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Alcohol consumption and the physical availability of take-away alcohol: Systematic reviews and meta-analyses of the days and hours of sale and outlet density

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ABSTRACT

Objective

Systematic reviews and meta-analyses were completed studying the effect of changes in the physical availability of take-away alcohol on per capita alcohol consumption. Previous reviews examining this topic have not focused on off-premise outlets where take-away alcohol is sold and have not completed meta-analyses.

Methods

Systematic reviews were conducted separately for policies affecting the temporal availability (days and hours of sale) and spatial availability (outlet density) of take-away alcohol. Studies were included up to December 2015. Quality criteria were used to select papers which studied the effect of changes in these policies on alcohol consumption with a focus on natural experiments. Random-effects meta-analyses were applied to produce the estimated effect of an additional day of sale on total and beverage-specific consumption.

Results

Separate systematic reviews identified seven studies regarding days and hours of sale and four studies regarding density. The majority of papers included in these systematic reviews, for days/hours of sale (7/7) and outlet density (3/4), concluded that restricting the physical availability of take-away alcohol reduces per capita alcohol consumption. Meta-analyses studying the effect of adding one additional day of sale found that this was associated with per capita consumption increases of 3.4% (95% CI: 2.7,4.1) for total alcohol, 5.3% (3.2, 7.4) for beer, 2.6% (1.8, 3.5) for wine and 2.6% (2.1,3.2) for spirits. The small number of included studies regarding hours of sale and density precluded meta-analysis.

Conclusion

This study suggests that decreasing the physical availability of take-away alcohol will decrease per capita consumption. As decreasing per capita consumption has been shown to reduce alcohol-related harm, restricting the physical availability of take-away alcohol would be expected to result in improvements to public health.

INTRODUCTION

Alcohol consumption and particular patterns of drinking are associated with myriad health and social harms including chronic disease, injury and crime (Babor et al., 2010). Despite substantial evidence of these harms, high levels of consumption persist and alcohol remains one of the leading causes of preventable death and injury worldwide (WHO, 2014). An increase in per capita consumption will increase the level of drinking in all consumption groups, from light to heavy drinkers; this is referred to as "single distribution theory" or the "total consumption model" (Kehoe et al., 2012; Skog, 1985). An important corollary of this theory should be a marked association between average drinking levels and alcohol-related harm rates. A large number of studies have indeed substantiated this relationship (for a review, see (Norström and Ramstedt, 2005)). In turn, an important component of public health policy regarding alcohol is limiting per capita consumption (Bruun et al., 1975).

A key issue, from a public health perspective, is thus to identify policies which can be employed by governments to decrease average drinking levels. Research suggests that regulating prices, physical availability and alcohol advertising may be efficient strategies for targeting consumption (Babor, et al., 2010). Comprehensive reviews, e.g. Wagenaar et al. (2009) & Elder et al. (2010), have investigated the relationship between pricing and consumption, a recent Cochrane review found inconsistent evidence regarding the effect of advertising bans on consumption (Siegfried et al., 2014) and a recent systematic review found some evidence of increased alcohol consumption in youth who were exposed to advertising (Jernigan et al., 2016) . However, for reasons explained below, there remains a dearth of more precise knowledge studying the effect of changes in spatial and temporal availability on per capita consumption.

For policy-makers to make evidence-informed decisions regarding the implementation of alcohol policies, data detailing the effects of these policies must be presented at an appropriate level of granularity. Previous reviews regarding physical availability, e.g. (Bryden et al., 2012; Campbell et al., 2009; Hahn et al., 2010; Holmes et al., 2014; Middleton et al., 2010; Popova et al., 2009), have presented highly aggregated measures of exposures and outcomes of interest. For example, within-study density measures often aggregate on-premise establishments (bars, restaurants) and off-premise outlets (take-away stores) into a generic category containing all alcohol outlets. For officials to determine the best course of action from a public health viewpoint, more detailed information by outlet type is needed so that policies may be chosen to give the greatest health benefit. Further, where possible, it is useful to combine the available estimates of policy effects into a single result using meta-analysis to provide an average effect across time and space. The lack of meta-analyses may be seen as a limitation of previous availability reviews (Bryden, et al., 2012; Campbell, et al., 2009; Hahn, et al., 2010; Holmes, et al., 2014; Middleton, et al., 2010; Popova, et al., 2009).

The aim of the present paper is thus to perform systematic reviews and meta-analyses detailing the relationship between policies regulating the physical availability of take-away alcohol and per capita consumption. Take-away alcohol is alcohol sold which cannot be consumed on the premises as would be done in a bar or restaurant. Physical availability is divided into temporal availability (days and hours of sale) and spatial availability (outlet density) and separate reviews are completed for these two categories. The study attains greater specificity than previously published by limiting results to the relationship between the temporal and spatial availability of take-away alcohol on per capita consumption. This focus on the policy to consumption relationship will aid policy-makers in translating the results of the study into

effective policy which can differentially target outlet types. In line with previous reviews, e.g. (Hahn, et al., 2010) & (Middleton, et al., 2010), quality criteria are applied to align constituent studies with the goal of studying policy interventions, with an eye to highlighting policy implications. Meta-analyses are calculated for the effect of allowing an additional day of sale per week on total and beverage-specific per capita alcohol consumption.

METHODS

Registration

This study has been registered with PROSPERO (Booth et al., 2012), the international prospective register of systematic reviews; the registration number is CRD42016040103.

Systematic reviews

Separate systematic review processes, following the methods described below, were completed for each of the temporal availability (days/hours of sale) and spatial availability (outlet density) of take-away alcohol.

Search strategy and selection criteria

A novel review process was employed for this study and is therefore detailed below. A difference from other systematic reviews was the formation of a literature base from recent systematic reviews; this was then supplemented with a systematic review update. As there were a number of recent reviews covering broader research questions (i.e. more than the effect of the physical availability of take-away alcohol on per capita consumption), it was decided to use the papers identified by these reviews as a literature base. The project team decided to identify the

four most recent systematic reviews from which to draw the literature base, in order to balance breadth and pragmatism. Modified PRISMA flow diagrams are shown in Figure 1 for days and hours of sale and in Figure 2 for outlet density (Moher et al., 2009). The strategy employed the steps below, completed in duplicate with differences resolved through discussion or, if necessary, mediation by a third team member. This process was completed separately for each research area (temporal and spatial availability of take-away alcohol).

(1) A systematic review was conducted, searching for systematic reviews subject to inclusion and exclusion criteria #1, 2 and 4 below. This systematic review for reviews was completed in February 2016 using Web of Science and the Cochrane Database of Systematic Reviews. A secondary search was conducted in Google Scholar and expert advice was solicited from the panel of team members. The search terms used are specified in Appendix B. The identified systematic reviews (shown in Appendix C, included reviews in bold) were read in full and their constituent papers extracted to create the literature base in each research area.

(2) A systematic literature review was subsequently conducted to update the literature base to papers published up to and including December 2015. A systematic review was conducted in March 2016 using Web of Science and a secondary search was conducted using Google Scholar. The period searched was from the least recent systematic review study period end date identified in (1) until December 2015. This was chosen to maximize the number of constituent papers in our study, as inclusion/exclusion criteria may differ across systematic reviews.

(3) Studies identified in both (1) and (2) constituted the identified literature. These were then screened against our inclusion and exclusion criteria by title and abstract by using a coding

template which was developed to standardize project practices. Remaining papers were acquired in full text.

(4) Full text papers were evaluated against our quality criteria and papers were fully coded for information regarding authorship, study context, exposure, study description and relevant findings. The expert group reviewed the list of included studies and suggesting additions to ensure a more comprehensive list of studies.

< Insert Figure 1 and Figure 2 about here >

Inclusion and exclusion criteria

For inclusion, individual articles had to meet the following criteria: (1) explicitly study an exposure of interest (hours of sale, days of sale, outlet density of take-away alcohol), (2) explicitly study the outcome of interest (per capita alcohol consumption – total alcohol consumption or beverage-specific consumption), (3) be categorized in Tier 1 or 2 of the quality criteria below, (4) be written in English, (5) be primary research and (6) be published in 1991 or later (to provide a study period of 25 years, as societies and their responses to interventions, will change over time).

Quality criteria

It is rarely feasible to design randomized controlled trials (RCTs) to study the effect of alcohol policies. In the absence of RCTs, alcohol policy researchers have turned to quasi-experimental research designs, in particular natural experiments. Natural experiments attempt to determine the impact of policy interventions by measuring the outcome of interest both pre- and post-implementation of a policy (e.g. before and after Sunday sales were made legal) or policy

proxy (e.g. changes in alcohol outlet density over time due to market forces). Natural experimental designs can be made more robust by the use of simultaneous control measurements, e.g. observations in a neighbouring jurisdiction where the studied policy was not changed (Babor, et al., 2010); in fact, in interpreting causation, maximum statistical confidence is achieved by using time-series designs with contemporaneous controls (Cook and Campbell, 1979). Policy or proxy interventions can be either sudden or gradual; for example, allowing Sunday sales would result in a sudden change in opening hours while allowing private alcohol outlets would lead to a gradual change in density as stores are added over time As our intent was to draw conclusions on the effectiveness of policies regarding the physical availability of take-away alcohol by studying its effect on per capita consumption, three quality tiers were defined in consideration of the information above:

Tier 1 – Pre-/post- natural experiments with simultaneous control observations

Tier 2 – Pre-/post- natural experiments with no control observations

Tier 3 – All other studies (e.g. cross-sectional)

Articles in Tiers 1 and 2 were included in the review after the application of the quality criteria. Tier 3 studies were excluded from our analysis, but are included in Appendix A for reference.

Standardizing effect sizes and standard errors for meta-analysis

Due to limitations in the number of identified articles for hours of sale (N=1) and outlet density (N=4) which met the quality criteria, meta-analyses were only conducted for days of sale (N=6). To complete these meta-analyses, it was necessary to standardize effect sizes into comparable measures across the identified studies. Further, meta-analyses require standard error values for inverse variance weighting (Woodward, 2013); these were not available for each

study. To create comparable measures for days of sale, a research question was developed and applied to each study: when alcohol sales were allowed on one additional day per week, what was the estimated change in per capita total and beverage-specific alcohol consumption? The articles regarding days of sale were consistent in presenting results that could be interpreted to answer this question; however, associated standard errors were not always included. When standard errors were not presented in the article, they were calculated from information provided. Where t-values were provided, e.g. (Stehr, 2007), standard errors were calculated as $SE_i = \hat{\theta}_i / t_i$ for study i, where $\hat{\theta}$ is the estimated effect size (Higgins and Green, 2008). Where only p-values were provided, e.g. (Yörük, 2014), z-values were calculated from the p-value and standard errors were calculated as $SE_i = \hat{\theta}_i / z_i$ (Altman and Bland, 2011; Higgins and Green, 2008).

Meta-analysis

Meta-analyses were conducted for the effect of one additional day of sale on per capita consumption. All calculations for these meta-analyses were completed using Comprehensive Meta-Analysis version 3.3 (Borenstein, 2013). Meta-analyses combined the standardized effect sizes identified above which quantified the effect on per capita consumption of allowing one additional day of sale. Meta-analyses were completed for total alcohol consumption and beverage-specific consumption (beer, wine and spirits).

Meta-analyses were completed in two steps. First, for each category (total alcohol, beer, wine and spirits), articles which studied similar contexts and situations were identified. For example, three articles studied an experiment in Sweden which, in two phases, allowed the sale of alcohol on Saturdays (Gronqvist and Niknami, 2014; Norström and Skog, 2003; Norström and Skog, 2005) and two articles studied allowing sales on Sunday in the United States (Stehr, 2007;

Yörük, 2014). In order to avoid overweighting the results from a similar context in the overall estimate, the results of these studies were first combined into a context-specific measure using fixed-effects meta-analysis, described in more detail below. Second, these context-specific results were combined with estimates from other studies to produce a final result using random-effects meta-analysis. In addition to this two-step process which combined context-specific measures, sensitivity analyses were completed which combined studies individually using random-effects. These sensitivity analyses for total and beverage-specific alcohol closely matched the two-step procedure and are therefore not presented.

Fixed effects meta-analysis assumes a true overall quantity that all studies are estimating while random effects assumes that the true quantities from individual studies are drawn from an underlying normal distribution (Woodward, 2013). Fixed effects meta-analysis was used for the context-specific combination of results as the constituent studies used similar sources of information from the same context. In the second step, effect sizes from differing contexts were combined using random effects methods.

In the fixed effects model, estimates are combined using inverse variance (IV) weighting, where weights are calculated as $w_i = 1/SE_i^2$ (Woodward, 2013). The combined effect size from the fixed effects model is calculated as $\bar{\theta}_{fx} = \Sigma\left(w_i\hat{\theta}_i\right)/\Sigma\, w_i$ and the standard error of the combined estimate is calculated as $\mathrm{SE}_{fx}=1/\sqrt{\sum w_i}$. In random effects meta-analysis, studies are expected to be more heterogeneous with respect to the effect of the policy exposure on consumption (Woodward, 2013). To test this, the homogeneity test statistic is calculated as $Q = \Sigma\, w_i\left(\hat{\theta}_i - \hat{\theta}_{fx}\right)^2$. When compared with a chi-square statistic on k-1 degrees of freedom, where k is the number of studies, a statistically significant Q indicates a heterogeneous distribution (Woodward, 2013). As random effects assume an underlying probability

distribution, the standard error for each effect size has both within-study and between-study components (Lipsey and Wilson, 2001). Calculating $D = (k-1)(k\,\overline{w}^2 - s_w^2)/k\overline{w}$ allows us to estimate the between-study component of the error as $\hat{\tau}^2 = (Q - k + 1)/D$ when $Q > k - 1$. If $Q \leq k - 1$ then $\hat{\tau}^2$ is taken to be zero and the random effect model collapses to the fixed effects model. IV weights for the random effect model are then calculated as $1/\left((1/w_i) + \hat{\tau}^2\right)$. The random effects model is more conservative, producing wider confidence limits around the estimated effect size (Lipsey and Wilson, 2001).

RESULTS

Systematic reviews

Days and hours of sale

As described in the methods, four systematic reviews were identified and used to create the literature base for days and hours of sale; this produced a total of 181 papers (see Figure 1). The systematic review update, used to update the systematic review to December 2015, identified an additional 1,331 papers and two papers were added by content experts on the research team. This resulted in a total of 1,514 papers, which then had duplicates removed and were screened by title and abstract against our inclusion and exclusion criteria. The high percentage of exclusions at the screening stage was due to the relatively strict inclusion and exclusion criteria which required studies to explicitly study both an exposure and outcome of interest; for example, a significant number of papers studied an outcome on a particular harm such as violent crime and did not consider consumption. Nine papers were forwarded from the screening stage to eligibility and were included in our full-text review. Of the nine papers reviewed in full, seven met our quality criteria and are summarized in Table 1. Six of these

studied the effect of allowing alcohol sales on either Saturday or Sunday (Carpenter and Eisenberg, 2009; Gronqvist and Niknami, 2014; Norström and Skog, 2003; Norström and Skog, 2005; Stehr, 2007; Yörük, 2014) and one studied the effect on consumption of differing hours of sale in regions of Russia (Kolosnitsyna et al., 2014).

< Insert Table 1 about here >

The six articles which studied the effect of an additional day of sale on per capita consumption were from three countries: Sweden (three articles), the United States (two articles) and Canada (one article). The three Swedish articles studied different time periods of the same experiment with Saturday sales in which the country was divided into experimental, buffer and control areas in Phase I and Saturday sales were allowed in the entire country in Phase II (Gronqvist and Niknami, 2014; Norström and Skog, 2003; Norström and Skog, 2005). Norström & Skog studied both Phase I (Norström and Skog, 2003) and Phase II (Norström and Skog, 2005). When pooling the experimental areas in Phase I, the authors concluded that an additional day of sale led to per capita consumption increases of 3.3% for total alcohol, 7.0% for beer, 2.0% for wine consumption, and 3.0% for spirits. Their article studying Phase II reported similar effect sizes. Grönqvist & Niknami (Gronqvist and Niknami, 2014) analyzed the effect of Phase I on total consumption as a component of an article studying changes in crime outcomes. The authors reported a 4.6% increase in per capita consumption of total alcohol.

Yörük (Yörük, 2014) and Stehr (Stehr, 2007) both employed natural experimental designs to assess the effect of Sunday sales bans in the U.S. Yörük (Yörük, 2014) compared five experimental states which repealed Sunday sales bans to 12 control states in which bans remained in place; the author reported a 2.8% increase in per capita consumption of total alcohol and a 4.0% increase in beer consumption. Stehr (Stehr, 2007) included all 50 U.S. states for the

period 1990 to 2004 - 12 states repealed their Sunday sales bans in this time period. A 3.5% increase in per capita beer consumption and a 7.5% increase in per capita spirits consumption were reported.

Carpenter & Eisenberg (Carpenter and Eisenberg, 2009) assessed the effect of lifting a Sunday alcohol sales ban in the province of Ontario in 1997. The authors found a non-significant 0.9% increase in consumption of total alcohol.

The study by Kolosnitsnya et al. (Kolosnitsyna, et al., 2014) examined the effect of hours of sale on per capita consumption. In 2009, Russian regions gained the ability to independently restrict the hours of alcohol sale. This created a natural experiment with various changes in opening hours by region which the authors used to estimate the effect of hours of sale on total consumption. The study reported that later evening opening hours were significantly related to total consumption: each additional hour of sale led to a 7.9% increase in alcohol sales.

Outlet density

Analyzing the four identified systematic reviews used to create the literature base identified 254 articles (see also Figure 2). The systematic review update subsequently identified 498 papers and two papers were added due to expert consultation. The resulting 754 articles were screened by title and abstract in duplicate. Fifty-nine papers were deemed eligible to continue to the full text review stage and four papers met our quality criteria. Table 2 summarizes the included articles.

< Insert Table 2 about here >

Of the four included studies, three took place in Canada and were population-level studies (Stockwell et al., 2009; Trolldal, 2005; Xie et al., 2000) and one individual-level study

took place in the United States (Brenner et al., 2015). Stockwell et al. (Stockwell, et al., 2009) examined the effect of increasing take-away alcohol outlet density due to a partial privatization of alcohol retail in British Columbia between 2003 and 2008. The authors found that a 1.0% increase in take-away outlet density was associated with a 0.15% increase in total alcohol consumption, as well as significant increases in beverage-specific consumption. Xie et al. (Xie, et al., 2000) found significant results supporting the hypothesis that greater take-away outlet density is associated with higher consumption; however, Trolldal, in (Trolldal, 2005), found non-significant effects using a study period of 1951 to 2000. In these studies, outlet density was operationalized by calculating the number of stores per residents (in (Stockwell, et al., 2009) & (Xie, et al., 2000), density per 10,000 residents and in (Trolldal, 2005), per 100,000 residents).

The U.S.-based, individual-level study by Brenner et al. (Brenner, et al., 2015) took place between 2000 and 2010 and examined changes in alcohol consumption which occurred when participants relocated to areas with changed outlet density. The study reported that a one standard deviation increase in outlet density was associated with a significant 11% increase in alcohol consumption for women and a significant 7% increase in consumption for men.

Meta-analysis for days of sale

A priori, our intention was to complete meta-analyses regarding the effect of days of sale, hours of sale and outlet density on per capita consumption. However, once systematic reviews were completed, the paucity of studies and of comparable results on hours of sale and density excluded those dimensions of physical availability from the possibility of meta-analysis. As there were six high-quality studies regarding days of sale, many of which included beverage-specific

results, it was possible to complete meta-analyses of the effect of days of sale on per capita consumption of total and beverage-specific alcohol.

< Insert Figure 3 about here >

Results are presented in Figure 3. Five studies included total alcohol consumption as an outcome and all of these estimated that an additional day of sale increased per capita alcohol consumption (four were statistically significant). The significant combined effect size was estimated to be 0.033 (95% CI: 0.026, 0.040), suggesting one additional day of sale was associated with a 3.4% increase in total per capita consumption. Beverage-specific results were also positive and highly significant: for beer, a 5.3% (95%CI: 3.2%, 7.4%) increase in per capita consumption, for wine, a 2.6% (95%CI: 1.8%, 3.5%) increase and for spirits, a 2.6% (95%CI: 2.1%, 3.2%) increase. Of note is the consistency of effect sizes in each of the four panels of Figure 3 - the meta-analyses paint a consistent picture of the effect on total consumption of an additional day of alcohol sale.

DISCUSSION

The results are generally consistent with previous systematic reviews relating physical availability and alcohol-related outcomes; however, we provide greater specificity by focusing on the physical availability of take-away alcohol and conducting novel meta-analyses regarding days of sale. Meta-analysis of high quality days of sale studies provide compelling evidence that one additional day of sale will lead to increased aggregate and beverage-specific alcohol consumption. The small number of studies found suggests that increasing hours of sale and outlet density may lead to increased consumption.

Previous reviews (Bryden, et al., 2012; Campbell, et al., 2009; Hahn, et al., 2010; Middleton, et al., 2010; Popova, et al., 2009) which have gathered evidence on broader exposures and outcomes have concluded that a majority of studies support a link between increased physical availability and increased alcohol-related outcomes, such as alcohol consumption. Among these reviews, the strongest conclusion is given for the effect of an additional day of sale (Middleton, et al., 2010). The findings of the present study are in line with this conclusion.

The results provide evidence to suggest that restricting the physical availability of take-away alcohol is an effective strategy for decreasing per capita alcohol consumption. Temporal availability may be restricted by regulating the days and hours of allowed alcohol sale and spatial availability may be restricted by stricter licensing laws for take-away outlets or government monopoly control of alcohol retail stores. The results from meta-analyses regarding days of sale provided particularly strong evidence. From the consistency of effect sizes presented in Figure 3, it is clear that there is a high level of agreement between studies from across different contexts and beverage types. The vast majority of individual study effect sizes show a significant and positive association between allowing an additional day of sale and the total and beverage-specific consumption of alcohol.

As with all systematic reviews, results are only as good as the assumptions and methods used to filter results and calculate meta-analyses. It is our opinion that our inclusion, exclusion and quality criteria led to the inclusion of studies which best captured the concept of interest, i.e. only natural experiments were included in order to best study policy interventions. This had the effect of disqualifying many cross-sectional studies which compared sites with different policies. It was not our intention to declare these other studies invalid, but only to choose, in this

circumstance, which studies we thought would best answer the question at hand. The generalizability of the results presents another limitation; all included studies were from developed nations and acquiring the data needed to study natural policy experiments is known to be more difficult in emerging economies (Babor, et al., 2010). The dissimilarities between developed and emerging economies preclude the ability to extend these results. Lastly, a recent critical review discusses challenges in aggregating take-away outlets. Though this is better than aggregating all types of outlets, it fails to consider the wide variety of take-away shops in the marketplace (Holmes, et al., 2014). Each limitation presents an opportunity for future work. There is a need for more studies examining the effect of changes in the physical availability of take-away alcohol on per capita consumption. Further, in emerging economies, emphasis should be placed on building data collection capacity, e.g. the collection of comprehensive alcohol sales data (Rehm and Room, 2009).

CONFLICT OF INTEREST

The study is partly funded by Systembolaget, the Swedish government alcohol monopoly which reports to the Minister for Health and has a mandate to protect the health and safety of the population. Funds cover part-time salary for the first author, as well as travel expenses and minor fees for co-authors. Systembolaget has agreed for the investigative team to be fully independent and responsible for the content of all publications arising from the project.

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Table 1: List of included studies after a systematic review for the effect of the days and hours of sale of take-away outlets on per capita alcohol consumption

Author(s), date	Study context: Country & year	Intervention studied	Study description	Findings
Days of sale (6)				
Gronqvist & Niknami (2014)	Sweden 1998-2001	Removal of Saturday sales restrictions	Studied Phase 1 of a natural experiment in Sweden removed Saturday sales restrictions in 2000. Sales data acquired from Systembolaget, the Swedish government alcohol retail monopoly.	The author's preferred linear trend model calculated a significant parameter estimate of 0.045 (SE 0.016).
Yörük (2014)	United States 1990-2007	Removal of Sunday sales restrictions	Seventeen US states (5 treatment and 12 control) were studied from 1990-2007 using a time series design with acquired sales data.	Combining the five treatment states gives significant parameter estimates for total consumption (0.028) and beer consumption (0.039).
Carpenter & Eisenberg (2009)	Canada 1994-1999	Removal of Sunday sales restrictions	A natural experimental approach was constructed comparing provinces with Sunday restrictions to those without. National-level survey data was used (n=95,970).	The author's time series model found a non-significant increase of 0.028 (SE 0.60) self-reported drinks per week compared to a mean rate of 3.06/week.
Stehr (2007)	United States 1990-2004	Removal of Sunday sales restrictions	Quantified the effect of series of natural experiments wherein twelve states removed restrictions on Sunday sales. Sales data from all 50 states for 15 years was acquired.	Parameter estimates from the author's full model were: Beer consumption = 0.034 (t 1.46) Spirits consumption = 0.072 (t 3.30)

Norström & Skog (2005)	Sweden 1995-2002	Removal of Saturday sales restrictions	Studied Phase 2 of the Swedish Saturday sales experiment from July 2001 to July 2002. Results from Phase I of the study were re-assessed.	ARIMA time-series modeling found the following parameter estimates: Total 0.035 (SE 0.005); Beer 0.052 (SE 0.008); Wine 0.033 (SE 0.006); Spirits 0.022 (SE 0.004).
Norström & Skog (2003)	Sweden 1995-2001	Removal of Saturday sales restrictions	Studied Phase 1 of the Swedish Saturday sales experiment. The country was divided into experimental, control and buffer areas.	ARIMA time-series modeling found the following parameter estimates: Total 0.032 (SE 0.006); Beer 0.068 (SE 0.009); Wine 0.020 (SE 0.006); Spirits 0.030 (SE 0.004).
Hours of sale (1)				
Kolosnitsyna et al. (2014)	Russia 2009-2010	Greater hours of sale allowed - Total number of hours, morning opening hours and evening closing hours	Sales data and survey data were used to examine differences in Russian regions. A natural experiment occurred in 2009 wherein regions gained the ability to regulate opening hours; consumption data before and after this change were studied.	For effect on total consumption, parameter estimate were: Total no. of hours of sale = 0.008 (SE 0.003) Time when sales end in the evening = 0.076 (SE 0.015) Time when sales begin in the morning = -0.025 (SE 0.006).

Table 2: List of included studies after a systematic review for the effect of the density of take-away outlets on per capita alcohol consumption

Author(s), date	Study context: Country & year	Intervention studied	Study description	Findings
Population-level studies (3)				
Stockwell, Zhao, Macdonald, Pakula, Gruenewald, & Holder (2009)	Canada 2003-2008	An increase in take-away alcohol outlet density due to the partial privatization of alcohol retail in British Columbia, Canada.	A multi-level regression analysis design was used to study a natural experiment where a retail monopoly was partially privatized. Alcohol sales data by beverage category and data providing the number of alcohol outlets were acquired from administrative sources.	The author's full model found that the density of take-away outlets significantly increased per capita consumption. The authors also provided elasticities (not included in article). They were: Total 0.149 (SE 0.022); Beer 0.126 (SE 0.022); Wine 0.254 (SE 0.026); Spirits 0.135 (SE 0.024)
Trolldal (2005)	Canada 1951-2000	Changes in take-away alcohol outlet density over time.	A time-series dataset with information on per capita sales and take-away outlet density was used to design approximate a natural experiment for four Canadian provinces.	ARIMA time series models produce the following effect sizes of take-away alcohol outlet density on beverage-specific sales (for four provinces, pooled): Total 0.07 (SE 0.13); Beer 0.02 (SE 0.10); Wine 0.04 (SE 0.17); Spirits 0.41 (SE 0.21).
Xie, Mann, & Smart (2000)	Canada 1968-1986	Changes in take-away alcohol outlet density over time.	As part of a study on alcohol policy measures and liver cirrhosis, a time-series dataset with information on per capita sales and take-away outlet density was created which approximated a natural experiment.	The authors found greater take-away outlet density to be significantly positively associated (0.19, $p<0.05$) with increased per capita consumption.

Individual-level studies (1)

Brenner, Borrell, Barrientos-Gutierrez, & Diez Rouz (2015)	United States 2000-2010	Natural changes in take-away alcohol outlet density due to participants moving homes	This longitudinal study examined the effect of changes in outlet density on daily consumption. Participants aged 45-84 were surveyed once at baseline with four follow-up surveys conducted at 1.5-2 year intervals (n=6,163).	A one standard deviation increase in take-away outlet density was found to have a significant effect on weekly consumption in both men and women: Men 1.07 ($p<0.05$); Women 1.11 ($p<0.05$).

Figure 1: Modified PRISMA flow diagram for a systematic review on the effect of the days and hours of sale of take-away alcohol outlets on per capita alcohol consumption

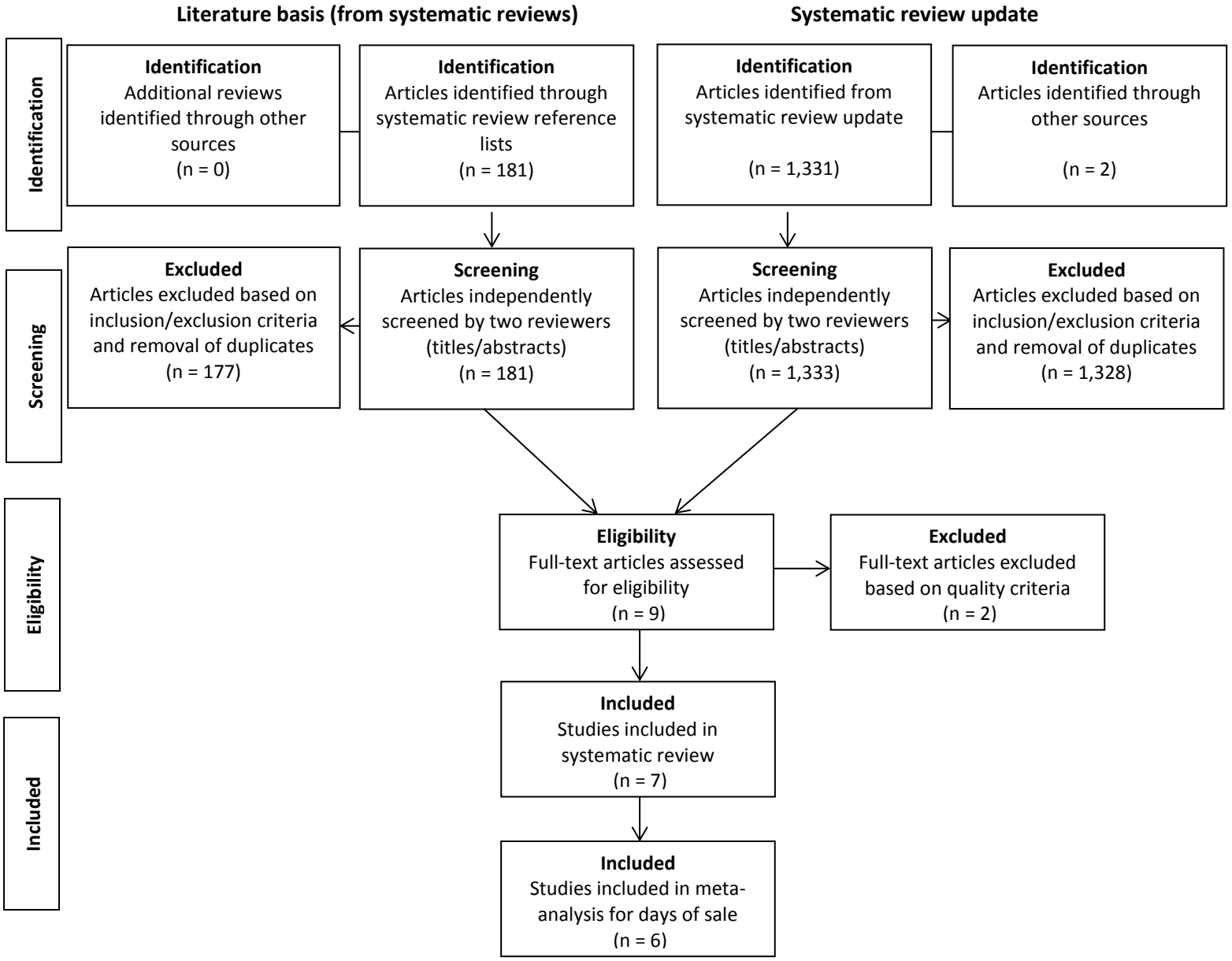


Figure 2: Modified PRISMA flow diagram for a systematic review on the effect of the density of take-away alcohol outlets on per capita alcohol consumption

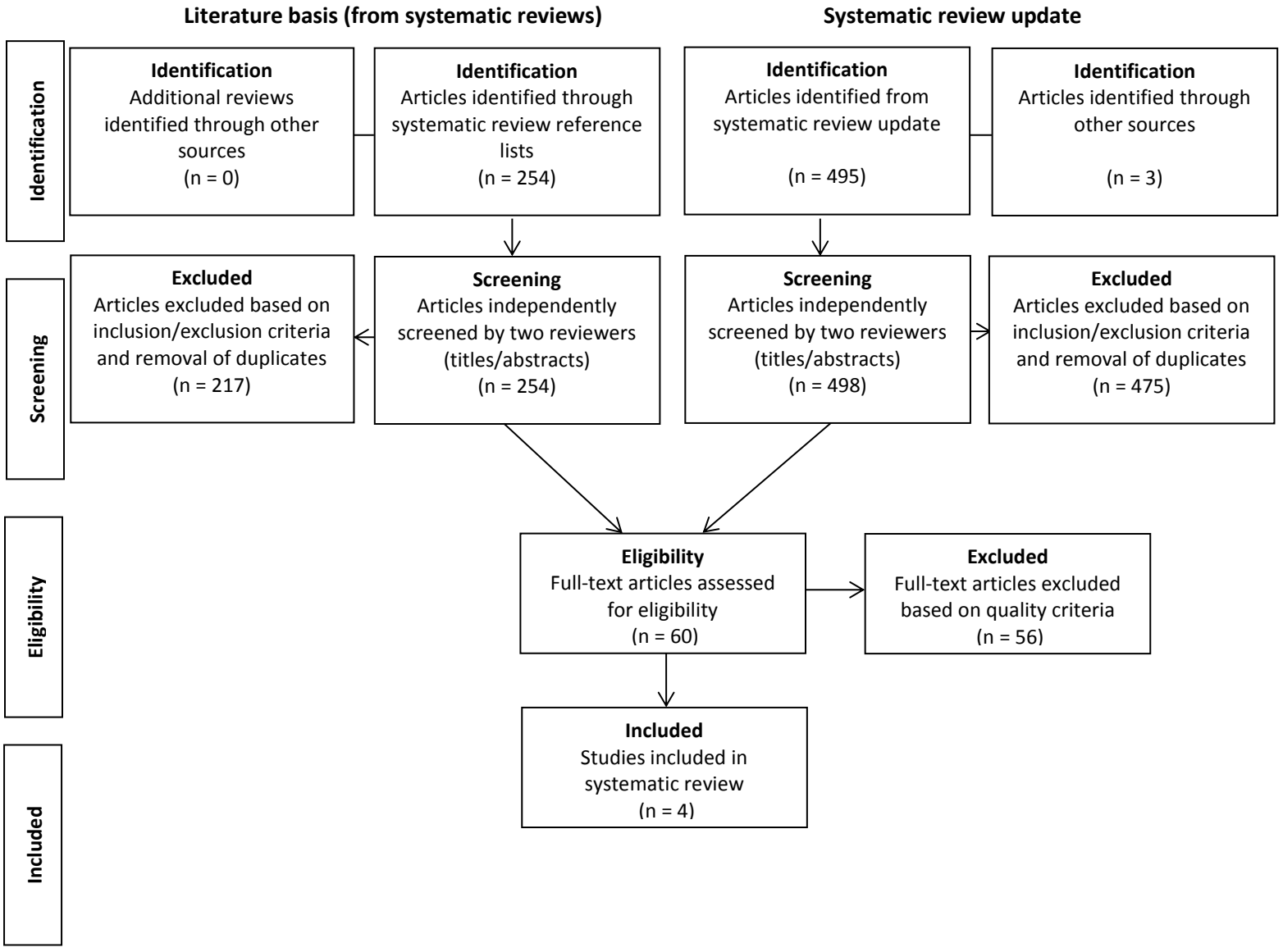
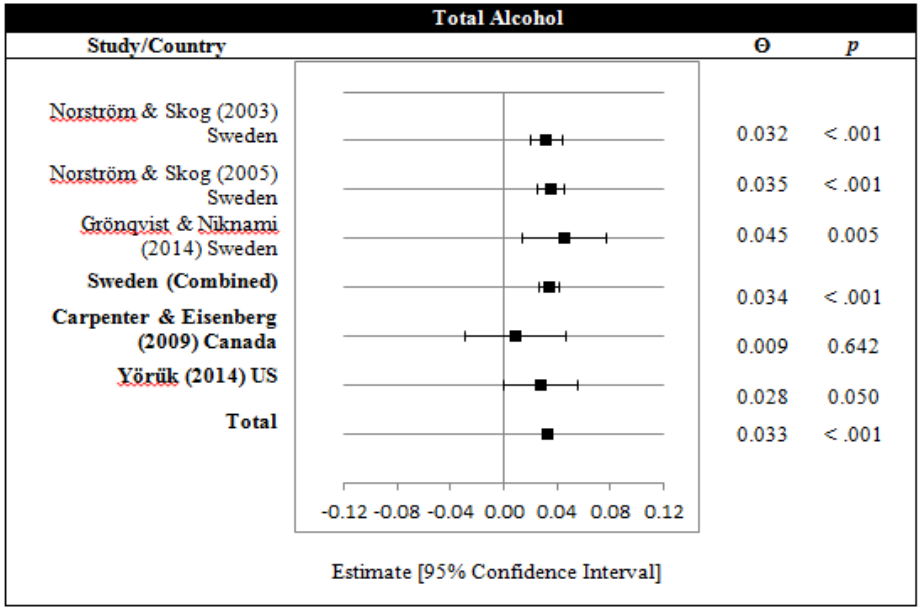
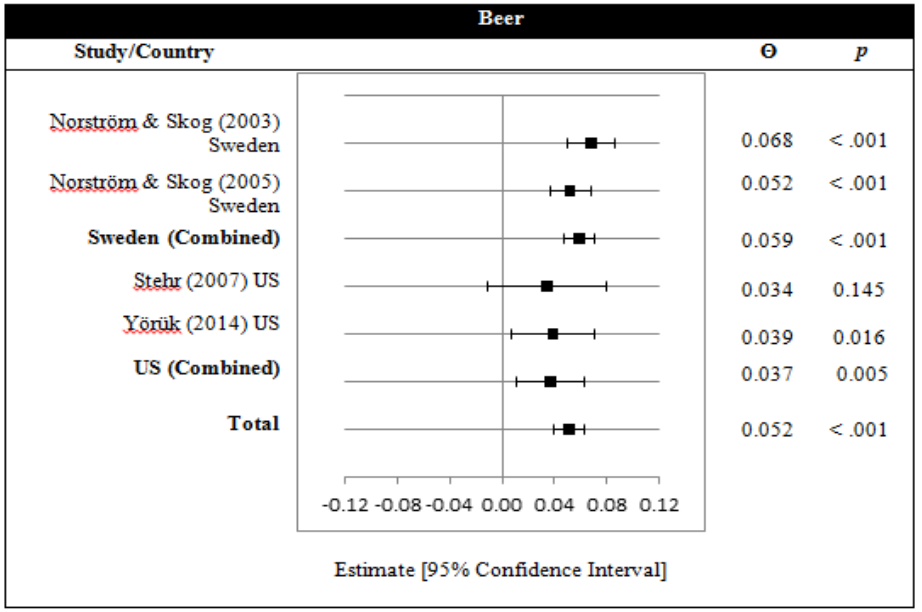
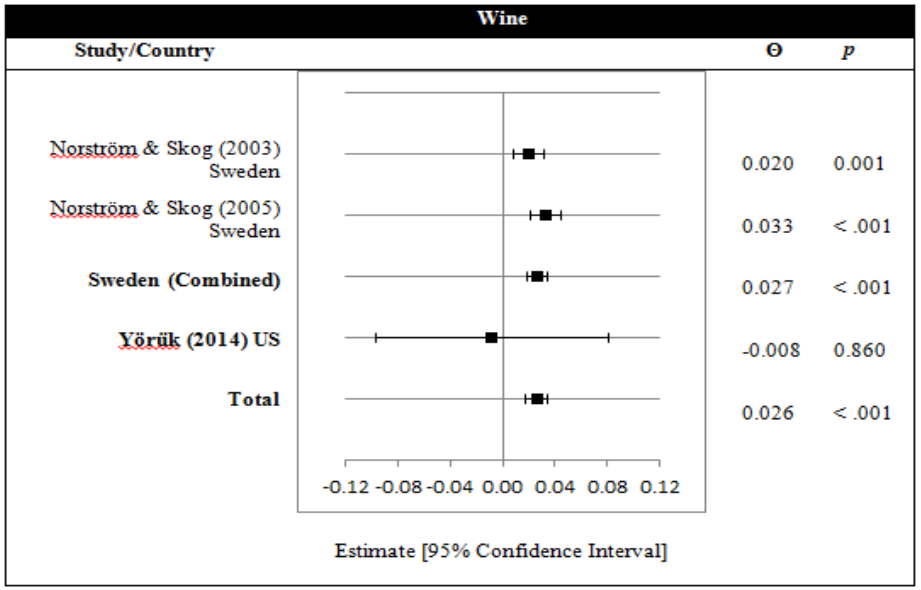
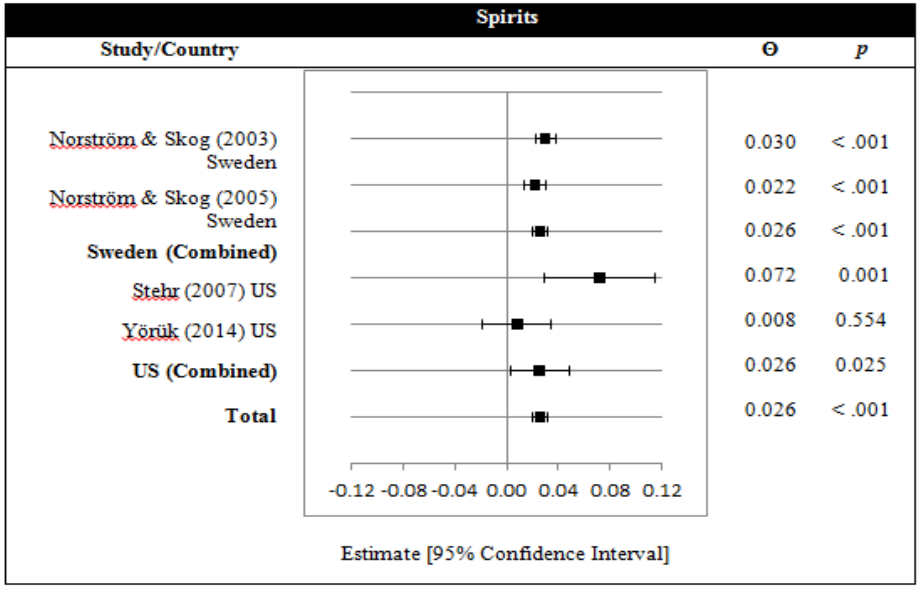


Figure 3: Forest plots showing results of meta-analyses of the effect of one additional day of sale on per capita total and beverage-specific alcohol consumption


Total Alcohol
Study/Country
Θ
p
Norström & Skog (2003) Sweden
0.032
< .001
Norström & Skog (2005) Sweden
0.035
< .001
Grönqvist & Niknami (2014) Sweden
0.045
0.005
Sweden (Combined)
0.034
< .001
Carpenter & Eisenberg (2009) Canada
0.009
0.642
Yörük (2014) US
0.028
0.050
Total
0.033
< .001
-0.12 -0.08 -0.04 0.00 0.04 0.08 0.12
Estimate [95% Confidence Interval]


Beer
Study/Country
Θ
p
Norström & Skog (2003) Sweden
0.068
< .001
Norström & Skog (2005) Sweden
0.052
< .001
Sweden (Combined)
0.059
< .001
Stehr (2007) US
0.034
0.145
Yörük (2014) US
0.039
0.016
US (Combined)
0.037
0.005
Total
0.052
< .001
-0.12 -0.08 -0.04 0.00 0.04 0.08 0.12
Estimate [95% Confidence Interval]


Wine
Study/Country
Θ
p
Norström & Skog (2003) Sweden
0.020
0.001
Norström & Skog (2005) Sweden
0.033
< .001
Sweden (Combined)
0.027
< .001
Yörük (2014) US
-0.008
0.860
Total
0.026
< .001
-0.12 -0.08 -0.04 0.00 0.04 0.08 0.12
Estimate [95% Confidence Interval]


Spirits
Study/Country
Θ
p
Norström & Skog (2003) Sweden
0.030
< .001
Norström & Skog (2005) Sweden
0.022
< .001
Sweden (Combined)
0.026
< .001
Stehr (2007) US
0.072
0.001
Yörük (2014) US
0.008
0.554
US (Combined)
0.026
0.025
Total
0.026
< .001
-0.12 -0.08 -0.04 0.00 0.04 0.08 0.12
Estimate [95% Confidence Interval]