Annual Review of Public Health

High-Deductible Health Plans and Prevention

Olena Mazurenko, Melinda J.B. Buntin, and Nir Menachemi

1Department of Health Policy and Management, Richard M. Fairbanks School of Public Health, Indiana University-IUPUI, Indianapolis, Indiana 46202-2872, USA; email: omazuren@iu.edu, nirmena@iu.edu
2Department of Health Policy, School of Medicine, Vanderbilt University, Nashville, Tennessee 37203, USA; email: melinda.buntin@vanderbilt.edu

Keywords
high-deductible health plan, prevention, current knowledge, methodological critique

Abstract
High-deductible health plans (HDHPs) are becoming more popular owing to their potential to curb rising health care costs. Relative to traditional health insurance plans, HDHPs involve higher out-of-pocket costs for consumers, which have been associated with lower utilization of health services. We focus specifically on the impact that HDHPs have on the use of preventive services. We critique the current evidence by discussing the benefits and drawbacks of the research designs used to examine this relationship. We also summarize the findings from the most methodologically sophisticated studies. We conclude that the balance of the evidence shows that HDHPs are reducing the use of some preventive service, especially screenings. However, it is not clear if HDHPs affect all preventive services. Additional research is needed to determine why variability in conclusions exists among studies. We describe an agenda for future research that can further inform public health decision makers on the impact of HDHPs on prevention.
INTRODUCTION

High-deductible health plans (HDHPs), also known as consumer-directed health plans, are considered effective tools to curb rising health care costs (4). Employers and policy makers have encouraged enrollment in such plans, and an estimated 40% of US adults now have an HDHP (7, 8). Figure 1 shows how the percent distribution of insured adults aged 18–64 with HDHPs has grown over time. Table 1 presents detailed information about various terms used to describe HDHPs and related plans. By definition, HDHPs are insurance plans that have higher deductibles, compared with traditional health plans. Specifically, in 2018, the minimum annual deductible for an HDHP to qualify for a health savings account (HSA) was $1,350 for an individual and $2,700 for a family (26 C.F.R. § 601.602). By imposing higher out-of-pocket spending on the individual, HDHPs incentivize patients to make higher-value health care decisions (29, 31). For example, individuals in HDHPs can save money by reducing unnecessary, low-value care and selecting lower-cost services and providers. However, experts have raised concerns that individuals with HDHPs may reduce unnecessary care but also forgo needed care (e.g., physician visits, medication refills) owing to higher out-of-pocket expenditures (11, 32). A recent systematic review found that HDHPs were associated with a significant reduction in overall utilization, which problematically included a reduction in the use of preventive services (1).

Preventive services are typically not subject to out-of-pocket costs for HDHP enrollees, which makes the reduction in enrollees’ use of preventive services perplexing. Several reasons may explain why patients with HDHPs are less likely to receive preventive care. First, researchers have found
Table 1  Different types of HDHPs

<table>
<thead>
<tr>
<th>Type of plan/feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-deductible health plan (HDHP)</td>
<td>An HDHP is a plan with a higher deductible than a traditional insurance plan, usually of $1,000 or more. The monthly premium is generally lower, but enrollees pay more health care costs themselves before the insurance company starts to pay its share. An HDHP can be combined with a health savings account (HSA). The Internal Revenue Service defines an HSA-qualified HDHP as any plan with a deductible of at least $1,350 for an individual or $2,700 for a family. An HDHP’s total yearly out-of-pocket expenses (including deductibles, copayments, and coinsurance) cannot be more than $6,650 for an individual or $13,300 for a family. (This limit does not apply to out-of-network services.)</td>
</tr>
<tr>
<td>Consumer-directed health plan (CDHP)</td>
<td>CDHP is a general term for plans with high deductibles and other features designed to encourage consumer behavior such as price shopping and considerations of the value of care.</td>
</tr>
<tr>
<td>Account-based health plan (ABHP)</td>
<td>An ABHP is a plan with a deductible offered together with a personal account—such as an HSA or a health reimbursement account (HRA)—that can be used to pay a portion of the medical expense not paid by the plan. ABHPs typically include decision support tools that help consumers better manage their health, health care, and medical spending.</td>
</tr>
<tr>
<td>Health savings account (HSA)</td>
<td>An HSA is a type of savings account that lets consumers set aside money on a pretax basis to pay for qualified medical expenses. By using untaxed dollars in an HSA to pay for deductibles, copayments, coinsurance, and some other expenses, consumers can lower their overall health care costs. An HSA can be used only with an HDHP—a health plan with a deductible of at least $1,350 for an individual or $2,700 for a family. For 2018, consumers can contribute up to $3,450 for self-only HDHP coverage and up to $6,900 for family HDHP coverage. HSA funds roll over year to year if not spent.</td>
</tr>
<tr>
<td>Health reimbursement arrangement (HRA)</td>
<td>HRAs are employer-established and must be funded solely by an employer. The contribution cannot be paid through a voluntary salary reduction agreement on the part of an employee. Employees are reimbursed tax free for qualified medical expenses up to a maximum dollar amount for a coverage period. Amounts that remain at the end of the year generally can be carried over to the next year, but amounts may never be used for anything but reimbursements for qualified medical expenses.</td>
</tr>
<tr>
<td>Flexible spending arrangement (FSA)</td>
<td>A health FSA allows employees to be reimbursed for medical expenses. FSAs are usually funded through voluntary salary reduction agreements with employers. No employment or federal income taxes are deducted from contributions. The accounts do not roll over from year to year.</td>
</tr>
</tbody>
</table>

Source: References 18, 35, 36.

that many patients do not understand the deductible structure of their insurance plan and are likely to forgo preventive care due to cost concerns (27). Second, because HDHP enrollees have higher out-of-pocket costs for regular office visits, they may use these services less often and thus have more limited opportunities to receive preventive care (11). Third, for preventive services that require anesthesia or pathology services (e.g., colonoscopy), enrollees are billed separately from the actual screening test. Such billing practices may create confusion for patients and payers regarding whether the anesthesia or pathology component of the charges should be exempt from out-of-pocket costs. Fourth, HDHP enrollees may be responsible for out-of-pocket costs for
preventive screenings when they are utilized more frequently than recommended by the US Preventive Services Task Force (e.g., colonoscopy utilized more often than recommended) (33). Finally, patients with HDHPs may be asked to cover the costs of a preventive screening when the results of the test are positive for the disease and the procedure becomes an intervention (e.g., colonoscopy leads to a polyp removal during the same procedure) (34). Given the rapid growth of HDHPs, additional research is needed to assess the mechanisms by which these plans impede the use of preventive services. Such research is needed to inform an evidence-based public health response. Some studies on this topic have utilized methodologies that are not designed to generate the evidence needed for public health action; fortunately, some of the existing studies use methodologies that are better suited for filling the gaps in the literature.

In this article, we give an overview of the methodological challenges involved in conducting research on the effects of HDHPs by highlighting the case of preventive services. We describe why certain existing studies, on the basis of the methods used, cannot provide sufficient evidence for public health decision making. Moreover, we compare such studies’ findings to those of other studies that utilize more suitable approaches to determining the true effect of HDHPs. In so doing, we highlight the current evidence base stemming from the most methodologically rigorous studies that examined the effects of HDHPs on the use of preventive services. Last, we describe an agenda for future research based on the knowledge gaps we identify. This article will be of interest to researchers, public health decision makers, providers, and employers interested in how HDHPs affect the use of preventive care services and to those in the field who can enhance the evidence still needed to guide action.

HDHP STUDY DESIGNS

Several study designs have been used to examine the effects of HDHPs on various outcomes of interest. We summarize in Table 2 the major strengths and weaknesses of different study designs that have appeared in the literature examining the effects of HDHPs. These study designs vary in their ability to assess a causal relationship between HDHP enrollment and outcomes. Below is an overview of key study designs used in the relevant literature, along with the strengths and limitations of each approach. Many additional study designs are applicable to the study of HDHPs but as of yet have not been used by researchers.

Case Study Design

The case study approach is used when investigators need to get an in-depth understanding of one particular “case” (e.g., a given patient, clinic, or policy) in its real-life context (9). With respect to HDHPs, Marshall and colleagues (22) presented a case study of one academic health center that implemented high deductibles for its employees. They reported significant increases in the use of preventive health services, including health risk assessments, flu shots, and cancer screenings, among employees following the implementation of an HDHP. The strength of the case study approach is its ability to provide detailed information about the case in a particular context. Case studies typically capture explanatory information, such as how a particular intervention was implemented and received by the employees in a particular organization. This exploratory information is especially valuable when trying to develop or refine a theory that underpins the phenomenon being studied (9). Limitations of this approach include (a) difficulty in generalizing the findings from the case study to a larger population, (b) subjectivity in interpretation of data and inferences, and (c) difficulty in determining whether the intervention was causally responsible for the outcomes.
Table 2  Different study design types that were used to examine the effects of HDHPs on outcomes

<table>
<thead>
<tr>
<th>Study design types</th>
<th>Purpose</th>
<th>Strengths/limitations</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case study</td>
<td>Hypothesis generating</td>
<td>Strengths: ◆ Provide detailed information about a given case in a unique context Limitations: ◆ Limited generalizability ◆ Subjectivity in data interpretation ◆ Inability to determine cause and effect</td>
<td>Marshall et al. (22)</td>
</tr>
<tr>
<td>Cross-sectional study</td>
<td>Hypothesis generating</td>
<td>Strengths: ◆ Ability to identify correlations ◆ Low cost and feasible to conduct Limitations: ◆ Inability to determine cause and effect</td>
<td>Wilson et al. (43)</td>
</tr>
<tr>
<td>Patient vignettes</td>
<td>Hypothesis generating</td>
<td>Strengths: ◆ Ability to manipulate multiple variables at once ◆ Ethically acceptable due to use of hypothetical scenarios that have no effect on the actual participants or their patients Limitations: ◆ Limited generalizability ◆ Potential for response bias</td>
<td>Pollack et al. (26)</td>
</tr>
<tr>
<td>Randomized controlled trial</td>
<td>Hypothesis testing (e.g., determining cause and effect)</td>
<td>Strengths: ◆ Ability to determine cause and effect Limitations: ◆ Expensive and timely to conduct ◆ Ethical constraints due to potentially withholding a treatment for certain individuals and potentially exposing them to further harm or risk ◆ Typically has limited generalizability</td>
<td>Newhouse (24)</td>
</tr>
<tr>
<td>Quasi-experimental design</td>
<td>Hypothesis testing (e.g., determining cause and effect)</td>
<td>Strengths: ◆ Ability to determine cause and effect Limitations: ◆ Inability to fully account for all confounders that may affect the relationship</td>
<td>Wharam et al. (38)</td>
</tr>
</tbody>
</table>

Cross-Sectional Study Design

The cross-sectional study design is an approach that compares two groups of interest using data collected at one point in time (21). For example, Wilson and colleagues (43) compared health care utilization among individuals enrolled in HDHPs versus traditional plans and reported significantly higher utilization rates of preventive care services among enrollees of HDHPs. The cross-sectional study design is useful for identifying correlations that can be studied more rigorously in the future. Given that cross-sectional studies require fewer resources to conduct and can be completed in a relatively short period, such studies are well-suited for hypothesis generation (as opposed to hypothesis testing). Cross-sectional studies are frequently used when more rigorous study designs are infeasible or unethical. Cross-sectional studies are limited mainly to identifying simple correlations and can never be used to determine the cause and effect.

Patient Vignettes

Patient vignettes are another study design that has been used to study the effects of HDHPs on various outcomes. Patient vignettes are hypothetical patient scenarios that are presented to
clinicians to elicit the likelihood of these scenarios for making a particular clinical decision on the basis of the patient’s characteristics described in the vignette. For example, Pollack and colleagues (26) used four different patient vignettes that were randomly assigned to primary care clinicians to assess the likelihood of colorectal screening recommendations. Pollack et al. reported that the odds of colonoscopy recommendations were more than 10 times higher for patient vignettes with high socioeconomic status (SES) and low-deductible plans compared with patient vignettes that described patients with low SES in HDHPs. The primary strength of this approach is its ability to manipulate several variables at once in a manner that would not be possible in observational designs. Furthermore, use of patient vignettes helps to avoid some of the ethical dilemmas, such as not giving the treatment to certain patients, which could appear in other designs (14). Major limitations of this approach include concerns about whether hypothetical scenarios genuinely portray the phenomenon of interest and whether clinician responses truly represent the real-world action they would take. Last, critics (14) believe that such studies have limited ability to generalize findings to a larger population.

Randomized Controlled Trials

Randomized controlled trials (RCTs) are considered the gold standard study design for determining cause and effect. In RCTs, researchers define strict inclusion criteria and then randomly assign individuals to either an intervention group or a control group to assess differences in the outcomes of interest in each group. RCTs are considered experimental designs because researchers intervene in the lives of those being studied (as opposed to simply observing study subjects). Strengths of RCTs lie in their ability to minimize the confounding effects of selection bias, which occurs when nonrandom factors (e.g., patient preference) influence the decision to select an intervention (e.g., HDHPs). Because randomization determines who gets assigned to the intervention, the resulting two groups are considered similar with respect to measurable characteristics (e.g., demographics) as well as harder-to-measure characteristics (e.g., health consciousness) that may otherwise influence the relationship of interest. Thus, a fair apples-to-apples comparison is possible to determine whether the intervention caused the differences in outcomes between the two groups.

Drawbacks of RCTs include (a) being relatively expensive to conduct; (b) potentially having ethical and feasibility constraints, depending on the scenario; and (c) being potentially weak on generalizability because subjects who are typically recruited for such studies may differ from the general population. With respect to HDHPs, the only study to use an RCT was the RAND Health Insurance Experiment of the 1970s. The RAND study randomized families to health insurance plans with various cost-sharing requirements, ranging from none (free care) to a high family deductible (95% coinsurance). Individuals in a large deductible plan had a stop-loss limit of $1,000, which is equivalent to $6,000 in 2004 using the rate of increase in medical spending per capita (24). Researchers reported that individuals in the high-deductible plan used 25–30% fewer services than did individuals in the free-care plan. Furthermore, individuals in the high-deductible plan cut back on necessary care and unnecessary care to the same extent. However, rates of preventive services were not differentially affected by cost-sharing arrangements; participants in a free plan used only marginally more preventive services compared with those in cost-sharing plans (including the high-deductible plan). In both study groups, most male adults used no preventive services during the three-year study period (25). Because the RAND study assigned more than 7,000 individuals to various structures of health insurance for a period of 3–5 years (and covered the cost of insurance for all participants), the study costs were approximately $295 million in 2011 dollars (3). Thus, economic constraints have prevented investigators from conducting more recent RCTs. Furthermore, findings from the RAND study may not be applicable to modern society,
given the growth in health care consumerism (17) and greater awareness about the need to use preventive care services on a regular basis compared with trends in the 1970s and 1980s (23). With low prospects of another RCT on the impact of HDHPs, the most useful available contemporary information is likely to come from quasi-experimental studies.

Quasi-Experimental Designs

Several study designs may be considered quasi-experimental. Quasi-experimental designs try to mimic the fairer apples-to-apples comparison achieved by RCTs but are different in the approach they take in creating a treatment group and a control group. Within the HDHP literature, quasi-experimental designs include the difference-in-difference (DID) approach, the use of instrumental variables, and the use of propensity score adjustment or matching (2). Although these studies lack the complete assurances of RCTs in creating comparable groups, they vastly improve the ability to determine cause and effect when compared with other observational study designs, including cross-sectional approaches.

The DID approach is used when an exogenous event exposes a given group of people to an intervention while a similar group exists that is not affected by the event. Ideally, an exogenous event is one that does not allow for individual preference to influence selection into the treatment. However, researchers also use approaches like DID when truly exogenous events are not available. Overall, outcomes before and after the intervention (e.g., implementation of HDHPs) are compared between the intervention group and a nonexposed comparison group. The researcher then observes how the outcome changes within the intervention group (first difference) and within the comparison group (second difference). The second difference is designed to determine what would have happened had the intervention group remained unexposed. Thus, when researchers subtract the second difference from the first (e.g., DID), the resulting change is the effect size attributable to the intervention (10). In the HDHP literature, Buntin and colleagues (4) compared the 2004 to 2005 change in use of preventive care services for families who were first enrolled in HDHPs in 2005 (intervention group) with the change in use of preventive care services for families who remained in conventional plans (comparison group). Using the DID approach, Buntin et al. reported that enrollment in HDHPs was associated with moderate reductions in the use of preventive care.

The propensity score approach creates a control group that is similar to the treatment group by estimating the probability of selection into the treatment group conditional on observed characteristics. Rather than comparing those in a treatment group with those in a control group, propensity scores allow researchers to compare those in the treatment group with controls that, based on their known attributes, had high expected probabilities of being exposed to the treatment. This approach does not eliminate selection bias but rather minimizes its effects. The researcher has to assume that the remaining unknown characteristics of the control group are minor and will not bias the results (19). Once propensity scores are calculated, they can be used in three main ways for subsequent analysis. First, the propensity score can be used as a covariate in addition to the treatment indicator when regressing the outcome of interest. Second, propensity scores can be used to match subjects/individuals in the control group to individuals in the treatment group on the basis of similar predicted probabilities of assignment to treatment (e.g., propensity scores); the researcher then compares the differences in the outcomes of interest between the treated subject and the matched comparison subject to derive an average treatment effect. Third, propensity scores can be used to stratify all subjects into bins (e.g., quintiles or quartiles) on the basis of the estimated scores. These bins then allow the researcher to calculate the treatment effect by estimating the difference in the outcome averaged across bins for those treated versus controls.
the HDHP literature, Wharam and colleagues (38) used propensity scores to predict individuals’ likelihood of being enrolled in an HDHP versus a traditional health maintenance organization (HMO) conditional on observed characteristics. They then matched each HDHP enrollee to an HMO enrollee who had similar likelihood (propensity) to be enrolled. This approach allowed for a fair comparison of outcomes because HDHP enrollees were compared with traditional HMO enrollees who, based on observed characteristics, had similar predicted probabilities of having selected an HDHP. Wharam and colleagues reported that switching to an HDHP was associated with lower colorectal cancer screening rates after two years.

To conclude, given the infeasibility of conducting RCTs, quasi-experimental designs provide the strongest evidence on the effects of HDHPs on various outcomes. Quasi-experimental designs are better than a case study design because they offer a control group to measure the counterfactual change in the outcome over time and can better control for differences in characteristics across the intervention and control groups. Thus, below we summarize the findings from quasi-experimental studies that examined the effects of HDHPs on various outcomes related to preventive care.

Summary of Evidence from Studies Using Quasi-Experimental Designs

Overall, nine studies that used quasi-experimental designs reported that enrollment in HDHPs was associated with a reduction in the use of preventive care (4–6, 12, 16, 37, 38, 41, 42); seven other studies reported no differences (11, 13, 15, 28, 30, 39, 40). The current evidence from studies using quasi-experimental designs is composed of studies that use different study populations, data sources, types of preventive care services, and various time horizons to examine the effects of HDHPs. Even the quasi-experimental studies with the fewest limitations—such as those that used multiple years of data from several employers and examined similar preventive care services—reported different findings. For example, Rowe and colleagues (30) reported no difference in the rates of mammograms among a national sample of HDHP enrollees continuously enrolled for three years. On the contrary, Wharam and colleagues (42) found significant delays in the use of mammograms among women who were continuously enrolled in HDHPs for four years. As a result, it is unclear whether the differences in the effects of HDHPs on the preventive care services are stemming from the differences in the types of populations studied, data sources, or temporal changes (2008 versus 2018). Thus, it is important to identify key variables, such as population types, that can influence the relationships between HDHP enrollment and outcomes and include those variables in the analyses.

Despite that quasi-experimental studies offer the current most useful evidence on the impact of HDHPs, it is important to consider also some of the limitations of existing studies. First, several studies used data from a single employer (5, 12) or a single insurance carrier (5, 6, 12, 30, 38, 39), which limits the generalizability of these studies. Second, several studies used data from firms that entirely replaced an existing traditional plan with an HDHP (5, 12, 15, 37–39). Although a full replacement of plan options is an exogenous event that reduces bias from individual-level selection into an HDHP, it does not account for firm-level selection bias. Firms that choose to switch all their employees into an HDHP may be different from the firms that give their employees options in ways that are difficult to measure and thus account for. Third, existing studies did not typically account for the fact that self-insured employers that offer HDHPs may be different from other firms and payers. Self-insured employers assume the financial risk for providing health care benefits to their employees by paying for claims as they are incurred instead of paying a fixed premium (that includes a profit margin) to an insurance carrier. Thus, self-insured employers may introduce other initiatives, such as on-site clinics and/or wellness programs, to reduce utilization, improve health outcomes, and control costs. Fourth, most existing studies examined short time
horizons (a majority examined only 1 or 2 years post HDHP enrollment) (4–6, 16, 28, 30, 38, 39), thus limiting their ability to detect the potential effects of HDHPs on outcomes that may require longer time frames. For example, rates of preventive care services that are recommended only on a periodic basis (e.g., screening colonoscopy is recommended every 10 years after the age of 50) are not expected to change within only one or two years after enrollment in an HDHP. Thus, it is important to examine screening rates over longer periods of time. Fifth, most of the studies focused on screening rates only, without considering the potential impact of screenings on the rates of early disease detection, treatment, or health outcomes (e.g., mortality). Additionally, most of the existing studies focused only on screening (11, 12, 37–39), ignoring other preventive care services, such as counseling for smoking cessation or receipt of vaccination, which are included among services shown to reduce mortality and reduce costs (20). Of note, most studies (4, 11, 13, 15, 30, 37–39) did not specify the level of the deductible, making it difficult to examine whether a dose-response effect exists for different levels of HDHPs. Sixth, given that many published studies reported no effect from HDHPs, these studies may have been underpowered to detect a statistical change in outcomes.

AREAS FOR FUTURE RESEARCH

On the basis of the knowledge gaps and limitations of the existing literature, we offer several recommendations for future studies aimed at further developing our understanding of how HDHPs affect preventive care. First, future research should examine a wider range of prevention-related outcomes, such as vaccination and smoking cessation, to gain a better understanding of the potential effects of HDHPs on a wider set of preventive services. The literature is currently limited to studies that examined screening services. Second, additional research is needed to better understand why most studies have found detrimental effects from HDHPs, whereas a smaller number show no ill effects. It is important to know whether the type of population studied, the specific outcomes examined, or some other factor can explain the variability in findings observed in the current literature. Third, researchers should design studies that can detect whether HDHPs have a differential impact on subsets of a population. For example, do HDHPs affect vulnerable populations differently than others do? Does chronic disease status, age, or geographic location matter? Finally, given that preventive services are exempt from out-of-pocket spending among those with HDHPs, considerable attention should be dedicated to identifying the most effective approaches to educate such enrollees and their providers and payers about the structure of their insurance plans.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

LITERATURE CITED

27. Reed ME, Graetz I, Fung V, Newhouse JP, Hsu J. 2012. In consumer-directed health plans, a majority of patients were unaware of free or low-cost preventive care. *Health Aff.* 31:2641–48
Contents

Symposium: Causal Inference and Public Health

Introduction to the Symposium: Causal Inference and Public Health
   Allison E. Aiello and Lawrence W. Green .............................................. 1

Commentary: Causal Inference for Social Exposures
   Jay S. Kaufman ............................................................... 7

Causal Modeling in Environmental Health
   Marie-Abèle Bind ............................................................ 23

Making Health Research Matter: A Call to Increase Attention to External Validity
   Amy G. Huebschmann, Ian M. Leavitt, and Russell E. Glasgow ............... 45

Epidemiology and Biostatistics

Introduction to the Symposium: Causal Inference and Public Health
   Allison E. Aiello and Lawrence W. Green .............................................. 1

Commentary: Causal Inference for Social Exposures
   Jay S. Kaufman ............................................................... 7

Causal Modeling in Environmental Health
   Marie-Abèle Bind ............................................................ 23

Making Health Research Matter: A Call to Increase Attention to External Validity
   Amy G. Huebschmann, Ian M. Leavitt, and Russell E. Glasgow ............... 45

Causes and Patterns of Dementia: An Update in the Era of Redefining Alzheimer’s Disease
   Bryan D. James and David A. Bennett .................................................. 65

Earth Observation: Investigating Noncommunicable Diseases from Space
   Peng Jia, Alfred Stein, Peter James, Ross C. Brownson, Tong Wu,
   Qian Xiao, Limin Wang, Clive E. Sabel, and Youfa Wang ......................... 85

Racism and Health: Evidence and Needed Research
   David R. Williams, Jourdyn A. Lawrence, and Brigette A. Davis ................ 105
Social Environment and Behavior

Making Health Research Matter: A Call to Increase Attention to External Validity
Amy G. Huebschmann, Ian M. Leavitt, and Russell E. Glasgow 45

Interventions to Support Behavioral Self-Management of Chronic Diseases
John P. Allegrante, Martin T. Wells, and Janey C. Peterson 127

Policies of Exclusion: Implications for the Health of Immigrants and Their Children
Krista M. Perreira and Juan M. Pedroza 147

Television News Coverage of Public Health Issues and Implications for Public Health Policy and Practice
Sarah E. Gollust, Erika Franklin Fowler, and Jeff Niederdeppe 167

The Use of Excise Taxes to Reduce Tobacco, Alcohol, and Sugary Beverage Consumption
Frank J. Chaloupka, Lisa M. Powell, and Kenneth E. Warner 187

Environmental and Occupational Health

Causal Modeling in Environmental Health
Marie-Abéle Bind 23

Ambient Air Pollution, Noise, and Late-Life Cognitive Decline and Dementia Risk
Kimberly C. Paul, Mary Haan, Elizabeth Rose Mayeda, and Beate R. Ritz 203

Brain and Salivary Gland Tumors and Mobile Phone Use: Evaluating the Evidence from Various Epidemiological Study Designs
Martin Röösli, Susanna Lagorio, Minouk J. Schoemaker, Joachim Schüz, and Maria Feychting 221

Environmental Exposures and Depression: Biological Mechanisms and Epidemiological Evidence
Matilda van den Bosch and Andreas Meyer-Lindenberg 239

Global Environmental Change and Noncommunicable Disease Risks
Howard Frumkin and Andy Haines 261

Hazardous Air Pollutants Associated with Upstream Oil and Natural Gas Development: A Critical Synthesis of Current Peer-Reviewed Literature
Diane A. García-Gonzales, Seth B.C. Shonkoff, Jake Hays, and Michael Jerrett 283
Health Impact Assessment of Transportation Projects and Policies: Living Up to Aims of Advancing Population Health and Health Equity?  
Brian L. Cole, Kara E. MacLeod, and Raenita Spriggs ........................................ 305

Public Health Practice and Policy

The Use of Excise Taxes to Reduce Tobacco, Alcohol, and Sugary Beverage Consumption  
Frank J. Chaloupka, Lisa M. Powell, and Kenneth E. Warner .............................. 187

Aligning Programs and Policies to Support Food Security and Public Health Goals in the United States  
Hilary K. Seligman and Seth A. Berkowitz .......................................................... 319

Happiness and Health  
Andrew Steptoe ........................................................................................................... 339

Realist Synthesis for Public Health: Building an Ontologically Deep Understanding of How Programs Work, For Whom, and In Which Contexts  
Justin Jagosh ................................................................................................................ 361

The Economic Case for the Prevention of Mental Illness  
David McDaid, A-La Park, and Kristian Wahlbeck .............................................. 373

The Next Generation of Diabetes Translation: A Path to Health Equity  
Debra Haire-Joshu and Felicia Hill-Briggs ............................................................. 391

Health Services

High-Deductible Health Plans and Prevention  
Olena Mazurenko, Melinda J.B. Buntin, and Nir Menachemi ............................. 411

Innovations in Mixed Methods Evaluations  
Lawrence A. Palinkas, Sapna J. Mendon, and Alison B. Hamilton ..................... 423

School Health as a Strategy to Improve Both Public Health and Education  
Lloyd J. Kolbe .......................................................................................................... 443

Solving Homelessness from a Complex Systems Perspective: Insights for Prevention Responses  
Patrick J. Fowler, Peter S. Hovmand, Katherine E. Marcal, and Sammay Das ....... 465
The Digitization of Patient Care: A Review of the Effects of Electronic Health Records on Health Care Quality and Utilization

Hilal Atasoy, Brad N. Greenwood, and Jeffrey Scott McCullough

Indexes

Cumulative Index of Contributing Authors, Volumes 31–40
Cumulative Index of Article Titles, Volumes 31–40

Errata

An online log of corrections to Annual Review of Public Health articles may be found at http://www.annualreviews.org/errata/publhealth