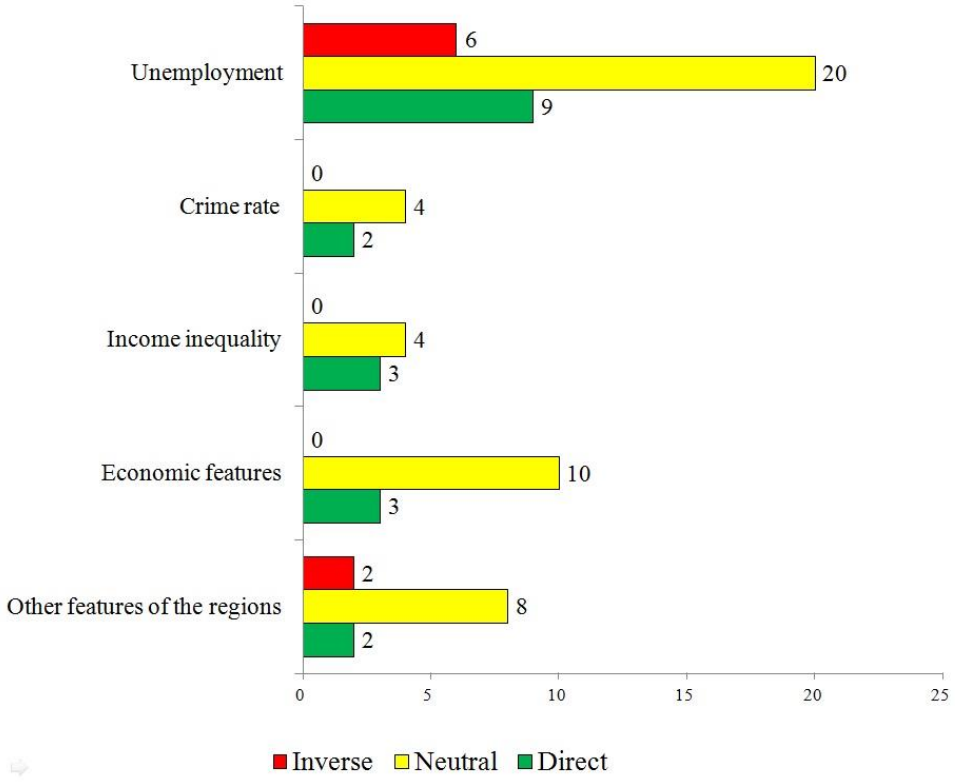

Figure 6. Number and direction of associations of social, economic and other characteristics in regions with alcohol consumption.

4.7 Impact of economic characteristics in the regions

Seven studies looked at the influence of regional economic characteristics on alcohol consumption. Out of four American [79,93,100–101] and one Canadian [99] articles presenting regional incomes of the population, only one demonstrated association with alcohol consumption. On a sample of American adults, Karriker-Jaffe [100] confirmed that

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an increase in the average household income in the region increased the amount of light drinking without affecting the amount of excessive drinking.

Two other studies assessed the impact of regional gross domestic product (GDP). On a Finnish sample of people aged 15–64 years, Johansson [95] showed that an increase in the growth rate of regional GDP did not affect the likelihood of any alcohol consumption albeit increasing the alcohol consumption volume. A Chinese research by Yang [98] on a sample of medical students revealed a direct relationship between alcohol abuse and GDP in the region of study but not in the region of residence.

Overall, economic characteristics indicated a direct impact on alcohol consumption in only 23% of associations (Figure 6). The paucity of these studies does not allow stating unequivocally the consistency of this effect.

4.8 Impact of other characteristics in the regions

In 6 publications, the effect of several regional features characterizing generalized nonspecific population features and living conditions was considered. On a sample of 21-year-old Americans who drank alcohol, Stout [60] demonstrated a reduction in the likelihood of binge drinking with an increase in the proportion of Jews in the population structure of the region, while other regional indicators (total road network length, countryside road network length, proportion of Catholics, proportion of Mormons, proportion of Baptists, proportion of other Protestants) did not exhibit statistically significant relationships in this study. On a sample of Irish students, Delaney [92] showed that the per capita number of Catholics was associated with a decrease in alcohol consumption, while the availability of a cricket club in a region was associated with an opposite pattern. In this study, no associations with the following regional characteristics were found: the location of the region within the Anglo-Norman culture, the average annual rainfall and average annual sunshine. Abel [46] examined a sample of young Swiss and established that in French-speaking regions, compared with German-speaking regions, men were more likely to experience risky alcohol drinking. Three American studies found no relationship between alcohol consumption and trade union membership rate [24], population density [79], or Republican and conservative predominance [102] in the population structure. Overall, 34% of the associations of general regional characteristics were statistically significantly associated, directly or inversely, with alcohol consumption (Figure 6). All of those characterize the population of the regions in terms of religious affiliation or ethnic characteristics. However, the scarcity of such publications does not attest the consistency of this effect.

4.9 Impact of regional features identified via data classification methods

The study by Shrestha [85] used latent regional factors as regional characteristics instead of specific indicators and living conditions scales. These latent factors were identified using the method of principal components as a statistical method of data classification. In this paper, presenting NLSY panel data for 1997–2008 on individuals 12–28 years of age, three latent factors were identified, including regional characteristics that could potentially affect individual alcohol consumption: the share of the population in religious organizations; the proportion of employees in the alcohol industry; the proportion of the population that have a negative attitude towards binge drinking; the number of outlets with a license to sell alcohol; the proportion of the population living in counties without alcohol sales; the availability of exceptions in the regional laws to prevent youth from accessing alcohol; the proportion of alcohol-related fatal traffic accidents. One of the latent factors characterizing the increase in the number of points of sale of alcoholic beverages in the region, the number of deaths in drunk driving, as well as the availability of exceptions in laws related to underage drinking, was directly associated with the volume of alcohol consumption.

5. Conclusions

The systematic review included 81 publications evaluating the impact of living conditions at the level of large regions on alcohol consumption at the individual level. The vast majority of studies were conducted in the USA. However, the share of published sources from other countries, analyzing the social, economic and various general characteristics of the regions, was one-third. In the last decade, the number of publications on this topic has increased significantly, which characterized the growing scientific interest in the environmental impact on individual health. While only 7 articles of the kind were published prior to year 2000, in the first decade of the 21st century their number was already 14, and in the second decade it constituted already 62 publications. The legislative environment and pricing policy regarding alcohol, along with social characteristics (in particular, the unemployment rate) were analyzed most often.

Of the identified articles, 23% were of high methodological quality, and another 50% were of satisfactory quality. High proportion of high-quality publications is probably explained by the fact that the analysis used data from large multicenter or national studies with high-quality design, methodology, and statistical support. Most publications had samples of over 10 thousand observations, and often more than 100 thousand observations. The studies covered all major categories of the population (children, youths, adults), whereas some articles investigated specific categories of the population.

The strongest associations with alcohol consumption were revealed for the legislative environment, alcohol pricing policy, prevalence of alcohol consumption and binge drinking in the population, and unemployment rates. The closest evidence-based links of the legislative environment were established with integral scales and indices. In addition, relatively strong associations with alcohol consumption were observed for a number of specific legislative initiatives, such as the laws on driving under the influence of alcohol, regarding the liability of alcohol-selling stores, age restrictions on the sale and consumption of alcohol, the legalization of marijuana, laws on gender equality and LGBT equality (for women and LGBT), and for the severity of general laws. In addition to the legislative environment, fairly consistent, albeit few, associations with alcohol consumption were also demonstrated for such social characteristics as crime rate and income inequality.

Among the shortcomings of the considered articles, it is necessary to point out that many of those evaluated the influence of only one type of regional characteristics. Most studies aimed at analyzing the impact of a specific feature (law/price/social characteristics, etc.). However, the impact of physical and social environment is diverse; therefore, in terms of future research within the framework of the health geography, the multidimensional assessments of living conditions are of special interest. The performed systematic review established that up to now there were no publications at all regarding the interaction of the effect of large national territory features with other spatial scales, such as a country-level scale and small administrative territory-level scale (districts, counties, residential neighborhoods). Hence, the issue of the spatial scale of the effect of physical and social environment remains open.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Figure S1: Algorithm for selecting articles on alcohol consumption and smoking for the review, published in 2021; Table S1: Features of reviewed studies on the impact of regional characteristics on alcohol consumption.

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