L.A. Care
HEALTH PLAN

Tobacco Cessation Provider Toolkit

2015

Dear Doctor:

L.A. Care Health Plan is pleased to provide you with this copy of the Tobacco Cessation Quality Improvement Toolkit. Tobacco use represents an important public health challenge that is preventable. Tobacco use remains the single largest preventable cause of death and disease in the United States. In Los Angeles County, tobacco use claims 8,500 lives annually, tobacco-related diseases cost $4.3 billion dollars each year, and the current smoking prevalence is 14%. Smoking during pregnancy is associated with premature birth, low infant birth weight, miscarriage and complications of pregnancy. Additionally, smokers expose others to secondhand smoke which causes other health problems, including a 20-30% increased risk for lung cancer for non-smokers exposed to secondhand smoke at home.

L.A. Care Health Plan is taking an active role in addressing this personal and public health challenge. This toolkit is an example of our efforts to assist you with the evaluation and management of this condition. More effective education, monitoring and treatment of tobacco use can improve patients' quality of life, and reduce avoidable ER visits and hospitalizations.

Evidence based guidelines now recommend initial and annual monitoring of each member for tobacco use. This toolkit offers clinical guidelines and patient education materials to assist you in the care of your members.

We hope you find the enclosed guidelines and patient education materials useful. We urge you to utilize the information and resources we have provided and to join us in the tobacco cessation effort.

Thank you for joining us in this effort. Please contact Jasmine A. Mines, MPH, CHES at (213) 694-1250 ext. 4937 or email jmines@lacare.org or Callum James, RN at (213) 694-1250 ext. 6383 or email cjames@lacare.org if you have questions, would like to provide feedback, or would like further information.

Sincerely,

Gertrude S. Carter, M.D.

Trudi S. Carter, MD
Chief Medical Officer

http://www.cdc.gov/tobacco/campaign/tips/resources/data/cigarette-smoking-in-united-states.html
http://publichealth.lacounty.gov/ha/reports/habriefs/2007/Cigarette_Smoking_Cities_finalS.pdf

Tobacco Cessation Provider Toolkit

Contents		Material Sources
C. Additional Resources (cont.)		
9	Tobacco Cessation Community Resources	L.A. Care Health Plan
10	Additional Materials available: L.A. Care Website @ http://www.lacare.org http://www.lacare.org/providers/resources/healtheducation/order-form	L.A. Care Health Plan
D. Member Health Education Resources		
1	Annual Tobacco Cessation Mailing All L.A. Care Members Receive (English/Spanish)	L.A. Care Health Plan
2	Quitting Smoking During Pregnancy (English/Spanish)	L.A. Care Health Plan
3	Quitting Smoking for Older Adults (English/Spanish)	L.A. Care Health Plan
4	Quitting Smoking for Teens (English/Spanish)	L.A. Care Health Plan

MINIMUM REQUIREMENTS FOR TOBACCO CESSATION SERVICES

L.A. Care HEALTH PLAN

OVERVIEW

As per MMCD Policy Letter 14-006, effective **November 1, 2014,** Primary Care Physicians (PCPs) are required to adhere to the following minimum requirements for tobacco cessation services for Medi-Cal members. The full policy letter can be found at: http://tinyurl.com/pxpe2j5

At minimum, PCPs must:

- Conduct an initial and annual assessment of tobacco use for each member (in addition, pregnant women are to be asked about their exposure to tobacco)
- Document tobacco use in the patient's medical record
- Ask tobacco users about tobacco status at every visit
- Complete an Individual Comprehensive Health Assessment, including the Staying Healthy Assessment (SHA), for all new patients within 120 days of enrollment

Tobacco Cessation Service Requirements

Tobacco cessation medications and services are covered for at least two separate quit attempts per year.

Tobacco Cessation Medications:

Health Plan	Nicotine patches	Nicotine gum	Nicotine lozenges	Nicotine nasal spray	Nicotine inhaler	Bupropion (Zyban) & SR (Wellbutrin)	Varenicline (Chantix)
Care1st Health Plan	PA required, smoking certificate no longer needed	PA required, smoking certificate no longer needed	PA required, smoking certificate no longer needed	PA required, smoking certificate no longer needed	PA required, smoking certificate no longer needed	Formulary, no PA or ST requirement	PA required, smoking certificate no longer needed
Anthem	Formulary	Formulary	Formulary	PA	PA	Formulary	PA
L.A. Care Health Plan	Formulary, no PA or ST requirement	Formulary, no PA or ST requirement	Formulary, no PA or ST requirement	Formulary, no PA or ST requirement	Formulary, no PA or ST requirement	Formulary, no PA or ST requirement	Formulary, with PA requirement

PA= Prior Authorization ST= Step Therapy

Individual, Group and Telephonic Counseling

- Individual, group, and telephonic counseling must be offered.
    - Refer to L.A. Care Health Education at http://tinyurl.com/qce58cd
    - CA Smoker's Helpline, 1-800-NO-BUTTS
    - Healthycity.org
    - Pregnant women must be offered at least one face-to-face counseling session per quit attempt.
    - School aged children and adolescents must be provided interventions to prevent tobacco use.
- 5 A's of Tobacco Cessation Counseling
    - Providers are encouraged to use the 5 A's when counseling patients: Ask, Advise, Assess, Assist, and Arrange.

Physician Training and Monitoring

For more information and additional training, including L.A. Care's Tobacco Cessation Provider Toolkit, please visit www.lacare.org. L.A. Care will monitor provider adherence to the new tobacco cessation requirements. Details to follow. Please call the Provider Service Line at 1-866-522-2736 with questions.

State of California—Health and Human Services Agency
Department of Health Care Services

TOBY DOUGLAS
Director

EDMUND G. BROWN JR.
Governor

DATE: SEPTEMBER 3, 2014

POLICY LETTER 14-006

TO: ALL MEDI-CAL MANAGED CARE HEALTH PLANS

SUBJECT: COMPREHENSIVE TOBACCO CESSATION SERVICES FOR MEDI-CAL MEMBERS; PREVENTING TOBACCO USE IN CHILDREN AND ADOLESCENTS

PURPOSE:
The purpose of this Policy Letter (PL) is to provide Medi-Cal managed care health plans (MCPs) with minimum requirements for comprehensive tobacco cessation services.

BACKGROUND:
Tobacco use is the leading preventable cause of death in the United States and Medi-Cal members have a higher prevalence of tobacco use than the general California population.[1]

Tobacco cessation services have been demonstrated to be both clinically effective and cost effective.[2] Research shows a return on investment of 3:1 for dollars spent on smoking cessation services in Medicaid populations.[3]
The Department of Health Care Services' (DHCS) Medi-Cal managed care contracts require MCPs to provide all preventive services identified as United States Preventive Services Task Force (USPSTF) grade "A" and "B" recommendations. The USPSTF recommends (grade A) that health care providers ask all individuals ages 18 and older about tobacco use and that providers offer cessation interventions to those who use tobacco products.

[1] UCLA Center for Health Policy Research, "California Health Interview Survey, 2011 to 2012," http://healthpolicy.ucla.edu/chis/design/Pages/questionnairesEnglish.aspx.
[2] 2008 US Public Health Service Clinical Practice Guideline, "Treating Tobacco Use and Dependence," http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/index.html.
[3] Patrick, R. West K, Ku L, "The Return on Investment of a Medicaid Tobacco Cessation Program in Massachusetts," PLOS One, January 6, 2012, http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0029665.

Augmented pregnancy tailored counseling should be offered to pregnant women who smoke.[4] Successful implementation strategies for primary care practice include instituting a tobacco user identification system, promoting clinician intervention, and dedicating staff to provide treatment. The USPSTF also recommends (grade B) that primary care clinicians provide interventions, including education or brief counseling, to prevent initiation of tobacco use in school-aged children and adolescents.[5]

Additional federal guidance is contained in "Clinical Practice Guideline, Treating Tobacco Use and Dependence: 2008 Update" [6] which was sponsored by the U.S. Department of Health and Human Services, Public Health Service (USPHS). A summary is included in Attachment A.

REQUIREMENTS:

Tobacco Cessation Services
Effective November 1, 2014, MCPs shall implement and cover payment of the following tobacco cessation services:

1. Initial and annual assessment of tobacco use for each adolescent and adult member.

   MCPs must ensure that providers identify (initially and annually) all members (of any age) who use tobacco products and note this use in the member's medical record. MCPs must ensure that providers document the following:

   - A completed Individual Comprehensive Health Assessment, which includes the Individual Health Education Behavioral Assessment (IHEBA), for all new members within 120 days of enrollment per PL 08-003.[7] The Staying Healthy Assessment (SHA) is DHCS's IHEBA per PL 13-001 (Revised). Each age-appropriate SHA questionnaire asks about smoking status and/or exposure to tobacco smoke;[8]

---

[4] United States Preventive Services Task Force, "Counseling and Interventions to Prevent Tobacco Use and Tobacco-Caused Disease in Adults and Pregnant Women," http://www.uspreventiveservicestaskforce.org/uspstf09/tobacco/tobaccors2.htm.
[5] United States Preventive Services Task Force, "Primary Care Interventions to Prevent Tobacco Use in Children and Adolescents," http://www.uspreventiveservicestaskforce.org/uspstf/uspstbac.htm.
[6] Fiore MC, Jaén CR, Baker TB, et al. "Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline." Rockville, MD. U.S. Department of Health and Human Services. Public Health Service. May 2008.
[7] Previous MMCD PLs are available at: http://www.dhcs.ca.gov/formsandpubs/Pages/PolicyLetters.aspx.
[8] California Department of Health Care Services, "Staying Healthy Assessment," http://www.dhcs.ca.gov/formsandpubs/forms/pages/stayinghealthy.aspx#.

- Tobacco use status for every member at least once per year. Since the IHEBA must be reviewed or re-administered on an annual basis, smoking status can be re-assessed through the use of the SHA; and
- That they have asked tobacco users about tobacco use at every visit.

2. FDA-approved tobacco cessation medications (non-pregnant adults of any age).
    - MCPs must cover all seven FDA-approved tobacco cessation medications: bupropion SR, Varenicline, nicotine gum, nicotine inhaler, nicotine lozenge, nicotine nasal spray, and the nicotine patch for adults who smoke or use other tobacco products. At least one must be available without prior authorization;
    - MCPs must provide a 90-day treatment regimen of medications without other requirements, restrictions, or barriers;
    - MCPs must cover any additional medications once approved by the FDA to treat tobacco use;
    - While counseling is encouraged, MCPs may not require members to attend classes or counseling sessions prior to receiving a prescription for an FDA-approved tobacco cessation medication. Studies have shown that quit attempts are more likely to be successful when policies remove barriers to tobacco cessation treatment, including prior authorizations or limitations on treatments;[9] and
    - MCPs must cover a minimum of two separate quit attempts per year, with no mandatory break required between quit attempts.

3. Individual, group, and telephone counseling for members of any age who use tobacco products.
    - MCPs must ensure that individual, group, and telephone counseling is offered to members who wish to quit smoking, whether or not those members opt to use tobacco cessation medications;
    - MCPs must ensure that four counseling sessions of at least 10 minutes in duration are covered for at least two separate quit attempts per year without

[9] Centers for Disease Control and Prevention. State Medicaid Coverage for Tobacco Cessation Treatments and Barriers to Coverage — United States, 2008–2014, MMWR, March 28, Volume 63, Number 12.

prior authorization. MCPs must offer individual, group, and telephone counseling without cost to the members; and

- MCPs must ensure that providers refer members to the California Smokers' Helpline (1-800-NO-BUTTS), a free statewide quit smoking service operated by the University of California San Diego (see below) or other comparable quit line services. MCPs should encourage providers to use the "5 A's" model or other validated behavior change model when counseling patients.[10]

4. Services for pregnant tobacco users.

   At a minimum, MCPs must ensure that providers:

   - Ask all pregnant women if they use tobacco or are exposed to tobacco smoke; and
   - Offer all pregnant smokers at least one face-to-face counseling session per quit attempt. Face-to-face tobacco-cessation counseling services may be provided by or under supervision of a physician, legally authorized to furnish such services under state law. MCPs must also ensure that pregnant women are referred to a tobacco cessation quit line. These counseling services must be covered for 60 days after delivery plus any additional days up to the end of the month.

   Since smoking cessation medication is not recommended during pregnancy, MCPs should alert clinicians to refer to the tobacco cessation guidelines by the American College of Obstetrics and Gynecology before considering offering tobacco cessation medication during pregnancy. MCPs are encouraged to post these guidelines on their websites.

5. Prevention of tobacco use in children and adolescents.

   MCPs must ensure primary care clinicians provide interventions, including education or brief counseling, to prevent initiation of tobacco use in school-aged children and

[10] Improving Chronic Illness Care, "5 A's Behavior Change Model, Adapted for Self-Management Support Improvement," http://www.improvingchroniccare.org/downloads/3.5_5_as_behaviior_change_model.pdf; and Agency for Healthcare Research and Quality, "Five Major Steps to Intervention (The "5A's)," http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/5steps.html.

adolescents. Anticipatory guidance as outlined in the American Academy of Pediatrics Bright Futures is recommended.[11]

6. Provider training.

   MCPs shall use the USPHS "Clinical Practice Guideline, Treating Tobacco Use and Dependence: 2008 Update," which is one of the supporting documents to the USPSTF recommendations. MCPs are also encouraged to use any updates to inform and educate clinicians regarding effective strategies and approaches for providing tobacco cessation treatment for all populations, including specific recommendations for pregnant women. MCPs should encourage providers to implement these comprehensive tobacco use treatment recommendations.

   MCPs should include tobacco cessation training with other provider trainings as required in DHCS contracts. These trainings must include:

   - New requirements for comprehensive tobacco cessation member services included in this PL;
   - Overview of the "Clinical Practice Guideline, Treating Tobacco Use and Dependence: 2008;"
   - How to use and adopt the "5 A's" or other validated model for treating tobacco use and dependence in the provider's clinic practice; and
   - Special requirements for providing services for pregnant tobacco users.

   MCPs should also inform providers about available online courses in tobacco cessation. Resources are listed in Attachment B.

Monitoring and Evaluation

MCPs must institute a tobacco user identification system in primary care practices, per USPSTF recommendations. In addition, MCPs should develop a system to monitor provider performance in implementing tobacco cessation interventions. Results should guide MCP and provider efforts to strengthen tobacco use screening and cessation interventions, and to determine if the prevalence of smoking decreases over time. At a minimum, measures for adults should include results from tobacco questions in the CAHPS survey.

---

[11] American Academy of Pediatrics Bright Futures, "Performing Preventive Services: A Bright Futures Handbook." https://brightfutures.aap.org/pdfs/Preventive%20Services%20PDFs/Anticipatory%20Guidance.PDF.

California Smokers' Helpline
The Public Health Service Guideline recommends the use of tobacco quit lines in addition to services offered by clinicians and health systems. The California Smokers' Helpline (1-800-NO-BUTTS) is a free statewide quit smoking service operated by the University of California San Diego's Moore's Cancer Center.[12] The Helpline offers self-help materials, referral to local programs, and one-on-one telephone counseling to quit smoking. Helpline services have been proven in clinical trials to double a smoker's chances of successfully quitting. Services are available in six languages (English, Spanish, Cantonese, Mandarin, Korean, and Vietnamese), and specialized services are available for teens, pregnant women, and tobacco chewers. The Helpline also provides information for friends and family members of tobacco users.

For more information about the Helpline, contact the Communications and Partner Relations Department at:

California Smokers' Helpline
9500 Gilman Drive, Mail Code #0905
La Jolla, CA 92093-0905
(858) 300-1010
cshoutreach@ucsd.edu

For questions about this PL, contact your Medi-Cal Managed Care Division Contract Manager.

Sincerely,

Original Signed by Margaret Tatar

Margaret Tatar
Acting Deputy Director
Health Care Delivery Systems

Attachments

[12] Additional information is available at: UC San Diego's Moore's Cancer Center, http://cancer.ucsd.edu/.

Attachment A: Summary of "2008 US Public Health Services Guidelines: Treating Tobacco Use and Dependence" and Additional Background

For the general population (nonpregnant adults):

1. Because tobacco dependence is a chronic condition that often requires repeated intervention, multiple attempts to quit may be required. At least two quit attempts per year should be covered;

2. While counseling and medication are both effective in treating tobacco use when used alone, they are more effective when used together; and

3. While individual, group, and telephone counseling are effective in treating tobacco use, effectiveness increases with treatment intensity.

   Note that federal guidance for implementation of the Patient Protection and Affordable Care Act (ACA) recommends the following coverage for each cessation attempt:

   i. Four tobacco cessation counseling sessions of at least 10 minutes each (including telephone counseling, group counseling, and individual counseling) without prior authorization; and

   ii. All Food and Drug Administration (FDA)-approved tobacco cessation medications (including both prescription and over-the-counter medications) for a 90-day treatment regimen when prescribed by a health care provider without prior authorization.

For pregnant women:

1. Because of the serious risk of smoking to the pregnant smoker and fetus, whenever possible, pregnant smokers should be offered tailored one-on-one counseling that exceeds minimal advice to quit; and

2. Pharmacotherapy is not recommended for pregnant women because there is insufficient evidence on the safety and effectiveness of pharmacotherapy in pregnant women.

   Note that the ACA (Section 4107) authorizes coverage of counseling and pharmacotherapy for tobacco cessation for pregnant women. American Academy of Obstetricians and Gynecologists recommends clinical interventions and strategies for pregnant women who smoke. (American Congress of Obstetricians and Gynecologists, "Smoking Cessation During Pregnancy: Committee Opinion," available at:

http://www.acog.org/Resources_And_Publications/Committee_Opinions/Committee_on_Health_Care_for_Underserved_Women/Smoking_Cessation_During_Pregnancy)

For children and adolescents:

1. Counseling is recommended for adolescents who smoke, because it has been shown to be effective in treating adolescent smokers; and

2. Counseling in a pediatric setting of parents who smoke has also shown to be effective and is recommended. Secondhand smoke can be harmful to children.

   Note that coverage of medically necessary tobacco cessation services, including both counseling and pharmacotherapy, is mandatory for children up to age 21 under Medicaid's Early and Periodic Screening, Diagnostic and Treatment benefit. This benefit includes the provision of anticipatory guidance and risk-reduction counseling regarding tobacco use.

Attachment B: Provider Trainings and Resources

Overview of the "Clinical Practice Guideline, Treating Tobacco Use and Dependence: 2008 Update" (SDL # 11-007): http://bphc.hrsa.gov/buckets/treatingtobacco.pdf.

Continuing Medical Education (CME)-accredited training on tobacco cessation and behavioral health: https://cmecalifornia.com/Activity/1023974/Detail.aspx.

Other cessation trainings: http://www.centerforcessation.org/training.html.

University of California San Francisco's (UCSF) Smoking Cessation Leader Center's tools and resources: http://smokingcessationleadership.ucsf.edu/Resources.htm

UCSF's Smoking Cessation Leadership Center Webinars for CME/Continuing Education Unit credit: http://smokingcessationleadership.ucsf.edu/Webinarscme.htm.

California Smokers' Helpline/Center for Tobacco Cessation: http://centerforcessation.org/training.html.

Medical Incentive to Quit Smoking Project: http://www.nobutts.org/migs/.

Five Major Steps to Intervention (The "5A's")

Successful intervention begins with identifying users and appropriate interventions based upon the patient's willingness to quit. The five major steps to intervention are the "5 A's": Ask, Advise, Assess, Assist, and Arrange.

Tobacco is the single greatest preventable cause of disease and premature death in America today.

"Starting today, every doctor, nurse, health plan, purchaser, and medical school in America should make treating tobacco dependence a top priority."

David Satcher, MD, Ph.D.
Former U.S. Surgeon General
Director, National Center for Primary Care, Morehouse School of Medicine

Ask

Identify and document tobacco use status for every patient at every visit. (You may wish to develop your own vital signs sticker, based on the sample below).

Advise

In a clear, strong, and personalized manner, urge every tobacco user to quit.

Assess

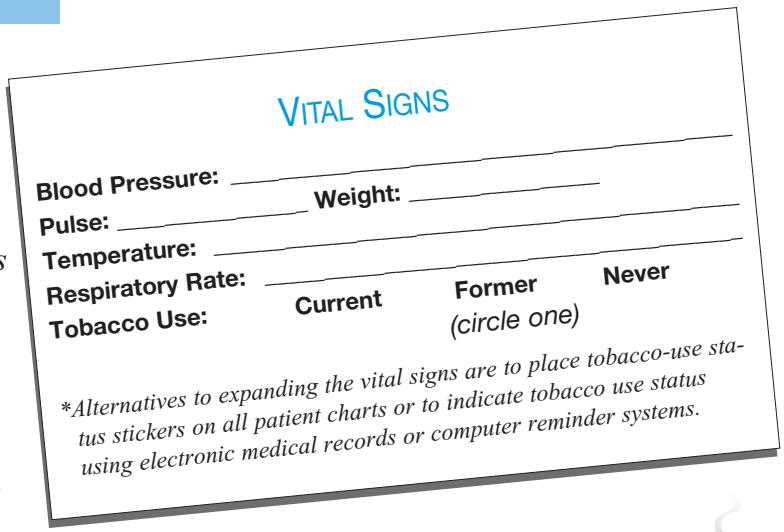
Is the tobacco user willing to make a quit attempt at this time?

Assist

For the patient willing to make a quit attempt, use counseling and pharmacotherapy to help him or her quit. (See *Counseling Patients To Quit* and pharmacotherapy information in this packet).

Arrange

Schedule followup contact, in person or by telephone, preferably within the first week after the quit date.



special report

Treating Tobacco Use and Dependence*

An Evidence-Based Clinical Practice Guideline for Tobacco Cessation

Jane E. Anderson, MD, MS; Douglas E. Jorenby, PhD; Walter J. Scott, MD, FCCP; and Michael C. Fiore, MD, MPH

The prevention of tobacco-related morbidity and mortality through smoking cessation intervention is among the most vital missions of the chest clinician. This article summarizes the major findings and clinical recommendations of the US Department of Health and Human Services/ Public Health Service Guideline, *Treating Tobacco Use and Dependence*, which is a comprehensive, evidence-based blueprint for smoking cessation. By becoming fluent in the clinical interventions and by implementing the simple institutional changes described in this article and in the guideline, chest clinicians can more effectively intervene with their patients who smoke.
(CHEST 2002; 121:932–941)

Key words: clinical guidelines; evidence-based medicine; pharmacotherapy; smoking cessation; tobacco dependence

Abbreviations: ACCP = American College of Chest Physicians; NRT = nicotine replacement therapy

The American College of Chest Physicians (ACCP) has been actively involved since 1960 in reducing the health burden caused by tobacco use. The ACCP, in conjunction with five other international organizations, released a report in 1995 entitled "Smoking and Health: Physician Responsibility." In this position statement, the ACCP recognized that "tobacco use is the single most important preventable risk to human health in developed countries and an important cause of premature death worldwide."[1]

*From the Center for Tobacco Research and Intervention (Drs. Anderson, Jorenby, and Fiore), University of Wisconsin Medical School, Madison, WI; and the School of Medicine (Dr. Scott), Creighton University, Omaha, NE.

Dr. Jorenby has given lectures or has conducted research sponsored by Ciba-Geigy, SmithKline Beecham, Lederle Laboratories, McNeil Consumer Products, Elan Pharmaceutical, Glaxo Wellcome, and Knoll Pharmaceutical. Dr. Scott has given lectures sponsored by Bristol-Myers Squibb. Dr. Fiore has served as a consultant for, given lectures sponsored by, or has conducted research sponsored by Ciba-Geigy, SmithKline Beecham, Lederle Laboratories, McNeil Consumer Products, Elan Pharmaceutical, Pharmacia, and Glaxo Wellcome.

Manuscript received May 30, 2001; revision accepted July 20, 2001.

Correspondence to: Michael C. Fiore, MD, MPH, University of Wisconsin Medical School, 1930 Monroe St, Suite 200, Madison, WI 53711-2027; e-mail: mcf@ctri.medicine.wisc.edu

A principal goal of the ACCP is to reduce the prevalence of tobacco use through smoking cessation. Chest clinicians are well-positioned to intervene with their patients who smoke. Frequently, the comorbidity of smoking manifests itself in the form of angina, coronary artery disease, lung cancer, bronchitis, COPD, myocardial infarction, and asthma. Each year, $>70\%$ of all smokers make at least one visit to a physician.[2] Approximately 35% of smokers report having made a serious attempt to quit smoking over the last year,[3] and 80% report an attempt to quit sometime in their past.[4] A population-based survey[5] found that $<15\%$ of smokers who saw a physician in the past year were offered assistance in quitting smoking, and only 3% had a follow-up appointment to address tobacco use.

In countries that report deaths that are attributable to smoking, cigarettes were responsible for an estimated 21 million deaths from 1990 to 1999, with more than half of those deaths occurring in people 35 to 69 years of age.[1] The 1990 report of the Surgeon General differentiates smoking-related deaths in the United States by disease category. Cigarette smoking accounts annually for an esti-

Table 1—*Key Clinical Practice Guideline Recommendations

Recommendation No.	Description
1	Tobacco dependence is a chronic condition that often requires repeated interventions; however, effective treatments exist that can produce long-term or even permanent abstinence.
2	Because effective tobacco-dependence treatments are available, every patient who uses tobacco should be offered at least one of these treatments: Patients willing to try to quit tobacco should be provided with treatments that are identified as effective in the guideline; and Patients unwilling to try to quit tobacco use should be provided with a brief intervention that is designed to increase their motivation to quit.
3	It is essential that clinicians and health-care delivery systems (including administrators, insurers, and purchasers) institutionalize the consistent identification, documentation, and treatment of every tobacco user who is seen in a health-care setting.
4	Brief tobacco-dependence treatment is effective, and every patient who uses tobacco should be offered at least brief treatment.
5	There is a strong dose-response relationship between the intensity of tobacco-dependence counseling and its effectiveness; treatments involving person-to-person contact (via individual, group, or proactive telephone counseling) are consistently effective, and their effectiveness increases with treatment intensity (*eg*, minutes of contact).
6	Three types of counseling and behavioral therapies were found to be especially effective and should be used with all patients who are attempting tobacco use cessation: Provision of practical counseling (problem solving/skills training); Provision of social support as part of treatment (intratreatment social support); and Help in securing social support outside of treatment (extratreatment social support).
7	Numerous effective pharmacotherapies for smoking cessation now exist; except in the presence of contraindication, these should be used with all patients who are attempting to quit smoking. Five first-line pharmacotherapies were identified that reliably increase long-term smoking abstinence rates: Bupropion SR Nicotine patch Nicotine gum Nicotine inhaler Nicotine nasal spray
8	Tobacco-dependence treatments are both clinically effective and cost-effective relative to other medical and disease prevention interventions; as such, insurers and purchasers should ensure that: All insurance plans include, as a reimbursed benefit, the counseling and pharmacotherapeutic treatments that are identified as being effective in this guideline; and Clinicians are reimbursed for providing tobacco-dependence treatment just as they are reimbursed for treating other chronic conditions.

*Table adapted from Fiore et al.[10]

mated 115,000 deaths from heart disease, 106,000 deaths from lung cancer, 32,000 deaths from other cancers, 57,000 deaths from COPD, and 27,500 deaths from strokes.[6] In addition to this extraordinary clinical toll, the annual direct burden of smoking is estimated to exceed $50 billion, which is about one tenth of all health-care costs in the United States each year.[7] Currently, 26.4% of adult men and 22.0% of adult women in the United States smoke, representing 47.2 million lives.[8]

In 1996, the Agency for Health Care Policy and Research released *Smoking Cessation: A Clinical Practice Guideline*.[9] This was the first comprehensive, evidence-based guideline for the clinical treatment of tobacco addiction, and it represented a review of > 3,000 articles on tobacco addiction that had been published from 1975 to 1994. The guideline was designed to provide clinicians and others with specific information regarding effective cessation treatments. The ACCP participated in the dissemination and implementation of the original guideline recommendations.

Since the publication of the original guideline, there has been a wealth of new research in the field of tobacco dependence. An additional 3,000 articles on tobacco were published between 1995 and 1999. As a result, an updated version of the guideline (*Treating Tobacco Use and Dependence: An Evidence-Based Clinical Practice Guideline for Tobacco Cessation*[10]) was released in 2000. The new guideline is based on a screening and review of a total 6,000 articles, with a smaller number of articles meeting select criteria for data analysis (primarily meta-analysis as discussed in the original guideline[9]) and panel opinion. A draft of the guideline was peer-reviewed, and the final publication incorporates the comments of 70 external reviewers.

The ACCP position statement advocates as a

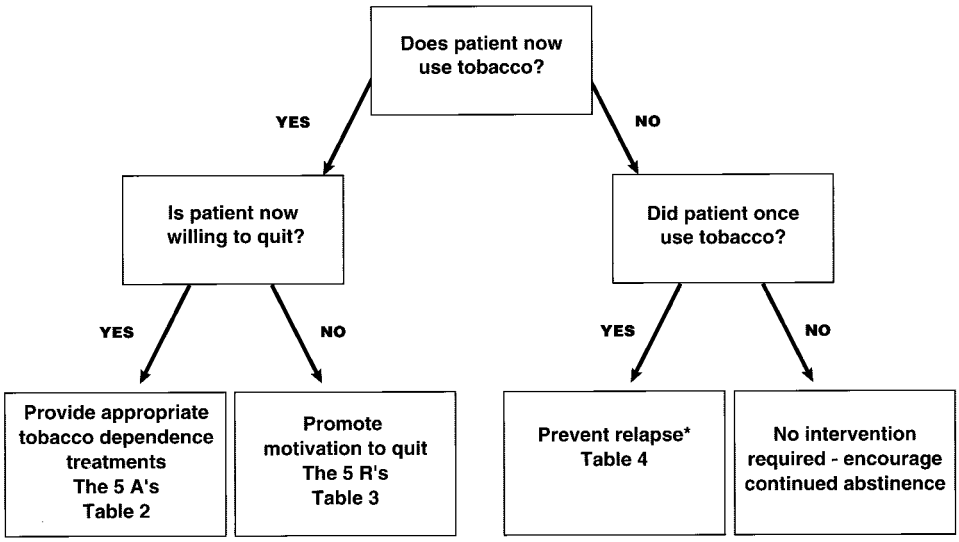


FIGURE 1. Algorithm to guide clinical tobacco intervention.

mandatory element of high-quality care for every patient, the "frank discussion of personal health risks, the benefits of smoking cessation, and available methods to assist in stopping smoking."[1] This article will highlight the key strategies and recommendations that are pertinent to the chest clinician in delivering effective interventions for tobacco cessation, which fulfills the mandate for high-quality patient care.

SPECIFIC GUIDELINE RECOMMENDATIONS

Treating Tobacco Use and Dependence outlines specific strategies for clinicians, the steps necessary to effectively and efficiently identify smokers, to motivate them to make an attempt to quit, and to support them in quitting successfully through counseling, pharmacotherapy, and follow-up. The guideline panel provided key recommendations for all clinicians (Table 1). Select recommendations are discussed below.

Recommendation 1

Tobacco dependence is a chronic condition that often requires repeated intervention. However, effective treatments exist that can produce long-term or even permanent abstinence.

One of the central tenets of the 2000 guideline is the recognition of tobacco dependence as a chronic disease. Tobacco addiction carries a vulnerability to relapse that persists over time and often requires repeated intervention. This places responsibility on the chest clinician to provide ongoing counseling, support, and appropriate pharmacotherapy, just as for other chronic diseases such as hypertension or hypercholesterolemia. While not every smoker who presents to a clinic setting is willing to commit to an attempt to quit smoking during that visit, treatments should be offered at every visit to maximize the patient's chance of success.

Recommendation 3

It is essential that clinicians and health-care delivery systems institutionalize the consistent identification, documentation, and treatment of every tobacco user who is seen in a health-care setting.

The first step in treating tobacco use and dependence is to identify tobacco users. The effective identification of tobacco use status not only opens the doors for successful interventions but also guides clinicians to identify appropriate interventions based on a patient's willingness to quit. The guideline panel recommended the implementation of an office-wide protocol that systematically solicits and documents the tobacco-use status of each patient at every visit. This can be done effectively by expanding the number of vital signs to include smoking status or by placing an appropriate tobacco-use sticker on all patient charts. In clinical settings where tobacco use has been universally documented, the rate at which physicians then asked their patients about smoking and provided specific advice on quitting approximately doubled.[11]

Table 2—*Brief Strategies: Helping the Patient Willing to Quit

Action	Strategies for implementation
Ask—systematically identify all tobacco users at every visit	
Implement an office-wide system that ensures that, for every patient at every clinic visit, tobacco-use status is queried and documented†	Expand the vital signs to include tobacco use or use an alternative universal identification system.‡
Advise—strongly urge all tobacco users to quit	
In a clear, strong, and personalized manner, urge every tobacco user to quit	Advice should be: Clear—"I think it is important for you to quit smoking now and I can help you." "Cutting down while you are ill is not enough." Strong—"As your clinician, I need you to know that quitting smoking is the most important thing you can do to protect your health now and in the future. The clinic staff and I will help you." Personalized—Tie tobacco use to current health/illness, and/or its social and economic costs, motivation level/readiness to quit, and/or the impact of tobacco use on children and others in the household. Encourage all clinical staff to reinforce the cessation message and support the patient's quit attempt.
Assess—determine willingness to make a quit attempt	
Ask every tobacco user if he or she is willing to make a quit attempt at this time (*eg*, within the next 30 d)	Assess patient's willingness to quit: If the patient is willing to make an attempt to quit at this time, provide assistance. If the patient will participate in an intensive treatment, deliver such a treatment or refer to an intensive intervention. If the patient clearly states he/she is unwilling to make an attempt to quit at this time, provide a motivational intervention. If the patient is a member of a special population (*eg*, adolescent, pregnant smoker, racial/ethnic minority), consider providing additional information.
Assist—aid the patient in quitting	
Help the patient with a plan to quit	A patient's preparations for quitting (STAR): Set a quit date, ideally, the quit date should be within 2 wk. Tell family, friends, and coworkers about quitting and request understanding and support. Anticipate challenges to planned quit attempt, particularly during the critical first few weeks; these include nicotine withdrawal symptoms. Remove tobacco products from your environment; prior to quitting, avoid smoking in places where you spend a lot of time (*eg*, work, home, car).
Provide practical counseling (problem solving/skills training)	Abstinence—total abstinence is essential; "not even a single puff after the quit date." Past quit experience—review past quit attempts including identification of what helped during the quit attempt and what factors contributed to relapse. Anticipate triggers or challenges in upcoming attempt—discuss challenges/triggers and how patient will successfully overcome them. Alcohol—drinking alcohol is highly associated with relapse; the patient should consider limiting/abstaining from alcohol during the quit process Other smokers in the household—the presence of other smokers in the household, particularly a spouse or partner, is associated with lower abstinence rates. Patients should encourage significant others to quit with them. If others continue to smoke they should be asked to smoke outdoors and not in the quitter's presence.
Provide intratreatment social support	Provide a supportive clinical environment while encouraging the patient in his or her quit attempt; "my office staff and I are available to assist you."
Help patient obtain extratreatment social support	Help patient develop social support for his or her attempt to quit in his or her environments outside of treatment: "ask your spouse/partner, friends and coworkers to support you in your quit attempt."
Recommend the use of approved pharmacotherapy except in special circumstances	Recommend the use of pharmacotherapies found to be effective in the guideline (see Table 5 for clinical guidelines); explain how these medications increase smoking cessation success and reduce withdrawal symptoms; the first-line pharmacotherapy medications include the following: bupropion SR, nicotine gum, nicotine inhaler, nicotine nasal spray, and nicotine patch.
Provide supplementary materials	Sources—federal agencies, nonprofit agencies, or local/state health departments Type—culturally/racially/educationally/age appropriate for the patient Location—readily available at every clinician's workstation

(*Table 2 continues*)

Table 2—*Continued*

Action	Strategies for implementation
Arrange—schedule follow-up contact	
Schedule follow-up contact, either in person or via telephone	Timing—follow-up contact should occur soon after the quit date, preferably during the first week; a second follow-up contact is recommended within the first month; schedule further follow-up contacts as indicated.
	Actions during follow-up contact—congratulate success; if tobacco use has occurred, review circumstances and elicit recommitment to total abstinence; remind patient that a lapse can be used as a learning experience; identify problems already encountered and anticipate challenges in the immediate future; assess pharmacotherapy use and problems; consider use or referral to more intensive treatment.

*Table adapted from Fiore et al.[10]

†Repeated assessment is not necessary in the case of the adult who has never used tobacco or has not used tobacco for many years, and for whom this information is clearly documented in the medical record. The following vital signs were documented: BP; pulse; weight; temperature; respiratory rate; tobacco use (circle one: current, former, never).

‡Alternatives to expanding the vital signs are to place tobacco-use status stickers on all patient charts or to indicate tobacco use status using electronic medical records or computer reminder systems.

Recommendation 4

Brief tobacco-dependence treatment is effective, and every patient who uses tobacco should be offered at least brief treatment.

The 2000 guideline documents that clinical interventions as brief as 3 min can substantially increase cessation success. These findings support the idea that a personalized clinician message meaningfully enhances the likelihood that a smoker will make a successful attempt to quit smoking. Therefore, it is essential to provide at least a brief intervention for all tobacco users at each clinic visit.

Recommendation 5

There is a strong dose-response relationship between the intensity of tobacco dependence counseling and its effectiveness. Treatments involving person-to-person contact (*ie*, via individual, group, or proactive telephone counseling) are consistently effective, and their effectiveness increases with treatment intensity (*eg*, the number of minutes of contact).

While even a brief intervention is effective in increasing quitting rates, there is a dose-response relationship between treatment duration and its effectiveness. Because clinicians frequently have limited time with patients, adjuvant staff may be utilized to maximize the impact of treatment.

Guideline analysis suggests that a wide variety of health-care professionals can effectively implement these brief strategies. Adjuvant staff (*eg*, physician assistants, nurses, and medical assistants) reinforce the brief clinician cessation message and provide follow-up and support services to patients attempting to quit.

Recommendation 2

Because effective tobacco-dependence treatments are available, every patient who uses tobacco should be offered at least one of the following treatments:

1. Patients willing to try to quit using tobacco should be provided with treatments that are identified as effective in the guideline; and
2. Patients unwilling to try to quit using tobacco should be provided with a brief intervention that is designed to increase their motivation to quit.

Based on the algorithm in Figure 1, there are the following three types of patients with regard to tobacco use: (1) current tobacco users who are now willing to make an attempt to quit smoking; (2) current tobacco users who are unwilling to make an attempt to quit; and (3) former tobacco users who have recently quit.

For Patients Willing To Quit: The 5 As

The "5As" are designed to be a brief and effective intervention for tobacco users now willing to make an attempt to quit smoking (Table 2). It is important for the clinician to ask patients whether they use tobacco, to advise them to quit in a clear, strong, and personalized manner, and to assess their willingness to make an attempt to quit at that time. If the patient agrees to attempt cessation, the clinician should then assist in making a quit attempt and should arrange for follow-up contacts to prevent a relapse.

For Patients Unwilling to Quit: The 5 Rs

For patients not willing to make an attempt to quit at the time, clinicians should provide a brief inter-

Table 3—*Enhancing Motivation to Quit Tobacco: the 5 Rs**

Motivation	Description
Relevance	Encourage the patient to indicate why quitting is personally relevant, being as specific as possible. Motivational information has the greatest impact if it is relevant to a patient's disease status or risk, family or social situation (*eg*, having children in the home), health concerns, age, gender, and other important patient characteristics (*eg*, prior quitting experience, personal barriers to cessation).
Risks	The clinician should ask the patient to identify potential negative consequences of tobacco use; the clinician may suggest and highlight those that seem to be the most relevant to the patient; the clinician should emphasize that smoking low-tar/low-nicotine cigarettes or use of other forms of tobacco (*eg*, smokeless tobacco, cigars, and pipes) will not eliminate these risks. Examples of risks are: Acute risks: shortness of breath, exacerbation of asthma, harm to pregnancy, impotence, infertility, increased serum carbon monoxide Long-term risks: heart attacks and strokes, lung and other cancers (larynx, oral cavity, pharynx, esophagus, pancreas, bladder, cervix), chronic obstructive pulmonary diseases (chronic bronchitis and emphysema), long-term disability and need for extended care Environmental risks: increased risk of lung cancer and heart disease in spouses; higher rates of smoking by children of tobacco users; increased risk for low birth weight, SIDS, asthma, middle ear disease, and respiratory infections in children of smokers
Rewards	The clinician should ask the patient to identify potential benefits of stopping tobacco use, the clinician may suggest and highlight those that seem to be the most relevant to the patient. Examples of rewards follow: Improved health Food will taste better Improved sense of smell Save money Feel better about yourself Home, car, clothing, breath will smell better Can stop worrying about quitting Set a good example for kids Have healthier babies and children Not worry about exposing others to smoke Feel better physically Perform better in physical activities Reduced wrinkling/aging of skin
Roadblocks	The clinician should ask the patient to identify barriers or impediments to quitting and note elements of treatment (*ie*, problem-solving, pharmacotherapy) that could address barriers. Typical barriers might include: Withdrawal symptoms Fear of failure Weight gain Lack of support Depression Enjoyment of tobacco
Repetition	The motivational intervention should be repeated every time an unmotivated patient visits the clinic setting; tobacco users who have failed in previous quit attempts should be told that most people make repeated quit attempts before they are successful.

*Table adapted from Fiore et al.[10] SIDS = sudden infant death syndrome.

vention that is designed to promote the motivation to quit (the "5 Rs"; Table 3).

Patients may be unwilling to make an attempt to quit for a variety of reasons. They may lack information about the harmful effects of tobacco, they may not realize how these effects are relevant to their personal health history, they may lack the required financial resources, they may have fears or concerns about quitting, or they may be demoralized because of previous relapse experiences.[12] These patients may, however, respond to a motivational intervention that provides the clinician an opportunity to educate and reassure the patient by means of the following 5 Rs: relevance, risks, rewards, roadblocks, and repetition. This is most likely to be successful when the clinician is empathic, promotes patient autonomy, avoids arguments, and supports the patient's self-efficacy.[13,14]

For the Patient Who Has Recently Quit

Because of the chronic relapsing nature of tobacco dependence, clinicians should promote relapse prevention among their patients who have recently quit. Specifically, the clinician should reinforce the decision to quit, should review the benefits of quitting, and should assist in resolving any residual problems. This can be accomplished during scheduled clinic visits or proactive telephone calls.

Because most relapses occur within the first 3

Table 4—*Components of Relapse Prevention

Intervention	Responses
Interventions that should be part of every encounter with a patient who has quit recently	
Every ex-tobacco user undergoing relapse prevention should receive congratulations on any success and strong encouragement to remain abstinent.	
When encountering a recent quitter, use open-ended questions designed to initiate patient problem-solving (*eg*, "How has stopping tobacco use helped you?").	
The clinician should encourage the patients' active discussion of the benefits the patient may derive from cessation, success the patient has had in quitting, problems encountered or anticipated threats to maintaining abstinence.	
Problems	
Lack of support for cessation	Schedule follow-up visits or phone calls with the patient
	Help the patient identify sources of support within his/her environment
	Refer the patient to an appropriate organization that offers cessation counseling or support
Negative mood or depression	If significant, provide counseling, prescribe appropriate medications, or refer the patient to a specialist
Strong or prolonged withdrawal symptoms	If the patient reports prolonged craving or other withdrawal symptoms, consider extending the use of an approved pharmacotherapy or adding/combining pharmacologic medications to reduce strong withdrawal symptoms
Weight gain	Recommend starting or increasing physical activity; discourage strict dieting
	Reassure the patient that some weight gain after quitting is common and appears to be self-limiting
	Emphasize the importance of a healthy diet with plenty of fruits and vegetables
	Maintain the patient on pharmacotherapy known to delay weight gain (*eg*, bupropion SR, NRTs, particularly nicotine gum)
	Refer the patient to a specialist or program
Flagging motivation/feeling deprived	Reassure the patient that these feelings are common
	Recommend rewarding activities
	Probe to insure that the patient is not engaged in periodic tobacco use
	Emphasize that beginning to smoke (even a puff) will increase urges and make quitting more difficult

*Table adapted from Fiore et al.[10]

months after quitting, particularly during the first 2 weeks, clinicians (or their staff) should arrange for follow-up visits and should provide relapse prevention during this critical time period. It should be noted that relapses may occur months or even years after quitting, however, so all former tobacco users may benefit from support and encouragement. Table 4 outlines components that should be part of all relapse-prevention contacts.

Recommendation 7

Numerous effective pharmacotherapies for smoking cessation now exist. Except in the presence of contraindication, these should be used with all patients who are attempting to quit smoking.

The treatment of tobacco dependence, like the treatment of other chronic diseases, requires the use of multiple modalities. Pharmacotherapy is an essential element of a multicomponent approach. The clinician should encourage all patients who are initiating an attempt to quit to use one or a combination of the recommended pharmacotherapies. Select patient groups (*eg*, those with medical contraindications, those smoking < 10 cigarettes a day, pregnant/breastfeeding women, and adolescent smokers) require special consideration before the recommendation of pharmacotherapy. A more detailed discussion of pharmacotherapy use for select populations is available in the guideline.

The guideline panel identified five first-line medications with an established empirical record of efficacy in smoking cessation. These medications include the following: bupropion SR (Zyban; Glaxo SmithKline; Research Triangle Park, NC); the nicotine patch (various manufacturers); nicotine gum (various manufacturers); nicotine inhaler (Nicotrol Inhaler; Pharmacia; Helsingborg, Sweden); and nicotine nasal spray (Nicotrol NS; Pharmacia). These medications should be considered first as part of tobacco-dependence treatment (except in cases of contraindications). Each of these medications has been documented to increase significantly the rate of long-term smoking abstinence, and each has been approved as safe and efficacious by the US Food and Drug Administration. General guidelines for prescribing these pharmacotherapies are shown in Tables 5 and 6.

Combining the nicotine patch with a self-administered form of nicotine replacement therapy (NRT), utilizing the gum, the inhaler, or the nasal spray, is

Table 5—*Clinical Guidelines for Prescribing Pharmacotherapy for Smoking Cessation**

Question	Answer
Who should receive pharmacotherapy for smoking cessation?	All smokers trying to quit except in the presence of special circumstances; special consideration should be given before using pharmacotherapy with selected populations: those with medical contraindications; those smoking < 10 cigarettes/d, pregnant and adolescent smokers
What first-line pharmacotherapies are recommended?	All five of the FDA-approved pharmacotherapies for smoking cessation are recommended including bupropion SR, nicotine gum, nicotine inhaler, nicotine nasal spray, and the nicotine patch
What factors should a clinician consider when choosing among the five first-line pharmacotherapies?	Because of the lack of sufficient data to rank-order these five medications, choice of a specific first-line pharmacotherapy must be guided by factors such as clinician familiarity with the medications, contraindications for selected patients, patient preference, previous patient experience with a specific pharmacotherapy (positive or negative), and patient characteristics (*eg*, history of depression, concerns about weight gain)
Are pharmacotherapeutic treatments appropriate for lighter smokers (*eg*, 10–15 cigarettes/d)?	If pharmacotherapy is used with lighter smokers, clinicians should consider reducing the dose of first-line pharmacotherapies
What second-line pharmacotherapies are recommended?	Clonidine and nortriptyline
When should second-line agents be used for treating tobacco dependence?	Consider prescribing second-line agents for patients unable to use first-line medications because of contraindications or for patients for whom first-line medications are not helpful; monitor patients for the known side effects of second-line agents
Which pharmacotherapies should be considered with patients particularly concerned about weight gain?	Bupropion SR and nicotine replacement therapies, in particular nicotine gum, have been shown to delay, but not prevent, weight gain
Which pharmacotherapies should be considered with patients with a history of depression?	Bupropion SR and nortriptyline appear to be effective with this population
Should nicotine replacement therapies be avoided in patients with a history of cardiovascular disease?	No. Nicotine replacement therapies are safe and have not been shown to cause adverse cardiovascular effects; however, the safety of these products has not been established for the immediate (2-wk) post-MI period, with serious arrythmias, or in patients with severe or unstable angina
May tobacco dependence pharmacotherapies be used long-term (*eg*, 6 months or more)?	Yes. This approach may be helpful with smokers who report persistent withdrawal symptoms during the course of pharmacotherapy or who desire long-term therapy; a minority of individuals who successfully quit smoking use ad libitum NRT medications (*ie*, gum, nasal spray, inhaler) long-term; the use of these medications long-term does not present a known health risk; additionally, the FDA has approved the use of bupropion SR for a long-term maintenance indication
May nicotine replacement pharmacotherapies ever be combined?	Yes. There is evidence that combining the nicotine patch with either nicotine gum or nicotine nasal spray increases long-term abstinence rates over those produced by a single form of NRT

*Table adapted from Fiore et al.[10] FDA = Food and Drug Administration; MI = myocardial infarction.

more efficacious than a single form of nicotine replacement. Patients should be encouraged to use such combined treatments if they are unable to quit using a single type of first-line pharmacotherapy. One study[15] has examined combining bupropion SR with NRT. There was a nonsignificant trend toward improved outcome. More research is needed in the realm of combination therapies.

Special Note: Use of NRT in Cardiovascular Patients

Cardiovascular risk and the use of NRT has been systematically studied since the nicotine patch was released in 1991. Separate analyses have documented the lack of an association between use of the nicotine patch and acute cardiovascular events,[16–18] even in patients who continue to smoke intermittently while using the nicotine patch.[19]

Because of inaccurate media coverage in the past, it may be important to inform patients who are reluctant to use NRTs that there is no evidence of increased cardiovascular risk with these medications.

Summary

Chest clinicians are ideally positioned to intervene with their patients who smoke. The guideline provides a comprehensive review of the extant literature and offers clinicians practical, evidence-based advice to assist patients who are addicted to tobacco. Tobacco use represents the leading cause of disease

Table 6—*Summary Table for Pharmacotherapy

Factor	Bupropion SR	Patch	Gum	Inhaler	Nasal Spray
Treatment period	7–12 wk Take for 1–2 wk before quitting smoking May use for maintenance for up to 6 mo	6–8 wk	Up to 12 wk May use for longer time as needed	3–6 mo Taper use over last few weeks	3–6 mo Taper use over last few weeks
Dosage	Days 1–3: 150-mg tablet each morning Days 4–end: 150-mg tablet in morning and evening	One patch each day Taper dose if using: 21 mg for 4 wk 14 mg for 2 wk 7 mg for 2 wk No taper if using 15 mg for 8 wk Light smokers (10 cigarettes/d) can start with lower dose	2 mg 4 mg (heavy smokers) Chew one piece every 1–2 h (10–15 pieces/d) Many people do not use enough gum—chew gum whenever you need it!	6–16 cartridges/d Need to inhale about 80 times to use up cartridge Can use part of cartridge and save the rest for later that day	One dose equals one squirt to each nostril Dose 1–2 times/h as needed Minimum = 8 doses/d Maximum = 40 doses/d
Pros	Easy to use Reduces urges to smoke	Easy to use Steady dose of nicotine	Can control your own dose Helps with predictable urges (*eg*, after meals) Keeps mouth busy	Can control your own dose Helps with predictable urges Keeps hands and mouth busy	Can control your own dose Fastest acting for relief of urges
Cons	May disturb sleep May cause dry mouth	May irritate skin May disturb sleep Can not adjust amount of nicotine in response to urges	Need to chew correctly—"chew and park" May stick to dentures Should not drink acidic beverages while chewing gum	May irritate mouth and throat (improves with use) Does not work well < 40° Should not drink acidic beverages while using inhaler	Need to use correctly (do not inhale it) May irritate nose (improves with use) May cause dependence
Caution	Do not use if you have a seizure disorder, an eating disorder, or are already taking a monoamine oxidase inhibitor	Do not use if you have severe uncontrolled eczema or psoriasis	Caution with dentures		Do not use if you have severe reactive airway disease (asthma)
Availability	Prescription only	Over the counter (regular/mint/orange flavors)	Over the counter	Prescription only	Prescription only
Cost per day for average use†	$3.50	Brand name, $3.50; store brand, $2.11	Brand name: $4.54 for 10 2-mg pieces; $5.00 for 10 4-mg pieces Store brand: $3.00 for 10 2-mg pieces; $3.70 for 10 4-mg pieces	$10.95 for 10 cartridges	$5.64 for 12 doses

*Table adapted from Fiore et al.[10]
†Updated information based on January 2001 data from a chain pharmacy.

that brings patients to chest clinicians. By adopting a guideline-based approach to universally identify and intervene with patients who use tobacco, clinicians can reduce the rates of smoking and its consequences among their patients.

To Obtain Guideline Materials

Printed copies of the *Clinical Practice Guideline: Treating Tobacco Use and Dependence* by the US Public Health Service and additional materials include the following: quick reference guide; consumer guide; health systems guide; quit-smoking posters; and packets of tear sheets for clinicians.

These are available from the following US Public Health Service clearinghouses: the Agency for Healthcare Research and Quality (phone, 800-358-9295); the Centers for Disease Control and Prevention (phone, 800-CDC-1311); and the National Cancer Institute (phone, 800–4-CANCER).

References

1 Joint Committee on Smoking and Health. Smoking and health: physician responsibility; a statement of the Joint Committee on Smoking and Health. Chest 1995; 198:201–208

2 Centers for Disease Control and Prevention. Tobacco use among high school students: United States, 1993. MMWR Morb Mortal Wkly Rep 1994; 43:925–930

3 Hatziandreu EJ, Pierce JP, Lefkopoulou M, et al. Quitting smoking the United States in 1986. J Natl Cancer Inst 1990; 82:1402–1406

4 US Department of Health and Human Services. Reducing the health consequences of smoking: 25 years of progress; a report of the Surgeon General. Rockville, MD: US Department of health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1989; DHHS Publication No. (CDC) 89–8411

5 Goldstein MG, Niaura R, Willey-Lessne C, et al. Physicians counseling smokers: a population-based survey of patients' perceptions of health care provider-delivered smoking cessation interventions. Arch Intern Med 1997; 157:1313–1319

6 US Department of Health, and Human Services. The health benefits of smoking cessation: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services. Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health, 1990; DHHS Publication No. (CDC) 90–8416

7 Herdman R, Hewitt M, Laschober M. Smoking-related deaths and financial costs: Office of Technology Assessment estimates for 1990. Washington, DC: Office of Technology Assessment, Congress of the United States, 1993

8 Centers for Disease Control and Prevention. Cigarette smoking among adults: United States, 1998. MMWR Morb Mortal Wkly Rep 2000; 49:881–884

9 Agency for Healthcare Policy and Research. Smoking cessation clinical practice guideline No. 18. Washington, DC: Agency for Healthcare Policy and Research, US Department of Health and Human Services, 1996

10 Fiore MC, Bailey WC, Cohen SJ, et al. Treating tobacco use and dependence: clinical practice guideline. Rockville, MD: US Department of Health and Human Services, Public Health Service, 2000

11 Fiore MC, Jorenby DE, Schensky AE, et al. Smoking status as the new vital sign: effect on assessment and intervention in the patients who smoke. Mayo Clin Proc 1995; 70:209–213

12 Rumdo T, Smedslund G, Gotestam KG. Motivation for smoking cessation among the Norwegian public. Addict Behav 1997; 22:377–386

13 Colby SM, Barnett NP, Monti PM, et al. Brief motivational interviewing in a hospital setting for adolescent smoking: a preliminary study. J Consult Clin Psychol 1998; 66:574–578

14 Prochaska J, Goldstein MG. Process of smoking cessation: implications for clinicians. Clin Chest Med 1991; 12:727–735

15 Jorenby DE, Leischow S, Nides M, et al. A controlled trial of sustained-release bupropion, a nicotine patch, or both for smoking cessation. N Engl J Med 1999; 340:685–691

16 Benowitz NL, Gourlay SG. Cardiovascular toxicity of nicotine: implications for nicotine replacement therapy. J Am Coll Cardiol 1997; 29:1422–1431

17 Joseph AM, Norman SM, Ferry LH, et al. The safety of transdermal nicotine as an aid to smoking cessation in patients with cardiac disease. N Engl J Med 1996; 335:1792–1798

18 Mahmarian JJ, Moye LA, Nasser Ga, et al. Nicotine patch therapy in smoking cessation reduces the extent of exercise-induced myocardial ischemia. J Am Coll Cardiol 1997; 30: 125–130

19 Working Group for the Study of Transdermal Nicotine in Patients with Coronary Artery Disease. Nicotine replacement therapy for patients with coronary artery disease. Arch Intern Med 1994; 154:989–995

Accreditation of Medi-Cal, Healthy Kids and Healthy Families Program.

L.A. Care HEALTH PLAN

Smoking Cessation Medications Available on the L.A. Care Formulary

Medications available without a Prior Authorization:

Nicotine Patches	Nicotine Gum	Nicotine Lozenges	Nicotine Nasal Spray	Nicotine Inhaler	Bupropion (Zyban)	Buproprion SR (Wellbutrin)

Medications available with a Prior Authorization:

Varenicline (Chantix)

Published in final edited form as:
N Engl J Med. 2013 January 24; 368(4): 351–364. doi:10.1056/NEJMsa1211127.

50-Year Trends in Smoking-Related Mortality in the United States

Michael J. Thun, M.D., **Brian D. Carter, M.P.H.**, **Diane Feskanich, Sc.D.**, **Neal D. Freedman, Ph.D., M.P.H.**, **Ross Prentice, Ph.D.**, **Alan D. Lopez, Ph.D.**, **Patricia Hartge, Sc.D.**, and **Susan M. Gapstur, Ph.D., M.P.H.**
Department of Epidemiology, American Cancer Society, Atlanta (M.J.T., B.D.C., S.M.G.); Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston (D.F.); the Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD (N.D.F., P.H.); the Division of Public Health Sciences, Fred Hutchison Cancer Research Center, Seattle (R.P.); and the School of Population Health, University of Queensland, Brisbane, Australia (A.D.L.)

Abstract

BACKGROUND—The disease risks from cigarette smoking increased in the United States over most of the 20th century, first among male smokers and later among female smokers. Whether these risks have continued to increase during the past 20 years is unclear.

METHODS—We measured temporal trends in mortality across three time periods (1959–1965, 1982–1988, and 2000–2010), comparing absolute and relative risks according to sex and self-reported smoking status in two historical cohort studies and in five pooled contemporary cohort studies, among participants who became 55 years of age or older during follow-up.

RESULTS—For women who were current smokers, as compared with women who had never smoked, the relative risks of death from lung cancer were 2.73, 12.65, and 25.66 in the 1960s, 1980s, and contemporary cohorts, respectively; corresponding relative risks for male current smokers, as compared with men who had never smoked, were 12.22, 23.81, and 24.97. In the contemporary cohorts, male and female current smokers also had similar relative risks for death from chronic obstructive pulmonary disease (COPD) (25.61 for men and 22.35 for women), ischemic heart disease (2.50 for men and 2.86 for women), any type of stroke (1.92 for men and 2.10 for women), and all causes combined (2.80 for men and 2.76 for women). Mortality from COPD among male smokers continued to increase in the contemporary cohorts in nearly all the age groups represented in the study and within each stratum of duration and intensity of smoking. Among men 55 to 74 years of age and women 60 to 74 years of age, all-cause mortality was at least three times as high among current smokers as among those who had never smoked. Smoking cessation at any age dramatically reduced death rates.

CONCLUSIONS—The risk of death from cigarette smoking continues to increase among women and the increased risks are now nearly identical for men and women, as compared with persons who have never smoked. Among men, the risks associated with smoking have plateaued at the high levels seen in the 1980s, except for a continuing, unexplained increase in mortality from COPD.

Address reprint requests to Dr. Thun at the American Cancer Society, National Home Office, 250 Williams St., NW, Atlanta, GA 30303-1002, or at michael.thun@cancer.org.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

The disease risks from cigarette smoking increased over most of the 20th century in the United States as successive generations of first male and then female smokers began smoking at progressively earlier ages. American men began smoking manufactured cigarettes early in the 20th century; by the 1930s, the average age at initiation fell below 18 years.[1,2] Relatively few women smoked regularly before World War II; their average age at initiation continued to decrease through the 1960s. Women were not included in the earliest prospective epidemiologic studies in the 1950s,[3–5] since mortality from lung cancer among women was not yet increasing in the general population.[6] The landmark 1964 U.S. Surgeon General's Report concluded only that "cigarette smoking is causally related to lung cancer in men."[7] Neither sex had yet experienced the full effects of smoking from adolescence throughout adulthood.

The first large, prospective study of smoking and mortality involving both women and men was Cancer Prevention Study I (CPS I), initiated by the American Cancer Society (ACS) in 1959.[8,9] The relative risk of death from lung cancer during the first 6 years of follow-up among current smokers, as compared with persons who had never smoked, was 2.69 (95% confidence interval [CI], 2.14 to 3.37) for women and 11.35 (95% CI, 9.10 to 14.15) for men.[10] In 1982, the ACS initiated the second Cancer Prevention Study (CPS II), which included nearly 1.2 million men and women nationwide.[11] During the intervening 20 to 25 years, the relative risk of death from lung cancer had increased to 11.94 (95% CI, 9.99 to 14.26) for female smokers and to 22.36 (95% CI, 17.77 to 28.13) for male smokers.[10,12]

Several factors may have altered the health risks incurred by smokers. Smoking patterns have changed. Women who began smoking in the 1950s or thereafter have smoked more like men than they did in previous generations (i.e., starting at an earlier age and smoking more heavily).[1] Daily cigarette consumption peaked during the 1970s among male smokers and during the 1980s among female smokers[13]; smoking prevalence in the two groups has since decreased in parallel. Contemporary smokers have spent much of their lives smoking filtered cigarettes made of blended tobacco.[2,14] Women have more difficulty quitting than men; thus, for both current and former female smokers, the number of years of smoking has increased. Male and female smokers today are less educated and less affluent than smokers were 20 to 40 years ago.[15] Since the 1950s, there has been a more rapid proportional decrease in the background risk of death from cardiovascular conditions among persons who have never smoked than among smokers.[16,17]

We calculated death rates and the relative risks associated with active cigarette smoking and smoking cessation during three time periods — 1959–1965, 1982–1988, and 2000–2010 — using data from the two historical ACS cohorts (CPS I and CPS II) and pooled data from five contemporary cohort studies in the United States.[18–23] A central question is whether the hazards for women are now approaching those for men as their lifetime smoking behaviors have become increasingly similar.

METHODS

STUDY POPULATIONS

Descriptions of the study populations are provided in the Supplementary Appendix, available with the full text of this article at NEJM.org. Because of the age distribution in the contemporary cohorts, analyses were restricted to participants who attained an age of 55 years or older during follow-up. CPS I analyses were based on 183,060 men and 335,922 women, enrolled in 1959 and followed through September 31, 1965. CPS II analyses are based on 293,592 men and 452,893 women enrolled in 1982 and followed through December 31, 1988. The five contemporary cohort studies representing the most recent period (2000– 2010) included the National Institutes of Health– American Association of

Retired Persons Diet and Health Study (NIH–AARP),[18] the ACS CPS II Nutrition Cohort[19] (a subset of the original CPS II mortality study), the Women's Health Initiative (WHI),[20,21] the Nurses' Health Study (NHS),[22] and the Health Professionals Follow-up Study (HPFS) (Table S1 in the Supplementary Appendix).[23] These are among the largest U.S. cohort studies that collected updated smoking information at least once during the period from 2000 through 2010.

ASSESSMENT OF SMOKING STATUS

The criteria used to define current smokers, former smokers, and those who had never smoked cigarettes in the various cohorts are described in the Supplementary Appendix. In CPS I and CPS II, we used only the information about smoking obtained at the time of enrollment, whereas in the contemporary cohort studies, we used updated information when available in time-dependent analyses. The frequency of updating varied across cohorts. Analyses of former smokers were restricted to those who had quit 2 or more years before the start of follow-up.

FOLLOW-UP OF VITAL STATUS

We restricted the follow-up time for participants in the CPS I and CPS II to 6 years to minimize the effects of smoking cessation on mortality. Follow-up of the contemporary cohorts began on January 1, 2000, and ended on or before December 31, 2010. More detailed information about follow-up is provided in the Supplementary Appendix.

STATISTICAL ANALYSIS

We tabulated age-specific deaths, person-years at risk, and death rates according to smoking status in each of the contributing cohorts, pooling the data for the five contemporary cohorts. Death rates were standardized according to the U.S. age distribution in 2000. Cox proportional-hazards regression was used to calculate age-adjusted and multivariable-adjusted relative-risk estimates according to smoking status (former smokers and current smokers vs. those who never smoked), according to the intensity and duration of smoking among current smokers, and according to the age at the time of quitting among former smokers. Multivariable-adjusted analyses were stratified according to cohort and age at baseline (in 1959, 1982, or 2000) and were further adjusted according to race and educational level.

We performed sensitivity analyses to assess whether educational level modified the relationship of current or former smoking to each end point, using both stratified analyses and interaction terms. To assess whether the lack of fully updated smoking information in some cohorts or differences in the follow-up periods might have biased the observed associations, we compared the results from the CPS II Nutrition cohort according to the time when smoking status was recorded: at baseline, 2 years before the end of follow-up, or at the most recent update through 2005.

RESULTS

STUDY POPULATIONS

Most of the participants were white; the majority were married and had a higher level of education than the general population[24,25] (Table 1). In the contemporary cohorts, approximately half the participants had at least a college or nursing-school education. At least 20% of participants in all the cohorts had no education beyond high school, a proportion that allowed us to perform analyses stratified according to or adjusted for educational level. In the contemporary cohorts, the prevalence of current smoking decreased over time to 9.3% among men and 9.7% among women, findings that are consistent with

trends in the educated general population.[26] More than half the current smokers in the contemporary cohorts reported smoking fewer than 20 cigarettes per day in 2000; about 25% had smoked for 50 or more years. Additional baseline characteristics are provided in Table S1 in the Supplementary Appendix.

MORTALITY

All Causes—Among the participants who had never smoked, the age-standardized rates of death from any cause were approximately 50% lower in the contemporary period than in the 1959–1965 period for both sexes (Tables 2 and 3). In contrast, there was no temporal decrease in the all-cause death rate among women who were current smokers (Table 2) and there was a 23.6% decrease among men who were current smokers (Table 3). Thus, the age-standardized relative risk for death from all causes among current smokers, as compared with those who had never smoked, increased across all three time periods, with a relative risk of 2.80 (95% CI, 2.72 to 2.88) for male smokers and 2.76 (95% CI, 2.69 to 2.84) for female smokers in the contemporary cohorts. The age-specific relative-risk estimates exceeded 3.00 for male current smokers who were 55 to 74 years of age and equaled or exceeded 3.00 for female current smokers who were 60 to 74 years of age (Table S2 in the Supplementary Appendix).

Lung Cancer—Among the participants who had never smoked, the age-standardized rate of death from lung cancer remained constant for men (Table 3) but increased slightly for women (Table 2) from the 1959–1965 period (CPS I) to the 1982–1988 period (CPS II), before decreasing in the contemporary period. Among female smokers, there was a large increase (by a factor of 16.8) in deaths from lung cancer over the entire 50-year period, about half of which occurred during the past 20 years (Table 2). In the CPS I cohort, lung-cancer mortality among male smokers was about 12 times as high as that among men who had never smoked; the mortality approximately doubled from the 1959–1965 period to the 1982–1988 period (Table 3) before stabilizing in the period after the 1980s. Only the two oldest age groups of male smokers had any increase in the rate of death from lung cancer from the 1982–1988 period to the contemporary period (Fig. 1); these age groups represent birth cohorts from 1900 to 1929 (Fig. S1 in the Supplementary Appendix). Absolute lung-cancer mortality was higher for men than for women in all three periods, irrespective of smoking status. However, in the contemporary period, the point estimates for the relative risk of death from lung cancer among current smokers, as compared with those who had never smoked, were virtually identical for men and women: 24.97 (95% CI, 22.20 to 28.09) and 25.66 (95% CI, 23.17 to 28.40), respectively (Tables 2 and 3).

Chronic Obstructive Pulmonary Disease—Among the participants who had never smoked, the age-standardized rate of death from chronic obstructive pulmonary disease (COPD) remained relatively constant for women (Table 2) but decreased by approximately 45% for men from the 1982–1988 period to the contemporary period (Table 3). In contrast, mortality increased for both male and female smokers across all three periods (Tables 2 and 3 and Fig. 1). The largest absolute increase in COPD mortality occurred among male smokers after the 1980s, affecting all smokers who were 55 years of age or older (Fig. 1) and all birth cohorts from 1900 through at least 1954 (Fig. S1 in the Supplementary Appendix). The multivariable adjusted relative risk of death from COPD among male smokers more than doubled from the 1982– 1988 period (9.98 [95% CI, 7.97 to 12.49]) to the contemporary period (25.61 [95% CI, 21.68 to 30.25]) (Table 3). Approximately half this increase reflected the lower background death rate among men in the contemporary period who had never smoked, as compared with those in the 1982– 1988 period. The relative risk for female smokers also more than doubled over this period, from 10.35 (95% CI, 8.63 to 12.41) to 22.35 (95% CI, 19.55 to 25.55) (Table 2).

Cardiovascular Diseases—Among participants who had never smoked, the combined rates of death from ischemic heart disease, other types of heart disease, and any type of stroke decreased from the 1959–1965 period to the contemporary period by 79% among women (Table 2) and by 74% among men (Table 3). These decreases were proportionately larger than those seen in the current smokers; consequently, the relative-risk estimates associated with current smoking increased for all three cardiovascular end points. In the contemporary cohorts, the relative risk for death from ischemic heart disease for current smokers, as compared with those who never smoked, was 2.86 (95% CI, 2.65 to 3.08) for women (Table 2) and 2.50 (95% CI, 2.34 to 2.66) for men (Table 3). The relative risk of death from ischemic heart disease exceeded 3.00 among male and female current smokers who were 55 to 74 years of age (Table S2 in the Supplementary Appendix). Hence, two thirds of the deaths due to ischemic heart disease among smokers in the contemporary cohorts were attributable to their smoking.

MORTALITY ACCORDING TO INTENSITY AND DURATION OF CURRENT SMOKING

The relative risks of death from lung cancer, death from COPD, and death from any cause among current smokers, as compared with those who had never smoked, increased according to the number of cigarettes smoked per day and the number of years of smoking during all three periods, although the relationships were less consistent for the cardiovascular end points (Tables S3, S4, and S5 in the Supplementary Appendix). Differences in these variables reported at the start of follow-up did not explain the increases from the 1980s (CPS II) to the contemporary period in rates of death from lung cancer and COPD among female smokers and the rate of death from COPD among male smokers. Even within each stratum of smoking intensity and duration, the relative-risk estimates increased over time.

MORTALITY AMONG FORMER SMOKERS

Former smokers of both sexes in the CPS II and contemporary cohorts had lower age-standardized rates of death and relative risks of death than did current smokers, for all the end points studied (Tables 2 and 3). The rates of death from cardiovascular conditions among men and women who were former smokers decreased significantly from the 1960s to the contemporary period, but the rates of death from lung cancer and COPD increased among women. Former smokers who had stopped smoking at earlier ages had progressively lower relative risks of death from lung cancer and COPD, as compared with current smokers in the contemporary cohorts (Fig. 2, and Table S6 in the Supplementary Appendix). Those who quit smoking by 40 years of age avoided nearly all the excess smoking-related deaths from these conditions; even those who quit smoking before 60 years of age had a lower relative risk than those who did not quit but smoked fewer than 10 cigarettes per day. Strong inverse relationships were also observed between years since quitting and deaths from these end points (Tables S6 through S13 in the Supplementary Appendix).

SENSITIVITY ANALYSES

Educational level significantly modified the association of current and former smoking with some of the mortality end points in the contemporary cohorts (P = 0.05) (Table S14 in the Supplementary Appendix). In general, the estimated relative risks for current and former smokers with only a high-school education or less were similar to or larger than the estimates for current and former smokers who were college graduates. This was consistently true with respect to the relative risks of death from COPD and ischemic and other heart diseases for women and former smokers but not for male current smokers. The timing of information on smoking status also affected the association between current smoking and certain end points, but the changes were small; in most cases, analyses based on fully

updated smoking information underestimated the associations when smoking status was documented at baseline or 2 years before death or the end of follow-up for women and men (Tables S15 and S16, respectively, in the Supplementary Appendix).

DISCUSSION

Our study of cohorts from three time periods provides a 50-year perspective on the evolution of smoking-related risks in the United States. We highlight five important findings.

First, the relative and absolute risks of death from smoking continue to increase among female smokers; the relative risks of death from lung cancer, COPD, ischemic heart disease, any type of stroke, and all causes are now nearly identical for female and male smokers. This finding is new and confirms the prediction that, in relative terms, "women who smoke like men die like men."[27] Convergence of the relative risks for men and women results from the convergence of smoking patterns among men and women since the 1960s[28,29] and the aging of birth cohorts with the heaviest lifetime history of smoking. The risk of death from lung cancer among male smokers appears to have stabilized since the 1980s, whereas it continues to increase among female smokers.

Second, we found that for men 55 to 74 years of age and for women 60 to 74 years of age, the rate of death from all causes combined is now at least three times as high among current smokers as among those who have never smoked. This finding parallels and extends the findings in the British Doctors' Study,[30] the Million Women Study,[31] and the U.S. National Health Interview Survey.[32] These studies show that more than two thirds of all deaths among current smokers in these age groups are associated with smoking.

Third, the rate of death from COPD continues to increase among both male and female smokers in contrast to a significant decrease in risk among men who never smoked. This increase is not simply a function of aging, since it affects male smokers 55 years of age or older and female smokers 60 years of age or older. Nor can it be explained by differences in the average duration of smoking or the number of cigarettes smoked per day, since daily consumption was actually lower in the contemporary cohorts than in the CPS II cohort, and the average duration of smoking did not change significantly at any age. The ability to diagnose COPD has improved over time,[33] but this would probably affect the number of prevalent cases more than the number of deaths for which COPD is considered to be the underlying cause of death. A plausible explanation for the continuing increase in deaths from COPD among male smokers is that cigarettes marketed since the late 1950s have undergone design changes that promote deeper inhalation of smoke.[34] For example, the introduction of blended tobacco and genetic selection of tobacco plants lowered the pH of smoke; as a result, inhalation was easier and deeper inhalation was needed for the absorption of protonated nicotine. [35] Other design changes, such as the use of more porous wrapping paper and perforated filters, also diluted the smoke. Deeper inhalation of more dilute smoke increases exposure of the lung parenchyma. These and other design changes in cigarettes may also have contributed to the shift, beginning in the 1970s, in the histologic and topographic features of lung cancers in male smokers,[36] with an increase in the incidence of peripheral adenocarcinomas that largely offset the decrease in squamous-cell and small-cell cancers of the central airways. The likely net effect of deeper inhalation on COPD could be wholly detrimental, since COPD results from injury to the lung parenchyma.

Fourth, our analyses of data from former smokers confirm that quitting smoking at any age dramatically lowers mortality from all major smoking-related diseases. As reported previously, nearly all the excess risk can be avoided if a person quits smoking before 40

years of age.[17,31,32] Quitting smoking is much more effective than reducing the number of cigarettes smoked.

Finally, our analyses according to educational level show that the relative-risk estimates associated with current and former smoking among smokers with only a high-school education are generally similar to or larger than those among smokers who are college graduates. Only among male current smokers were the relative-risk estimates for ischemic and other heart disease significantly lower in the least-educated group. Hence, the relative-risk estimates presented here will in general correspond to those in a less-educated population. Similarly, differences in the time when information on smoking was obtained in the contemporary cohorts will not appreciably affect the results.

The strengths of our study include its size, prospective design, national scope, and 50-year time span. Our results provide estimates of temporal changes in cause-specific mortality and the contemporary risks from smoking in the United States. Its limitations are that it principally represents whites, 50 years of age or older, who were born between 1870 and 1954. We could not assess risks among younger contemporary smokers. Most current smokers in the contemporary cohorts had smoked for at least 30 years, limiting the range over which we could examine the influence of the duration of smoking.

In conclusion, there have been large, persistent increases in the risks of smoking-related deaths among female cigarette smokers over the past half century; in relative terms, the risks for women now equal those for men. The risks among male smokers have plateaued at the high levels of the 1980s, except for a continuing, unexplained increase in deaths from COPD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Support for the National Institutes of Health (NIH)–AARP Diet and Health Study was provided by the Intramural Research Program of the National Cancer Institute (NCI), NIH. Support for all the American Cancer Society (ACS) cohort studies was provided by the Intramural Research Programs of the ACS. Support for the Nurses' Health Study and the Health Professionals Follow-up Study was provided by grants (P01 CA87969 and P01 CA055075, respectively) from the NCI. Support for the Women's Health Initiative program is provided by contracts (N01WH22110, N01WH24152, N01WH32100–32102, N01WH32105, N01WH32106, N01WH32108, N01WH32109, N01WH32111, N01WH32112, N01WH32113, N01WH32115, N01WH32118, N01WH32119, N01WH32122, N01WH42107–N01WH42126, N01WH42129– N01WH42132, and N01WH44221) from the National Heart, Lung, and Blood Institute.

We thank the investigators and staff of all the study cohorts for their dedication; and the study participants for making the program possible.

References

1. Burns, D.; Lee, L.; Shen, L., et al. Smoking and tobacco control monograph no. 8. Bethesda, MD: National Cancer Institute; 1997. Cigarette smoking behavior in the United States: changes in cigarette-related disease risks and their implication for prevention and control; p. 13-112.(NIH publication no. 97-4213.)
2. Thun MJ, Lally CA, Flannery JT, Calle EE, Flanders WD, Heath CW Jr. Cigarette smoking and changes in the histopathology of lung cancer. J Natl Cancer Inst. 1997; 89:1580–6. [PubMed: 9362155]
3. Doll R, Hill A. The mortality of doctors in relation to their smoking habits: a preliminary report. BMJ. 1954; 1:1451–5. [PubMed: 13160495]

4. Hammond EC, Horn D. Smoking and death rates: report on forty-four months of follow-up of 187,783 men. II. Death rates by cause. JAMA. 1958; 166:1294–308.
5. Dorn H. The mortality of smokers and nonsmokers. Proc Soc Stat Sect Am Stat Assn. 1958:34–71.
6. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012. CA Cancer J Clin. 2012; 62:10–29. [PubMed: 22237781]
7. Smoking and health: report of the Advisory Committee to the Surgeon General of the Public Health Service. Washington, DC: Department of Health, Education, and Welfare; 1964. p. 387(PHS publication no. 1103.)
8. Hammond EC, Horn D. The relationship between human smoking habits and death rates: a follow-up study of 187,766 men. JAMA. 1954; 155:1316–28.
9. Hammond E. Smoking in relation to the death rates of one million men and women. Natl Cancer Inst Monogr. 1966; 19:127–204. [PubMed: 5905667]
10. Department of Health and Human Services. Reducing the health consequences of smoking: 25 years of progress: a report of the Surgeon General. Washington, DC: Government Printing Office; 1989. (DHHS publication no. [CDC] 89–8411.)
11. Garfinkel L. Selection, follow-up and analysis in the American Cancer Society prospective studies. Natl Cancer Inst Monogr. 1985; 67:49–52. [PubMed: 4047150]
12. Thun MJ, Day-Lally CA, Calle EE, Flanders WD, Heath CW Jr. Excess mortality among cigarette smokers: changes in a 20-year interval. Am J Public Health. 1995; 85:1223–30. [PubMed: 7661229]
13. Burns, D.; Major, J.; Shanks, T. Those who continue to smoke: is achieving abstinence harder and do we need to change our interventions? Smoking and tobacco control monograph no. 15. Bethesda, MD: National Cancer Institute; 2003. Changes in number of cigarettes smoked per day: cross-sectional and birth cohort analyses using NHIS; p. 83-99.(NIH publication no. 03–5370.)
14. Burns, D.; Major, J.; Shanks, T.; Thun, M.; Samet, J. Risks associated with smoking cigarettes with low machine-measured yields of tar and nicotine. Smoking and tobacco control monograph no. 13. Bethesda, MD: National Cancer Institute; 2001. Smoking lower yield cigarettes and disease risks; p. 65-158.(NIH publication no. 02-5074.)
15. Chahine T, Subramanian SV, Levy JI. Sociodemographic and geographic variability in smoking in the U.S: a multilevel analysis of the 2006–2007 Current Population Survey. Tobacco Use Supplement. Soc Sci Med. 2011; 73:752–8. [PubMed: 21813218]
16. Thun, M.; Day-Lally, C.; Meyers, D., et al. Cigarette smoking behavior in the United States: changes in cigarette-related disease risks and their implication for prevention and control. Smoking and tobacco control monograph no. 8. Bethesda, MD: National Cancer Institute; 1997. Trends in tobacco smoking and mortality from cigarette use in cancer prevention studies I (1959 through 1965) and II (1982 through 1988); p. 305-82.(NIH publication no. 97-4213.)
17. Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors. BMJ. 2004; 328:1519. [PubMed: 15213107]
18. Schatzkin A, Subar AF, Thompson FE, et al. Design and serendipity in establishing a large cohort with wide dietary intake distributions: the National Institutes of Health–American Association of Retired Persons Diet and Health Study. Am J Epidemiol. 2001; 154:1119–25. [PubMed: 11744517]
19. Calle EE, Rodriguez C, Jacobs EJ, et al. The American Cancer Society Cancer Prevention Study II Nutrition Cohort: rationale, study design, and baseline characteristics. Cancer. 2002; 94:2490–501. [PubMed: 12015775]
20. Hays J, Hunt JR, Hubbell FA, et al. The Women's Health Initiative recruitment methods and results. Ann Epidemiol. 2003; 13(Suppl):S18–S77. [PubMed: 14575939]
21. Anderson GL, Manson J, Wallace R, et al. Implementation of the Women's Health Initiative study design. Ann Epidemiol. 2003; 13(Suppl):S5–S17. [PubMed: 14575938]
22. Colditz GA, Manson JE, Hankinson SE. The Nurses' Health Study: 20-year contribution to the understanding of health among women. J Womens Health. 1997; 6:49–62. [PubMed: 9065374]
23. Rimm EB, Chan J, Stampfer MJ, Colditz GA, Willett WC. Prospective study of cigarette smoking, alcohol use, and the risk of diabetes in men. BMJ. 1995; 310:555–9. [PubMed: 7888928]

24. Current Population Survey annual social and economic supplement, 2010 to current. Washington, DC: Census Bureau; (http://www.census.gov/hhes/www/poverty/publications/pubs-cps.html)
25. America's families and living arrangements: 2010 — Table 1A: marital status of people 15 years and over by age, sex, personal earnings, race and Hispanic origin. Washington, DC: Census Bureau; (http://www.census.gov/population/www/socdemo/hh-fam/cps2010.html)
26. Health, United States. Atlanta: Centers for Disease Control and Prevention; 2011. (http://www.cdc.gov/nchs/hus/contents2011.htm#061)
27. Peto and Doll win King Olav V prize for outstanding cancer research. Science Blog. Jul. 2002 (http://scienceblog.com/community/older/2002/E/20023717.html)
28. Department of Health and Human Services. Women and smoking: a report of the Surgeon General. Atlanta: Centers for Disease Control and Prevention; 2001.
29. Anderson, C.; Burns, D. Changing adolescent smoking prevalence. Smoking and tobacco control monograph no. 14. Bethesda, MD: National Cancer Institute; 2001. Pattern of adolescent initiation rates over time: national and California data. (NIH publication no. 02–5086.)
30. Doll R, Peto R, Wheatley K, Gray R, Sutherland I. Mortality in relation to smoking: 40 years' observations on male British doctors. BMJ. 1994; 309:901–11. [PubMed: 7755693]
31. Pirie K, Peto R, Reeves GK, Green J, Beral V. The 21st century hazards of smoking and benefits of stopping: a prospective study of one million women in the UK. Lancet. 2012 Oct 26. (Epub ahead of print).
32. Jha P, Ramasundarahettige C, Landsman V, et al. 21st-Century hazards of smoking and benefits of cessation in the United States. N Engl J Med. 2013; 368:351–60. [PubMed: 23343064]
33. Chronic obstructive pulmonary disease surveillance — United States, 1971– 2000. MMWR Surveill Summ. 2002; 51(6):1–16.
34. Burns, D.; Benowitz, N. Risks associated with smoking cigarettes with low machine-measured tar and nicotine. Smoking and tobacco control monograph no. 15. Bethesda, MD: National Cancer Institute; 2001. Public health Implications of changes in cigarette design and marketing; p. 1-12. (NIH publication no. 02-5074.)
35. Department of Health and Human Services. How tobacco smoke causes disease: the biology and behavioral basis for smoking-attributable disease: a report of the Surgeon General. Atlanta: Centers for Disease Control and Prevention; 2010.
36. Thun MJ, Henley SJ, Calle EE. Tobacco use and cancer: an epidemiologic perspective for geneticists. Oncogene. 2002; 21:7307–25. [PubMed: 12379875]

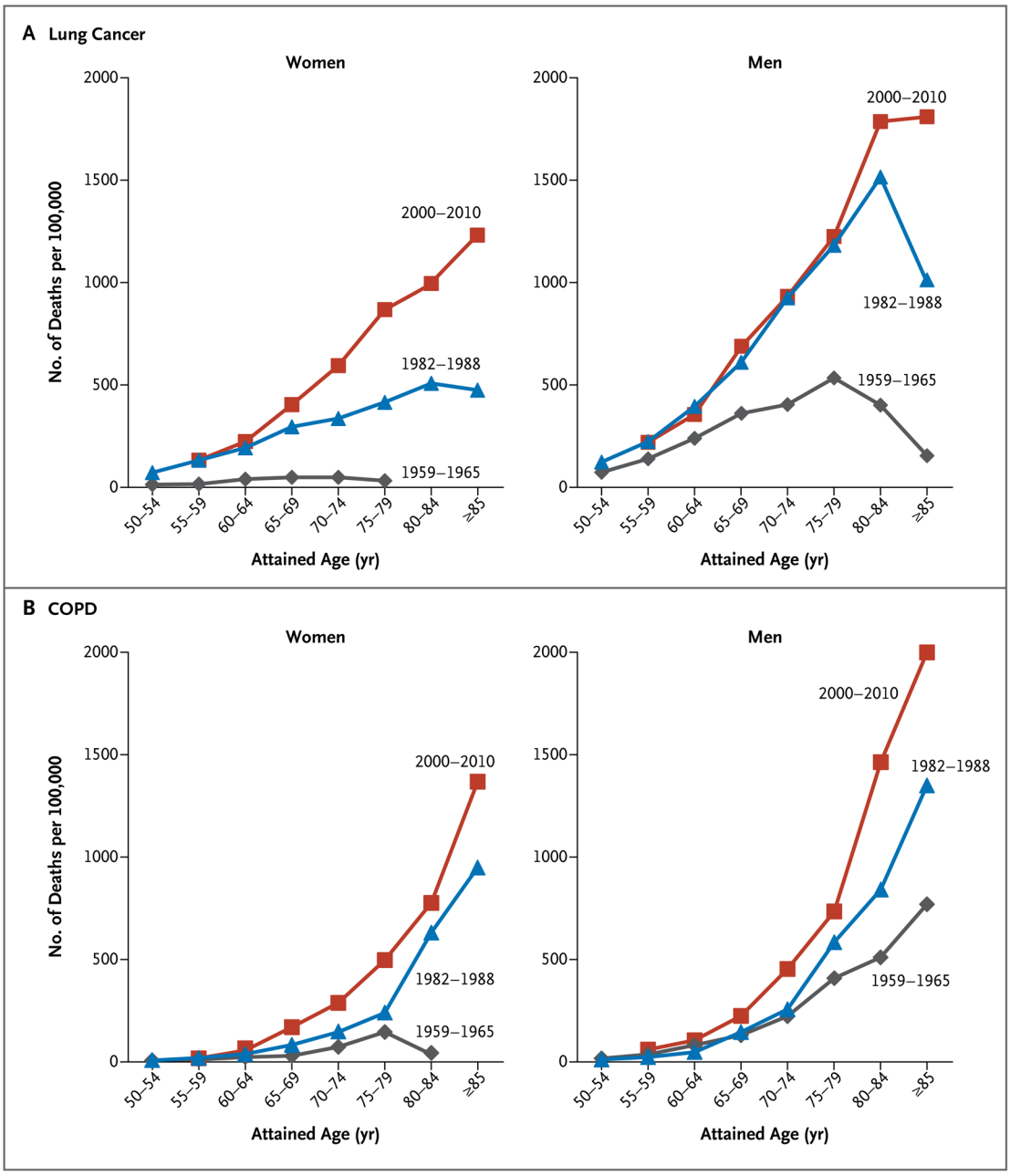


Figure 1. Changes in Rates of Death from Lung Cancer and Chronic Obstructive Pulmonary Disease (COPD) over Time among Current Female and Male Smokers in the Three Time Periods

Data were obtained from the first Cancer Prevention Study (CPS I) for the period from 1959 to 1965, from the second Cancer Prevention Study (CPS II) for the period from 1982 to 1988, and from five contemporary cohort studies for the period from 2000 to 2010.

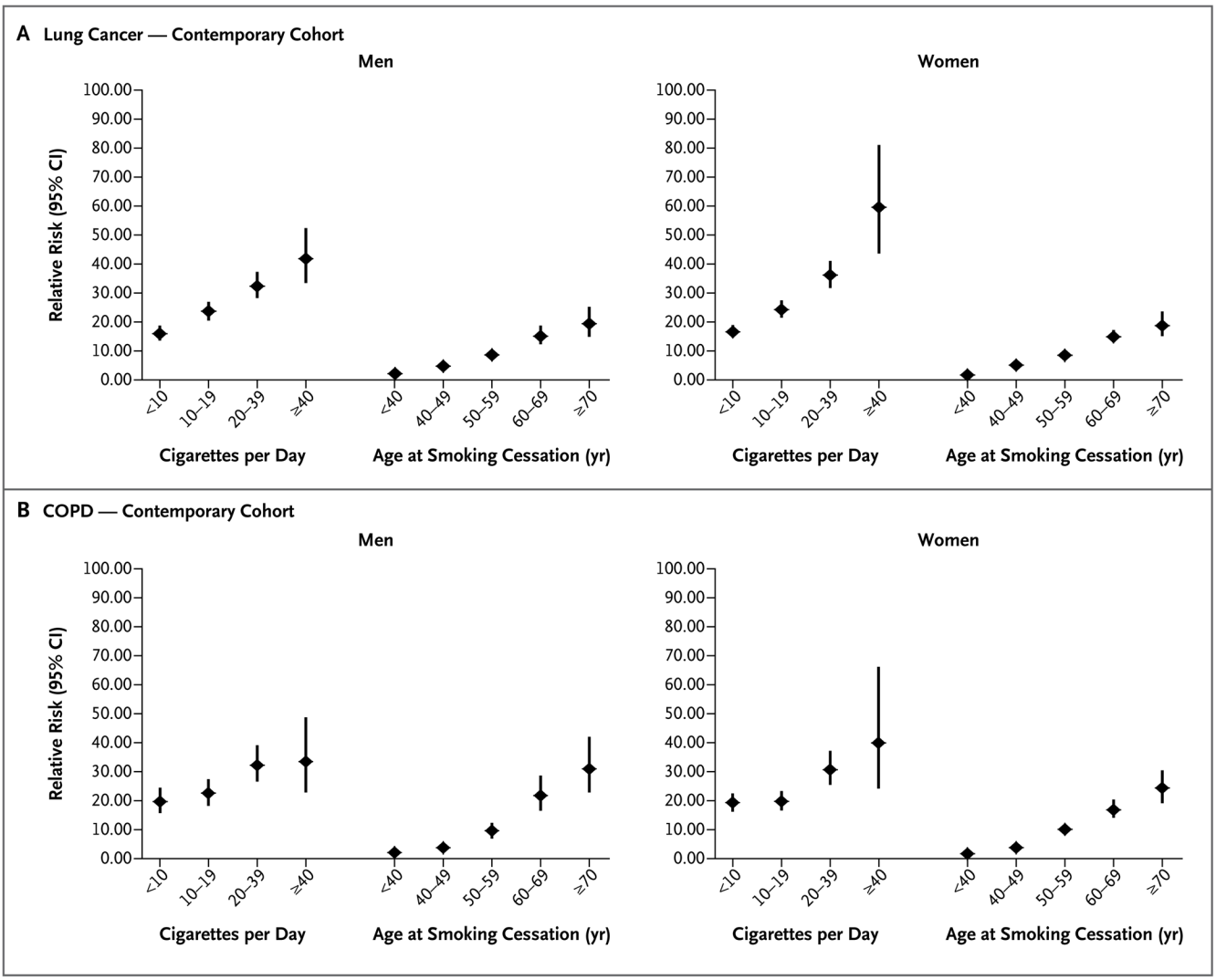


Figure 2. Relative Risks of Lung Cancer and COPD among Current Smokers, According to Number of Cigarettes Smoked per Day, and among Former Smokers, According to Age at the Time of Quitting, in the Contemporary Cohorts

Pooled Cox proportional-hazards, multivariable models were used to determine relative risks for current or former smokers who participated in the Cancer Prevention Study II Nutrition cohort, the Health Professionals Follow-up Study, the Nurses' Health Study, the National Institutes of Health–American Association of Retired Persons Diet and Health Study (NIH–AARP), and the Women's Health Initiative study, 2000–2010. All models were controlled for education level, race, and cohort and were stratified according to the participant's age in 2000. Data were not available for age at the time of quitting for former smokers in the NIH–AARP study. Former smokers who had quit more than 2 years before the survey date were included. $P<0.001$ for the test for trend. Vertical lines indicate 95% confidence intervals.

N Engl J Med. Author manuscript; available in PMC 2013 July 24.

Table 1

Baseline Characteristics and Number of Deaths According to Study Cohort.[*]

	CPS I Cohort (1959–1965)[†]		CPS II Cohort (1982–1988)[†]		Contemporary Cohort (2000–2010)[‡]	
Characteristic	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Participants included in analysis (no.)	183,060	335,922	293,592	452,893	421,702	535,054
Deaths (no.)						
All causes	22,363	25,787	32,335	30,342	73,800	62,956
Lung cancer	1,027	266	3,158	1,799	6,635	4,785
COPD	571	211	1,296	832	3,478	3,034
Ischemic heart disease	9,706	8,103	9,580	6,728	14,753	7,869
Other heart disease	1,494	2,658	3,043	3,054	5,261	4,641
Any type of stroke	2,213	3,677	1,720	2,317	3,431	4,105
Mean age[§]	59.0±7.6	60.2±8.3	60.9±7.8	61.4±8.3	66.7±6.2	66.5±6.5
Educational level (%)[¶]						
High school or less	65.2	64.5	39.0	34.4	20.9	20.7
Some college	16.3	20.7	27.0	29.9	27.7	28.6
College or nursing school or more	17.1	13.5	32.6	34.1	49.4	49.1
Race (%)[//]						
White	97.1	96.4	94.6	93.8	93.8	90.2
Black	1.9	2.1	3.3	4.2	2.3	5.2
Other or missing data	1.0	1.5	2.4	2.0	3.9	4.6
Ethnic group (%)[**]						

Characteristic	CPS I Cohort (1959–1965)†		CPS II Cohort (1982–1988)†		Contemporary Cohort (2000–2010)‡	
	Men	Women	Men	Women	Men	Women
Non-Hispanic			99.3	99.3	97.6	97.4
Hispanic			0.8	0.7	1.6	2.0
Married at time of enrollment (%)	94.8	68.2	94.8	71.7	87.7	64.1
Smoking status (%)††						
Never smoked	43.5	81.0	33.6	61.2	36.2	49.3
Current smoker	39.5	15.2	23.5	18.0	9.3	9.7
Former smoker	17.0	3.8	42.9	20.8	54.5	41.0
Characteristics of current smokers						
No. of cigarettes smoked per day (%)‡‡						
<10	14.7	34.4	11.2	16.3	24.0	42.9
10–19	23.5	31.2	17.3	24.5	36.0	35.9
20–39	51.8	32.2	50.4	43.5	34.3	18.4
≥40	8.7	2.2	17.9	8.0	4.4	1.2
Mean duration of smoking by age group (yr)§§¶¶						
50–59 yr	34.9±6.0	26.3±8.8	36.8±5.2	34.0±6.6	35.2±7.9	34.6±8.9
60–69 yr	43.6±7.3	29.2±9.6	45.7±5.8	41.9±8.1	44.0±8.9	41.7±9.8
70–79 yr	50.9±9.8	33.5±10.0	54.5±6.6	47.8±9.9	51.2±10.4	48.2±10.7
≥80 yr	58.6±12.5	39.9±10.8	63.6±9.1	50.3±13.3	56.3±15.5	48.9±13.7
Age at initiation of smoking (%)‡‡§§						
<15 yr	13.1	0.9	16.5	4.2	13.7	6.5

Characteristic	CPS I Cohort (1959–1965)†		CPS II Cohort (1982–1988)†		Contemporary Cohort (2000–2010)‡	
	Men	Women	Men	Women	Men	Women
15–19 yr	44.5	10.0	52.0	40.1	49.9	51.9
20–29 yr	27.4	27.4	24.4	35.6	31.6	35.4
≥30 yr	9.0	56.8	3.1	16.2	3.7	6.0

* Plus–minus signs are means ±SD. COPD denotes chronic obstructive pulmonary disease.

† Participants were enrolled in Cancer Prevention Study I (CPS I) in 1959 and in Cancer Prevention Study II (CPS II) in 1982. Analyses of both studies excluded participants younger than 50 years of age.

‡ The contemporary cohort consisted of cohorts from five studies. Participants were enrolled in the Nurses' Health Study (NHS) in 1976, the Health Professionals Follow-up Study (HPFS) in 1986, the CPS II Nutrition Cohort in 1992, the National Institutes of Health–American Association of Retired Persons (NIH–AARP) Diet and Health Study in 1995–1996, and the Women's Health Initiative (WHI) in 1993–1998.

§ Age at the start of follow-up is shown.

¶ For women, the spouse's educational level was used if it was more advanced.

‖ Race was self-reported.

** Ethnic group was self-reported. The HPFS was not included in this analysis.

†† Smoking status was recorded as of 1959 for CPS I, 1982 for CPS II, 1999 for the CPS II Nutrition Cohort, 2000 for the HPFS and the NHS, 1996 for the NIH–AARP cohort, and 1995–2001 for the WHI.

‡‡ These data were age-adjusted to the U.S. population standard for the year 2000.

§§ Current smokers in the NIH–AARP cohort were excluded from this analysis because the age at smoking initiation was available only for the subgroup that completed the 2004 survey.

¶¶ Categories refer to age at the start of follow-up.

Table 2

Age-Adjusted and Multivariable-Adjusted Relative Risks of Death from Smoking-Related Diseases among Women 55 Years of Age or Older in the Three Study Cohorts, According to Smoking Status.*

	Never Smoked			Current Smoker			Former Smoker†		
Variable	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)
Death from all causes									
No. of deaths	21,825	17,585	26,182	3214	7188	7240	748	5569	29,534
Rate per 100,000	2,884.23	1741.18‡	1247.93‡	3225.49	2953.70	3015.68	3553.76	2104.71‡	1676.23‡
Age-adjusted RR	1.00	1.00	1.00	1.33	2.08	2.80	1.29	1.28	1.44
95% CI				1.28–1.38	2.03–2.14	2.73–2.88	1.20–1.39	1.24–1.32	1.41–1.46
Multivariable-adjusted RR§	1.00	1.00	1.00	1.35	2.08	2.76	1.33	1.33	1.45
95% CI				1.30–1.40	2.02–2.14	2.69–2.84	1.23–1.43	1.29–1.37	1.43–1.48
Death from lung cancer									
No. of deaths	179	334	513	79	1084	1485	8	381	2787
Rate per 100,000	17.70	27.74‡	21.77‡	30.19	291.86‡	505.79‡	46.50	97.77	128.84‡
Age-adjusted RR	1.00	1.00	1.00	2.74	12.62	26.18	1.30	3.77	6.66
95% CI				2.07–3.62	11.13–14.31	23.65–28.98	0.64–2.65	3.25–4.38	6.06–7.31
Multivariable-adjusted RR§	1.00	1.00	1.00	2.73	12.65	25.66	1.30	3.85	6.70
95% CI				2.07–3.61	1.15–14.34	23.17–28.40	0.64–2.64	3.32–4.47	6.09–7.36
Death from COPD									
No. of deaths	136	192	320	66	367	720	9	273	1994
Rate per 100,000	15.70	18.71	16.09	45.74	199.17‡	312.92‡	43.32	104.14‡	103.40

	Never Smoked			Current Smoker			Former Smoker†		
Variable	**CPS I Cohort (1959–1965)**	**CPS II Cohort (1982–1988)**	**Contemporary Cohort (2000–2010)**	**CPS I Cohort (1959–1965)**	**CPS II Cohort (1982–1988)**	**Contemporary Cohort (2000–2010)**	**CPS I Cohort (1959–1965)**	**CPS II Cohort (1982–1988)**	**Contemporary Cohort (2000–2010)**
Age-adjusted RR	1.00	1.00	1.00	3.93	10.31	23.03	2.32	5.84	7.88
95% CI				2.88–5.38	8.60–12.36	20.15–26.31	1.18–4.56	4.83–7.05	7.00–8.87
Multivariable-adjusted RR§	1.00	1.00	1.00	3.95	10.35	22.35	2.31	6.10	8.09
95% CI				2.89–5.41	8.63–12.41	19.55–25.55	1.17–4.56	5.05–7.37	7.19–9.10
Death from ischemic heart disease¶									
No. of deaths	6881	4266	3349	998	1357	907	224	1105	3613
Rate per 100,000	952.02	464.05≠	168.69≠	1148.82	676.13≠	368.00≠	1107.60	553.82≠	212.64≠
Age-adjusted RR	1.00	1.00	1.00	1.53	2.00	2.93	1.35	1.20	1.40
95% CI				1.43–1.64	1.87–2.13	2.72–3.16	1.19–1.55	1.12–1.28	1.34–1.47
Multivariable-adjusted RR§	1.00	1.00	1.00	1.56	2.00	2.86	1.39	1.27	1.44
95% CI				1.46–1.67	1.88–2.13	2.65–3.08	1.22–1.59	1.19–1.36	1.38–1.51
Death from other heart disease¶									
No. of deaths	2332	1972	2212	252	597	374	74	485	2055
Rate per 100,000	345.59	220.60≠	115.75≠	348.01	310.07	188.29≠	383.00	231.04≠	126.83≠
Age-adjusted RR	1.00	1.00	1.00	1.16	1.89	1.89	1.35	1.15	1.21
95% CI				1.01–1.33	1.72–2.08	1.69–2.11	1.07–1.70	1.04–1.28	1.14–1.29
Multivariable-adjusted RR§	1.00	1.00	1.00	1.20	1.88	1.84	1.40	1.22	1.24
95% CI				1.04–1.37	1.71–2.07	1.65–2.06	1.11–1.77	1.10–1.35	1.17–1.32
Death from any stroke¶									

Variable	Never Smoked			Current Smoker			Former Smoker†		
	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)
No. of deaths	3188	1507	2015	390	474	358	99	336	1732
Rate per 100,000	497.58	177.11‡	100.01‡	445.61	223.16‡	206.39‡	664.09	169.63‡	114.81‡
Age-adjusted RR	1.00	1.00	1.00	1.48	2.20	2.12	1.42	1.12	1.14
95% CI				1.33–1.65	1.97–2.45	1.89–2.38	1.16–1.73	0.99–1.27	1.07–1.21
Multivariable-adjusted RR§	1.00	1.00	1.00	1.51	2.19	2.10	1.46	1.16	1.15
95% CI				1.35–1.69	1.96–2.44	1.87–2.36	1.19–1.78	1.03–1.31	1.07–1.22

*Mortality was adjusted to the U.S. population standard for the year 2000, and relative risks were calculated with the use of age-adjusted and multivariable-adjusted Cox proportional-hazards models of the five most common diseases related to smoking. CI denotes confidence interval, and RR relative risk.

†This group consists of former smokers who quit more than 2 years before the survey date.

‡The age-standardized rate differed significantly from that for the immediately preceding time period.

§Multivariable models were adjusted for exact age, race, and educational level.

¶The combined rates per 100,000 participants for the three cardiovascular disease categories (ischemic heart disease, other heart disease, and any type of stroke) in those who never smoked were 1795.19 in the CPS I cohort, 861.76 in the CPS II cohort, and 384.45 in the contemporary cohort — a reduction of 79% from the 1959–1965 period to the contemporary period.

Table 3

Age-Adjusted and Multivariable-Adjusted Relative Risks of Death from Smoking-Related Diseases among Men 55 to 85 Years of Age or Older in the Three Study Cohorts, According to Smoking Status.*

	Never Smoked			Current Smoker			Former Smoker†		
Variable	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)
Death from all causes									
No. of deaths	8244	8206	17,462	10,843	10,608	6920	3276	13,521	49,418
Rate per 100,000	4,142.19	2,676.85‡	1,917.95‡	6,126.42	5,202.46‡	4,679.65‡	4,707.95	3,527.17‡	2,716.45‡
Age-adjusted RR	1.00	1.00	1.00	1.78	2.43	2.98	1.28	1.43	1.53
95% CI				1.73–1.84	2.36–2.50	2.90–3.07	1.23–1.33	1.40–1.47	1.50–1.55
Multivariable-adjusted RR§	1.00	1.00	1.00	1.76	2.33	2.80	1.28	1.42	1.47
95% CI				1.71–1.81	2.26–2.40	2.72–2.88	1.23–1.34	1.38–1.45	1.45–1.50
Death from lung cancer									
No. of deaths	73	125	357	859	1887	1455	95	1146	4823
Rate per 100,000	27.35	34.87	34.07	305.40	707.14‡	798.81	101.51	251.74‡	208.05‡
Age-adjusted RR	1.00	1.00	1.00	12.49	25.30	27.32	3.50	7.60	7.13
95% CI				9.80–15.92	21.10–30.34	24.30–30.70	2.58–4.76	6.32–9.15	6.40–7.94
Multivariable-adjusted RR§	1.00	1.00	1.00	12.22	23.81	24.97	3.48	7.41	6.75
95% CI				9.59–15.58	19.85–28.57	22.20–28.09	2.56–4.74	6.16–8.91	6.06–7.52
Death from COPD									
No. of deaths	82	94	183	338	462	656	151	740	2639

Variable	Never Smoked			Current Smoker			Former Smoker†		
	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)
Rate per 100,000	39.42	33.72	18.56‡	227.64	318.24‡	497.62‡	168.23	209.27	138.57‡
Age-adjusted RR	1.00	1.00	1.00	5.61	10.50	28.97	5.78	6.96	7.62
95% CI				4.38–7.20	8.39–13.13	24.55–34.19	4.40–7.59	5.61–8.62	6.56–8.85
Multivariable-adjusted RR§	1.00	1.00	1.00	5.52	9.98	25.61	5.75	6.77	7.05
95% CI				4.30–7.08	7.97–12.49	21.68–30.25	4.37–7.55	5.46–8.40	6.07–8.19
Death from ischemic heart disease¶									
No. of deaths	3529	2731	3582	4711	2743	1286	1466	4106	9885
Rate per 100,000	1,678.67	852.71‡	411.17‡	2,403.70	1,289.73‡	891.64‡	1,977.97	1,026.76‡	558.93‡
Age-adjusted RR	1.00	1.00	1.00	1.71	1.86	2.69	1.29	1.30	1.49
95% CI				1.63–1.79	1.76–1.96	2.53–2.88	1.21–1.37	1.24–1.36	1.44–1.55
Multivariable-adjusted RR§	1.00	1.00	1.00	1.69	1.78	2.50	1.28	1.27	1.43
95% CI				1.61–1.77	1.69–1.88	2.34–2.66	1.21–1.36	1.21–1.33	1.37–1.48
Death from other heart disease¶									
No. of deaths	635	911	1400	630	907	403	229	1225	3458
Rate per 100,000	349.30	320.80	168.46‡	498.03	502.64	292.70‡	428.68	364.10	210.74‡
Age-adjusted RR	1.00	1.00	1.00	1.55	1.99	2.35	1.28	1.20	1.34
95% CI				1.37–1.74	1.81–2.18	2.10–2.63	1.10–1.50	1.10–1.31	1.26–1.43
Multivariable-adjusted RR§	1.00	1.00	1.00	1.51	1.88	2.15	1.29	1.19	1.27

Variable	Never Smoked			Current Smoker			Former Smoker†		
	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)	CPS I Cohort (1959–1965)	CPS II Cohort (1982–1988)	Contemporary Cohort (2000–2010)
95% CI				1.34–1.70	1.71–2.07	1.92–2.41	1.11–1.51	1.09–1.29	1.20–1.36
Death from any stroke¶									
No. of deaths	1083	558	1001	862	511	236	268	651	2194
Rate per 100,000	654.06	220.84‡	124.58‡	719.66	320.97‡	202.52‡	515.76	216.91‡	135.89‡
Age-adjusted RR	1.00	1.00	1.00	1.41	2.08	2.00	0.94	1.07	1.18
95% CI				1.28–1.55	1.84–2.35	1.73–2.31	0.82–1.08	0.96–1.20	1.10–1.28
Multivariable-adjusted RR§	1.00	1.00	1.00	1.38	1.97	1.92	0.95	1.07	1.16
95% CI				1.26–1.52	1.74–2.23	1.66–2.21	0.83–1.09	0.95–1.20	1.07–1.25

*Mortality was adjusted to the U.S. population standard for the year 2000, and relative risks were calculated with the use of age-adjusted and multivariable-adjusted Cox proportional-hazards models of the five most common diseases related to smoking.

†This group consists of former smokers who quit more than 2 years before the survey date.

‡The age-standardized rate differed significantly from that for the immediately preceding time period.

§Multivariable models were adjusted for exact age, race, and educational level.

¶The combined rates per 100,000 participants for the three cardiovascular disease categories (ischemic heart disease, other heart disease, and any type of stroke) in those who never smoked were 2682.03 in the CPS I cohort, 1394.35 in the CPS II cohort, and 704.21 in the contemporary cohort — a reduction of 74% from the 1959–1965 period to the contemporary period.

Smoking and Smoking Cessation in Pregnancy

Susan Murin, MD, MSc[a,b,*], Rokhsara Rafii, MD, MPH[a,b], Kathryn Bilello, MD[c]

KEYWORDS

• Tobacco • Smoking • Pregnancy • Women

Smoking during pregnancy is among the leading preventable causes of adverse maternal and fetal outcomes. Because only a minority of smoking women of childbearing age manage to quit smoking when they become pregnant, smoking among young women is the primary determinant of the prevalence of smoking during pregnancy. Smoking among women of childbearing age is associated with reduced fertility, increased complications of pregnancy such as placenta previa and placental abruption, and a variety of adverse fetal outcomes such as stillbirth, low birth weight (LBW), and small for gestational age (SGA). In addition, there is increasing evidence of adverse effects on offspring including increased risk of sudden infant death syndrome (SIDS), reduced lung function, increased incidence of neurocognitive disorders, and increased risk of tobacco addiction and obesity. Pregnancy represents a unique motivation for smoking cessation, and more women quit smoking during pregnancy than at any other time in their lives. However, most women smoking at conception continue to smoke, and relapse rates after parturition are high. Guidelines for smoking cessation during pregnancy have been developed to guide health care professionals in their efforts to help women who are pregnant to cease smoking. This article reviews the epidemiology of smoking during pregnancy; the adverse effects of smoking on the mother, fetus, and offspring; and recommended approaches to smoking cessation for pregnant women.

EPIDEMIOLOGY OF SMOKING AND SMOKING CESSATION IN PREGNANCY

Smoking Among Women of Reproductive Age

Smoking among women of reproductive age has decreased in the United States. In 1965, 38% of women aged 18 to 24 years smoked, as did 44% of women aged 25 to 44 years.[1] In 2000, these percentages decreased to 25% and 23%, respectively.[1] In the past decade, smoking rates among women of reproductive age have reached a plateau. According to the 2006 Behavioral Risk Factor Surveillance System (BRFSS), 22.4% of women of reproductive age (18–44 years) were current smokers.[2] Findings from the Global Youth Tobacco Survey show an increase in smoking among young girls compared with adult women, raising the possibility that, worldwide, smoking among women of childbearing age may increase in the future.[3]

Smoking During Pregnancy: US Trends

Smoking prevalence during pregnancy is usually based on self-reported information (taken from birth certificates and questionnaires) and probably underestimates the true prevalence of smoking. Studies validating smoking status during pregnancy using cotinine measurements have shown underestimation of smoking by as much as 25%.[4] Smoking prevalence during pregnancy in the United States has fallen, and this decrease is attributable more to the overall decline in smoking

The authors have nothing to disclose.

[a] Division of Pulmonary, Critical Care and Sleep Medicine, UC Davis School of Medicine, 4150 V Street, Suite 3400, Sacramento, CA 95817, USA
[b] VA Northern California Healthcare System, CA, USA
[c] Department of Medicine, University of California, San Francisco-Fresno Program, 2823 Fresno Street, Fresno, CA 93721, USA
* Corresponding author. Division of Pulmonary, Critical Care and Sleep Medicine, UC Davis School of Medicine, 4150 V Street, Suite 3400, Sacramento, CA 95817.
E-mail address: susan.murin@ucdmc.ucdavis.edu

Clin Chest Med 32 (2011) 75–91
doi:10.1016/j.ccm.2010.11.004
0272-5231/11/$ – see front matter

initiation rates among women of childbearing age than to an increased rate of smoking cessation during pregnancy. According to BRFSS data collected yearly from 1987 to 1996, the smoking initiation rate among women aged 18 to 44 years decreased significantly from 44.1% in 1987 to 38.2% in 1996.[5] In the same 10-year interval, the prevalence of current smoking also decreased significantly among both pregnant women (from 16.3% to 11.8%) and nonpregnant women (from 26.7% to 23.6%). In contrast, the percentage of women who had quit smoking changed minimally between 1987 and 1996 among both pregnant women (from 26.3% to 25.2%) and nonpregnant women (from 16.3% to 14.4%). Using data collected on birth certificates reported by 49 states and the District of Columbia, smoking during pregnancy decreased from 18.4% in 1990 to 11.4% in 2002.[6] The highest percentage of women who smoked during pregnancy was seen in Kentucky (24.4%) and the lowest in Utah (7.0%).

The most recent trends examining smoking during pregnancy used data from the Pregnancy Risk Assessment Monitoring System (PRAMS) from 31 sites covering the years 2000 to 2005.[7] These 31 sites represented approximately 54% of the live births in 2005. Based on aggregated data from 16 sites for which data were available for all 6 years, the prevalence of smoking during the 3 months before pregnancy did not change significantly (22.3% in 2000 to 21.5% in 2005). However, the prevalence of smoking during pregnancy did decrease significantly (from 15.2% in 2000 to 13.8% in 2005). There was marked spread among the sites, with prevalence of smoking during pregnancy in 2005 ranging from 35.7% in West Virginia to 5.2% in New York City.

Smoking During Pregnancy: International Trends

Most of the international information on smoking during pregnancy comes from developed countries where smoking trends parallel those seen in the United States. In Canada, cigarette smoking during pregnancy decreased from 31% in 1992[8] to 12% in 2002.[9] The prevalence of smoking during pregnancy among Danish women decreased from 22% in 1997 to 16% in 2005.[10] In Australia, the percentage of women reporting smoking during pregnancy decreased from 23% in 2001 to 20% in 2004.[11] In contrast, in Japan, where male smokers historically have outnumbered female smokers, the prevalence of smoking among women of childbearing age and among pregnant women has increased significantly. The prevalence of smoking among women in their 20s increased from 10.7% in 1994 to 19.2% in 2004[12]; the prevalence of smoking during pregnancy nearly doubled as well, going from 5.6% in 1991 to 10.0% in 2001.[13] The targeting of new markets by the tobacco industry in eastern European and Asian countries raises concern that the prevalence of smoking among young women and pregnant women in these regions will increase in the future.[14–16]

Factors Associated with Smoking During Pregnancy

Maternal smoking prevalence differs according to age, race, education, and socioeconomic status (SES). Higher smoking rates are consistently reported among younger pregnant women (adolescents and 18–24 years old). Review of yearly birth certificates from 1990 to 2002 showed that, for every year from 1996 to 2001, girls and women aged 15 to 19 years had the highest percentage of smoking during pregnancy. In 2002, the percentage of maternal smokers aged 15 to 19 years (16.7%) was the same for women aged 20 to 24 years, with the highest percentage reported among women aged 18 to 19 years (18.2%).[6] United States birth statistics from 2005 showed that 16.6% of mothers aged 15 to 19 years smoked and 18.6% of mothers aged 20 to 24 years smoked, whereas only 11.5% of mothers aged 25 to 29 years and 7.1% of mothers aged 30 to 39 years smoked during pregnancy.[17]

Although overall pregnancy-related smoking rates have decreased over time, rates among young women have increased. From 1987 to 1996, the smoking prevalence rate among pregnant 18 to 20 year olds increased from 13.4% to 15.3%.[5] The prevalence of smoking among white, non-Hispanic women aged 20 to 24 years increased significantly, from 30.0% in 2000 to 32.8% in 2005.[7] In Denmark, although the overall prevalence of women who smoked during pregnancy decreased, among women younger than 20 years, the prevalence of pregnancy-related smoking increased from 37% in 1997 to 43% in 2005.[10] In Japan, the prevalence of smoking among young women in their 20s increased from 10.7% in 1994 to 19.2% in 2004, with a doubling of smoking prevalence among pregnant women seen in the same time interval.[12,13]

Race and ethnicity influence smoking rates during pregnancy. A study of trends in pregnancy-related smoking rates in the United States from 1987 to 1996 showed that white mothers smoke more than nonwhite mothers (11.9% vs 8.5% in 1996).[5] In 2005, prevalence of smoking during pregnancy was highest among Alaska Natives (36.3%) and

American Indians (20.6%) and lowest among Hispanic women (4.0%) and Asian/Pacific Islanders (5.4%).[7] Prevalence among white non-Hispanic women was 18.5% and 10.1% among black non-Hispanic women.[7]

Lower SES and lack of education have been associated with higher pregnancy-related smoking rates. In the United States, only 1.8% of mothers who completed college reported smoking during 2005 in contrast to 20.2% of mothers with less than a high school education.[17] A systematic review of 9 cohort studies of the determinants of smoking during pregnancy consistently identified lower SES and less education as risk factors for smoking during pregnancy.[18] PRAMS data from 2005 showed that, compared with nonsmokers, women who smoked during pregnancy were more likely to have 12 years of education or less, have an annual income of less than $15,000, and be enrolled in Medicaid.[7] Other factors associated with a higher likelihood of smoking during pregnancy include being unmarried, having an unplanned pregnancy, having a partner who smokes, higher nicotine addiction, early age at smoking initiation, and increased parity.[7,18–20]

Smoking Cessation During Pregnancy

In spite of the known adverse effects of smoking on fetal health, most smokers who become pregnant continue smoking, and most of those who do quit resume smoking after delivery. Cessation rates by cigarette smokers after becoming aware of their pregnancy vary according to time period and geographic region. A systematic review of 9 cohort studies from 8 European countries and Australia reported quit rates ranging from 11.5% to 48%.[18] A cross-sectional survey from Japan reported that 66.5% of women who had smoked before pregnancy quit.[21] Data reported by the BRFSS between 1987 and 1996 showed that the percentage of women who quit smoking during pregnancy remained stable at around 25% (26.3% in 1987 vs 25.2% in 1996).[5] The most recent trends in the United States do show improvement in smoking cessation rates during pregnancy, with the percentage of smokers who quit during pregnancy climbing to 45% (43.9% in 2000 vs 45.7% in 2005).[7] However, relapse rates among women who abstain from smoking during pregnancy are high, with most women resuming smoking by 6 months after parturition.[7,20–22] According to PRAMS data from 2000 to 2005, the percentage of quitters who relapsed after delivery remained in excess of 50% (50.3% in 2000 vs 51.4% in 2005).[7]

Most women smokers who successfully abstain from smoking throughout pregnancy have quit on their own shortly after discovering their pregnancy and before their first prenatal visit.[22] Factors associated with continued smoking during pregnancy versus quitting have been examined. Women who quit smoking during pregnancy are more likely to have more years of education, less poverty, be married, have a planned pregnancy, and be a first-time mother.[7,20,22,23] In the United States, Hispanic women are more likely to quit smoking during pregnancy compared with other ethnic groups.[7,23] Intensity of nicotine addiction and cohabitation with a smoker are strong determinants of continued smoking during pregnancy as well as relapse after delivery. Women who were lighter smokers, started smoking at an older age, and had smoked for fewer years at the time of conception were more likely to quit.[7,18,22,23] Partner's smoking habits play a significant role in the ability to refrain from smoking during and after pregnancy.[18–22] In a multivariate analysis of factors associated with continued smoking during pregnancy, living with a partner who smokes was associated with double the risk of smoking during pregnancy (odds ratio [OR] 2.3) compared with living with a nonsmoker.[19] In a large longitudinal cohort study of maternal smoking in the United States, women who lived with another smoker were 4 times as likely to relapse after delivery as women who did not live with another smoker.[20]

ADVERSE EFFECTS OF SMOKING ON MOTHER, FETUS, AND OFFSPRING

Since the middle of the twentieth century, researchers have been studying the adverse effects of smoking tobacco during pregnancy.[24] Smoking exerts indirect adverse effects on the fetus by altering umbilical blood flow and direct effects through placental transfer of toxins to the fetus.[25,26] Cigarette smoke is made up of more than 4000 compounds, which include a variety of harmful chemicals such as nicotine, carbon monoxide, tar, benzene, and heavy metals.[27,28] Of these chemicals, an ever-increasing body of evidence implicates nicotine as causing the most harm to the fetus.[28]

Because of its high lipid solubility, nicotine (and its main metabolite, cotinine) readily crosses the placental tissue into the fetal bloodstream.[25] When nicotine is measured in the amniotic fluid and fetal plasma, the fetus is found to have greater exposure to nicotine than the smoking mother.[25] Animal models have indicated that nicotine has neuroteratogenic effects during development, including induction of mitotic arrest, cell death, and decreased central nervous system cell number.[25] Evidence from human studies has linked fetal exposure to tobacco smoke to complications

during pregnancy, adverse effects on growth, abnormal neurodevelopment (manifesting later as conduct disorders, propensity to addiction, and decreased cognitive and learning skills), as well as lasting adverse effects on the respiratory system.[25] This article highlights the adverse effects tobacco smoke has on the mother, her fetus, and residual effects in her offspring.

Delayed Conception and Infertility

Epidemiologic studies have provided evidence of a dose-related effect of smoking on conception, with a delay in conception of about 2 months.[29] Tobacco can cause DNA and chromosomal damage to human germinal cells, oocytes, and spermatozoa.[29] Chemicals in cigarette smoke also accelerate follicular depletion and reduce the number of oocytes in a dose-related fashion, which is clinically manifested by a reduction in the age of menopause by about 2 years among smokers, thus shortening the span of the woman's fertile years.[29]

A growing number of studies support the association between smoking and a delay in conception and infertility. A meta-analysis performed by Augood and colleagues[30] found a 60% increased risk of infertility among smoking women (OR 1.60, 95% confidence interval [CI] 1.34−1.91). A reduced OR of becoming pregnant was also noted for smokers in a meta-analysis of women undergoing in vitro fertilization treatment (OR 0.66, 95% CI 0.49−0.88).[30] The adverse effects of smoking on fertility seem to be reversible. Former smokers seem to have comparable rates of infertility with those who never smoked.[30]

Complications During Pregnancy

The effects of tobacco smoke become tangible and clinically apparent before the birth of the fetus. Tobacco can adversely affect the woman's ability to carry a pregnancy to term without complications.[31] In a meta-analysis performed by Castles and colleagues,[31] smoking during pregnancy was strongly associated with an increased risk for abruption of placenta, ectopic pregnancy, and preterm premature rupture of the membrane. After reviewing the data reported in 34 studies, the authors conclude that the OR among smokers for the outcomes mentioned earlier ranged from 1.6 to 1.91. The OR for preeclampsia was 0.51. The explanation for this seemingly protective finding remains unclear. Theories proposed include that the plasma volume expands less in pregnant smokers than in pregnant nonsmokers, that the thiocyanate found in tobacco smoke has a hypotensive effect, and that nicotine has an inhibitory effect on the production of fetal thromboxane A2, a potent vasoconstrictor. Nevertheless, this likely benefit is outnumbered by the risk of pregnancy-related complications that tobacco smoke presents.

The risk of stillbirths among pregnant smokers has also been investigated in the last several years. In a review of the Missouri maternally linked cohort data files spanning from 1978 to 1997, the rate of stillbirths (defined by in utero fetal death at $\geq$20 weeks) climbed with increasing tobacco use.[32] Furthermore, smoking mothers were about 50% more likely to experience intrapartum (occurrence during labor) fetal death than their nonsmoking counterparts.[32]

The same investigators also assessed the effect of prenatal smoking among women of advanced maternal age. Women were divided into 2 age groups (<35 years of age, or $\geq$35 years of age). Compared with nonsmoking younger gravidas, younger (group aged <35 years) smoking mothers had a 30% greater likelihood of stillbirth (both antepartum and intrapartum). The adjusted hazard ratios (AHR) for the smokers greater than age 35 years were 2.6 (antepartum) and 3.2 (intrapartum) compared with the younger nonsmoker referent group.[33] Thus, when adjusted for confounders, increasing age appeared to be an important modifier in the relationship between in utero fetal exposure to tobacco smoke and stillbirths, particularly intrapartum stillbirths.

An increased risk was noted in the other end of the age spectrum: adolescence. Pregnant adolescents already have an increased risk for adverse birth outcomes, including preterm birth, LBW, fetal growth restriction, late fetal death, and infant mortality.[34] After adjusting for maternal race, body mass index (BMI), prenatal care received, fetal sex, and year of birth, the investigators found the risk for intrapartum stillbirth among smoking adolescents less than 15 years of age to be twice the risk for older adolescent and mature mothers. Based on the AHR, the risk of intrapartum stillbirth among smokers decreased as maternal age increased (AHR of 4.0 for mothers <15 years of age, AHR of 1.5 for mothers aged 15−19 years, and AHR of 1.8 for mothers aged 20−24 years). These studies are in concordance with others that report an increased risk of stillbirths among smoking mothers, and point to a particular need for smoking cessation interventions at both ends of the maternal age spectrum.

LBW and SGA

In 1957, Simpson[24] reported an adverse relationship between maternal smoking and birth weight. The association between tobacco smoke exposure and infant LBW and SGA has since been

confirmed in numerous studies, and has been attributed to intrauterine growth retardation rather than preterm delivery.[35–37] LBW, less than 2500 g, is one of the most reported complications of tobacco smoke in the literature. Cigarette smoking is the single most important factor affecting birth weight in developed countries.[27,36]

Women who smoke are 2 to 3 times more likely to deliver an LBW infant than their nonsmoking counterparts, with an average decrease in their baby's weight of 150 to 300 g at birth.[35,38] Smokers also have an increased risk for an SGA infant, with a relative risk ranging from 1.3 to 10.0.[1] In a recent population-based analysis among smoking and nonsmoking mothers, maternal tobacco use was an independent predictor of SGA (<10th percentile for gestational age).[39] A disproportionate increase in SGA remained when compounded with additional maternal nutritional and uteroplacental constraints such as maternal underweight and essential hypertension.[39] Studies have shown a statistically significant dose-response relationship between the number of cigarettes smoked by the mother and the risk of LBW and SGA.[1,35,40] This dose-response relationship seems to be more pronounced among older (≥30 years) mothers.[35] Both maternal and paternal smoking is associated with LBW, with maternal smoking having a greater effect.[27]

In a prospective study of the offspring of 1518 women, anthropometric measurements (including birth weight, crown-heel length, ponderal index) were less affected when women stopped smoking during their pregnancy compared with those who continued to smoke throughout pregnancy.[1,41] It is not yet fully understood at what point during pregnancy a mother can quit smoking and avoid the increased risks of LBW and SGA. Most studies have shown that those who quit in the first trimester can achieve the same lower relative risk of LBW and SGA than those who never smoked during pregnancy, whereas others show the greatest effect occurring during the third trimester.[1,38,40,42] These findings highlight the importance of continued smoking cessation interventions throughout pregnancy.

SIDS

SIDS has been linked repeatedly with maternal smoking. SIDS is one of the leading causes of death among infants 1 month to 1 year of age in the United States.[27,43] Multiple risk factors have been identified, and the incidence of SIDS declined in developed nations in the 1990s thanks to an aggressive Back to Sleep public health campaign advising parents to lay sleeping infants on their back.[27] Given the success of this intervention, maternal smoking has now become a major risk factor for SIDS.

There are many hypotheses as to the cause of SIDS and the role tobacco plays. It is believed that the immediate cause of death in SIDS is functional and affects the cardiorespiratory system.[44] One theory is that these infants have an abnormal arousal or respiratory control mechanism.[44] Additional reports reveal evidence that nicotine may affect the ventilatory response to hypoxia, that there is impairment of the peripheral autonomic nervous system, and that there is an absent adrenomedullary response to hypoxia after nicotine exposure.[44,45]

The relationship between tobacco smoke and SIDS has been reviewed extensively in the literature as well as by federal agencies and the World Health Organization.[27] In a large systematic review conducted by Anderson and Cook,[44] it was determined that maternal smoking doubles the risk of SIDS, and that the data point to a causal relationship between SIDS and postnatal exposure to tobacco smoke. A report by the National Cancer Institute/California Environmental Protection Agency concludes that, after a review of the literature, a causal relationship between maternal smoking and SIDS is implied.[46] Additional investigations have quantified smoking and found a significant dose-response relationship between smoking and SIDS, and one study found that the risk of SIDS was reduced with smoking cessation during pregnancy.[27]

Behavior and Cognitive Function

The effect of nicotine on neurotransmitters

Smoking-induced changes in utero to the fetal central nervous system may lead to the long-term development of learning, memory, and attention deficits.[25] Once nicotine has entered the fetal bloodstream, it binds to nicotinic acetylcholine receptors (nAChRs), which are present in the fetal brain as early as 4 to 5 weeks of gestation.[25] Following binding and activation by nicotine, the nAChR can influence the expression of several neurotransmitters in the peripheral and central nervous system, including acetylcholine, dopamine, norepinephrine, epinephrine, serotonin, glutamate, and γ-aminobutyric acid.[25]

Catecholamines have been implicated in drug addiction and affective disorders, behavioral and cognitive functions regulated in the prefrontal cortex, and response to stress.[25] Both increases and decreases in catecholamines have been noted in the animal offspring following nicotine exposure during gestation.[25] In humans, the

effects of smoking on catecholamines during pregnancy are still being scrutinized. Amniotic fluid of smokers has been shown to contain higher levels of norepinephrine and epinephrine during the third trimester compared with nonsmokers, suggesting fetal adrenergic activation.[25] Furthermore, levels of epinephrine in the umbilical artery cord blood were found to be decreased among smokers compared with nonsmokers following birth.[47] Such alterations point to a likely sympathetic nervous system dysfunction. Further studies are needed to better understand this imbalance of neurotransmitters and their clinical relevance.

Maternal smoking during pregnancy has also been associated with an increased rate of mood and conduct disorders in the offspring.[25,48] This link has spurred an increasing interest in the effect of nicotine on the serotonin system. After being exposed prenatally to nicotine, neonatal and juvenile rats were found to have decreased serotonin turnover in certain regions of the brain.[25] At birth and in adolescence, both an increased density of serotonin transporter (SERT) and decreased density of SERT binding sites in the cortex have been reported in animals exposed to prenatal nicotine.[25] These studies propose that nicotine has long-lasting effects on the fetal neurotransmitter system, lasting even into adulthood. The myriad interactions of nicotine on the neurotransmitter systems contribute to understanding of the gross implications on fetal development that seem to extend into adulthood.

Attention-deficit disorder/hyperactivity

The effect of prenatal and postnatal tobacco smoke on behavioral and cognitive functions has been reported increasingly in the past 2 decades. Studies of children whose mothers smoked during pregnancy have repeatedly shown an increased rate of behavior problems compared with children of nonsmoking mothers.[27,28] Weitzman and colleagues[49] investigated the possible association between maternal smoking and behavioral problems among 2256 children aged 4 to 11 years. They found that maternal smoking (prenatal, postnatal, and combined) had an independent association with an increase in behavioral problems (eg, anxiety, depression, antisocial behavior, and hyperactivity). In addition, smoking a pack or more per day was independently associated with a twofold increase in extreme behavior problem scores compared with children of mothers who did not smoke.[49]

Fergusson and colleagues[50] set out to replicate these findings while controlling for confounders believed to be limitations in the study by Weitzman and colleagues.[49] Using longitudinal data, they assessed the relationship between maternal smoking and conduct and attention-deficit disorders on a cohort of 1265 children in New Zealand. Overall, they concluded that smoking during pregnancy increases the risk of conduct and attention-deficit disorders among the offspring, with a greater significant association for smoking during, rather than after, pregnancy. Reports have continued to be published, including a systematic analysis of 24 studies of children born to mothers who smoked prenatally, with findings consistent with an increased risk of attention-deficit hyperactivity disorder–related disorders.[51] Because of methodological limitations and variations among the literature, further studies are needed to fully understand the relationship between perinatal tobacco exposure and behavioral disorders among offspring.

Cognitive impairments

Studies on cognitive development among children exposed to tobacco smoke perinatally are conflicting because confounders in this area of research are particularly difficult to control for. Women who smoke during pregnancy tend be of lower SES, and differ in other health-related behaviors, personality, and childrearing approaches.[52]

Among studies that attempted to control for potential confounders, several have found a dose-dependent relationship.[53–55] In a prospective follow-up study of 400 families in upstate New York, Olds and colleagues[56] found a decline in Stanford-Binet scores of 4.35 points among 3- and 4-year-old children of smokers compared with those of nonsmokers. This finding was assessed after controlling for confounders such as social class, maternal education and intelligence quotient (IQ), and qualities of caregiving.[56] Conversely, Fergusson and Lloyd[57] found that, after controlling for SES and features of home environment, intellectual differences among 8 and 10 year olds were lost when comparing those exposed to prenatal tobacco with those who were not.[57] Differences in study methodology as well as in age of the children studied may account for the different findings. In a recent cohort analysis performed by Lundberg and colleagues,[58] sons of smoking mothers had an increased risk of poor intellectual performance compared with sons of nonsmoking mothers. However, this finding was lost once familial factors such as birth order and maternal age were controlled for. Thus, further research is needed in this field to better understand the role pre- and postnatal tobacco smoke plays in the cognitive and intellectual performance among offspring.

Addiction: use of tobacco among offspring

When adolescent rats are given the opportunity, those exposed prenatally to nicotine will self-administer larger amounts than rats that were not exposed to nicotine.[28] Results from human analyses indicate that prenatal tobacco smoke is associated with a higher likelihood of offspring smoking later in life.

In a retrospective study of 2 cohorts conducted by Kandel and colleagues,[59] prenatal smoking increased the odds of smoking among daughters fourfold. Cornelius and colleagues[60] studied a cohort of 589 10 year olds who were followed since their gestation. Offspring who were exposed to greater than half a pack per day were 5.5 times more likely to have experimented with smoking tobacco. In a 30-year prospective study (sample size 1248), Buka and colleagues[61] evaluated the link between prenatal tobacco smoke and smoking among the offspring. When adjusted for SES, maternal age at pregnancy, offspring gender, and age at time of interview, the investigators report a twofold statistically significant increase between mothers who smoked 1 pack or more per day during pregnancy and offspring nicotine dependence.

There are several proposed mechanisms to support the association between prenatal tobacco use and the predilection for tobacco use among the offspring. One such hypothesis is that in utero nicotine exposure causes embryologic changes that lead to an increase in the number of nicotine receptors, which may increase susceptibility for tobacco use later in life.[60] Another mechanism is that the association can be the result of the disruption that nicotine exposure causes on fetal brain development. Nicotine receptors (which are present early in fetal development), are stimulated and thus upregulated by nicotine.[45] This upregulation causes a premature switch from cell replication to differentiation, and the changes this leads to in fetal brain development can have lasting behavioral effects that become evident later in life. There is also the possibility that mothers who smoke may pass on a genetic predisposition to their offspring.[61]

Prenatal Smoking and Child Overweight

Recent research indicates that prenatal smoking is associated with overweight and obesity among offspring later in life. The strength of this relationship, as well as the effect of confounders such as maternal weight and social differences, still need to be better understood.

Oken and colleagues[62] studied the association of perinatal tobacco smoke and child overweight in a prospective cohort study. Women of singleton birth in Massachusetts were enrolled at gestational age less than 22 weeks, and were interviewed during prenatal care visits, at delivery, and at 6 months and 3 years after parturition. Both BMI and various skinfold measurements were obtained, and potential confounders such as maternal education, race/ethnicity, income, and child diet were adjusted for. Maternal early pregnancy smoking (smoking during the 3 months before learning of pregnancy) was strongly associated with offspring being overweight by age 3 years, with an adjusted OR for overweight of 2.2 compared with those of mothers who never smoked. In addition, children of mothers who had quit smoking before pregnancy were not more overweight compared with children of never smokers (OR of 1.0). The small sample size of women who smoked past their first trimester did not allow for multivariable analysis of exposure.[62]

Some of the same investigators conducted a meta-analysis of the existing literature to better understand the link between prenatal tobacco exposure and childhood adiposity.[63] Fourteen studies were ultimately eligible, included 84,563 children, and represented pregnancies from 1958 to 2002 among low- and non–low-income populations residing in North America, Europe, and Australia. Children of mothers who smoked during pregnancy were at increased risk for being overweight (adjusted OR 1.5) compared with children of those who did not smoke during pregnancy. Most studies adjusted for maternal weight, fetal growth, and SES. Among studies that included quantitative measurements of prenatal tobacco smoke, a dose-response relationship was consistently evident. Furthermore, in several studies, smoking throughout pregnancy was associated with a greater risk for child overweight than smoking only during early pregnancy.[63] Thus, despite a wide range of populations and after adjusting for certain confounders, the literature suggests that exposure to prenatal tobacco smoke increases the risk for childhood overweight.

To date, the association between prenatal tobacco exposure and offspring overweight is not fully understood. A hypothesized mechanism is that fetal exposure to nicotine leads to changes in the catecholaminergic system associated with the brain's reward system, or that nicotine directly affects the hypothalamic centers that direct appetite and eating behavior.[45,62,64] A better understanding of the relationship between prenatal tobacco exposure and overweight in children can offer valuable insight into the fight against the current childhood obesity epidemic.

Respiratory Illness and Lung Function in Offspring

Studies have shown an increase in respiratory illnesses among infants and children of smoking mothers. The effects of prenatal nicotine exposure have been studied in both animal models and humans. In a national British study of 12,743 children, Taylor and Wadsworth[65] found a significant increase in bronchitis and hospital admissions for lower respiratory tract illnesses in the first 5 years of life among those born to mothers who smoked during pregnancy. Smoking after birth did not influence the rate of hospital admissions for respiratory illnesses, thus suggesting a significant prenatal effect on outcome. Other studies have had similar findings, with prenatal (and not postnatal) exposure to nicotine being associated with increased number of respiratory illnesses among the offspring.[66]

There is also some evidence that maternal smoking increases the risk of childhood asthma. In a population-based cohort study, 58,842 singleton births were followed by means of registries from birth until the age of 7 years.[67] The primary outcome was asthma, and adjustments were made for gender, birth order, maternal age, marital status, and maternal occupation (used as an indicator for SES). Maternal smoking increased the risk of asthma, with an adjusted OR of 1.23 for light (<10 cigarettes per day) and 1.35 for heavy (>10 cigarettes per day) smoking.[67]

Evidence also shows a correlation between perinatal tobacco smoke and decreased lung function among infants as well as among school-age children. Hanrahan and colleagues[68] showed that infants whose mothers smoked during pregnancy had decreased functional flow rates at functional residual capacity compared with those whose mothers did not smoke during pregnancy. Cunningham and colleagues[69] furthered this assessment by comparing spirometry results among children age 8 to 12 years whose mothers did not smoke during or after pregnancy, smoked during pregnancy and not after, smoked during and after pregnancy, and did not smoke during pregnancy but did so later. After adjusting for certain confounders, the investigators found that children whose mothers smoked during pregnancy had slight but statistically significant deficits, the largest of which were a 5.2% decrease in forced expiratory flow at 25% to 75% and 6.8% in forced expiratory flow at 65% to 75%. The spirometry values among children whose mothers smoked only after pregnancy were not significantly different from those of nonsmokers. Thus, it seems that there is not only an association with prenatal smoking and decreased lung function among offspring, but that this may have a lasting effect, at least until early adolescence.

In animal models, the neonatal lung manifests maternal nicotine exposure by hypoplasia, decreased elastin in the parenchyma, and increased alveolar volume, which suggests emphysemalike changes.[70] Nicotine receptors are present in bronchial smooth muscle, submucosal glands, bronchial epithelial cells, and vascular endothelial cells. Work by Sekhon and colleagues[66] showed that maternal nicotine exposure greatly increases α-7 nACHR subunit expression in airway epithelial cells, increases collagen gene expression and collagen staining in airway and alveolar walls, and increases type II cells in newborn rhesus monkeys. Nicotine may therefore directly stimulate α-7 nACHR–bearing fibroblasts to lay down an increased amount of connective tissue, leading to increased airway wall thickness.

Sekhon and colleagues[71] were able to identify an increase in collagen mRNA and protein expression following nicotine exposure throughout the lung. The investigators propose that this accumulation of excess collagen may play an important role in the decrease in fixed lung volume found in the nicotine-exposed neonatal lung. Furthermore, increased collagen content may also explain the decrease in functional residual capacity and decrease in lung compliance found in infants subjected to prenatal tobacco exposure.[71] The collagen accumulation and airway wall dimensions discovered by the investigators were more prominent in the peripheral rather than central airways. Because changes in peripheral airways produce greater alterations in airway resistance and maximum expiratory flow rates than those in central airways, this provides insight into why the spirometry measurements discussed earlier among children exposed to tobacco prenatally were decreased compared with their non–nicotine-exposed cohorts.[71]

SMOKING CESSATION AND PREGNANCY

Given the well-documented adverse effects of smoking during pregnancy, efforts to reduce the prevalence of smoking among pregnant women are critically important. Women are uniquely motivated to quit during pregnancy; they are more likely to quit during pregnancy than at any other point in their lives.[1] However, tobacco addiction is a chronic disorder, and most women smoking when they become pregnant continue to smoke. The United States Public Health Service has estimated that if all women ceased smoking during pregnancy, the cumulative benefits would be

Box 1
Components of the 5 A's approach

1. Ask. All pregnant women should be questioned about smoking status at each visit. Because of the stigma against smoking in pregnancy, there is greater risk of deception about smoking behavior in this population.[78,79] A more nuanced approach, using multiple-choice questions about smoking rather than Yes/No questions, has been shown to increase disclosure, and is recommended.[74] An example of appropriate multiple-choice questions is provided in **Box 2**.
2. Advise. Women who smoke should be given clear, strong, direct, and personalized advice to cease smoking, emphasizing the potential benefits to mother and fetus. Self-help materials (discussed later) should be offered. The combination of brief counseling and simple self-help materials increase quit rates by 30% to 70% compared with simple advice to quit.[77]
3. Assess. Smokers' readiness to quit smoking should be assessed at each prenatal visit. It is suggested that this be framed as readiness to quit within the next 30 days. If yes, assistance with cessation should be provided (see #4). For those patients who are not yet ready to quit, nonjudgmental encouragement should be provided, and obstacles to cessation identified and, if possible, addressed. Motivational interviewing may be helpful in moving patients toward cessation readiness.
4. Assist. Patients who express a willingness to quit should be encouraged to set a quit date and counseled about strategies for a successful quit attempt. Although even minimal counseling has been shown to improve quit rates, more extensive counseling is superior and the USDHHS PHS guidelines recommend that more than minimal counseling be provided to pregnant women. As part of the counseling intervention, women should be encouraged to review past quit attempts to identify and remedy reasons why they may not have been successful, and to anticipate challenges and identify strategies for coping with them. Specific concerns raised by patients about the quitting process should be addressed, and patients should be encouraged to seek social support for their quit attempt from family, friends, and others. Self-help materials should be provided, and the patient directed to other available resources that might help in the quit attempt (additional individual or group counseling, cognitive behavioral therapy, quit helplines).
5. Arrange. Follow-up visits to assess and support the cessation effort should be arranged.

Box 2
An example of appropriate multiple-choice questions about smoking status

Which of the following best describes your cigarette smoking?

- I smoke regularly now, about the same as before finding out I was pregnant
- I smoke regularly now, but have cut down since I found out I was pregnant
- I smoke every once in a while
- I have quit smoking since finding out I was pregnant
- I was not smoking around the time I found out I was pregnant, and I do not currently smoke cigarettes[74]

substantial, with an 11% reduction in stillbirths and a 5% reduction in newborn deaths.[72] Although most women who quit during pregnancy resume smoking after delivery, some do remain abstinent. Pregnancy thus provides a window of opportunity for smoking cessation that should be maximally exploited by health care workers.

Tobacco dependence is considered a chronic but treatable condition. Cessation is difficult but achievable, and smoking cessation interventions in pregnancy have been shown to reduce the proportion of women who continue to smoke and to reduce the complications associated with smoking.[73] Extensive, evidence-based, well-referenced guidelines for smoking cessation have been published and are readily available.[74,75] Although most recommendations are applicable to all smoking patients, pregnant women are considered a special population for which there is some variation from standard recommendations, chiefly concerning the role of pharmacotherapy in cessation efforts. Recommendations specifically tailored to the pregnant smoker are included in the United States Department of Health and Human Services (USDHHS) Public Health Service (PHS) Clinical Practice Guideline *Treating Tobacco Use and Dependence: 2008 Update*,[74] as well as in a Committee Opinion of the American College of Obstetricians and Gynecologists.[75] A brief overview of smoking cessation during pregnancy, largely drawn from these sources, is provided later.

Timing of Cessation

Smoking cessation before conception is ideal. Quitting before pregnancy offers the greatest potential benefits to mother and fetus, and also presents the broadest range of cessation options because there are no concerns about the potential adverse effects to the fetus of including medications in the cessation

Table 1
Key features of the published randomized clinical trials of efficacy and safety of NRT use during pregnancy

Study	Year Published	Design	Subjects	Intervention	Outcomes	Chemical Confirmation?	Results	Comments
Wisborg et al[89]	2000	RCT, single blind, placebo controlled	Pregnant, smoking ≥10 cigarettes/d after first trimester	Patch (N = 124) vs placebo patch (N = 126). All subjects received counseling	Continuous abstinence, abstinence at various visits, birth weight, gestational age	Salivary cotinine	Continuous abstinence 21% in NRT vs 19% in placebo group. No significant differences in other endpoints	Compliance very low in both groups. Abstinence lower in both groups than in patients not enrolled in trial
Kapur et al[84]	2001	RCT, double-blind, placebo controlled	Pregnant, smoking ≥15 cigarettes/d	Patch (N = 17) vs placebo patch (N = 13)	Cessation rate, time point unclear	Serum and salivary cotinine	23.5% cessation vs 0% but $P = .11$	Study underpowered
Hegaard et al[86]	2003	Prospective, randomized by birth dates	Pregnant, daily smokers	Intervention with multimodal program (individual counseling and invitation to cessation group with option of nicotine patch and/or gum) (N = 327) vs usual care (N = 320)	Self-reported cessation rate and combined self-reported cessation plus low salivary cotinine	Salivary cotinine	Cessation with low cotinine 7% in intervention vs 2.2% in control group ($P = .004$). No significant differences in birth weight	Only 75 of 327 women in intervention arm elected to receive NRT

Hotham et al[90]	2006	Prospective, randomized pilot study	Pregnant, smoking ≥15 cigarettes/d	Counseling plus free nicotine patch (N = 20) vs counseling only (N = 20)	Abstinence at delivery	Exhaled carbon monoxide and salivary cotinine	15% vs 0% cessation; 35% vs 25% had a reduction in cotinine level from baseline	Low compliance with treatment. No patients had cotinine levels on patch that were higher than baseline
Pollak et al[87]	2007	Prospective, randomized, open label	Pregnant, smoking >5 cigarettes/d	CBT plus NRT (patch, gum, or lozenge) N = 122 vs CBT alone (N = 59)	7-day point prevalence self-reported, chemically confirmed abstinence at various time points	Exhaled carbon monoxide and salivary cotinine	18% vs 7% abstinent at 38 wk gestation (P = .04) but no difference 3 mo after parturition	Study terminated prematurely caused by/ because of higher rate of adverse birth outcomes in treatment arm
Oncken et al[88]	2008	Prospective, randomized, placebo controlled, single blind	Pregnant, smoking ≥1 cigarettes/d	Nicotine gum (N = 100) vs placebo (N = 94). All subjects received brief counseling	7-day point prevalence self-reported, chemically confirmed abstinence; birth weight, others	Exhaled carbon monoxide and urinary cotinine; other tobacco alkaloids	Study terminated early because of lack of efficacy. 18% vs 14.9% abstinent at 34 wk gestation (P = .56)	Statistically significant increases in birth weight and gestational age in NRT group

Abbreviations: CBT, cognitive behavioral therapy; RCT, randomized controlled trial.

effort. Women of childbearing age, particularly those who are contemplating pregnancy, should be encouraged to quit, and offered assistance with doing so. Although for smoking cessation during pregnancy the adage "the sooner the better" applies, quitting at any time during pregnancy is better than not quitting at all. Even quitting later in pregnancy is associated with a reduction in complications, especially LBW.[76]

Approach to Smoking Cessation

The 5 A's approach to smoking cessation is broadly endorsed. The 5 A's approach has been adapted for pregnant women.[75,77] The components of this approach are detailed in **Box 1**; **Box 2**.

Self-help Materials

Self-help materials are materials that can be used alone. The most common self-help materials are written materials such as booklets, but videos, computer-based interventions, audiocassettes, and recorded telephone messages are also in this category. Although self-help materials are generally considered only marginally effective in aiding smoking cessation, a 2008 systematic review and meta-analysis of self-help materials for smoking cessation in pregnancy found that they were associated with a pooled ratio of 1.834 for cessation in this population.[80] Self-help materials that are tailored to pregnancy have been shown to be associated with a significantly higher quit rate than general materials.[81] Materials may also be tailored to the patient's age group, educational level, or cultural group. There is no evidence that self-help materials of greater intensity are associated with higher quit rates than lower intensity interventions.[80]

Counseling

A variety of psychosocial interventions to support smoking cessation have been studied, including informational counseling, cognitive behavior therapy (intended to identify and modify faulty or distorted negative thinking styles and the maladaptive behaviors associated with those thinking styles), and motivational interviewing (a question-and-answer method of interviewing intended to increase the patient's motivation to change). The themes that emerge from this literature are that trained counselors are more effective than untrained counselors, heavier smokers seem to be more resistant to the effects of counseling and other interventions than are lighter smokers, and that counseling of any extent is more effective than usual care, usually defined as simple advice to quit and brief (<3 minutes) counseling. The USDHHS guidelines recommend that "…because of the serious risks of smoking to the pregnant smoker and the fetus, whenever possible pregnant smokers should be offered person-to-person psychosocial interventions that exceed minimal advice to quit."[74] No specific counseling approach is recommended, and it is not clear that, once counseling is more than minimal, additional benefit is derived from more intensive interventions.

Pharmacologic Therapies

Among nonpregnant smokers, the efficacy of nicotine replacement therapy (NRT) and other pharmacotherapies is well established and pharmacotherapy is recommended as part of usual care. However, pharmacotherapy as an aid for smoking cessation during pregnancy remains controversial; the evidence base to guide decision making in this area is minimal, and neither safety nor efficacy has been proved. There are numerous concerns about NRT during pregnancy. Because nicotine is considered to be the primary agent of the injurious effects of smoking on the fetus, prescribing nicotine carries risk of the same adverse outcomes as smoking, including congenital malformations, LBW, and preterm delivery. It is unknown whether the different pharmacokinetics of constant-rate nicotine delivery, such as from the nicotine patch, carry different risks of harm than the intermittent dosing that results from smoking and intermittent forms of NRT (gum, lozenge, inhaler, nasal spray). Theoretically, during a period of NRT, the fetus could be exposed to higher levels of nicotine than from smoking if the dose used for replacement therapy exceeded that obtained from smoking, or if active smoking continued during NRT. However, in those trials that have monitored baseline cotinine levels and cotinine levels on NRT, this has not been the case. Although guidelines have suggested that practitioners consider monitoring blood nicotine levels in pregnant women prescribed NRT,[82] this is not common practice.

One potential benefit to NRT is allowing the fetus a more gradual withdrawal from nicotine than might occur with abrupt smoking cessation, which may cause physiologic stress to the fetus.[83,84] This topic of NRT during pregnancy was recently and comprehensively reviewed.[85] To date, there have been only 6 published randomized clinical trials of efficacy and safety of NRT use during pregnancy. Key features of these trials are summarized in **Table 1** and several are discussed here in greater detail.

The largest study to date was that of Hegaard and colleagues.[86] This prospective

quasi-randomized, unblinded study compared intervention (individual counseling plus invitation to join a cessation program with optional NRT) versus usual care (standard counseling). The study showed a substantial benefit to intervention compared with usual care, with an OR for cessation of 4.2 in the intervention group. Cotinine validated cessation rates were 7% in the intervention group and 2% in the control group. Low caffeine consumption, years of education, lack of exposure to passive smoking outside the home, and previous quit attempts were positively associated with cessation. However, only a minority of women in the intervention arm (87 of 327) elected to participate in the intensive smoking cessation program. Of those who did, 75 (86%) used NRT as either patch, gum, or patch plus gum. Their self-reported cessation rate was 14.4% versus 5% in the control group, and the outcome of self-reported cessation plus cotinine less than 30 ng/ml was also significantly better for intervention versus control patients (7% vs 2.2%). There was no difference in birth outcomes. Although this study supports the efficacy of a multimodal intervention including NRT to promote cessation among pregnant smokers, it also indicates a lack of enthusiasm for such therapy among pregnant smokers.

A large, open-label randomized trial comparing cognitive behavioral therapy plus NRT (patch, gum, or lozenge) with cognitive behavioral therapy alone found a nearly threefold increase in biochemically validated smoking cessation at multiple time points.[87] However, study recruitment was suspended because interim analysis found a higher rate of negative birth outcomes (prematurity, neonatal intensive care unit admission, SGA, abruption, fetal demise) in the NRT arm. However, randomization in the groups resulted in a much higher proportion of women with a history of previous preterm birth in the NRT arm (32% vs 12%), which may have contributed to this difference in outcome. The benefit of the pharmacologic intervention in this study did not persist after parturition. Cotinine levels were measured and were higher in women with adverse fetal outcomes than in those without, and lower in those on NRT than in continued smokers.

Most recently, a randomized, double blind, placebo-controlled study of NRT (nicotine gum) versus placebo was performed. Subjects had to be smoking only 1 cigarette per day at enrollment, although the average was 18/d. All subjects received individualized counseling. Compliance was low in both groups, with an average of only ~3 pieces of gum used per day per subject. The study terminated early because of lack of efficacy at interim analysis; biochemically confirmed abstinence rates were not significantly different for NRT versus usual care groups, 18% versus 14.9% abstinent at 34 weeks' gestation ($P = .56$). However, birth weights and gestational age were both greater with NRT than placebo.[88]

Cumulatively, the trials of NRT in pregnancy show that quit rates are low among women still smoking at the end of the first trimester whether or not intervention is offered, that pregnant women are not eager to use NRT during pregnancy, and that there are substantial difficulties inherent in intervention studies in pregnant women.

Without definitive evidence on which to base recommendations, current guidelines are based on expert opinion and call for judgment on the part of the treating clinician. The USDHHS guidelines state: "Although the use of NRT exposes pregnant women to nicotine, smoking exposes them to nicotine plus numerous other chemicals that are injurious to the woman and fetus. These concerns must be considered in the context of inconclusive evidence that cessation medications boost abstinence rates in pregnant smokers." The American College of Obstetricians and Gynecologists (ACOG) recommends that NRT should be used only when the potential benefits outweigh the unknown risks.[75]

The safety and efficacy of other pharmacotherapies for smoking cessation are unknown. ACOG suggests that bupropion may be considered during pregnancy and lactation when nonpharmacologic therapies fail,[75] and the USDHHS guidelines state that "Bupropion SR should be used during pregnancy only if the increased likelihood of smoking abstinence, with its potential benefits, outweighs the risk of bupropion SR treatment and potential concomitant smoking."[74]

SUMMARY

Smoking during pregnancy is a leading cause of adverse maternal and fetal outcomes and causes a variety of lasting ill effects in offspring. Most women who are smoking at conception continue to smoke during pregnancy. Although fewer women now smoke during pregnancy than during past decades, most of this gain has been caused by reduced smoking prevalence among young women rather than improved rates of cessation among pregnant women, and troubling trends in smoking among youth suggest that smoking during pregnancy will continue to be a major public health issue. Smoking during pregnancy is most prevalent among young, uneducated women, and partner smoking is a major risk factor for both smoking during pregnancy and resuming

smoking afterward among those who have quit. All pregnant women should be assessed for smoking status, advised to quit, and offered assistance in doing so at all prenatal visits. Counseling and self-help materials are the cornerstones of cessation, and the role of NRT and other pharmacologic approaches in cessation remains unclear. Further research is needed into optimal approaches to smoking cessation for pregnant women to reduce the myriad adverse effects of smoking during pregnancy on mother, fetus, and offspring, and for relapse prevention for those women who do manage to quit smoking during pregnancy.

REFERENCES

1. Women and smoking: a report of the surgeon general. Washington, DC: US Department of Health and Human Services, Public Health Service; 2001.
2. Centers for Disease Control and Prevention (CDC). Smoking prevalence among women of reproductive age—United States, 2006. MMWR Morb Mortal Wkly Rep 2008;57(31):849—52.
3. Warren CW, Jones NR, Peruga A, et al. Global youth tobacco surveillance, 2000—2007. MMWR Surveill Summ 2008;57(1):1—28.
4. Shipton D, Tappin DM, Vadiveloo T, et al. Reliability of self reported smoking status by pregnant women for estimating smoking prevalence: a retrospective, cross sectional study. BMJ 2009;339:b4347.
5. Ebrahim SH, Floyd RL, Merritt RK 2nd, et al. Trends in pregnancy-related smoking rates in the United States, 1987—1996. JAMA 2000;283(3):361—6.
6. Centers for Disease Control and Prevention (CDC). Smoking during pregnancy—United States, 1990—2002. MMWR Morb Mortal Wkly Rep 2004; 53(39):911—5.
7. Tong VT, Jones JR, Dietz PM, et al. Trends in smoking before, during, and after pregnancy - Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 sites, 2000—2005. MMWR Surveill Summ 2009;58(4):1—29.
8. Dodds L. Prevalence of smoking among pregnant women in Nova Scotia from 1988 to 1992. CMAJ 1995;152(2):185—90.
9. Chan B, Einarson A, Koren G. Effectiveness of bupropion for smoking cessation during pregnancy. J Addict Dis 2005;24(2):19—23.
10. Jensen DM, Korsholm L, Ovesen P, et al. Adverse pregnancy outcome in women with mild glucose intolerance: is there a clinically meaningful threshold value for glucose? Acta Obstet Gynecol Scand 2008;87(1):59—62.
11. Laws P, Hilder L. Australia's mothers and babies 2006. Perinatal statistics series no. 22. Sydney (Australia): AIHW National Perinatal Statistics Unit: 2006; 2008. PER 46.
12. Annual Report of the National Nutrition Survey Japan. Tokyo: Ministry of Health, Labour and Welfare; 2003.
13. Surveys on the growth of infants and preschool children Japan. Tokyo: Ministry of Health, Labour and Welfare; 2000.
14. Some like it "light." Women and smoking in the European Union. Brussels (Belgium): European Network for Smoking Prevention; 1999.
15. WHO framework convention on tobacco control. 205. Geneva (Switzerland): WHO; 2003.
16. Warren CW, Jones NR, Eriksen MP, et al. Patterns of global tobacco use in young people and implications for future chronic disease burden in adults. Lancet 2006;367(9512):749—53.
17. Martin JA, Hamilton BE, Sutton PD, et al. Births: final data for 2005. Natl Vital Stat Rep 2007;56(6):1—103.
18. Lu Y, Tong S, Oldenburg B. Determinants of smoking and cessation during and after pregnancy. Health Promot Int 2001;16(4):355—65.
19. Penn G, Owen L. Factors associated with continued smoking during pregnancy: analysis of sociodemographic, pregnancy and smoking-related factors. Drug Alcohol Rev 2002;21(1):17—25.
20. Kahn RS, Certain L, Whitaker RC. A reexamination of smoking before, during, and after pregnancy. Am J Public Health 2002;92(11):1801—8.
21. Kaneko A, Kaneita Y, Yokoyama E, et al. Smoking trends before, during, and after pregnancy among women and their spouses. Pediatr Int 2008;50(3): 367—75.
22. Solomon L, Quinn V. Spontaneous quitting: self-initiated smoking cessation in early pregnancy. Nicotine Tob Res 2004;6(Suppl 2):S203—16.
23. Yu SM, Park CH, Schwalberg RH. Factors associated with smoking cessation among U.S. pregnant women. Matern Child Health J 2002;6(2):89—97.
24. Simpson WJ. A preliminary report on cigarette smoking and the incidence of prematurity. Am J Obstet Gynecol 1957;73(4):807—15.
25. Shea AK, Steiner M. Cigarette smoking during pregnancy. Nicotine Tob Res 2008;10(2):267—78.
26. Albuquerque CA, Smith KR, Johnson C, et al. Influence of maternal tobacco smoking during pregnancy on uterine, umbilical and fetal cerebral artery blood flows. Early Hum Dev 2004;80(1):31—42.
27. DiFranza JR, Aligne CA, Weitzman M. Prenatal and postnatal environmental tobacco smoke exposure and children's health. Pediatrics 2004;113(Suppl 4): 1007—15.
28. Blood-Siegfried J, Rende EK. The long-term effects of prenatal nicotine exposure on neurologic development. J Midwifery Womens Health 2010;55(2): 143—52.
29. Zenzes MT. Smoking and reproduction: gene damage to human gametes and embryos. Hum Reprod Update 2000;6(2):122—31.

30. Augood C, Duckitt K, Templeton AA. Smoking and female infertility: a systematic review and meta-analysis. Hum Reprod 1998;13(6):1532–9.
31. Castles A, Adams EK, Melvin CL, et al. Effects of smoking during pregnancy. Five meta-analyses. Am J Prev Med 1999;16(3):208–15.
32. Aliyu MH, Salihu HM, Wilson RE, et al. Prenatal smoking and risk of intrapartum stillbirth. Arch Environ Occup Health 2007;62(2):87–92.
33. Aliyu MH, Salihu HM, Wilson RE, et al. The risk of intrapartum stillbirth among smokers of advanced maternal age. Arch Gynecol Obstet 2008;278(1): 39–45.
34. Aliyu MH, Salihu HM, Alio AP, et al. Prenatal smoking among adolescents and risk of fetal demise before and during labor. J Pediatr Adolesc Gynecol 2010; 23:129–35.
35. Windham GC, Hopkins B, Fenster L, et al. Prenatal active or passive tobacco smoke exposure and the risk of preterm delivery or low birth weight. Epidemiology 2000;11(4):427–33.
36. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bull World Health Organ 1987;65(5):663.
37. Kramer MS. Socioeconomic determinants of intrauterine growth retardation. Eur J Clin Nutr 1998;52-(Suppl 1):S29–32 [discussion: S32–3].
38. Vardavas CI, Chatzi L, Patelarou E, et al. Smoking and smoking cessation during early pregnancy and its effect on adverse pregnancy outcomes and fetal growth. Eur J Pediatr 2010;169(6):741–8.
39. Aagaard-Tillery KM, Porter TF, Lane RH, et al. In utero tobacco exposure is associated with modified effects of maternal factors on fetal growth. Am J Obstet Gynecol 2008;198(1):66, e61–6.
40. Lieberman E, Gremy I, Lang JM, et al. Low birthweight at term and the timing of fetal exposure to maternal smoking. Am J Public Health 1994;84(7): 1127–31.
41. Cliver SP, Goldenberg RL, Cutter GR, et al. The effect of cigarette smoking on neonatal anthropometric measurements. Obstet Gynecol 1995;85(4): 625–30.
42. Polakowski LL, Akinbami LJ, Mendola P. Prenratal smoking cessation and the risk of delivering preterm and small-for-gestational-age newborns. Obstet Gynecol 2009;114(2 Pt 1):318–25.
43. Martin JA, Kung HC, Mathews TJ, et al. Annual summary of vital statistics: 2006. Pediatrics 2008; 121(4):788–801.
44. Anderson HR, Cook DG. Passive smoking and sudden infant death syndrome: review of the epidemiological evidence. Thorax 1997;52(11): 1003–9.
45. Slotkin TA. Fetal nicotine or cocaine exposure: which one is worse? J Pharmacol Exp Ther 1998;285(3): 931–45.
46. California Environmental Protection Agency, National Cancer Institute (US). Health effects of exposure to environmental tobacco smoke: the report of the California Environmental Protection Agency. Oakland (CA). Bethesda (MD): US Department of Health and Human Services, Public Health Service, National Institutes of Health. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Reproductive and Cancer Hazard Assessment Section, Air Toxicology and Epidemiology Section; 1999.
47. Oncken CA, Henry KM, Campbell WA, et al. Effect of maternal smoking on fetal catecholamine concentrations at birth. Pediatr Res 2003;53(1):119–24.
48. Fergusson DM, Woodward LJ, Horwood LJ. Maternal smoking during pregnancy and psychiatric adjustment in late adolescence. Arch Gen Psychiatry 1998;55(8):721–7.
49. Weitzman M, Gortmaker S, Sobol A. Maternal smoking and behavior problems of children. Pediatrics 1992;90(3):342–9.
50. Fergusson DM, Horwood LJ, Lynskey MT. Maternal smoking before and after pregnancy: effects on behavioral outcomes in middle childhood. Pediatrics 1993;92(6):815–22.
51. Linnet KM, Dalsgaard S, Obel C, et al. Maternal lifestyle factors in pregnancy risk of attention deficit hyperactivity disorder and associated behaviors: review of the current evidence. Am J Psychiatry 2003;160(6):1028–40.
52. Olds DL, Henderson CR Jr, Tatelbaum R. Prevention of intellectual impairment in children of women who smoke cigarettes during pregnancy. Pediatrics 1994;93(2):228–33.
53. McCartney JS, Fried PA, Watkinson B. Central auditory processing in school-age children prenatally exposed to cigarette smoke. Neurotoxicol Teratol 1994;16(3):269–76.
54. Fried PA, Watkinson B, Gray R. Differential effects on cognitive functioning in 9- to 12-year olds prenatally exposed to cigarettes and marihuana. Neurotoxicol Teratol 1998;20(3):293–306.
55. Obel C, Henriksen TB, Hedegaard M, et al. Smoking during pregnancy and babbling abilities of the 8-month-old infant. Paediatr Perinat Epidemiol 1998; 12(1):37–48.
56. Olds DL, Henderson CR Jr, Tatelbaum R. Intellectual impairment in children of women who smoke cigarettes during pregnancy. Pediatrics 1994;93(2):221–7.
57. Fergusson DM, Lloyd M. Smoking during pregnancy and its effects on child cognitive ability from the ages of 8 to 12 years. Paediatr Perinat Epidemiol 1991;5(2):189–200.
58. Lundgren F, Chattingius S, D'Onofrio B, et al. Maternal smoking during pregnancy and intellectual performance in young adult Swedish male offspring. Paediatr Perinat Epidemiol 2010;24(1):79–87.

59. Kandel DB, Wu P, Davies M. Maternal smoking during pregnancy and smoking by adolescent daughters. Am J Public Health 1994;84(9): 1407–13.
60. Cornelius MD, Leech SL, Goldschmidt L, et al. Prenatal tobacco exposure: is it a risk factor for early tobacco experimentation? Nicotine Tob Res 2000; 2(1):45–52.
61. Buka SL, Shenassa ED, Niaura R. Elevated risk of tobacco dependence among offspring of mothers who smoked during pregnancy: a 30-year prospective study. Am J Psychiatry 2003;160(11): 1978–84.
62. Oken E, Huh SY, Taveras EM, et al. Associations of maternal prenatal smoking with child adiposity and blood pressure. Obes Res 2005;13(11):2021–8.
63. Oken E, Levitan EB, Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. Int J Obes (Lond) 2008; 32(2):201–10.
64. von Kries R, Toschke AM, Koletzko B, et al. Maternal smoking during pregnancy and childhood obesity. Am J Epidemiol 2002;156(10):954.
65. Taylor B, Wadsworth J. Maternal smoking during pregnancy and lower respiratory tract illness in early life. Arch Dis Child 1987;62(8):786–91.
66. Sekhon HS, Jia Y, Raab R, et al. Prenatal nicotine increases pulmonary alpha7 nicotinic receptor expression and alters fetal lung development in monkeys. J Clin Invest 1999;103(5):637–47.
67. Jaakkola JJ, Gissler M. Maternal smoking in pregnancy, fetal development, and childhood asthma. Am J Public Health 2004;94(1):136–40.
68. Hanrahan JP, Tager IB, Segal MR, et al. The effect of maternal smoking during pregnancy on early infant lung function. Am Rev Respir Dis 1992;145(5): 1129–35.
69. Cunningham J, Dockery DW, Speizer FE. Maternal smoking during pregnancy as a predictor of lung function in children. Am J Epidemiol 1994;139(12): 1139–52.
70. Hafstrom O, Milerad J, Sandberg KL, et al. Cardiorespiratory effects of nicotine exposure during development. Respir Physiol Neurobiol 2005;149(1–3): 325–41.
71. Sekhon HS, Keller JA, Proskocil BJ, et al. Maternal nicotine exposure upregulates collagen gene expression in fetal monkey lung. Association with alpha7 nicotinic acetylcholine receptors. Am J Respir Cell Mol Biol 2002;26(1):31–41.
72. The health consequences of smoking: a report of the surgeon general. Atlanta (GA): US Department of Health and Human Services, Center for Disease Control and Prevention; 2004.
73. Lumley J, Oliver SS, Chamberlain C, et al. Interventions for promoting smoking cessation during pregnancy. Cochrane Database Syst Rev 2004;4: CD001055.
74. Fiore M. United States. Tobacco use and dependence guideline panel. Treating tobacco use and dependence: 2008 update. 2008 update. Rockville (MD): US Department of Health and Human Services, Public Health Service; 2008.
75. ACOG Committee on Health Care for Underserved Women, ACOG Committee on Obstetric Practice. ACOG committee opinion. Number 316, October 2005. Smoking cessation during pregnancy. Obstet Gynecol 2005;106(4):883–8.
76. Bernstein IM, Mongeon JA, Badger GJ, et al. Maternal smoking and its association with birth weight. Obstet Gynecol 2005;106(5 Pt 1):986–91.
77. Melvin CL, Dolan-Mullen P, Windsor RA, et al. Recommended cessation counselling for pregnant women who smoke: a review of the evidence. Tob Control 2000;9(Suppl 3):III80–4.
78. Kendrick JS, Zahniser SC, Miller N, et al. Integrating smoking cessation into routine public prenatal care: the Smoking Cessation in Pregnancy project. Am J Public Health 1995;85(2):217–22.
79. Moore L, Campbell R, Whelan A, et al. Self help smoking cessation in pregnancy: cluster randomised controlled trial. BMJ 2002;325(7377):1383.
80. Naughton F, Prevost AT, Sutton S. Self-help smoking cessation interventions in pregnancy: a systematic review and meta-analysis. Addiction 2008;103(4): 566–79.
81. Windsor RA, Cutter G, Morris J, et al. The effectiveness of smoking cessation methods for smokers in public health maternity clinics: a randomized trial. Am J Public Health 1985;75(12):1389–92.
82. Fiore M. United States. Tobacco use and dependence guideline panel. Treating tobacco use and dependence. Rockville (MD): US Department of Health and Human Services, Public Health Service; 2000.
83. Selby P, Kapur B, Hackman R, et al. No one asked the baby – an ethical issue in placebo-controlled trials in pregnant smokers. Can J Clin Pharmacol 2005;12(2):e180–1.
84. Kapur B, Hackman R, Selby P, et al. Randomized, double-blind, placebo-controlled trial of nicotine replacement therapy in pregnancy. Curr Ther Res 2001;62(4):274–8.
85. Forest S. Controversy and evidence about nicotine replacement therapy in pregnancy. MCN Am J Matern Child Nurs 2010;35(2):89–95.
86. Hegaard HK, Kjaergaard H, Moller LF, et al. Multimodal intervention raises smoking cessation rate during pregnancy. Acta Obstet Gynecol Scand 2003;82(9):813–9.
87. Pollak KI, Oncken CA, Lipkus IM, et al. Nicotine replacement and behavioral therapy for smoking cessation in pregnancy. Am J Prev Med 2007;33(4):297–305.

88. Oncken C, Dornelas E, Greene J, et al. Nicotine gum for pregnant smokers: a randomized controlled trial. Obstet Gynecol 2008;112(4): 859–67.
89. Wisborg K, Henriksen TB, Jespersen LB, et al. Nicotine patches for pregnant smokers: a randomized controlled study. Obstet Gynecol 2000;96(6): 967–71.
90. Hotham ED, Gilbert AL, Atkinson ER. A randomised-controlled pilot study using nicotine patches with pregnant women. Addict Behav 2006;31(4): 641–8.

Maternal Smoking in Pregnancy and Asthma in Preschool Children

A Pooled Analysis of Eight Birth Cohorts

Åsa Neuman[1,2], Cynthia Hohmann[3], Nicola Orsini[1], Göran Pershagen[1,4], Esben Eller[5], Henrik Fomsgaard Kjaer[6], Ulrike Gehring[7], Raquel Granell[8], John Henderson[8], Joachim Heinrich[9], Susanne Lau[10], Mark Nieuwenhuijsen[11,12,13], Jordi Sunyer[11,12,13,14], Christina Tischer[9], Maties Torrent[12,15], Ulrich Wahn[10], Alet H. Wijga[16], Magnus Wickman[1,17], Thomas Keil[3]*, and Anna Bergström[1]*; as part of the ENRIECO Consortium

[1]Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden; [2]Department of Women's and Children's Health, Uppsala University Hospital, Uppsala, Sweden; [3]Institute for Social Medicine, Epidemiology and Health Economics, Charité University Medical Center, Berlin, Germany; [4]Centre for Occupational and Environmental Medicine, Stockholm County Council, Stockholm, Sweden; [5]Department of Dermatology and Allergy Center, Odense University Hospital, Odense, Denmark; [6]Hans Christian Andersen Children's Hospital, Odense University Hospital, Odense, Denmark; [7]Institute for Risk Assessment Sciences (IRAS), University of Utrecht, Utrecht, The Netherlands; [8]School of Social and Community Medicine, University of Bristol, Bristol, United Kingdom: [9]Helmholtz Zentrum München, German Research Centre for Environmental Health, Institute of Epidemiology I, Neuherberg, Germany; [10]Department for Pediatric Pneumology and Immunology, Charité University Medical Center, Berlin, Germany; [11]Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain; [12]CIBER Epidemiologia y Salud Publica (CIBERESP), Barcelona, Spain; [13]IMIM (Hospital del Mar Research Institute), Barcelona, Spain; [14]Universitat Pompeu Fabra (UPF), Barcelona, Spain; [15]Ib-salut, Area de Salut de Menorca, Palma, Spain; [16]Centre for Prevention and Health Services Research, National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands; and [17]Department of Paediatrics, Sachs' Children's Hospital, Stockholm, Sweden

***Rationale*: Although epidemiological studies suggest that exposure to maternal smoking during fetal and early life increases the risk of childhood wheezing and asthma, previous studies were not able to differentiate the effects of prenatal from postnatal exposure.**

***Objectives*: To assess the effect of exposure to maternal smoking only during pregnancy on wheeze and asthma among preschool-age children.**

***Methods*: A pooled analysis was performed based on individual participant data from eight European birth cohorts. Cohort-specific effects of maternal smoking during pregnancy, but not during the first year, on wheeze and asthma at 4 to 6 years of age were estimated using logistic regression and then combined using a random effects model. Adjustments were made for sex, parental education, parental asthma, birth weight, and siblings.**

***Measurements and Main Results*: Among the 21,600 children included in the analysis, 735 children (3.4%) were exposed to maternal smoking exclusively during pregnancy but not in the first year after birth. In the pooled analysis, maternal smoking only during pregnancy was associated with wheeze and asthma at 4 to 6 years of age, with adjusted odds ratios of 1.39 (95% confidence interval, 1.08–1.77) and 1.65 (95% confidence interval, 1.18–2.31), respectively. The likelihood to develop wheeze and asthma increased statistically significantly in a linear dose-dependent manner in relation to maternal daily cigarette consumption during the first trimester of pregnancy.**

***Conclusions*: Maternal smoking during pregnancy appears to increase the risk of wheeze and asthma among children who are not exposed to maternal smoking after birth.**

AT A GLANCE COMMENTARY

Scientific Knowledge on the Subject

Several epidemiological studies suggest that exposure to maternal smoking during fetal and early life increases the risk of childhood wheezing and asthma. However, previous studies were not able to differentiate effects of prenatal from postnatal exposure.

What This Study Adds to the Field

This large pooled analysis of eight birth cohorts with data on more than 21,000 children showed that maternal smoking during pregnancy is associated with wheeze and asthma in preschool children, even among children who are not exposed to maternal smoking late in pregnancy or after birth.

(*Received in original form April 20, 2012; accepted in final form August 3, 2012*)

* These authors contributed equally to this work.

Supported by the European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement no 226285. The data collection and study teams of all participating birth cohorts were funded by local and/or national research organizations.

Author Contributions: Å.N., C.H., T.K., and A.B. had full access to the data in the study. A.B. and T.K. had leadership responsibility for analyses, drafting, and final editing and contributed equally to the study. C.H., T.K., A.B., and M.W. designed the study. C.H. and T.K. collected the data from the participating birth cohorts. C.H. prepared the dataset for analyses. Å.N., N.O., and A.B. analyzed the data. Å.N., C.H., N.O., G.P., M.W., T.K., and A.B. interpreted the results. Å.N., A.B., and M.V. reviewed the literature and wrote the first draft of the manuscript. All other coauthors provided critical review of the manuscript. All authors contributed to and have full knowledge of the contents of the manuscript.

Correspondence and requests for reprints should be addressed to Anna Bergström, Ph.D., Institute of Environmental Medicine, Karolinska Institutet, Box 210, SE-171 77 Stockholm, Sweden. E-mail: anna.bergstrom@ki.se

This article has online supplement, which is accessible from this issue's table of contents at www.atsjournals.org

Am J Respir Crit Care Med Vol 186, Iss. 10, pp 1037–1043, Nov 15, 2012

Originally Published in Press as DOI: 10.1164/rccm.201203-0501OC on September 6, 2012
Internet address: www.atsjournals.org

Keywords: asthma; cohort studies; epidemiology; preschool children; tobacco smoking

Children are especially susceptible to environmental toxicants due to their growing and differentiating organs and tissues (1–3). There are critical windows of lung growth and maturation in fetal life and in the first years after birth. Thus, the impact of tobacco smoke exposure is most prominent during these periods (4). Nicotine, carcinogens, and other toxic substances pass the placental barrier and are also found in the amniotic fluid, affecting the fetus (5, 6).

An association has been reported between smoking in pregnancy and respiratory morbidity in the child, such as impaired lung function and lower airway obstruction (7–10). Because most women who smoke during pregnancy continue doing so

after delivery (11), it has been difficult to disentangle the effects of smoking during and after pregnancy (10). However, human and animal studies indicate that different biological mechanisms influence respiratory disease development before and after birth (9, 12–14). Although pregnant women may quit smoking (11, 15), the challenge for assessment of fetal smoke exposure effects on airway disease has been identifying a sufficient number of children exposed only during pregnancy.

Our principal objective was to assess the effect of exposure to maternal smoking only during pregnancy on wheeze and asthma in European children at 4 to 6 years of age followed from pregnancy or birth. Some of the results of this study have been previously reported in the form of an abstract (16).

METHODS

We conducted a pooled analysis based on individual participant data from European birth cohorts from the ENRIECO (Environmental Health Risks in European Birth Cohorts) collaboration (17). Cohorts were included if they satisfied the following criteria: (*1*) population-based cohort focusing on allergy and asthma with ethical approval, (*2*) recruitment during pregnancy or shortly (i.e., in the first months) after birth, (*3*) at least one follow-up assessment of the outcomes wheeze or asthma during 4 to 6 years of age, and (*4*) information on maternal smoking from at least one time point during pregnancy and from the first year after birth. Eight cohorts met these criteria: ALSPAC (Bristol, UK); AMICS-Menorca (Island of Menorca, Spain); BAMSE (Stockholm, Sweden); DARC (Odense, Denmark); GINIplus, LISAplus, MAS (all multicenter, Germany); and PIAMA-NHS (multicenter, The Netherlands).

Definition of Exposures and Health Outcomes

All exposure information was based on parental questionnaires. The information on maternal smoking during pregnancy and the child's first year of life available in each birth cohort is described in Tables E1 and E2 in the online supplement. "Maternal smoking during pregnancy" was defined as smoking of at least one cigarette daily during any trimester. "Maternal smoking during the first year of life" was defined as maternal smoking in the dwelling or near the child during the child's first year of life. GINIplus lacked information on maternal smoking when the children were 1 year of age; therefore, information from 4 months were used as a proxy. "Any tobacco smoke exposure during the first year of life" was defined as mother, father, partner, or other person smoking in the dwelling or near the child during the child's first year of life. "Current maternal smoking" was defined as smoking in the dwelling or near the child at the time of outcome assessment (4–6 yr). "Any current smoke exposure" was defined as mother, father, or other person smoking in the dwelling or near the child at the time of outcome assessment. ALSPAC lacked information on paternal and other persons smoking when the child was 4 to 6 years of age and was not included in the analyses of any current smoke exposure. To evaluate the effect of smoking during pregnancy, maternal smoking during pregnancy and during the first year of the child's life was allocated into four categories: (*1*) no smoking during pregnancy or in the first year (reference category), (*2*) maternal smoking during pregnancy only, (*3*) maternal smoking in the first year only, and (*4*) maternal smoking during pregnancy and during the first year. The effect of maternal smoking during the first trimester was evaluated, irrespective of maternal smoking in the latter trimesters, as well as among mothers who smoked in the first but not in the third trimester. DARC lacked trimester-specific information and was excluded from these analyses.

Information on symptoms of wheeze and asthma were obtained from parental questionnaires (the information on wheeze and asthma available in each cohort is described in Table E3). "Current wheeze" was defined as parental-reported wheezing during the last 12 months according to the International Study of Asthma and Allergy in Childhood (ISAAC) core questions. This information was available from all cohorts. "Current asthma" was defined as satisfying at least two out of three of the following criteria: (*1*) a doctor's diagnosis of asthma ever, (*2*) parental-reported wheezing during the last 12 months according to the ISAAC core questions (18), or (*3*) asthma medication in the last 12 months. ALSPAC lacked information on doctor's diagnosis of asthma and was not included in the analyses of asthma. The time point for outcome assessments was 5 years of age, except for BAMSE and ALSPAC, which had available outcome data at 4 and 6 years of age, respectively.

Statistical Analysis

A pooled analysis of eight birth cohorts was performed using a two-stage approach. In stage 1, cohort-specific crude and adjusted estimates, including dose-response effects, were calculated using logistic regression analyses. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). Different potential confounder models were tested. The final logistic model included adjustments for sex, parental asthma based on mother's and/or father's history of asthma, parental education counting the parent with the highest educational level, siblings (having older siblings at birth or not), and birth weight in grams as a continuous variable, because these covariates resulted in an OR change of more than 5% or due to prior knowledge. To further exclude the effect of smoke exposure in childhood, we performed an additional analysis among children with no current maternal smoking or any other current smoke exposure at the time of outcome assessment (i.e., at 4–6 yr of age).

In stage 2, the cohort-specific OR estimates were combined using a random effects model, which considers within-cohort and between-cohort variation (19). The results are presented as forest plots with central point estimates and 95% CI of adjusted ORs, where the size of the square represents the inverse of the variance of the individual cohort. Statistical heterogeneity among studies was evaluated using the Q-test and I^2 statistics (20).

To examine dose-response relations between the numbers of cigarettes smoked per day and current wheeze or asthma, a two-stage multivariate random effects dose-response pooled analysis was performed. In the first stage, a quadratic logistic model was estimated for each study. In the second stage, we combined the two regression coefficients and the variance/covariance matrix that had been estimated within each study using a restricted maximum likelihood method in a multivariate, random effects metaanalysis. A P value for nonlinearity was calculated by testing the null hypothesis that the coefficient of the quadratic term is equal to zero. For DARC, MAS, and PIAMA-NHS, information on number of cigarettes from any time during pregnancy was used as a proxy due to lack of trimester-specific data.

All statistical analyses were performed with STATA software, version 11 (Stata Corp., College Station, TX), and $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 presents characteristics of the eight birth cohorts, including the prevalence of maternal smoking during pregnancy, in the first year after delivery, and at the time of outcome assessment as well as wheeze and asthma prevalence at 4 to 6 years of age. The proportion of internal missing on the main exposure or outcome variables (often due to loss to follow-up) ranged between 5 and 42% across the cohorts, and the final proportion of children included in the pooled analyses was 66% out of the recruited children, in total 21,600 children. These children were somewhat less exposed to maternal smoking during pregnancy (19.2%; 95% CI, 18.7–19.7) compared with all eligible children (22.7%; 95% CI, 22.3–23.2). Moreover, their parents more often had a high educational level (55.9%; 95% CI, 55.3–56.6) compared with the parents of all eligible children (52.8%; 95% CI, 52.1–53.2). No statistically significant differences were seen for other potential confounders or for wheeze and asthma prevalence (data not shown).

The prevalence of maternal smoking during pregnancy and the first year of the child's life allocated into four disjunctive categories are presented in Table 2. On average, 23.5% of the children were exposed to maternal smoking during pregnancy or the first year of life, with a range of 16.9 to 39.2% between the cohorts. About 80% of the mothers who smoked during pregnancy continued smoking during the first postnatal year. In total, 735 children were identified who had been exposed to maternal smoke during pregnancy but not in the first year of life. The prevalence

TABLE 1. CHARACTERISTICS OF THE EIGHT EUROPEAN BIRTH COHORTS, INCLUDING PREVALENCE OF MATERNAL SMOKING DURING PREGNANCY, IN THE FIRST YEAR AFTER DELIVERY AND AT THE TIME OF OUTCOME ASSESSMENTS AS WELL AS PREVALENCE OF WHEEZE AND ASTHMA AT 4 TO 6 YEARS OF AGE

Birth Cohort	Country	Enrolment Period	Number of Recruited Children	Child's Age at Recruitment	Mean Birth Weight (*g*)	Mother Smoked during Pregnancy, n (%)*	Mother Smoked First Year after Delivery, n (%)†	Mother Smoked when the Child Was 4–6 yr of Age, n (%)‡	Wheeze at 4–6 yr of Age, n (%)§	Asthma at 4–6 yr of Age, n (%)§
ALSPAC	UK	1991–1992	14,057	During pregnancy	3,384	3,670 (27.5)	3,606 (33.9)	1,918 (24.8)	829 (9.9)	na‖
AMICS-Menorca	Spain	1997–1998	482	During pregnancy	3,187	182 (37.9)	152 (32.8)	112 (24.3)	41 (8.9)	34 (7.4)
BAMSE	Sweden	1994–1996	4,089	2 mo	3,530	529 (12.9)	584 (14.8)	534 (14.3)	546 (14.7)	512 (13.7)
DARC	Denmark	1998–1999	562	1 mo	3,541	183 (32.6)	154 (29.8)	88 (19.1)	27 (5.9)	18 (4.1)
GINIplus	Germany	1995–1998	5,991	Shortly before or after birth	3,472	709 (14.8)	713 (14.9)¶	428 (12.4)	341 (8.9)	135 (3.5)
LISAplus	Germany	1997–1999	3,097	3 d	3,473	536 (18.0)	362 (16.4)	177 (8.8)	208 (9.5)	70 (3.2)
MAS	Germany	1990	1,314	1 mo	3,409	308 (25.4)	443 (38.9)	272 (27.6)	103 (10.5)	34 (3.8)
PIAMA-NHS	The Netherlands	1996–1997	3,182	During pregnancy	3,515	676 (21.3)	546 (17.6)	419 (14.5)	278 (9.7)	122 (4.4)

* Mother smoked at least one cigarette daily during any time of pregnancy.
† Mother smoked during the first year after delivery.
‡ Mother smoked at the time of outcome assessment (i.e., when the child was 4, 5, or 6 yr of age).
§ Outcome data are from follow-up visits when the children were 5 yr of age except for BAMSE (4 yr of age), and ALSPAC (6 yr of age).
‖ Not assessed.
¶ Information on maternal smoking collected 4 mo after delivery for GINIplus.

of wheeze at 4 to 6 years of age was 10.4% among the included children, and the prevalence of asthma was 6.6% (Table 2).

In Figure 1, the cohort-specific and combined adjusted ORs of maternal smoking during pregnancy, but not in the first year after delivery, on current wheeze (Figure 1A) and asthma (Figure 1B) are displayed. The combined estimates were statistically significant for wheeze with an adjusted OR of 1.39 (95% CI, 1.08–1.77) and for asthma with an adjusted OR of 1.65 (95% CI, 1.18–2.31). No significant heterogeneity was observed between the studies ($Q = 5.03$, $P = 0.656$ for wheeze; $Q = 4.96$, $P = 0.55$ for asthma).

In Figure 2, the cohort-specific and combined adjusted ORs of maternal smoking in the first year of life, but not during pregnancy, on current wheeze (Figure 2A) and asthma (Figure 2B) are displayed. No increased risk for current wheeze or asthma was seen, the combined adjusted ORs being 0.91 (95% CI, 0.71–1.17) for wheeze and 1.20 (95% CI, 0.84–1.71) for asthma. There was no heterogeneity between the studies ($Q = 2.23$, $P = 0.946$; $Q = 2.60$, $P = 0.627$).

Figure 3 displays the cohort-specific and combined adjusted ORs for children exposed to maternal smoking during pregnancy as well as in the first year of life. The combined estimates were significant for wheeze (Figure 3A) (adjusted OR, 1.25; 95% CI, 1.09–1.43) and asthma (Figure 3B) (adjusted OR, 1.30; 95% CI, 1.00–1.68). Again, there was no heterogeneity ($Q = 2.32$, $P = 0.940$; $Q = 7.26$, $P = 0.297$).

Excluding children with smoke exposure not only by the mother but also by the father or other persons in the household (i.e., any smoke exposure) in the child's first year of life resulted in similar results for all three exposure categories as those presented above (data not shown). We also restricted the analysis to children with no current maternal smoke exposure (i.e., at 4–6 yr of age) (n = 16,241; 507 children were exposed to maternal smoking during pregnancy but not thereafter). Exposure to maternal smoking during pregnancy but not during the first year of life was associated with an increased risk of wheeze (adjusted OR, 1.63; 95% CI, 1.25–2.12) and asthma (adjusted OR, 1.95; 95% CI, 1.34–2.85) among these children. Similar results were observed among children with no current smoke exposure from any persons as well as during the first year of life (n = 9,882; data not shown).

Clear effects of maternal smoking during pregnancy were seen already for the first trimester. Maternal smoking during the first trimester of pregnancy only but not during the third trimester

TABLE 2. PREVALENCE OF MATERNAL SMOKING DURING PREGNANCY AND DURING THE FIRST YEAR AFTER DELIVERY IN EIGHT EUROPEAN BIRTH COHORTS COMPRISING 21,600 CHILDREN INCLUDED IN THE POOLED ANALYSES

Birth cohort	No Smoking (Reference), n (%)*	Smoking during Pregnancy Only, n (%)†	Smoking in the First Year Only, n (%)‡	Smoking during Pregnancy and First Year, n (%)§	Wheeze at 4–6 yr of Age, n (%)‖	Asthma at 4–6 yr of age, n (%)‖
ALSPAC	5,460 (71.2)	157 (2.1)	407 (5.3)	1,584 (20.8)	742 (9.7)	na¶
AMICS-Menorca	268 (60.8)	28 (6.3)	12 (2.7)	133 (30.2)	39 (8.8)	33 (7.5)
BAMSE	3,051 (83.1)	93 (2.5)	153 (4.2)	376 (10.2)	537 (14.7)	503 (13.7)
DARC	315 (63.6)	35 (7.1)	17 (3.4)	128 (25.9)	26 (6.2)	18 (4.2)
GINIplus	3,159 (83.3)**	123 (3.2)**	137 (3.6)**	375 (9.9)**	333 (8.9)	129 (3.4)
LISAplus	1,421 (80.7)	106 (6.0)	67 (3.8)	166 (9.4)	181 (10.4)	61 (3.5)
MAS	561 (63.6)	18 (2.0)	127 (13.9)	188 (20.6)	95 (10.7)	33 (4.0)
PIAMA-NHS	2,291 (78.1)	175 (6.0)	56 (1.9)	413 (14.1)	275 (9.6)	121 (4.4)
Total	16,526 (76.5)	735 (3.4)	976 (4.5)	3,363 (15.6)	2,228 (10.4)	898 (6.6)

* No maternal smoking during pregnancy or in the first year after delivery.
† Maternal smoking of at least one cigarette daily during any time of pregnancy but no smoking during the first year after delivery.
‡ No maternal smoking during pregnancy but maternal smoking during the first year after delivery.
§ Maternal smoking of at least one cigarette daily during any time of pregnancy and during the first year after delivery.
‖ Outcome data are from follow-up visits when the children were 5 yr of age except for BAMSE (4 yr of age) and ALSPAC (6 yr of age).
¶ Not assessed.
** Information on maternal smoking collected 4 mo after delivery.

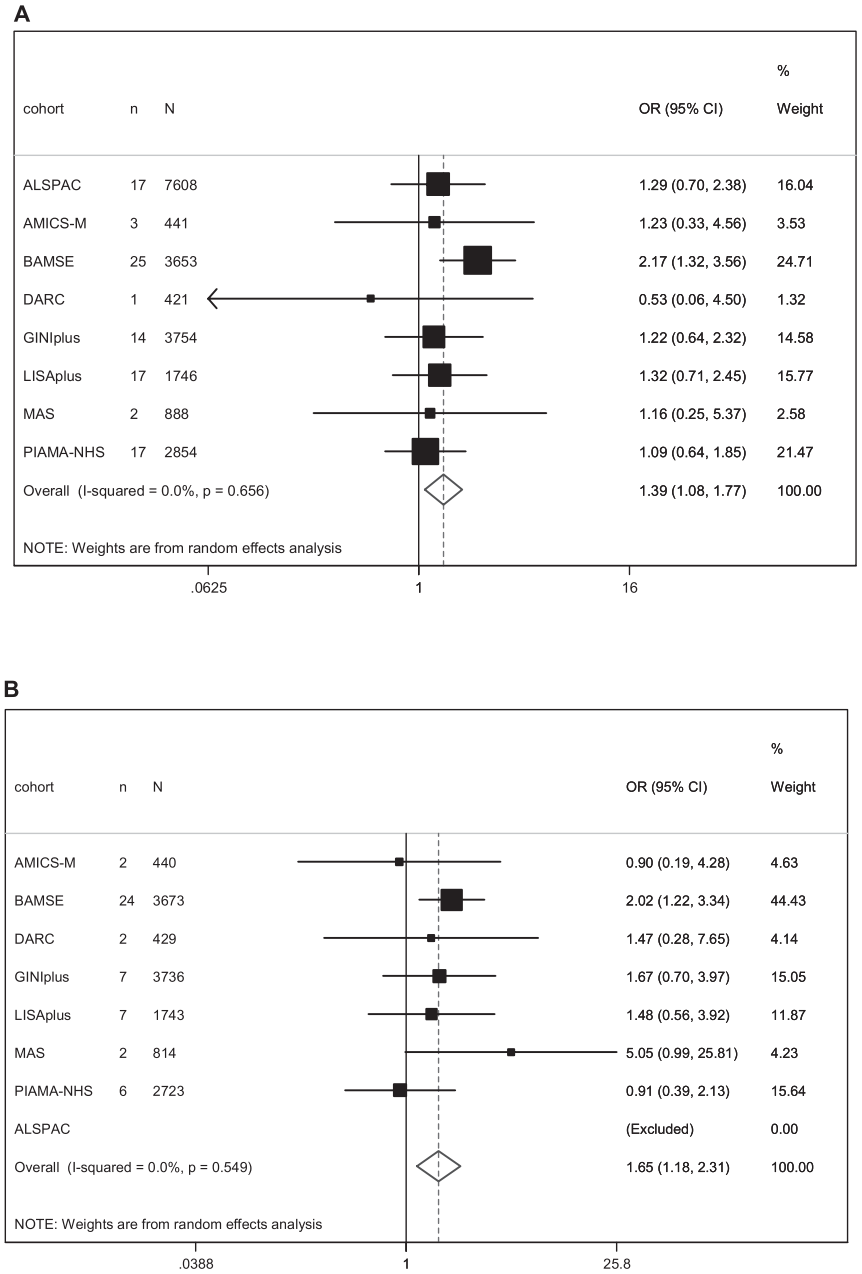


Figure 1. Associations between maternal smoking during pregnancy only (no maternal smoking during the first year of life) in relation to preschool wheeze and asthma in eight European birth cohorts. Cohort-specific odds ratios (ORs) and 95% confidence intervals (CIs) were obtained by logistic regression adjusted for sex, parental asthma, parental education, siblings, and birth weight. Combined ORs and 95% CIs derived by random effects methods are shown. AMICS-M = AMICS-Menorca; N = total number of cases in each birth cohort; n = number of exposed cases in each cohort. (*A*) Wheeze, 4 to 6 years of age. (*B*) Asthma, 4 to 6 years of age. ALSPAC (UK) lacked information on doctor's diagnosis of asthma and was not included in the analyses of asthma.

or the first year after birth was associated with an increased risk of wheeze (adjusted OR, 1.45; 95% CI, 1.00–2.12) and asthma (adjusted OR, 2.10; 95% CI, 1.38–3.21). Of the 735 women that smoked during pregnancy but not in the first year after delivery, 496 (67%) quitted smoking during the first or second trimester. In dose-response analyses of maternal smoking during the first trimester of pregnancy and the risk of wheeze and asthma at 4 to 6 years of age, there was no evidence of nonlinearity of the association with the number of cigarettes smoked for wheeze ($P = 0.505$) and asthma ($P = 0.268$). Every five cigarette increase in daily consumption conferred an adjusted OR of 1.18 (95% CI, 1.02–1.38) for wheeze and 1.23 (95% CI, 1.03–1.47) for asthma.

DISCUSSION

This pooled analysis of individual participant data from eight European birth cohorts including 21,600 children enabled us to estimate the independent effect of maternal smoking during pregnancy on wheeze and asthma in preschool children. The results were consistent, showing an increased risk for preschool wheeze and for asthma among children exposed to cigarette smoke by their mothers during pregnancy. The effect appeared to be particularly strong for smoking during the first trimester of pregnancy with a significant dose-response effect relation.

There were several strengths with this study. Individual participant data from eight European birth cohorts were used, enabling us to assess the effect from different patterns of smoke exposure from various populations. To our knowledge, this is the largest database assessing the specific influence of maternal smoking during pregnancy on childhood respiratory disease. Information on maternal smoking during pregnancy was collected at baseline assessment in all cohorts before development of childhood respiratory disease. Moreover, data were harmonized before analyses, reducing between-study heterogeneity. Separation of pre- and postnatal smoke exposure was also possible, as well as assessment of dose-response effects for amount of cigarettes smoked in the first trimester in relation to preschool wheeze and asthma.

There were some possible limitations. In total, 66% of the eligible children in the selected cohorts were included in our

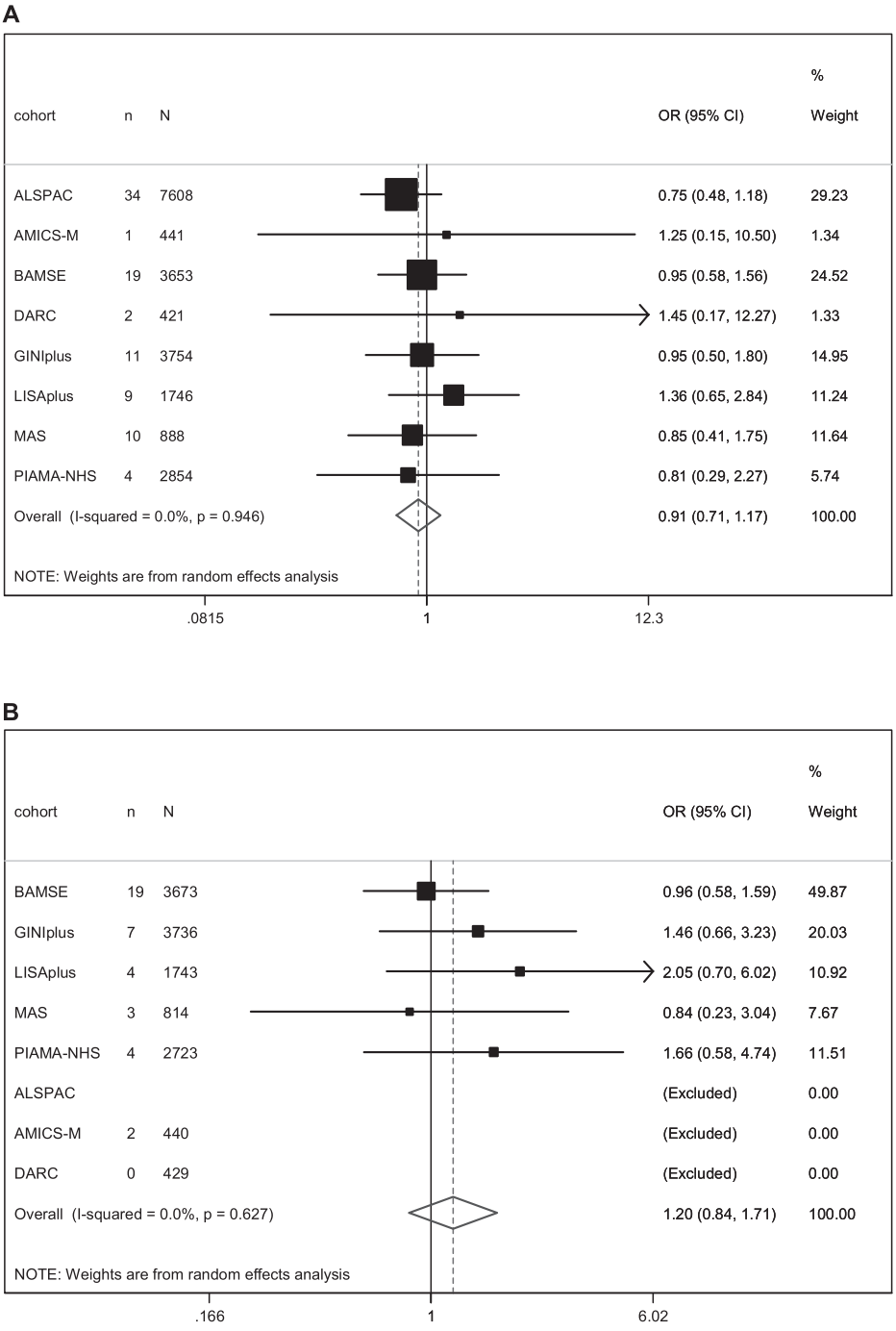


Figure 2. Associations between maternal smoking during the first year only (no maternal smoking during pregnancy) in relation to preschool wheeze and asthma in eight European birth cohorts. Cohort-specific odds ratios (ORs) and 95% confidence intervals (CIs) were obtained by logistic regression adjusted for sex, parental asthma, parental education, siblings, and birth weight. Combined ORs and 95% CIs derived by random effects methods are shown. AMICS-M = AMICS-Menorca; N = total number of cases in each birth cohort; n = number of exposed cases in each cohort. (*A*) Wheeze, 4 to 6 years of age. (*B*) Asthma, 4 to 6 years of age. ALSPAC (UK) lacked information on doctor's diagnosis of asthma and was not included in the analyses of asthma. AMICS-Menorca (Spain) and DARC (Denmark) were excluded due to insufficient numbers of cases.

analyses. Fewer children exposed to tobacco smoke during pregnancy met our inclusion criteria compared with the original cohorts. In contrast, there was no difference in the prevalence of wheeze and asthma among the included children and those not included. Thus, it is unlikely that our finding of an increased risk among children born to smoking mothers would be explained by selection.

All exposure information was based on parental questionnaire answers. The questions were not entirely standardized, but we were able to extract comparable exposure information from all cohorts. Exposure information on maternal smoking during pregnancy was collected during pregnancy or in the first months after delivery (i.e., before disease occurrence). Thus, any misclassification of prenatal smoke exposure is likely to be nondifferential. Moreover, pregnant women have been shown to report smoking accurately, although women who quit smoking may underreport smoking (21). Maternal smoking during the first year of life was assessed when the child was 1 year of age. A validation study including four of our birth cohorts demonstrated a fair agreement between parental reported tobacco smoking and indoor air nicotine or urinary cotinine measurements (22).

Questionnaire information on wheeze and asthma during the past 12 months was comparable among the cohorts. To enhance asthma outcome accuracy, we used a composite variable satisfying at least two out of three conditions to define asthma. Although some studies suggest that smoking parents may underreport symptoms of wheeze or underutilize health care for mild respiratory symptoms in their children (23, 24), such bias would primarily lead to an underestimation of the true effect of maternal smoking if nondifferential in relation to exposure.

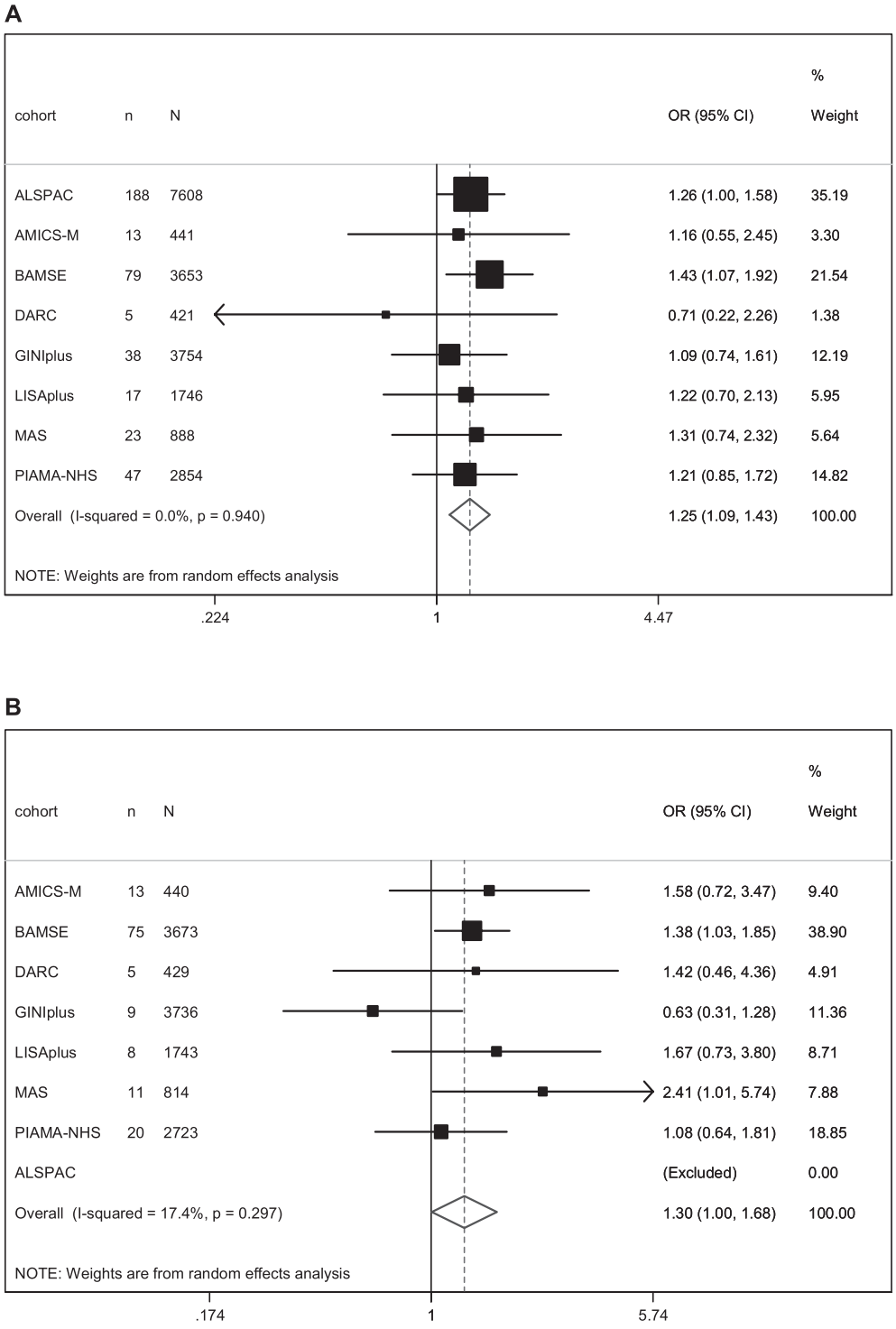


Figure 3. Associations between maternal smoking during pregnancy and in the first year after delivery in relation to preschool wheeze and asthma in eight European birth cohorts. Cohort-specific odds ratios (ORs) and 95% confidence intervals (CIs) were obtained by logistic regression adjusted for sex, parental asthma, parental education, siblings, and birth weight. Combined ORs and 95% CIs derived by random effects methods are shown. AMICS-M = AMICS-Menorca; N = total number of cases in each birth cohort; n = number of exposed cases in each cohort. (*A*) Wheeze, 4 to 6 years of age. (*B*). Asthma, age 4 to 6 years of age. ALSPAC (UK) lacked information on doctor's diagnosis of asthma and were not included in the analyses of asthma.

Our results showing an increased risk of asthma and wheeze among children whose mothers smoked during pregnancy are in line with earlier findings (8–10, 25, 26). However, in none of the previous studies was it possible to disentangle the effect of pre- versus postnatal smoking, mainly due to small sample sizes. A positive dose-dependent effect was shown in our study estimating the odds ratio for every five-cigarette increase in daily consumption during the first trimester. The risk remained statistically significant even for the group of mothers smoking in the first but not in the third trimester. This indicates that the hazardous effects of maternal smoking on the fetal respiratory system might be present before the woman knows that she is pregnant.

An effect of maternal smoking during pregnancy on the subsequent development of childhood asthma is biologically plausible, although the underlying mechanisms remain unclear. Changes in airway sensory innervation, thickening of the airway smooth muscle layer, and altered smooth muscle relaxation causing airway hyperresponsiveness have been seen in animals exposed to tobacco smoke *in utero* (13, 14, 27, 28). Airway remodeling by collagen deposition rendering stiffer airways and increased lung inflammation and a TH2-biased immune response were also observed (13, 27). Several tobacco smoke constituents have been proposed as causative agents for asthma development. For example, nicotine can interfere with various aspects of lung development, disturbing

alveolar architecture or changing tissue elasticity (12, 29, 30). The fetal lung begins to develop in the fourth week of pregnancy, and terminal bronchioles have been formed early in the second trimester (31). Our data indicate that the early stage of organogenesis may be affected by maternal smoking.

In our study, children exposed to maternal smoking during pregnancy and in the first year of life had an increased risk of preschool wheeze and asthma, whereas no significant associations were observed for children exposed to maternal smoking only during the first year of life. Previous studies have shown such an association (1, 3, 7), and the lack of effect in our study may be an effect of the parents avoiding direct smoke exposure of their children during early childhood (10). This might be due to increased awareness of the health hazards from second-hand smoke exposure (3). Early signs of respiratory disease in toddlers might also result in adjusted parental smoking behavior (25). Moreover, given the strong effect of maternal smoking during pregnancy, the potential adverse effects of postnatal maternal smoking might only be visible beyond preschool age.

This large pooled analysis of eight birth cohorts with data on more than 21,000 children showed that maternal smoking during pregnancy is associated with wheeze and asthma in preschool children and among children who are not exposed to maternal smoking late in pregnancy or after birth. Policy makers should be aware of the important role of motivating tobacco smoking teenage girls and young women to stop before getting pregnant to prevent asthma in their children.

Author disclosures are available with the text of this article at www.atsjournals.org.

Acknowledgment: The authors thank all birth cohort teams that provided data for this project, including Carel Thijs from the KOALA birth cohort, Maastricht, The Netherlands; Maria-Pia Fantini from the CO.N.ER birth cohort, Bologna, Italy; and Lorenzo Richiardi from the NINFEA birth cohort, Turin, Italy.

References

1. Cheraghi M, Salvi S. Environmental tobacco smoke (ETS) and respiratory health in children. *Eur J Pediatr* 2009;168:897–905.
2. Moya J, Bearer CF, Etzel RA. Children's behavior and physiology and how it affects exposure to environmental contaminants. *Pediatrics* 2004;113:996–1006.
3. Öberg M, Jaakkola MS, Woodward A, Peruga A, Pruss-Ustun A. Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries. *Lancet* 2011;377:139–146.
4. Wang L, Pinkerton KE. Detrimental effects of tobacco smoke exposure during development on postnatal lung function and asthma. *Birth Defects Res C Embryo Today* 2008;84:54–60.
5. Lackmann GM, Salzberger U, Tollner U, Chen M, Carmella SG, Hecht SS. Metabolites of a tobacco-specific carcinogen in urine from newborns. *J Natl Cancer Inst* 1999;91:459–465.
6. Wu FY, Chiu HT, Wu HD, Lin CJ, Lai JS, Kuo HW. Comparison of urinary and plasma cotinine levels during the three trimesters of pregnancy. *Paediatr Perinat Epidemiol* 2008;22:296–301.
7. Burke H, Leonardi-Bee J, Hashim A, Pine-Abata H, Chen Y, Cook DG, Britton JR, McKeever TM. Prenatal and passive smoke exposure and incidence of asthma and wheeze: systematic review and meta-analysis. *Pediatrics* 2012;129:735–744.
8. Gilliland FD, Li YF, Peters JM. Effects of maternal smoking during pregnancy and environmental tobacco smoke on asthma and wheezing in children. *Am J Respir Crit Care Med* 2001;163:429–436.
9. Jaakkola JJ, Gissler M. Maternal smoking in pregnancy, fetal development, and childhood asthma. *Am J Public Health* 2004;94:136–140.
10. Lannerö E, Wickman M, Pershagen G, Nordvall L. Maternal smoking during pregnancy increases the risk of recurrent wheezing during the first years of life (BAMSE). *Respir Res* 2006;7:3.
11. Murin S, Rafii R, Bilello K. Smoking and smoking cessation in pregnancy. *Clin Chest Med* 2011;32:75–91.
12. Sekhon HS, Keller JA, Proskocil BJ, Martin EL, Spindel ER. Maternal nicotine exposure upregulates collagen gene expression in fetal monkey lung: association with alpha7 nicotinic acetylcholine receptors. *Am J Respir Cell Mol Biol* 2002;26:31–41.
13. Singh SP, Mishra NC, Rir-Sima-Ah J, Campen M, Kurup V, Razani-Boroujerdi S, Sopori ML. Maternal exposure to secondhand cigarette smoke primes the lung for induction of phosphodiesterase-4D5 isozyme and exacerbated Th2 responses: rolipram attenuates the airway hyperreactivity and muscarinic receptor expression but not lung inflammation and atopy. *J Immunol* 2009;183:2115–2121.
14. Wu ZX, Hunter DD, Kish VL, Benders KM, Batchelor TP, Dey RD. Prenatal and early, but not late, postnatal exposure of mice to sidestream tobacco smoke increases airway hyperresponsiveness later in life. *Environ Health Perspect* 2009;117:1434–1440.
15. Torrent M, Sunyer J, Cullinan P, Basagana X, Harris J, Garcia O, Anto JM. Smoking cessation and associated factors during pregnancy. *Gac Sanit* 2004;18:184–189.
16. Neuman Å, Hohmann C, Pershagen G, Orsini N, Wickman M, Keil T, Bergström A. Maternal smoking during pregnancy and wheeze or asthma in preschool children: a pooled analysis of eight birth cohorts. *Allergy* 2011;66:646.
17. Vrijheid M, Casas M, Bergström A, Carmichael A, Cordier S, Eggesbo M, Eller E, Fantini MP, Fernandez MF, Fernandez-Somoano A, *et al*. European birth cohorts for environmental health research. *Environ Health Perspect* 2012;120:29–37.
18. Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F, Mitchell EA, Pearce N, Sibbald B, Stewart AW, *et al*. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J* 1995;8:483–491.
19. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials* 1986;7:177–188.
20. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med* 2002;21:1539–1558.
21. George L, Granath F, Johansson AL, Cnattingius S. Self-reported nicotine exposure and plasma levels of cotinine in early and late pregnancy. *Acta Obstet Gynecol Scand* 2006;85:1331–1337.
22. Gehring U, Leaderer BP, Heinrich J, Oldenwening M, Giovannangelo ME, Nordling E, Merkel G, Hoek G, Bellander T, Brunekreef B. Comparison of parental reports of smoking and residential air nicotine concentrations in children. *Occup Environ Med* 2006;63:766–772.
23. Jacobs-van der Bruggen MA, Wijga AH, Brunekreef B, de Jongste JC, Baan CA, Kerkhof M, Smit HA. Do parents who smoke underutilize health care services for their children? A cross sectional study within the longitudinal PIAMA study. *BMC Health Serv Res* 2007;7:83.
24. Siroux V, Guilbert P, Le Moual N, Oryszczyn MP, Kauffmann F. Influence of asthma on the validity of reported lifelong environmental tobacco smoke in the EGEA study. *Eur J Epidemiol* 2004;19:841–849.
25. Håberg SE, Stigum H, Nystad W, Nafstad P. Effects of pre- and postnatal exposure to parental smoking on early childhood respiratory health. *Am J Epidemiol* 2007;166:679–686.
26. Lux AL, Henderson AJ, Pocock SJ. Wheeze associated with prenatal tobacco smoke exposure: a prospective, longitudinal study. ALSPAC Study Team. *Arch Dis Child* 2000;83:307–312.
27. Blacquiere MJ, Timens W, Melgert BN, Geerlings M, Postma DS, Hylkema MN. Maternal smoking during pregnancy induces airway remodelling in mice offspring. *Eur Respir J* 2009;33:1133–1140.
28. Yu M, Zheng X, Peake J, Joad JP, Pinkerton KE. Perinatal environmental tobacco smoke exposure alters the immune response and airway innervation in infant primates. *J Allergy Clin Immunol* 2008;122:640–647, e641.
29. Maritz GS. Maternal nicotine exposure during gestation and lactation of rats induce microscopic emphysema in the offspring. *Exp Lung Res* 2002;28:391–403.
30. Maritz GS, Harding R. Life-long programming implications of exposure to tobacco smoking and nicotine before and soon after birth: evidence for altered lung development. *Int J Environ Res Public Health* 2011;8:875–898.
31. Larsen WJ. Human embryology. New York: Churchill Livingstone; 1997.

Parental smoking during pregnancy, early growth, and risk of obesity in preschool children: the Generation R Study[1–3]

Büşra Durmuş, Claudia J Kruithof, Matthew H Gillman, Sten P Willemsen, Albert Hofman, Hein Raat, Paul HC Eilers, Eric AP Steegers, and Vincent WV Jaddoe

ABSTRACT

Background: Maternal smoking during pregnancy seems to be associated with obesity in offspring. Not much is known about the specific critical exposure periods or underlying mechanisms for this association.

Objective: We assessed the associations of active maternal and paternal smoking during pregnancy with early growth characteristics and risks of overweight and obesity in preschool children.

Design: This study was a population-based, prospective cohort study from early fetal life until the age of 4 y in 5342 mothers and fathers and their children. Growth characteristics [head circumference, length, weight, and body mass index (BMI; in kg/m^2)] and overweight and obesity were repeatedly measured at the ages of 1, 2, 3, and 4 y.

Results: In comparison with children from nonsmoking mothers, children from mothers who continued smoking during pregnancy had persistently smaller head circumferences and heights until the age of 4 y, whereas their weights were lower only until the age of 3 mo. This smaller length and normal to higher weight led to an increased BMI [SD score difference: 0.11; 95% CI: 0.02, 0.20; $P <$ 0.05)] and an increased risk of obesity (odds ratio: 1.61; 95% CI: 1.03, 2.53; $P < 0.05$) at the age of 4 y. In nonsmoking mothers, paternal smoking was not associated with postnatal growth characteristics or risk of obesity in offspring. Maternal smoking during pregnancy was associated with a higher BMI at the age of 4 y in children with a normal birth weight and in those who were small for gestational age at birth.

Conclusion: Our findings suggest that direct intrauterine exposure to smoke until late pregnancy leads to different height and weight growth adaptations and increased risks of overweight and obesity in preschool children. *Am J Clin Nutr* 2011;94:164–71.

INTRODUCTION

The hypothesis of developmental origins proposes that fetal adaptations in organ function and metabolism in response to adverse intrauterine conditions lead to fetal growth retardation and predispose the individual to increased risks of obesity and type 2 diabetes in adult life (1, 2). Not much is known about the influence of specific adverse exposures. In Western countries, active maternal smoking during pregnancy is a common and preventable specific adverse environmental exposure (3, 4). Maternal smoking during pregnancy is associated with fetal growth retardation and increased risks of preterm birth and low birth weight (5–7). It has been suggested that maternal smoking during pregnancy also increases risk of obesity in offspring (8, 9). A recent systematic review suggested that prenatal smoke exposure led to a 50% increased risk of overweight in childhood (10). Most previous studies were not able to assess the effect of maternal smoking exposure in different periods of pregnancy. This information is important because it might identify specific critical time windows. It is also not known whether the associations between maternal smoking during pregnancy and risk of childhood obesity are explained by intrauterine effects or just reflect various unmeasured environmental confounders. Stronger effect estimates for maternal smoking than for paternal smoking with childhood obesity may suggest direct intrauterine effects, whereas similar effect estimates may suggest that the associations are explained by unmeasured environmental exposures (11, 12).

Therefore, in a population-based prospective cohort study in 5342 mothers and fathers and their children, who were followed from early fetal life onwards, we examined associations of exposure to maternal and paternal smoking during pregnancy with early growth characteristics and risks of overweight and obesity until the age of 4 y.

SUBJECTS AND METHODS

Design and setting

This study was embedded in the Generation R Study, which is a population-based prospective cohort study of pregnant women and their children from fetal life onwards in Rotterdam, Netherlands (13, 14). Enrollment in the study was aimed at early pregnancy (gestational age <18 wk) but was possible until the

[1] From the Generation R Study Group (BD, CJK, and VWVJ) and the Departments of Pediatrics (BD and VWVJ), Epidemiology (BD, AH, and VWVJ), Biostatistics (SPW and PHCE), Public Health (HR), and Obstetrics and Gynecology (EAPS), Erasmus Medical Center, Rotterdam, Netherlands, and the Harvard Medical School/Harvard Pilgrim Health Care Institute, Boston, MA (MHG).

[2] Supported by the Erasmus Medical Center, the Erasmus University Rotterdam, the Netherlands Organization for Health Research and Development, the Netherlands Organization for Health Research and Development (ZonMw 90700303, 916.10159; to VWVJ), and an unrestricted grant from Danone Research (to BD).

[3] Address correspondence to VWV Jaddoe, Dr. Molewaterplein 50, Postbus 2040, 3000 CA Rotterdam, Netherlands. E-mail: v.jaddoe@erasmusmc.nl.

Received November 27, 2010. Accepted for publication April 14, 2011.
First published online May 18, 2011; doi: 10.3945/ajcn.110.009225.

Supplemental Material can be found at:
http://ajcn.nutrition.org/content/suppl/2011/06/17/ajcn.110.009225.DC1.html

birth of the child. Assessments during pregnancy, including physical examinations, fetal ultrasound examinations, and questionnaires, were planned in each trimester (14). All children were born between April 2002 and January 2006 and form a prenatally enrolled birth cohort that is currently followed until young adulthood. Postnatal growth data for the current study were available until the age of 4 y. Of all eligible children in the study area, 61% of children were participating in the study at birth (14). The study protocol was approved by the Medical Ethical Committee of the Erasmus Medical Centre (Rotterdam, Netherlands). Written informed consent was obtained from all participants or their parents.

Data collection and measurements

Maternal and paternal smoking during pregnancy

Information about maternal smoking was obtained by postal questionnaires sent in the first, second, and third trimesters of pregnancy. Response rates for these questionnaires were 91%, 80%, 77%, respectively (14). Active maternal smoking at enrollment was assessed in the first questionnaire by asking whether the mother smoked during her pregnancy. We grouped mothers into 3 categories as follows: *1*) never smoked during pregnancy, *2*) only smoked until their pregnancy was acknowledged (first trimester only), and 3) continued to smoke during pregnancy. This questionnaire was sent to all mothers independent of the gestational age at enrollment. In the second and third questionnaires, mothers were asked whether they had smoked during the past 2 mo (yes or no). Mothers who reported in the first questionnaire not to have smoked or to have smoked until their pregnancy was acknowledged but reported to have smoked in the second or third questionnaire were reclassified as continued smoking. Active paternal smoking was assessed in the first questionnaire by asking the mother whether the father smoked during pregnancy (yes, no, or do not know). Similar information completed by the father was available in a subset of participants (n = 3558). Agreement between these assessments was good (sensitivity: 91%; specificity: 95%). We used data collected from the mother's questionnaire because this information was available for all children. No difference in effect estimates were observed when we used information completed by the father himself. In smokers, the numbers of cigarettes smoked daily was available in the following categories: no smoking, <5 cigarettes/d, and ≥5 cigarettes/d. All mothers included in these analyses were selected on the basis of complete information about the duration of smoking during pregnancy. Because we used 2 different questions (ie, Did you smoke? and What is the number of smoked cigarettes?), the number of cigarettes smoked per day was not known for all mothers.

Fetal growth characteristics

Fetal ultrasound examinations were carried out at the research centers in the first trimester (median: 13.5 wk; 95% range: 11.0, 17.0 wk), second trimester (median: 20.7 wk; 95% range: 18.9, 22.8 wk), and third trimester (median: 30.5 wk; 95% range: 28.9, 32.4 wk). The first ultrasound was used for establishing gestational age because these methods were superior than the use of the last menstrual period because of its limitations, including the large number of women who did not know the exact date of their last menstrual period or had irregular menstrual cycles (15–17). Second and third trimester ultrasounds were used to assess fetal growth. We measured fetal head circumference (HC), abdominal circumference (AC), and femur length (FL) to the nearest millimeter by using standardized ultrasound procedures (18), and the estimated fetal weight (EFW) was calculated by using the following formula of Hadlock et al (19):

$$\mathrm{Log}_{10}\mathrm{EFW} = 1.5662 - 0.0108\ (\mathrm{HC}) + 0.0468\ (\mathrm{AC}) + 0.171\ (\mathrm{FL}) + 0.00034\ (\mathrm{HC})^2 - 0.003685\ (\mathrm{AC} \times \mathrm{FL}) \quad (1)$$

SD scores (SDS) for all fetal growth characteristics were constructed by using data from the study group. Ultrasound examinations were performed with an Aloka model SSD-1700 (Aloka Co Ltd, Tokyo, Japan) or ATL-Philips model HDI 5000 (Philips, Seattle, WA).

Postnatal growth characteristics

Information on weight at birth was obtained from community midwife and hospital registries. Because head circumferences and lengths were not routinely measured at birth, these measurements were only available in a subset. Postnatal growth was measured by well-trained staff at Community Health Centers according to a standard schedule and procedures at the ages of 3 mo (median: 3.1 mo; 95% range: 1.3, 4.2 mo), 6 mo (median: 6.7 mo; 95% range: 5.5, 10.3 mo), 12 mo (median: 13.0 mo; 95% range: 11.1, 15.3 mo), 24 mo (median: 24.4 mo; 95% range: 18.6, 27.5 mo), 36 mo (median: 36.4 mo; 95% range: 31.1, 39.2 mo), and 48 mo (median: 45.3 mo; 95% range: 25.7, 47.8 mo). Head circumferences were measured to the nearest millimeter with a standardized tape (SECA, Hamburg, Germany) until the age of 12 mo. Lengths were measured in a supine position to the nearest millimeter until the age of 12 mo with a neonatometer. From the age of 24 mo, heights were measured in a standing position with a Harpenden stadiometer (Holtain Ltd, Dyfed, United Kingdom). Weights were measured with a mechanical personal scale (SECA). Body mass index (BMI; in kg/m^2) was calculated. SDS for postnatal growth characteristics were obtained with Dutch reference growth charts (Growth Analyzer 3.0; Dutch Growth Research Foundation, Rotterdam, Netherlands). Definitions of overweight (BMI >1.1–2.3 SDS) and obesity (BMI >2.3 SDS) were based on the age- and sex-adjusted BMI distributions on the basis of the definition of Cole et al (20). Frederiks et al (21) transformed the international criteria for overweight and obesity to SDs to identify the pediatric centiles at younger ages and showed that an adult BMI of 25 (overweight) corresponded to a +1.1 SD and that an adult BMI of 30 (obesity) corresponded to a +2.3 SD in the reference growth diagrams on the basis of the 1997 Dutch Growth Study. Therefore, the +1.1- and +2.3-SD lines in the 1997 BMI charts correspond to the recommended limits for overweight and obesity, respectively, that Cole et al (20) also used.

Covariates

Gestational age at birth and sex were obtained from midwife and hospital registries at birth. Information about parental

educational level and ethnicity were obtained from the first questionnaire at enrollment in the study. Ethnicity and educational level of parents were defined according to the classification of Statistics Netherlands (22, 23). Parental anthropometric measurements were assessed at enrollment. Height and weight were measured while the parent stood without shoes and heavy clothing, and BMI was calculated. Information on breastfeeding was obtained by postnatal questionnaires at the ages of 2, 6, and 12 mo.

Population for analysis

In total, 6969 children and their mothers had been included prenatally and fully participated in the postnatal phase of the study (*see* supplemental Figure 1 under "Supplemental data" in the online issue). Subjects without information about smoking during pregnancy in the 3 questionnaires were excluded from the current analyses (13%; $n = 936$). Of the remaining mothers, those with twin pregnancies ($n = 125$) and those with second or third participating infants of the same mother in the study ($n = 382$) were excluded from the current analyses to prevent a bias because of correlation. Of the remaining 5526 singleton live births with complete data on maternal smoking during pregnancy, information about at least one postnatal growth characteristic measure was available in 5342 children. There were no differences in categories of active smoking between participants compared with those of lost to follow-up subjects ($P = 0.14$).

Statistical analysis

Differences in baseline characteristics between maternal smoking categories were compared by using the *t* test and analysis of variance with Bonferroni correction in **Table 1**. Associations of the period of maternal smoking during pregnancy (no, first trimester only, or continued) with growth characteristics (SDS of head circumference, height, weight, and BMI) were assessed by using linear mixed models. These models take the correlation between repeated measurements of the same participant into account and allow for incomplete outcome data (24). To account for the within-child correlation, we included a random intercept in the model. The models were adjusted for potential confounders including the visit (second trimester, third trimester, birth, and 3, 6, 12, 24, 36, or 48 mo), because the intercept might not have been the same at every visit, child's age at the visit relative to the mean per visit, sex, maternal ethnicity and education, maternal height and weight at enrollment, and breastfeeding (yes or no). All interactions between the visit and the other confounders where also included in the model because of the possible variability of confounder effects. Confounders were included in the models on the basis of their associations with postnatal BMI in previous studies or a change in effect estimates of interest >10% because this criterion took into account the covariate-outcome association and the change in the estimate upon removal of the covariate (25).

Similar linear mixed models were used for the assessment of associations of reported numbers of cigarettes smoked by the mother during pregnancy, smoking of the father, and the number of cigarettes smoked by the father with growth characteristics in offspring. Postnatal smoking, parity, and maternal alcohol consumption were not included in models because they did not materially change effect estimates. Multiple logistic regression models were used for the analysis of associations of the period of maternal and paternal smoking during pregnancy with risks of overweight and obesity at the age of 4 y. Analyses that focused on associations of maternal and paternal smoking with anthropometrics in offspring were not adjusted for multiple testing because these were closely correlated outcomes. Finally, to assess whether associations of maternal smoking during pregnancy with postnatal BMI and risks of overweight and obesity were modified by gestational age-adjusted birth weight, we repeated these analyses with overweight and obesity as outcomes in strata of small size for gestational age defined as the lowest 10% of gestational age-adjusted birth weight in the cohort. Tests for trends were performed by treating each categorized variable as a continuous term and entering the variable into the fully adjusted regression model. To handle missing values in covariates (<23% missing values), we performed multiple imputations for linear mixed models in **Table 2** and supplemental Table 2 (under "Supplemental data" in the online issue) by using the chained equations approach in the R program (version 2.12.1; The R Foundation for Statistical Computing, Vienna, Austria) (26) and for **Table 3** by generating 5 independent data sets using the Markov chain Monte Carlo method in the Statistical Package of Social Sciences program (version 17.0 for Windows; SPSS Inc, Chicago, IL). According to both methods, SEs from each of the 5 imputation sets were combined to an overall SE on the basis of the within-imputation variance and the between-imputation variance. All measures of associations are presented with their 95% CIs. Statistical analyses were performed with the Statistical Package of Social Sciences (version 17.0 for Windows; SPSS Inc) and R (version 2.12.1; The R Foundation for Statistical Computing) programs.

RESULTS

Subject characteristics

Of all mothers included in the analyses, 9.0% ($n = 481$) of them reported only smoking in the first trimester, and 15.6% ($n = 833$) of them continued smoking during pregnancy (Table). Mothers who continued smoking were younger and less educated than mothers who never smoked during pregnancy. The largest ethnic group was Dutch or other European (60.4%). Mean (±SD) birth weights of children from mothers who never smoked during pregnancy and who continued smoking were 3463 ± 540 and 3265 ± 540 g, respectively (*see* supplemental Table 1 under "Supplemental data" in the online issue for unadjusted growth characteristics per maternal smoking category).

Parental smoking during pregnancy, growth, and obesity in offspring

Compared with no maternal smoking, maternal smoking in the first trimester only was not associated with growth differences in head circumferences, lengths, weights, and BMI of offspring (Table 2). Children from mothers who continued smoking had smaller head circumferences until the age of 12 mo and smaller heights until the age of 4 y, whereas their weights were only lower until the age of 3 mo (P for trend < 0.01). The persistently smaller heights and normal to higher weights led to a higher BMI at the age of 4 y (difference: 0.11 SDS 95% CI: 0.02, 0.20 SDS; $P < 0.05$). In mothers who continued smoking, we observed the largest effect estimates for mothers who smoked ≥5 cigarettes/d [at 4 y: height

TABLE 1
Characteristics of mothers and their children according to the category of maternal smoking during pregnancy[1]

	Smoking during pregnancy (n = 5342)			
	No (n = 4028; 75.4%)	First trimester only (n = 481; 9.0%)	Continued (n = 833; 15.6%)	ANOVA
Maternal characteristics				
Age (y)	30.4 (21.4, 38.2)[2]	29.7 (20.4, 37.5)*	29.0 (19.9, 37.8)**	<0.01
Height (cm)	167.6 (7.5)[3]	168.7 (7.1)**	167.1 (7.2)	<0.01
Weight (kg)	69.0 (12.9)	69.2 (12.5)	70.1 (14.0)	0.10
BMI (kg/m^2)	24.6 (4.4)	24.3 (4.3)	25.1 (4.7)**	<0.01
Education (%)				<0.01
Primary	9.0	7.9	16.6**	
Secondary	40.4	45.1	62.2**	
Higher	50.6	47.0	21.2**	
Ethnicity (%)				0.04
Dutch or European	60.4	65.1	58.0**	
Non-European	39.6	34.9	42.0**	
Paternal characteristics				
Age (y)	33.4 (24.5, 43.5)	32.2 (22.5, 41.9)**	31.7 (21.4, 42.3)**	<0.01
Weight (kg)	83.5 (12.7)	83.7 (12.7)	82.2 (13.3)	0.25
Height (cm)	181.4 (7.7)	182.5 (7.8)	179.9 (8.0)**	<0.01
BMI (kg/m^2)	25.4 (3.4)	25.1 (3.3)	25.4 (3.6)	0.33
Smoking, yes (%)	34.7	65.1**	74.1**	<0.01
Birth				
Male sex (%)	50	48	52	0.30
Gestational age (wk)	40.0 (37.1, 42.1)	39.9 (37.1, 42.0)	39.8 (36.4, 42.1)**	<0.01
Weight (g)	3463 (540)	3462 (532)	3265 (540)**	<0.01
Small for gestational age, <10% (%)	9.0	8.1	15.5**	<0.01
Low birth weight, <2500 g (%)	3.8	3.3	6.6**	<0.01
Preterm birth (%)	4.0	4.0	6.1*	0.02
Breastfeeding				
Ever (%)	93.7	92.7	84.3**	<0.01
Duration (mo)	5.1 (0.5, 12.0)	4.0 (0.5, 12.0)**	3.4 (0.5, 12.0)**	<0.01

[1] Differences in maternal and child characteristics (compared with the maternal nonsmoking category) were evaluated by using the t test and ANOVA with Bonferroni correction. Values were missing for maternal height (n = 6), maternal weight (n = 16), maternal education (n = 93), maternal ethnicity (n = 20), paternal age (n = 482), paternal height (n = 1227), paternal weight (n = 1232), paternal smoking (n = 83), birth weight (n = 2), ever breastfeeding (n = 553), and duration of breastfeeding (n = 1932). *$P < 0.05$, **$P < 0.01$.
[2] Median; 90% range in parentheses (all such values; for variables with skewed distribution).
[3] Mean; SD in parentheses (all such values).

difference of −0.23 SDS (95% CI: −0.35, −0.10 SDS; $P < 0.01$); weight difference of −0.02 SDS (95% CI: −0.14, 0.11 SDS; P = 0.97); and BMI difference of 0.15 SDS (95% CI: 0.03, 0.28 SDS; $P <$ 0.05)]. No dose-response associations between maternal smoking during the first trimester only and postnatal childhood growth characteristics were observed (data not shown). In mothers who did not smoke during pregnancy, we did not observe associations of paternal smoking with postnatal growth characteristics (*see* supplemental Table 2 under "Supplemental data" in the online issue). Estimated differences in age- and sex-adjusted SDS for fetal and childhood head circumferences, femur and body lengths, estimated fetal weights, and body weights and BMI between children from mothers who did not smoke and mothers who continued smoking during pregnancy are presented in **Figure 1**. The largest effect estimates for head circumferences, lengths, and weights in mothers who continued smoking during pregnancy were observed in the third trimester of pregnancy and at birth.

As shown in Table 3, continued maternal smoking during pregnancy was not associated with risk of overweight at the age of 4 y. Children of mothers who continued smoking during pregnancy had an increased risk of obesity at the age of 4 y (odds ratio: 1.61; 95% CI: 1.03, 2.53; $P < 0.05$). Paternal smoking during the pregnancy of the partner was not associated with risks of overweight or obesity in offspring.

Smoking during pregnancy, small size for gestational age, and obesity

The additional adjustment of the logistic regression models focused on associations between maternal smoking during pregnancy and risks of overweight and obesity for gestational age-adjusted birth weight resulted in stronger effect estimates in terms of the odds ratio [odds ratios at the age of 4 y: 1.10 (95% CI: 0.86, 1.41; P = 0.45) for overweight, 1.73 (95% CI :1.09, 2.74; P = 0.02) for obesity, and 1.23 (95% CI: 0.98, 1.56; P = 0.08)] for overweight or obesity. Maternal smoking during pregnancy was associated with a higher BMI at the age of 4 y in children with normal birth weight and in those who were small for gestational age at birth (interaction between smoking and SDS birth weight was $P < 0.001$). Compared with children from nonsmoking mothers who were normal size for gestational age, children from mothers who did not smoke during pregnancy and who were

TABLE 2
Associations of maternal smoking during pregnancy with repeatedly measured postnatal growth characteristics[1]

	Birth	3 mo	6 mo	12 mo	24 mo	36 mo	48 mo
Head circumference							
Maternal smoking category							
No (n = 4028)	Reference	Reference	Reference	Reference	—	—	—
First trimester only (n = 481)	−0.07 (−0.18, 0.05)	0.03 (−0.06, 0.12)	0.01 (−0.08, 0.10)	−0.03 (−0.13, 0.07)	—	—	—
Continued (n = 833)	−0.26 (−0.35, −0.17)**	−0.19 (−0.27, −0.11)**	−0.11 (−0.18, −0.03)**	−0.10 (−0.18, −0.01)*	—	—	—
0–4 cigarettes/d (n = 313)	−0.22 (−0.35, −0.08)**	−0.08 (−0.19, 0.02)	−0.04 (−0.14, 0.07)	−0.08 (−0.20, 0.03)	—	—	—
≥5 cigarettes/d (n = 296)	−0.31 (−0.45, −0.17)**	−0.31 (−0.43, −0.20)**	−0.20 (−0.31, −0.08)**	−0.13 (−0.25, −0.01)*	—	—	—
P for trend	<0.01	<0.01	<0.01	<0.01	—	—	—
Height							
Maternal smoking category							
No (n = 4028)	Reference	Reference	Reference	Reference	Reference	Reference	Reference
First trimester only (n = 481)	−0.05 (−0.16, 0.05)	0 (−0.09, 0.10)	−0 (−0.10, 0.09)	−0.02 (−0.12, 0.07)	0.04 (−0.06, 0.13)	0.01 (−0.10, 0.11)	0.02 (−0.09, 0.13)
Continued (n = 833)	−0.40 (−0.49, −0.31)**	−0.30 (−0.38, −0.23)**	−0.14 (−0.21, −0.06)**	−0.14 (−0.21, −0.06)**	−0.13(−0.21, −0.05)**	−0.11 (−0.20, −0.03)**	−0.10 (−0.19, −0.01)*
0–4 cigarettes/d (n = 313)	−0.36 (−0.49, −0.23)**	−0.15 (−0.26, −0.04)**	−0.04 (−0.15, 0.07)	−0.04 (−0.14, 0.07)	−0.03 (−0.14, 0.07)	−0.04 (−0.15, 0.07)	0 (−0.12, 0.12)
≥5 cigarettes/d (n = 296)	−0.45 (−0.59, −0.31)**	−0.48 (−0.59, −0.37)**	−0.26 (−0.38, −0.14)**	−0.25 (−0.36, −0.14)**	−0.25 (−0.36, −0.13) **	−0.20 (−0.32, −0.08)**	−0.23 (−0.35, −0.10)**
P for trend	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Weight							
Maternal smoking category							
No (n = 4028)	Reference	Reference	Reference	Reference	Reference	Reference	Reference
First trimester only (n = 481)	−0.01 (−0.10, 0.08)	0.04 (−0.05, 0.14)	0 (−0.09, 0.09)	−0.03 (−0.12, 0.07)	−0.04 (−0.13, 0.06)	−0 (−0.10, 0.10)	0.03 (−0.08, 0.13)
Continued (n = 833)	−0.35 (−0.43, −0.28) **	−0.17 (−0.24, −0.09)**	−0.05 (−0.13, 0.03)	−0.04 (−0.11, 0.04)	−0.07 (−0.15, 0.01)	−0 (−0.08, 0.08)	0.02 (−0.07, 0.11)
0–4 cigarettes/d (n = 313)	−0.32 (−0.42, −0.22)**	−0.08 (−0.19, 0.03)	0.02 (−0.09, 0.13)	0.01 (−0.10, 0.12)	−0.03 (−0.14, 0.08)	0.01 (−0.10, 0.12)	0.05 (−0.07, 0.17)
≥5 cigarettes/d (n = 296)	−0.39 (−0.50, −0.28)**	−0.26 (−0.38, −0.14)**	−0.13 (−0.25, −0.01)*	−0.10 (−0.21, 0.02)	−0.13 (−0.24, −0.02)*	−0.02 (−0.14, 0.10)	−0.02 (−0.14, 0.11)
P for trend	<0.01	<0.01	0.25	0.06	0.01	0.24	0.39
BMI							
Maternal smoking category							
No (n = 4028)	Reference	Reference	Reference	Reference	Reference	Reference	Reference
First trimester only (n = 481)	—	0.04 (−0.06, 0.14)	0.01 (−0.08, 0.11)	−0.01 (−0.11, 0.09)	−0.07 (−0.18, 0.03)	0 (−0.10, 0.11)	0.01 (−0.10, 0.12)
Continued (n = 833)	—	0.04 (−0.04, 0.12)	0.05 (−0.03, 0.13)	0.06 (−0.02, 0.14)	0.03 (−0.05, 0.11)	0.10 (0.02, 0.19)*	0.11 (0.02, 0.20)*
0–4 cigarettes/d (n = 313)	—	0.02 (−0.09, 0.13)	0.05 (−0.05, 0.16)	0.04 (−0.07, 0.14)	0.01 (−0.10, 0.12)	0.05 (−0.06, 0.16)	0.07 (−0.06, 0.19)
≥5 cigarettes/d (n = 296)	—	0.08 (−0.04, 0.20)	0.06 (−0.06, 0.17)	0.07 (−0.04, 0.19)	0.05 (−0.07, 0.16)	0.16 (0.04, 0.28)*	0.15 (0.03, 0.28)*
P for trend	—	0.02	0.27	0.24	0.24	0.02	0.03

[1] All values are standardized regression coefficients (95% CIs) assessed by using linear mixed models. Trend tests for the number of cigarettes smoked per day were performed by using fully adjusted linear regression models and by treating categorized dose variables as continuous variables in these models. Models were adjusted for child age at visit, sex, maternal ethnicity and education, maternal height and weight, and breastfeeding (yes or no). *$P < 0.05$, **$P < 0.01$.

TABLE 3
Associations between maternal and paternal smoking with overweight and obesity at the age of 4 y compared with nonsmokers[1]

	Risk of overweight	Risk of obesity	Risk of overweight or obesity
Maternal smoking category			
n[2]	4540 (590)	4540 (106)	4540 (696)
No (n = 4028)	Reference	Reference	Reference
First trimester only (n = 481)	1.39 (1.04, 1.85)[3,]*	0.76 (0.32, 1.79)	1.32 (0.99, 1.73)
Continued (n = 833)	1.00 (0.78, 1.28)	1.61 (1.03, 2.53)*	1.11 (0.89, 1.39)
P for trend	0.57	0.07	0.19
Paternal smoking category			
n[2]	3394 (420)	3394 (69)	3394 (489)
No (n = 2527)	Reference	Reference	Reference
Yes (n = 1397)	1.17 (0.95, 1.45)	1.09 (0.66, 1.76)	1.16 (0.95, 1.42)
P for trend	0.15	0.75	0.16

[1] Models were adjusted for child age at visit, sex, parental ethnicity and education, parental height and weight, and breastfeeding (yes or no). Overweight was defined as age-and sex-adjusted BMI >1.1–2.3 SD score (SDS), obesity was defined as age-and sex-adjusted BMI >2.3 SDS, and overweight or obesity was defined as age-and sex-adjusted BMI >1.1 SDS. *$P < 0.05$.
[2] Values in parentheses represent cases of overweight, obesity, and overweight or obesity, respectively.
[3] Odds ratio (95% CI) assessed by using multivariate logistic regression models (all such values).

born small for gestational age had a lower BMI at the age of 4 y (difference: −0.56; 95% CI: −0.72, −0.41; $P < 0.01$), whereas no difference in BMI at the age of 4 y was observed in children from mothers who smoked during pregnancy and who were born small for gestational age (data not shown).

DISCUSSION

Main findings

This population-based prospective cohort study showed that continued maternal smoking during pregnancy, and not maternal smoking in the first trimester only, was associated with persistent smaller head and length growths and increased weights and BMI in offspring at the age of 4 y. Children of mothers who continued smoking during pregnancy also showed an increased risk of obesity at the age of 4 y. No association between paternal smoking during pregnancy and postnatal growth characteristics were observed.

Strengths and weaknesses

An important strength of this study was the population-based cohort with a large number of subjects who were studied from early pregnancy onwards, and information about a large number of potential confounders was available. To our knowledge, this was the largest population-based prospective cohort study that has examined the associations of maternal and paternal smoking habits during specific periods in pregnancy with postnatal growth characteristics. Some methodologies need to be considered. Information about smoking during pregnancy at enrollment was missing for 13% of all mothers. This nonresponse would lead to biased effect estimates if associations of maternal smoking in pregnancy with postnatal growth characteristics would be different between those mothers included and not included in the analyses. However, this bias seemed unlikely because biased estimates in large cohort studies mainly arise from a loss to follow-up rather than from a nonresponse at baseline (27). The percentage of mothers who smoked during pregnancy may have been higher in those who were not included in the current analyses than in those who were included. This might have led to loss of statistical power and some underestimation of estimated effects. In the current analysis, the loss to follow-up was limited (<5%). Because active-smoking categories were similarly distributed at baseline in women who participated and in women who did not participate, we did not expect that the results were biased because of the loss to follow-up. Information about maternal and paternal smoking during pregnancy was collected by questionnaires without reference to postnatal growth characteristics. Although the assessment of smoking during pregnancy by questionnaire seems to be a valid method, misclassifications may occur (28). Underreporting of maternal smoking across the various smoking categories may have been present and led to misclassification. In general, underreporting would lead to an underestimation of differences between children from smoking and nonsmoking mothers. To overcome these limitations, some smaller previous studies used biomarkers such as cotinine in maternal urine samples (29, 30). However, this method does not seem to be superior to the use of self-report data of smoke exposure because of the low correlations between cotinine amounts and self-reported smoking habits (31, 32).

Comparison of main findings with other studies

The associations of maternal smoking during pregnancy associated with fetal growth retardation and increased risks of preterm birth and low birth weight are well established (3, 4, 33–35). Various studies have suggested that exposure to smoke during fetal life led to overweight and obesity in childhood (9, 36, 37). A systematic review by Oken et al (10) suggested that prenatal smoke exposure led to a 50% increased risk of overweight in the offspring aged 3–33 y. Also, a recent meta-analysis that used 17 studies showed that maternal smoking was consistently associated with obesity in children with a mean age of 9 y (9). Our results are in line with this recent review (9) by showing that children of mothers who continued smoking during pregnancy had an increased risk of obesity (odds ratio: 1.61) at the age of 4 y. It is likely that this high risk of obesity at this young age is part of

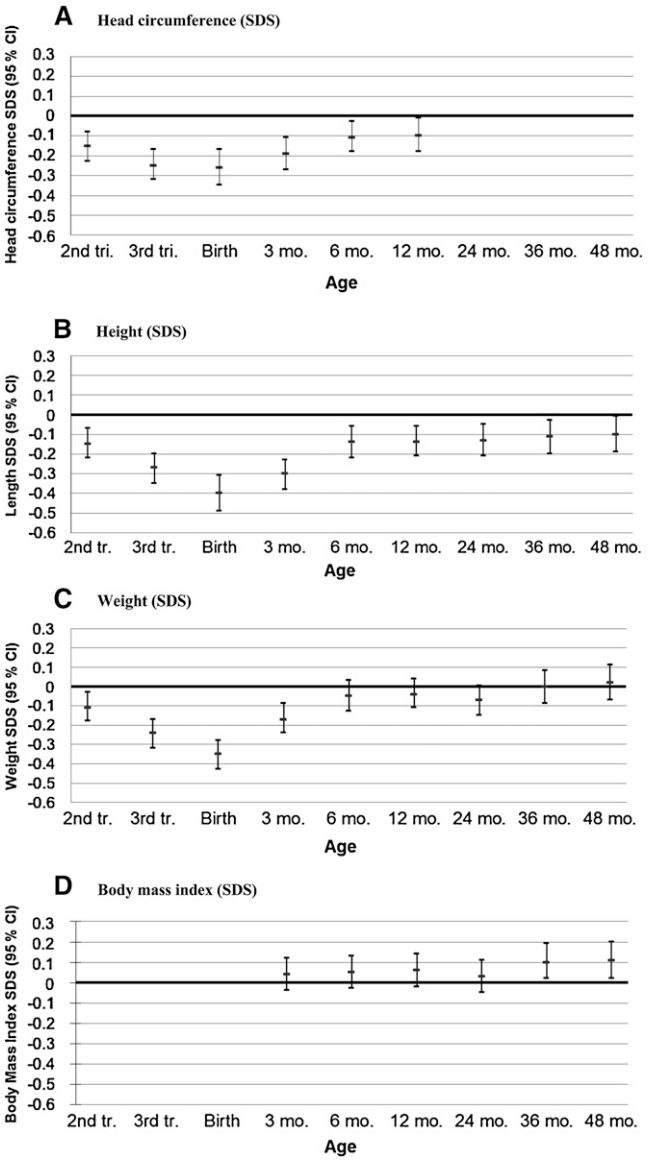


FIGURE 1. A–D: Associations between continued maternal smoking during pregnancy and repeatedly measured fetal and postnatal growth characteristics [SD scores (SDS)] compared with no maternal smoking (n = 5342). Values are standardized coefficients (95% CI) on the basis of repeated measurements using linear mixed models. Models were adjusted for child age at visit, sex, maternal ethnicity and education, maternal height and weight, and breastfeeding (yes or no). tri./tr., trimester.

a trajectory, and risk of obesity tracks into late childhood and adolescently. Our results also showed that there was a dose-response relation between the number of cigarettes and postnatal growth characteristics and risk of obesity. Only a few studies assessed associations of exposure to maternal smoke in different periods of pregnancy with postnatal growth characteristics (10, 38, 39). However, this assessment might identify critical time periods that are important from a developmental and preventive perspective. In addition to Adams et al (38) and Mendez et al (39), we observed that smoking in only the first trimester was not associated with postnatal growth and childhood obesity, whereas continued smoking until the third trimester of pregnancy was associated with these outcomes. Similarly, it has been shown that smoking in only the first trimester did not adversely affects risks of spontaneous preterm birth and small size for gestational age compared with risks for nonsmoking mothers (40). Therefore, advising pregnant women and offering them help to quit smoking during pregnancy, by using proven methods is important (41). Encouraging reproductive-age women to quit smoking before pregnancy is also important. Previous studies suggested that the observed associations between maternal smoking during pregnancy and childhood obesity were not affected by the adjustment for potential confounders such as sociodemographic factors (10). However, residual confounding might still be an issue because of unmeasured social- and lifestyle-related factors. To overcome this limitation, we also examined whether paternal smoking during pregnancy in nonsmoking mothers is associated with postnatal growth and risks of childhood overweight and obesity. This approach was previously used for other outcomes (11, 12). We did not observe any associations between paternal smoking during pregnancy and these outcomes. This result was in line with results from a cross-sectional study in 5899 children in Bavaria that showed that paternal smoking could only partially explain the association of maternal smoking before or in pregnancy with childhood obesity (42). Our findings suggested that underlying mechanisms might include direct intrauterine processes. Smoking during pregnancy might permanently lead to impaired skeletal growth, a shorter stature, and a normal or higher weight. Maternal smoking may also lead to impaired embryogenic growth and fetal growth retardation, which was associated with a more rapid postnatal weight gain (43, 44). We showed that maternal smoking during pregnancy is associated with a higher BMI in children with and without small size for gestational age at birth. Thus, the small size for gestational age did not explain the associations shown. The mechanisms by which maternal smoking during pregnancy may program postnatal child height and weight growths need to be studied further. We observed that continued maternal smoking, but not first trimester smoking, led to a persistent smaller length and higher BMI. Our results suggested that exposure to active maternal smoking during fetal life led to impaired skeletal growth and persistently a shorter height in postnatal life. The mechanisms of nicotine on skeletal growth might include programming effects on growth and adiposity hormones such as growth hormone, leptin, and ghrelin responsive pathways and a direct stimulation of the fetal hypothalamic-pituitary axis leading to increased adrenocorticotropic hormone (ACTH) and chronic changes in the proportion of body fat (45). It has also been shown that maternal smoking during pregnancy is related to changes in DNA methylation (46). However, whether these changes in methylation underlie the associations between fetal smoke exposure and postnatal obesity remains to be studied.

Implications and future research

Our results underlined the importance of health care interventions to reduce the smoking of mothers during pregnancy for the prevention of short-term outcomes during pregnancy and long-term outcomes in their children. Additional follow-up studies are needed in children at older ages and to identify associations of maternal smoking during pregnancy with more refined metabolic syndrome measures such as concentrations of glucose, triglycerides, and total cholesterol and detailed measures of body composition.

The Generation R Study is conducted by the Erasmus Medical Center in close collaboration with the School of Law and Faculty of Social Sciences of

the Erasmus University Rotterdam (Rotterdam, Netherlands), the Municipal Health Service Rotterdam area (Rotterdam, Netherlands), the Rotterdam Homecare Foundation (Rotterdam, Netherlands), and the Stichting Trombosedienst and Artsenlaboratorium Rijnmond (Rotterdam, Netherlands). We gratefully acknowledge the contributions of participating mothers, general practitioners, hospitals, midwives, and pharmacies in Rotterdam, Netherlands.

The authors' responsibilities were as follows—BD, SPW, and VWVJ: designed and conducted research, analyzed data, and wrote the manuscript; CJK: provided essential materials and analyzed data; MHG, AH, HR, PHCE, and EAPS: provided comments and consultation regarding analyses and the manuscript; VWVJ: had primary responsibility for the final content of the manuscript; and all authors: gave final approval of the version of the manuscript to be published. None of the authors declared a conflict of interest.

REFERENCES

1. Barker DJ. Fetal origins of coronary heart disease. BMJ 1995;311:171–4.
2. Bateson P, Barker D, Clutton-Brock T, et al. Developmental plasticity and human health. Nature 2004;430:419–21.
3. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bull World Health Organ 1987;65:663–737.
4. Abel EL. Smoking during pregnancy: a review of effects on growth and development of offspring. Hum Biol 1980;52:593–625.
5. Cnattingius S. The epidemiology of smoking during pregnancy: smoking prevalence, maternal characteristics, and pregnancy outcomes. Nicotine Tob Res 2004;6(suppl 2):S125–40.
6. Andres RL. Perinatal complications associated with maternal smoking. Semin Neonatol 2000;5:231–41.
7. Castles A, Adams EK, Melvin CL, Kelsch C, Boulton ML. Effects of smoking during pregnancy. Five meta-analyses. Am J Prev Med 1999; 16:208–15.
8. von-Kries R, Toschke AM, Kolezko B, Slikker W Jr. Maternal smoking during pregnancy and childhood obesity. Am J Epidemiol 2002;156: 954–61.
9. Ino T. Maternal smoking during pregnancy and offspring obesity: meta-analysis. Pediatr Int 2010;52:94–9.
10. Oken E, Levitan EB, Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. Int J Obes (Lond) 2008;32:201–10.
11. Roza SJ, Verhulst FC, Jaddoe VWV, et al. Maternal smoking during pregnancy and child behaviour problems: the Generation R Study. Int J Epidemiol 2008;38:680–9.
12. Brion MJ, Leary SD, Smith GD, Ness AR. Similar associations of parental prenatal smoking suggest child blood pressure is not influenced by intrauterine effects. Hypertension 2007;49:1422–8.
13. Jaddoe VW, Bakker R, van Duijn CM, et al. The Generation R Study Biobank: a resource for epidemiological studies in children and their parents. Eur J Epidemiol 2007;22:917–23.
14. Jaddoe VW, van Duijn CM, van der Heijden AJ, et al. The Generation R Study: design and cohort update 2010. Eur J Epidemiol 2010;25:823–41.
15. Tunon K, Eik-Nes SH, Grottum P. A comparison between ultrasound and a reliable last menstrual period as predictors of the day of delivery in 15,000 examinations. Ultrasound Obstet Gynecol 1996;8:178–85.
16. Robinson HP, Sweet EM, Adam AH. The accuracy of radiological estimates of gestational age using early fetal crown-rump length measurements by ultrasound as a basis for comparison. Br J Obstet Gynaecol 1979;86:525–8.
17. Altman DG, Chitty LS. New charts for ultrasound dating of pregnancy. Ultrasound Obstet Gynecol 1997;10:174–91.
18. Royal College of Obstetricians and Gynaecologists. Routine ultrasound screening in pregnancy: protocol. London, United Kingdom: RCOG Press, 2000.
19. Hadlock FP, Harrist RB, Carpenter RJ, Deter RL, Park SK. Sonographic estimation of fetal weight. The value of femur length in addition to head and abdomen measurements. Radiology 1984;150:535–40.
20. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240–3.
21. Fredriks AM, van Buuren S, Wit JM, Verloove-Vanhorick SP. Body index measurements in 1996-7 compared with 1980. Arch Dis Child 2000;82:107–12.
22. Allochtonen in Nederland 2004. [Immigrants in The Netherlands 2004.] Voorburg/Heerlen, Netherlands: Statistics Netherlands; 2004 (in Dutch).
23. Standaard onderwijsindeling 2003. [Regular education classification 2003.] Voorburg/Heerlen, Netherlands: Statistics Netherlands; 2004 (in Dutch).
24. Cnaan A, Laird NM, Slasor P. Using the general linear mixed model to analyse unbalanced repeated measures and longitudinal data. Stat Med 1997;16:2349–80.
25. Walter S, Tiemeier H. Variable selection: current practice in epidemiological studies. Eur J Epidemiol 2009;24:733–6.
26. Van Buuren S, Oudshoorn CCM. Multivariate imputation by chained equations: MICE V1.0 user's manual. 2000. Report PG/VGZ/00.038. Leiden, Netherlands: TNO Prevention and Health, 2000.
27. Nohr EA, Frydenberg M, Henriksen TB, Olsen J. Does low participation in cohort studies induce bias? Epidemiology 2006;17:413–8.
28. Klebanoff MA, Levine RJ, Morris CD, Hauth JC, Sibai BM, Ben Curet L. Accuracy of self-reported cigarette smoking among pregnant women in the 1990s. Paediatr Perinat Epidemiol 2001;15:140–3.
29. Hebel JR, Fox NL, Sexton M. Dose-response of birth weight to various measures of maternal smoking during pregnancy. J Clin Epidemiol 1988;41:483–9.
30. Wang X, Tager IB, Van Vunakis H, Speizer FE, Hanrahan JP. Maternal smoking during pregnancy, urine cotinine concentrations, and birth outcomes. A prospective cohort study. Int J Epidemiol 1997;26: 978–88.
31. English PB, Eskenazi B, Christianson RE. Black-white differences in serum cotinine levels among pregnant women and subsequent effects on infant birthweight. Am J Public Health 1994;84:1439–43.
32. Haddow JE, Knight GJ, Palomaki GE, Kloza EM, Wald NJ. Cigarette consumption and serum cotinine in relation to birthweight. Br J Obstet Gynaecol 1987;94:678–81.
33. Bernstein IM, Mongeon JA, Badger GJ, Solomon L, Heil SH, Higgins ST. Maternal smoking and its association with birth weight. Obstet Gynecol 2005;106:986–91.
34. Ng SP, Conklin DJ, Bhatnagar A, Bolanowski DD, Lyon J, Zelikoff JT. Prenatal exposure to cigarette smoke induces diet- and sex-dependent dyslipidemia and weight gain in adult murine offspring. Environ Health Perspect 2009;117:1042–8.
35. Chen H, Vlahos R, Bozinovski S, Jones J, Anderson GP, Morris MJ. Effect of short-term cigarette smoke exposure on body weight, appetite and brain neuropeptide Y in mice. Neuropsychopharmacology 2005; 30:713–9.
36. Chen A, Pennell ML, Klebanoff MA, Rogan WJ, Longnecker MP. Maternal smoking during pregnancy in relation to child overweight: Follow-up to age 8 years. Int J Epidemiol 2006;35:121–30.
37. Al Mamun A, Lawlor DA, Alati R, O'Callaghan MJ, Williams GM, Najman JM. Does maternal smoking during pregnancy have a direct effect on future offspring obesity? Evidence from a prospective birth cohort study. Am J Epidemiol 2006;164:317–25.
38. Adams AK, Harvey HE, Prince RJ. Association of maternal smoking with overweight at age 3 y in American Indian children. Am J Clin Nutr 2005;82:393–8.
39. Mendez MA, Torrent M, Ferrer C, Ribas-Fitó N, Sunyer J. Maternal smoking very early in pregnancy is related to child overweight at age 5-7 y. Am J Clin Nutr 2008;87:1906–13.
40. McCowan LME, Dekker GA, Chan E, et al. Spontaneous preterm birth and small for gestational age infants in women who stop smoking early in pregnancy: prospective cohort study. BMJ 2009;338:b1081.
41. Hays JT, Ebbert JO, Sood A. Treating tobacco dependence in light of the 2008 US Department of Health and Human Services clinical practice guideline. Mayo Clin Proc 2009;84:730–5; quiz 735–6.
42. von Kries R, Bolte G, Baghi L, Toschke AM; GME Study Group. Parental smoking and childhood obesity-is maternal smoking in pregnancy the critical exposure? Int J Epidemiol 2008;37:210–6.
43. Hokken-Koelega AC, De Ridder MA, Lemmen RJ, Den Hartog H, De Muinck Keizer-Schrama SM, Drop SL. Children born small for gestational age: do they catch up? Pediatr Res 1995;38:267–71.
44. Mook-Kanamori DO, Steegers EA, Eilers PH, Raat H, Hofman A, Jaddoe VW. Risk factors and outcomes associated with first-trimester fetal growth restriction. JAMA 2010;303:527–34.
45. Koshy G, Delpisheh A, Brabin BJ. Dose response association of pregnancy cigarette smoke exposure, childhood stature, overweight and obesity. Eur J Public Health (Epub ahead of print 1 December 2010).
46. Breton CV, Byun HM, Wenten M, Pan F, Yang A, Gilliland FD. Prenatal tobacco smoke exposure affects global and gene-specific DNA methylation. Am J Respir Crit Care Med 2009;180:462–7.

Smoking cessation in pregnancy: What's a man to do?

Sue Ziebland and Alice Fuller

Health Education Journal 2001 60: 232
DOI: 10.1177/001789690106000305

Smoking cessation in pregnancy: What's a man to do?

Sue Ziebland[1] and Alice Fuller[2]

Abstract

Objectives To explore women's attitudes to their partners' smoking behaviours during pregnancy.

Design Qualitative semi-structured interview study.

Setting Interviews were collected in the participants' homes in Oxfordshire and Berkshire in the UK.

Subjects A purposive sample of women who were smokers at the start of a pregnancy, who also had a partner who smoked.

Results Examples of four strategies that are, at least theoretically, available to men were identified and described. These are: carry on smoking and encourage the woman to quit; carry on smoking and do not comment on the woman's smoking; avoid smoking in front of the woman and encourage the woman to quit; and avoid smoking in front of the woman and do not comment on the woman's smoking. Some women report feeling unsupported by partners who carry on smoking during the pregnancy, even if they did not smoke near them. Smoking status is often shared among couples and if the man does not quit during pregnancy the women may be more likely to relapse, particularly after the baby is born.

Discussion There may be a mismatch between men's and women's motivation to quit smoking during pregnancy and the postpartum period. While women are particularly motivated by the pregnancy, men may be more keen on quitting once the baby is born. However, once the baby is born women are more inclined to relapse. Awareness of this mismatch may make it easier for couples to use pregnancy as an opportunity for them both to stop smoking.

[1]Senior Research Fellow, [2]Research Officer, ICRF General Practice Research Group, Institute of Health Sciences, Oxford.

Correspondence to: Sue Ziebland, ICRF General Practice Research Group, University of Oxford Department of Primary Health Care, Institute of Health Sciences, Headington, Oxford UK OX3 7LF. sue.ziebland@dphpc.ox.ac.uk

Key words: smoking cessation, pregnancy, partner support, qualitative research, interviews

Introduction

Women are strongly advised to stop smoking when they are pregnant and most do report trying to quit or cut down, although cessation rates remain considerably lower than government targets. Prospective fathers are encouraged to support the woman's efforts, by trying to quit or avoid smoking in front of her (for example, a leaflet for the partners of pregnant smokers, Help Your Partner Stop, published by the Health Education Authority). Although it is assumed that women will benefit from and appreciate their partner's attempts to modify their smoking habits, little attention has been paid to how women perceive such changes. Recent studies, noting the tendency for those women who successfully quit to have nonsmoking partners, have suggested that advice to partners would enhance smoking cessation programmes in pregnancy[1,2].

This paper reports a qualitative study using in-depth interviews with women whose partners were smokers at the beginning of pregnancy. Analysis of the interview transcripts has identified four approaches that are, at least theoretically, open to the prospective fathers. The women's reactions to their menfolk's smoking behaviour are discussed in relation to their own smoking habits during pregnancy and experiences of relapse postpartum.

Methods

The study was conducted by social scientists, from an academic department of primary health care, who had no connection to any antenatal or clinical services. Women who were invited to take part were told that we were interested in hearing about their experiences as smokers and that we did not intend to try to persuade them to stop.

The study methods were approved by the local research ethics committee. Women who had been smokers at the beginning of their pregnancy, who also had a partner who was a smoker, were invited to take part in a tape-recorded interview at home. Respondents were recruited through three different sources: community midwives gave eligible women invitations to participate in the study; invitations were sent to eligible women who had taken part in an earlier study in our department (and had expressed willingness to take part in further research); and participants in a young mothers' focus group discussion were invited to take part in an individual interview. The variety of methods of recruitment meant that we did not have a denominator to calculate a response rate, but purposive sampling[3] was used to include a range of ages, parity and social class backgrounds among women who were pregnant at the time of the intervention or had given birth in the last two years. In-depth tape-recorded interviews lasting between 45 minutes and two hours were conducted with 19 women.

The interviews resembled guided conversations in which women were encouraged to talk freely about their smoking histories, including their perceptions of any positive

aspects of smoking. Women described when and how they started smoking; appealing and unappealing features of smoking, and what had motivated any attempts to cut down or quit. Any changes in smoking when they were pregnant; their reactions to advice to quit; and smoking within their family and social network were discussed. They were asked what they knew about their partner's smoking history and if they were aware of any attempts he might have made to cut down or stop in the past. If necessary, they were also specifically asked if their partner had made any attempts to change how much or where he smoked during the pregnancy.

All of the interviews were transcribed for analysis. SZ listened to all of the tapes, and developed the analysis in consultation with AF. This paper presents women's views of their partner's smoking strategies during the pregnancy, a theme that was developed and explored using the analytic method of constant comparison[4].

Results

These interviews add to the evidence that pregnancy is a powerful motivator for women to quit, or at least consume as few cigarettes as possible. None of the women we interviewed was unaware of the desirability of stopping smoking, nor of the particular social stigma associated with smoking in pregnancy. Those who had not managed to stop described feeling guilty and disappointed in themselves and all told stories of friends, colleagues and relations who had 'given them a hard time' about smoking when pregnant. Stopping smoking, at least for the duration of the pregnancy, is clearly expected of women: but what about the prospective father?

A man who is a regular smoker could try to change his own smoking habits and could encourage the women to quit. Based on these options, there are four smoking strategies available to men during the pregnancy. Each of these strategies was identified in the interviews and the implications for the woman's smoking behaviours discussed and illustrated.

Option One: Carry on smoking and encourage the woman to quit

> Interviewer *Did he change his smoking habit while you were pregnant?*
> Respondent *Yeah, he smoked more... He said he found it really stressful. He turned round to me and said 'give up'. I said 'Yeah, I will, you as well then'. He said 'Oh, I don't have to give up, only you do'. I said 'No, actually you do as well'. I asked him to go outside to have a fag but he wouldn't. He smoked all the time. Here, there, in the car. I mean it's the first thing he does, he's a really heavy smoker.*
> (ID A09, continued smoking in pregnancy)

To carry on smoking while encouraging the woman to quit is not an uncommon strategy for an expectant father[5]. The somewhat entrenched position quoted above is hopefully rarer. This woman's husband stated that if she did not stop it would be her fault if there was anything wrong with the baby, while he refused to accept that he ought

to quit, cut down, or avoid smoking near her when she was pregnant.

Some women were prepared to accept what others saw as a 'double standard' about smoking in pregnancy. The following quote describes the disapproval of smoking within one husband's social group, who were frequent visitors (and smokers) within their home:

> *He doesn't really agree with smoking anyway in pregnancy and a lot of his friends have really strong views on it as well. You know, they say things like 'I don't want to see you with a cigarette in your hand' and things like that, which is fair enough.*
> (ID A02, gave up at 4 months, started again during labour)

Men may not think that there is any reason to discourage smoking among prospective fathers, even if they are aware that pregnant women ought not to smoke. Melanie Wakefield et al's focus group study of expectant fathers in Australia[5] found they were unaware that passive smoking could be harmful to the baby during pregnancy, and believed that the baby in utero was protected from any smoke the mother breathed. As a result smoking around a pregnant woman was thought to be unacceptable only if the woman felt nauseous and expressed a preference for a smoke free environment.

Option Two: Carry on smoking and do not comment on the woman's smoking behaviour

Although recent health promotion materials have suggested that men should encourage their pregnant partners to stop smoking, some men who continue to smoke may not feel that this is appropriate. This may be because they do not know or believe information about the health risks, but equally they may be reluctant to be confrontational or be accused of double standards. This woman described her partner as a heavy smoker with no intention of quitting, while she had tried to stop but found it too difficult:

> *He reckons it's my problem and if I want to smoke I can.*
> (ID S01, cut down smoking in pregnancy)

Later in the interview she volunteered that they both had strong views about not smoking in the house once the baby was born, but her description of their smoking patterns during their evenings together suggested that this would be a considerable challenge for them both.

The following quote is from a woman who decided to give up smoking and drinking alcohol and was careful about what she ate during pregnancy. Although she had made these decisions independently, and without any particular encouragement from her partner, she was clearly annoyed by his behaviour during an extended stay in France:

> *He drank a lot of wine and had alcohol and cream cheese, all the cheeses in France that you can't eat. So he did three things that you're not allowed to do when you're pregnant - he used to do them in front of me which used to just annoy me. I think it was because if I have given up, why can't he?*
> (ID A03, gave up in pregnancy, 'social smoking' postpartum)

Option Three: Avoid smoking in front of the woman and encourage woman to stop

This is the approach recommended by current health promotion advice for partners and within our interview sample, which was not designed to be statistically representative[3], was the most frequently described. Unfortunately, even though the problem of passive smoking may be alleviated if the partner goes elsewhere for his cigarettes, the pregnant woman is not necessarily appreciative . While these women's partners dutifully went outside to smoke, their efforts were not applauded, and in each case the women started smoking again soon after their babies were born. Smoking status is often shared among couples and if the man does not quit during pregnancy the women may be more likely to relapse.

> *It made me feel that it's futile to give up and it's also been quite tempting to see someone smoking... He should have, throughout my pregnancy, supported me and not been in the garden where I could see him, smoking...*
>
> *I feel quite angry because it wasn't supportive of me and ultimately I think one of the reasons why possibly I've gone back to it is that I'm living with someone who is carrying on smoking and just seeing him go out to the garden used to make me angry.*
>
> (ID A04, gave up in pregnancy, relapsed postpartum)
>
> *He's an anti-smoker in pregnancy but a bit of a hypocrite because he smokes himself... But he didn't smoke around me. I think he thought that he was doing the right thing by not smoking around me therefore that was acceptable. But it got me, it did make me cross.*
>
> (ID A05, gave up in pregnancy, relapsed postpartum)

Option Four: Avoid smoking in front of the woman and do not comment on the woman's smoking behaviour

There was only one example of this behaviour in our data. The respondent, a woman in her late twenties who was halfway through her first, unplanned pregnancy stated that she appreciated her partner's behaviour:

> *[He] has been great in the sense that he's put no pressure on me, you know he never did say that ... I had to give up smoking because I was carrying his child ... and when I had a cigarette he was fine about it ... there are no recriminations from him.*

However, later in the same interview when asked about whether her partner had changed his smoking at all since she became pregnant it was evident that she did not feel entirely convinced by his efforts:

> *Well, if I trust him – which I hope I do at this stage – he's on about one or two a day at most ... but he was on twenty a day recently. So, although he did say he would give up with me and share the burden of pregnancy he hasn't, he cheats.*
>
> (ID SO11, has smoked the 'odd one or two' during pregnancy)

Shared smoking status and relapse postpartum

The smoking habit of a woman's partner has long been identified as a strong predictor of sustained cessation in pregnancy[6,7], and the growing literature on postpartum smoking behaviour has confirmed that the association is also strong after the baby is born[8,9]. As described by the women in our study, there is little mystery about why this should be so, especially if smoking cessation has been encouraged as something that is primarily for the health of the foetus:

> *When I stopped being pregnant, when that reason was taken away from me, he was smoking and it was just too easy. If you've got cigarettes in the house and someone's smoking around you that's ... one of the reasons I went back.*
> (ID A04)

One respondent described how, despite occasional lapses in late pregnancy, her motivation to stop had lasted until she had the baby. However, because her smoking cessation was clearly associated with the pregnancy, she relapsed soon after she had the baby, helping herself to one of her partner's cigarettes after settling the baby at 3am:

> *Once the reason has gone and you don't feel so, like the guilt has gone and all the rest of it, especially if you've had a successful pregnancy. ...I stopped until the very end of my pregnancy. It got towards the end and you know you get frustrated and you just want the baby to come out and I had a couple now and again and then as soon as I had her I started again.*
> (ID A11)

The simple fact that cigarettes are available in the house if the partner smokes was mentioned by several women as a key factor in their relapse. Unusually, one woman actually started smoking again during labour. As she describes, the cigarettes were 'just there':

> *That night I started to smoke (again). I got through quite a lot of cigarettes because my partner was fast asleep on the sofa and I was having contractions every 10 minutes, 8 minutes, 5 minutes and everything and the cigarettes were just there and I couldn't eat anything, I couldn't sleep.*
> (ID A02)

Some women acknowledged that it is probably difficult for men to give up smoking during their partner's pregnancy, not least because it does not seem as 'real' to them as it does to the woman:

> *I think part of the problem is that men don't actually see it as having anything to do with them ... everyone's too busy thinking about their own smoking behaviour and not really thinking about how the other partner's smoking is influenced.*
> (ID A04)

While many women felt unsupported if their partner did not stop smoking, rather than just avoid smoking in front of them, there was some recognition of the difficulty of trying to stop when not fully motivated. One respondent who empathised with her partner's difficulty illustrated the point by recalling how she had felt when a previous

partner had given up smoking during their relationship:

> *My last relationship, my partner gave up while I was seeing him. That was hard 'cos then I felt you know I was with someone that previously I had shared these kind of smoking moments with and ... I think people often have people they associate smoking with. And he was one of those: we'd smoke in bed, go down the pub and smoke ... I did try to give up while I was with him, but very half-heartedly 'cos I was doing it for him not me.*
> (ID SO11)

Discussion

This qualitative study was designed to explore women's views of their partner's smoking behaviour during pregnancy. The participants were all volunteers who were willing to discuss their smoking history with a researcher, therefore may not be typical of pregnant women who smoke. The invitation letter stated that the researchers were from a university department and that their interest was in learning more about women's experiences as smokers. The reassurance that they would not be telling the woman that they ought to stop smoking was mentioned by some women as having encouraged participation.

The sample was not chosen to be *statistically* representative of the population of pregnant smokers, but to represent a wide range of experiences. The identification of each of the four logically possible options for men who smoke during their partner's pregnancy encourages us to believe that an acceptable range of experience is represented. The study does not include women whose partners gave up smoking before the beginning of the pregnancy. It should be noted that we did not interview any men, whose perspectives of their smoking during the pregnancy might be very different from those of the women. We suggest that their views would be a useful area for further study.

Interventions in pregnancy are remarkable within the smoking cessation field in that the health gains are fairly immediate. It is the association of smoking in pregnancy with low birth weight that has made cessation in pregnancy an important public health issue [10], although smoking in the presence of a small baby and while breastfeeding are also strongly discouraged. However, this focus on stopping smoking for the duration of pregnancy may be counterproductive to long-term quitting. Women who have given up smoking for the pregnancy may even expect to relapse once they return to normal life. After nine months of pregnancy, when 'you're not allowed to do anything' the prospect of getting back to normal may be extremely appealing. As our respondents descriptions of postpartum relapse illustrate, if smoking is part of that normality, and particularly if it is a feature of the relationship with the partner, it may be hard to resist.

Wakefield et al's Australian focus group study suggested that pregnancy, and especially the early stages, may seem unreal to the first time father. While these men did not think that smoking around a pregnant woman was harmful, they were much

more negative about smoking near a new born baby. This suggests that, for new fathers, motivation to quit may be higher after the baby has been born than during the pregnancy.

The authors' tentative conclusion is that there may be a mismatch between men's and women's motivation to quit smoking during and after pregnancy. A first pregnancy begins a major life change for a woman, with many of the characteristics of a rite of passage[11] whereas for her partner the pregnancy represents his last few months of life before parenthood. The man may be encouraged by health promotion materials to believe that he is supporting the woman's attempts to quit smoking by refraining in her presence, but our study suggests that this may be seen as inadequate. If the man continues to smoke there is evidence from surveys[12,9] that the women is likely to relapse. Reasons why this occurs have been identified in this qualitative study. After the baby is born the man's motivation to moderate his smoking may become stronger, but the woman's motivation may start to decrease as pressure from antenatal care and social disapproval lessen. The partner's smoking habit is, of course, not alone as an influence on a woman's decision to start smoking again: breastfeeding, returning to work, wanting to lose weight gained in pregnancy, positive associations with smoking[13] and wanting to feel 'adult' again are among the others. However, it is a major predictor of relapse.

Some 70 per cent of adult smokers say that they would like to quit and most couples have their first pregnancies at an age when there is ample opportunity to recover from most of the damage to health caused by youthful cigarette smoking[14]. While there is good evidence that stopping in pregnancy is beneficial for the baby's health, perhaps it would be better to emphasise the opportunity for both parents to quit for their own health. Quit attempts may be more successful if the couple recognise any mismatch in the timing and intensity of their motivations to quit, rather than following advice that may impair conjugal harmony.

Acknowledgements

Sue Ziebland and Alice Fuller are employed by the Imperial Cancer Research Fund.

We wish to thank the women who took part in the study, Oxfordshire Community Midwives, Mike Murphy and Kate Hey, for helping to identify participants and Sophia Nightingale for transcribing the interviews.

The work was supported by a small grant from Oxfordshire Health Authority Charitable Fund.

References

1 Appleton P, Pharoah P. Partner smoking behaviour change is associated with women's smoking reduction and cessation during pregnancy. *British Journal of Health Psychology* 1998: **3**: 361–74.

2 McBride C, Curry S, Grothaus, L, Nelson J, Lando H, Pirie P. Partner smoking status and pregnant smoker's perceptions of support for and likelihood of smoking

cessation. *Health Psychology* 1998: **17**: 63–9.
3 Marshall M. Sampling for qualitative research. *Family Practice* 1996: **13**: 522–5.
4 Pope C, Ziebland S, Mays N. Analysing qualitative data. In: Pope C, Mays N (Eds), *Qualitative Research in Health Care.* 2nd Edition. London: BMJ Publishing Group, 1999.
5 Wakefield M, Reid Y, Roberts L, Mullins R, Gillies P. Smoking and smoking cessation among men whose partners are pregnant: a qualitative study. *Soc Sci Med* 1998: **47**: 657–64.
6 Macarthur C, Newton JR, Knox EG. Effect of anti-smoking health education on infant size at birth: a randomised controlled trial. *Brit J of Obs and Gynae* 1987: **94**: 295–300.
7 Severson H, Andrews J, Lichtenstein E, Wall M, Akers J. Reducing maternal smoking and relapse: long term evaluation of a pediatric intervention. *Prev Med* 1997: **26**: 120–30.
8 Pollak K, Mullen P. An Exploration of effects of partner smoking, type of social support, and stress on postpartum smoking in married women who stopped smoking during pregnancy. *Psychology of Addictive Behaviors* 1997: **11**: 182–9.
9 Ratner P, Johnson J, Bottorff J, Hall W, Dahinten S. Preventing Smoking Relapse in Postpartum Women. *Nursing Research* 2000: **49**: 44–52.
10 Lumley J, Oliver S, Waters E. Interventions for promoting smoking cessation during pregnancy (Cochrane Review). In: *The Cochrane Library*, Issue 4. Oxford, 2000.
11 Van Gennep A. *The Rites of Passage.* London: Routledge,1960 (originally 1908).
12 Mullen P, Richardson M, Quinn V, Ershoff D. Postpartum return to smoking: who is at risk and when. *American Journal of Health Promotion* 1997 May–June: **11**: 323–30.
13 Laurier E, McKie L, Goodwin N. Daily and lifecourse contexts of smoking. *Sociology of Health and Illness* 2000: 289–309.
14 Peto R, Darby S, Deo H, Silcocks P, Whitley E, Doll R. Smoking, smoking cessation, and lung cancer in the UK since 1950: combination of national statistics with two case-control studies. *British Medical Journal* 2000: **321**: 323–9.

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Parental Smoking Cessation to Protect Young Children:A Systematic Review and Meta-analysis

Laura J. Rosen, Michal Ben Noach, Jonathan P. Winickoff and Mel F. Hovell

Pediatrics 2012;129;141; originally published online December 26, 2011;
DOI: 10.1542/peds.2010-3209

Parental Smoking Cessation to Protect Young Children: A Systematic Review and Meta-analysis

AUTHORS: Laura J. Rosen, PhD,[a] Michal Ben Noach, MSe,[a] Jonathan P. Winickoff, MD, MPH,[b] and Mel F. Hovell, PhD, MPH[c]

[a]Department of Health Promotion, School of Public Health, Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel; [b]Department of Pediatrics, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts and [c]Center for Behavioral Epidemiology and Community Health, School of Public Health, San Diego State University, San Diego, California

KEY WORDS

parenting, second hand smoke, smoking cessation, systematic reviews, tobacco use/smoking

ABBREVIATIONS

AD—absolute difference
CI—confidence interval
CT—controlled trial
RCT—randomized controlled trial
RD—risk difference
RR—risk ratio

www.pediatrics.org/cgi/doi/10.1542/peds.2010-3209

doi:10.1542/peds.2010-3209

Accepted for publication Sep 9, 2011

Address correspondence to Laura J Rosen, PhD, Department of Health Promotion, School of Public Health, Sackler, Faculty of Medicine,Tel Aviv University, POB 39040, Ramat Aviv, Israel 69978. E-mail: rosenl@post.tau.ac.il.

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

COMPANION PAPERS: Companions to this article can be found on pages 45 and 170, and online at www.pediatrics.org/cgi/doi/10.1542/2011-0249 and www.pediatrics.org/cgi/doi/10.1542/2011-3190.

abstract

FREE

BACKGROUND: Young children can be protected from much of the harm from tobacco smoke exposure if their parents quit smoking. Some researchers encourage parents to quit for their children's benefit, but the evidence for effectiveness of such approaches is mixed.

OBJECTIVE: To perform a systematic review and meta-analysis to quantify the effects of interventions that encourage parental cessation.

METHODS: We searched PubMed, the Cochrane Library, Web of Science, and PsycINFO. Controlled trials published before April 2011 that targeted smoking parents of infants or young children, encouraged parents to quit smoking for their children's benefit, and measured parental quit rates were included. Study quality was assessed. Relative risks and risk differences were calculated by using the DerSimonian and Laird random-effects model.

RESULTS: Eighteen trials were included. Interventions took place in hospitals, pediatric clinical settings, well-baby clinics, and family homes. Quit rates averaged 23.1% in the intervention group and 18.4% in the control group. The interventions successfully increased the parental quit rate. Subgroups with significant intervention benefits were children aged 4 to 17 years, interventions whose primary goal was cessation, interventions that offered medications, and interventions with high follow-up rates (>80%).

CONCLUSIONS: Interventions to achieve cessation among parents, for the sake of the children, provide a worthwhile addition to the arsenal of cessation approaches, and can help protect vulnerable children from harm due to tobacco smoke exposure. However, most parents do not quit, and additional strategies to protect children are needed. *Pediatrics* 2012;129:141–152

Tobacco, a legal product worldwide, killed 100 million people in the 20th century, and could kill as many as a billion human beings in the current century.[1] Efforts to prevent tobacco-related morbidity and premature mortality depend on prevention programs, policies protecting people from tobacco smoke exposure, and effective cessation programs. Over a decade ago, Peto and Lopez showed that cessation will contribute quickly to lowering the burden of smoking-induced disease, because of the immediate health benefits of quitting and the long lag time for the development of many smoking-related diseases.[2] Cessation has the additional benefit of the prevention of exposure of others to tobacco smoke. Yet, cessation for many smokers remains an elusive goal,[3(p.15)] with most quitters returning to their habit over time.[4]

Principles of behavior assume that the provision of knowledge works to change behavior when motivation for change is present. Increased perception of risk has been shown to be associated with healthier behaviors.[5] Common ignorance of the magnitude of damage from tobacco, in combination with the tendency of smokers to underestimate their personal risk,[6,7] suggests that the provision of accurate risk information may aid some smokers in quitting. Because this approach has been unsuccessful in convincing many smokers to quit for good, some researchers have considered an alternate track: They have focused on the health of others exposed to tobacco smoke rather than on the smoker's personal risk. This strategy may be particularly effective when the smoker considers the health of his/her own children, which affords several benefits: child health benefits due to lowered tobacco smoke exposure, including lowered risk of sudden infant death syndrome, middle ear disease, asthma, pneumonia, and compromised lung function[8]; possible reduced risk of future smoking among children of parents who have quit[9]; and benefits of quitting to parents themselves. An additional benefit, less well known, is the eventual removal of most third-hand smoke[10] from the homes of smokers, particularly when all smokers in the home quit permanently and do not allow visitors to smoke in the home.

The World Health Organization estimates that 40% of children worldwide are exposed to secondhand smoke.[11] A 2008 study showed very high median air nicotine concentrations in homes with smokers in 31 countries, and concluded that "women and children living with smokers are at increased risk of premature death and disease from exposure to SHS."[12]

The earliest published trial to encourage parental quitting for child protection[13] focused on protecting infants from tobacco smoke exposure, while emphasizing the benefits of quitting for the parents. This trial did not successfully affect tobacco smoke exposure or quit rates. Interventions tested since then aimed at families and caretakers have been implemented in physicians' offices, well-baby clinics, schools, and the community.[14] Some interventions have focused on getting parents to quit or reduce smoking, whereas others have focused on getting parents to protect their children from tobacco smoke exposure by moving their smoking and others' smoking behaviors away from the home, car, or child. Tools used to effect change have been both brief and of varying degrees of intensity, and have included cognitive behavioral approaches, self-help materials, individual counseling, and biofeedback.[14]

In this article, we present meta-analyses of parental quit rates from published intervention trials that were designed to protect children from tobacco smoke exposure through parental cessation or modification of parental smoking patterns, and that evaluated cessation among smoking parents of young children. To identify specific factors that might be associated with effective programs, we performed exploratory subgroup analyses on factors related to the child, the intervention, and the study methodology.

METHODS

Data Sources

We searched Medline, PsycINFO, Web of Science, and the Cochrane Library for articles published in English from any date through the end of March 2011. We used regular search terms for all databases, and also used Medical Subject Headings search terms for Medline.

Search terms used with all databases were: intervention to reduce environmental tobacco smoke children/preschool children/infants/newborn, intervention to reduce exposure of passive smoke in infant/children/preschool/newborn, reducing exposure passive smoking children/infants/newborn, the impact of a brief intervention on maternal smoking behavior, decreasing environmental tobacco smoke exposure among children/infants/newborn, advising parents on passive smoking, reducing tobacco smoke in the environment of the child, and intervention to reduce passive smoking in infancy.

The Medical Subject Headings search terms used were "smoking/prevention and control" AND "tobacco smoke pollution" OR "tobacco smoke pollution/prevention and control" AND "child", "smoking/prevention and control" AND "tobacco smoke pollution" OR "tobacco smoke pollution/prevention and control" AND "infant."

We were interested in original articles and reviews. We checked references in all retrieved review papers for additional related articles.

Data Extraction

Two reviewers (M.B.N. and T.B.) independently undertook extraction of study details and results. L.J.R. and M.B.N. independently assessed quality characteristics. We resolved differences between reviewers' extraction results by discussion.

Methodological Quality

The following parameters describing methodologic quality were assessed: study design (randomized controlled trial [RCT] using a cluster randomization scheme, RCT, quasi-RCT, controlled trial [CT]), randomization concealment (yes, no, or not reported), blinding of observers (yes, no, or not reported), biochemical validation of quit rates (yes, no), follow-up (percentage of follow-up at last time point measured), fidelity to treatment (percentage of participants receiving full intervention).

Study Eligibility

To be included, the studies had to meet the following criteria:

Study design: RCT using a cluster or individual-level randomization scheme, quasi-randomized RCT, CT.

Participants: Parents (mother, father or both parents) of children between the ages of 0 and 6 years in one of the following cohorts: well (including children visiting well-child clinics and population cohorts), asthmatic children, or children visiting hospitals or pediatric clinics. Trials that included children older than 6 years were acceptable only if children 6 years old or less were eligible for inclusion.

Types of interventions: Unrestricted.

Program providers: Unrestricted.

Study objectives: Primary goal must have been either reduction or cessation of parental smoking to benefit children, or child tobacco smoke exposure reduction.

Study outcome: Quit rates of parents, mothers, or fathers must have been monitored.

Length of observation period: Minimum 1 month from start of intervention.

Study Outcomes

Our primary outcome was parental quit rate. If a biochemically validated quit rate was available, that was used in the analysis; otherwise, parental report was used. We present (1) the parental quit rate (both parents if available, or maternal quit rate if that is the only measure available; no studies had paternal rates without maternal or parental rates), (2) the maternal quit rate, and (3) the paternal quit rate.

Quit rates at different follow-up times were sometimes presented in the same report. In these instances, we used the quit rate representing the longest available period.

Subgroup Analyses

We performed exploratory subgroup analyses on the parental quit rate by using the following categorizations:

Child-Related Subgroups

Child age at recruitment (<1 year, 1–4 years, 4+ years), child cohort (well, asthmatic, hospital, or clinic visit).

Intervention-Related Subgroups

Intervention setting (hospital, usual care physician's office, well-baby care setting, and family home), provider (physician, nurse, clinic staff, and research assistant), use of cessation medication (yes, no), and number of sessions (1, 2, 3–4, 5+)

Study-Related Subgroups

Use of theory in developing the intervention (none, theory-based); primary research objective (parental or maternal cessation, cessation and reduction of child exposure, reduction of child exposure to tobacco smoke), length of maximum follow-up (<6 months, 6 months, and >6 months), use of cessation medication (yes, no), provision of cessation or smoking-related intervention to the control group (yes/no).

Study Quality-Related Subgroups

Study design (cluster RCT, individually RCT, CT); blinding of observers (yes, no, or not reported), follow-up of participants (61%–80%, 81%–100%), fidelity to treatment. Because of the lack of reported information on fidelity for most studies, we were unable to perform this subanalysis.

Statistical Analysis

Meta-analytic Approach

Statistical analyses and meta-analyses were performed with the use of RevMan 5.0.24. We used the DerSimonian and Laird random-effects method with 95% confidence intervals to pool results.[15] We chose to use the random-effects method because we assumed that different intervention conditions would be associated with different effects, and we were interested in getting an average of the distribution of true effects from the population of intervention studies (as opposed to an estimate of a single-population effect, as would be the case were we to use the fixed-effects method).[16]

We present risk ratios (RRs) and risk differences (RDs) for the primary analyses, as well as risk ratios for the subgroup analyses. All measures are presented with 2-sided 95% confidence intervals.

Pooled quit rates for each group were calculated. Weights used to pool the data, obtained from RevMan, were based on the inverse variance method (weights proportional to the inverse variance of estimate), and adjusted for the random effects assumption.[16 (p.128)]

Heterogeneity and Publication Bias

We used the I^2 statistic to investigate statistical heterogeneity. This describes the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (due to chance).[17] The existence of publication bias was checked by visual examination of funnel plots.[16]

Exploratory Subgroup Analyses

We performed exploratory analyses to understand whether some settings or conditions were clearly associated with intervention effects, as well as to see if heterogeneity could be explained. We determined that the intervention was significant in a particular subgroup if the results were statistically significant at the corrected Bonferonni .05 level. Because the numbers of studies and individuals within subgroups varied, it would have been misleading to directly compare across subgroups.[16] (p. 141, Section 8.8.2)

RESULTS

Description of Studies

Out of a total of 876 articles identified initially, 468 articles were screened. Of these, 403 articles concerned topics not relevant to this study, and 18 met the inclusion criteria for this review.[13,18–34] The trials were conducted in the United States, China, Norway, Scotland, Finland, Italy, and Australia between 1987 and 2010. Forty-seven studies were excluded for the following reasons: quit rates were not reported or were not reported separately for intervention and control groups, or numbers of participants were not reported (24 studies[35–58]; the study design was not a controlled trial [11 studies[59–69]]), the interventions were not aimed at parents of young children (9 studies[70–78]); the reporting period was less than 1 month (1 study[79]); a protocol only was reported (1 study[80]); the report was not in English (1 study[81]). The flowchart describing the identification process can be found in Fig 1. Study characteristics of included trials are presented in Table 1.

Intervention Components

Interventions included some of the following components: self-help materials (12 studies[13,18,20–22,24,26,29–31,33,34]), face-to-face counseling (16 studies[19–34]), telephone counseling (6 studies[13,18–20,32,34]), cessation medications (2 studies[24,28]), and cotinine feedback (1 study[32,39]). Three studies included one component ([23,25,27]), 12 studies included 2 components ([13,18,19,21,22,26,28–31,33,34]), and 3 studies included 3 components ([20,24,32]).

Age of Children

Six of the studies enrolled infants up to a year old,[13,21,22,29,30,34] and 12 of the studies enrolled children up to 16 years old.[18–20,23–28,31–33]

Child Cohort

Ten of the studies enrolled healthy children,[13,18,21,22,24,26,29,30,33,34] five of the studies enrolled asthmatic children,[23,25,27,31,32] and three of the studies enrolled children visiting hospitals or pediatric clinics.[19,20,28]

Setting

The intervention setting was the family home in 5 studies,[22–24,27,34] the hospital in 4 studies,[13,19,28,32] the well-baby clinic in 4 studies,[18,26,30,33] the pediatrician's office in 3 studies,[20,21,31] the hospital and well-baby clinic in 1 study,[29] and the hospital and family home in 1 study.[25]

Program Providers

Nurses were the intervention providers in 6 studies,[19,20,22,25,30,33] physicians were providers in 3 studies,[26,28,29] research assistants were providers in 7 studies,[13,18,23,24,27,31,32] and clinic

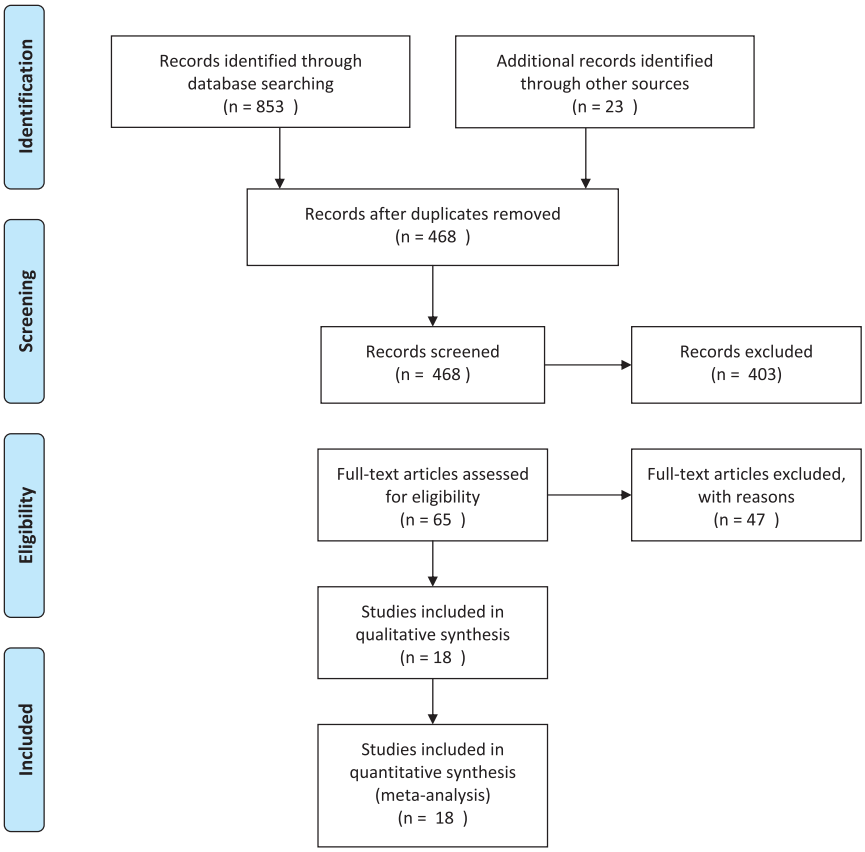


FIGURE 1
Flowchart for identification of studies.

TABLE 1 Characteristics of Included Studies

Study	Age at Recruitment	Child Cohort	Setting	Provider	No. of Sessions	Theory Based	Length of Observation	Primary Goal	Intervention Components
Abdullah et al[18] (2005)	5 y	Well	Well-baby clinic	Research assistant	3	Yes	6 mo	Cessation	A,C
Chan et al[19] (2005)	Children	Hospital / clinic visit	Hospital	Nurse	1	No	1 mo	Cessation	B,C
Curry et al[20] (2003)	Children	Hospital / clinic visit	Pediatric	Nurse	4	No	12 mo	Cessation	A,B,C
Eriksen et al[21] (1996)	6 wk, 2, 4 y	Well	Pediatric	Clinic staff	1	No	1 mo	Reduction, cessation	A,B
Greenberg et al[22](1994)	<6 mo	Well	Home	Nurse	4	Yes	6 mo	Reduction	A,B
Hovell et al[23] (2002)	3-17 y	Asthmatic	Home	Research assistant	7	Yes	12 mo	Reduction	B
Hovell et al[24] (2009)	<4	Well	Home	Study counselor	14	Yes	18 mo	Reduction, cessation	A,B,D
Hughes et al[25] (1991)	6-16 y	Asthmatic	Hospital and family home	Nurse	4	No	12 mo	Reduction	B
Kallio et al[26] (2006)	5 mo	Well	Well-baby clinic	Physician	16	No	8 y	Reduction, cessation	A,B
Krieger et al[27] (2005)	4-12 y	Asthmatic	Home	Research assistant	5–9	No	12 mo	Reduction	B
Ralston and Roohi[28] (2008)	Children	Hospital / clinic visit	Hospital	Physician	1	Yes	6 mo	Cessation	B,D
Severson et al[29] (1997)	<6 mo	Well	Hospital & well-baby clinic	Physician	4	No	12 mo	Reduction, Cessation	A,B
Vineis et al[30] (1993)	0-3 mo	Well	Well-baby clinic	Nurse	NR	No	2 y	Cessation	A,B
Wahlgren et al[31] (1997)	6-17 y	Asthmatic	Pediatric	Research assistant	6	Yes	2 y	Reduction	A,B
Wilson et al[32] (2011)	3-12 y	Asthmatic	Home	Research assistant	6	Yes	12 mo	Reduction	B,C,E
Woodward et al[15] (1987)	Newborn	Well	Hospital	Research assistant	1	No	3 mo	Reduction	A,C
Yilmaz et al[33] (2006)	<16 y	Well	Hospital	Nurse	1	No	6 mo	Reduction, cessation	A,B
Zakarian et al[34] (2004)	<4 y	Well	Home	Clinic staff	7	Yes	12 mo	Reduction	A,B,C

[a] A, self-help materials; B, counseling; C, phone support; D, medication; E, biochemical feedback.

staff provided the intervention in 2 studies.[21,34]

Use of Medicine

Two of the 18 studies reported the use of cessation medication.[24,28]

Number of Sessions

In five of the studies only 1 session was given,[13,19,21,28,33] in five of the studies 3 to 4 sessions were given,[18,20,22,25,29] and in seven of the studies more than 5 sessions were given.[23,24,26,27,31,32,34] In one study, the number of sessions was not reported.[30]

Theoretical Basis

Nine of the studies used theory-based interventions.[18,19,22–24,28,31,34] Of these, 3 studies used learning theory interventions.[22–24] Nine studies did not mention the use of theory.[13,20,21,25–27,29,30,33]

Primary Goal

The study objective was reduction of child exposure in 8 studies,[13,22,23,25,27,31,32,34] maternal cessation in 5 studies,[18–20,28,30] and both reduction of child exposure and maternal cessation in 5 studies.[21,24,26,29,33]

Length of Observation

The observation period was less than 6 months in 3 studies,[13,19,21] 6 months in 3 studies,[18,28,33] 12 months in 8 studies,[20,22,23,25,27,29,32,34] and more than 12 months in 4 studies.[24,26,30,31]

Control Group Intervention

In eight of the studies, the control group received some sort of intervention (usual care or special to the trial) related to smoking, cessation, or risk to children from smoking.[18,21,23,25,27–29,32] In four of the studies, the control group did not receive any information on the topic of cessation or reduction of child exposure, in usual care or as a special intervention.[19,24,26,33] In the remainder of the studies, we were unable to

determine what the control group received.[13,20,22,30,31,34]

Methodologic Quality

The characteristics of the studies pertaining to methodological quality are presented in Table 2. Of the 18 studies, one used a cluster randomized design,[29] fourteen used an individually randomized design,[18–24,26–28,31–34] two used a quasi-randomized design,[13,25] and one used a controlled but not randomized design.[30] Nine of the studies reported randomization concealment.[18–21,23,24,27,32,33] In the remainder of the studies, concealment was not reported or was unclear. Blinding of observers/assessors was reported in seven of the trials.[18,19,22,23,32–34] Biochemical validation of quit status was reported in five of the trials.[13,18,20,23,34] Percentage of follow-up ranged from 61% to 97%. Five studies had follow-up of greater than 90%,[19,23,25,32,33] and 13 studies had follow-up of greater than 80%.[13,18–21,23–25,30–34] Information on fidelity to treatment was addressed in a minority of trials.[13,22–25,30] Two studies reported very high fidelity to treatment (Greenberg, 97%[22]; Hovell 2002, 98%[23]), and 1 study provided in-depth information on fidelity to various program components (Hovell 2009[24]).

Effects of Interventions (Main Effects)

Effects of Interventions on Parental, Maternal, and Paternal Quit Rates

Eighteen studies, with a combined N of 7053, are included in this analysis.[13,18–34] Results from each trial are summarized in Table 3 and Fig 2. Parental quit rates in individual studies ranged from 0.9% to 83.6% in the intervention group, with a weighted mean of 23.1%, and from 0.8% to 72.1% in the control group, with a weighted mean of 18.4%.

A positive effect of the intervention was found in thirteen (72%) of the studies, with four (22%) showing a statistically significant advantage to the intervention group. RRs ranged from 0.14 to 29.43. Overall, the RR was 1.34 (confidence interval [CI] 1.05,1.71; $P = .02$), showing a modest but statistically significant improvement in the intervention group. The RD of 0.04 (CI 0.01,0.07; $P = .005$) showed that an additional 4% of the intervention parents quit smoking than did control parents.

The pooled analyses of maternal quit rate (N = 12 trials) were similar to the results of parental quit rate. (RR = 1.44; CI 0.99,2.09; $P = .06$). A positive or significant effect of the intervention was not found in either of the 2 studies that examined paternal quit rates, nor was there a difference in the pooled RR (RR = 0.95; CI 0.71,1.29; $P = .76$).

Publication Bias

The funnel plot showing the SE of the log (RR) versus the RR is presented in Fig 3. As expected, higher RRs are associated with lower variance. The reasonably symmetrical plot shows that publication bias is not a concern.

Heterogeneity of Results

The test for heterogeneity was significant for the RR ($I^2 = 60\%$; $P = .0006$) and RD ($I^2 = 82\%$; $P < .001$), indicating that the results were not homogeneous.

We examined heterogeneity by subgroups. Sixteen subgroups (41% of all subgroups) had nonsignificant levels of heterogeneity: I^2 ranged from 0% to 56%, with P values ranging from 0.08 to 0.97. The other 23 subgroups

TABLE 2 Methodologic Characteristics of Included Studies

	Size	Design (RCT/CT/ Cluster CT)	Randomization Concealment (Yes, No, NR)	Blinding of Observers (Yes, No, NR)	Biochemical validation of outcome data (Yes/No))	Follow-up, %	Participants Received Full Intervention (%, NR)
Abdullah et al[18] (2005)	952	RCT	Yes	Yes	Yes	88	NR
Chan et al[19] (2005)	80	RCT	Yes	Yes	No	96	NR
Curry et al[20] (2003)	303	RCT	Yes	NR	Yes	81	NR
Eriksen et al[21] (1996)	443	RCT	Yes	NR	No	82	NR
Greenberg et al[22](1994)	933	RCT	NR	Yes	No	71	96
Hovell et al[23] (2002)	204	RCT	Yes	Yes	Yes	97	98
Hovell et al[24] (2009)	150	RCT	Yes	Yes	No	87	54
Hughes et al[25] (1991)	95	Quasi-RCT	No	NR	No	94	NR
Kallio et al[26] (2006)	1062	RCT	No	No	No	61	NR
Krieger et al[27] (2005)	274	RCT	Yes	No	No	78	NR
Ralston and Roohi[28] (2008)	42	RCT	No	NR	No	67	NR
Severson et al[29] (1997)	2901	Cluster RCT	No	No	No	69	NR
Vineis et al[30] (1993)	1015	CT	No	NR	No	82	NR
Wahlgren et al[31] (1997)	91	RCT	No	NR	No	87	NR
Wilson et al[32] (2011)	519	RCT	Yes	Yes	No	95	NR
Woodward et al[13] (1987)	184	Quasi-RCT	No	NR	Yes	85	NR
Yilmaz et al[33] (2006)	375	RCT	Yes	Yes	No	97	NR
Zakarian et al[34] (2004)	150	RCT	No	Yes	Yes	85.3	72

NR, not reported.

TABLE 3 Effects of Intervention Programs on Quit Rate by Intervention Group, With Risk Ratios, for Each Included Trial

	Size	Quit Rate Intervention, %	Quit Rate Control, %	Risk Ratio (CI)
ALL				1.34 (1.05,1.71)
Abdullah et al[18] (2005)	952	15	7	2.07 (1.40,3.06)
Chan et al[19] (2005)	80	8	3	3.00 (0.33,27.63)
Curry et al[20] (2003)	303	14	7	2.07 (1.02,4.23)
Eriksen et al[21] (1996)	443	0	3	0.14 (0.02,1.16)
Greenberg et al[22](1994)	933	1	3	0.30 (0.08,1.08)
Hovell et al[23] (2002)	204	8	9	0.88 (0.35,2.18)
Hovell et al[24] (2009)	150	17	5	3.16 (1.08,9.26)
Hughes et al[25] (1991)	95	13	8	1.53 (0.46,5.08)
Kallio et al[26] (2006)	1062	20	20	0.99 (0.78,1.27)
Krieger et al[27] (2005)	274	84	72	1.16 (1.00,1.34)
Ralston and Roohi[28] (2008)	42	14	5	3.00 (0.34,26.56)
Severson et al[29] (1997)	2901	5	5	1.13 (0.73,1.76)
Vineis et al[30] (1993)	1015	12	11	1.11 (0.70,1.75)
Wahlgren et al[31] (1997)	91	21	4	5.57 (0.72,43.22)
Wilson et al[32] (2011)	519	16	11	1.51 (0.86,2.63)
Woodward et al[13] (1987)	184	6	2	2.70 (0.29,25.04)
Yilmaz et al[33] (2006)	375	24	1	29.43 ([4.07,213.01)
Zakarian et al[34] (2004)	150	10	13	0.76 (0.29,2.00)

had statistically significant levels of heterogeneity.

Subgroup Analyses

Results from the analyses by subgroup are presented in Table 4. The relative risks ranged from 0.42 to 3.13, and the relative differences from −0.03 to 0.11.

The interventions were beneficial in the following subgroups: parents whose children were 4 years old and over (RR = 1.57; CI 1.14,2.16; P = .006); interventions that included use of cessation medication (RR = 3.13; CI 1.19,8.21;, P = .02); interventions whose primary purpose was cessation (RR = 1.69; CI 1.2,2.4; P = .003); and interventions whose follow-up was 81% to 100% (RR = 1.64; CI 1.12,2.42; P = .01).

DISCUSSION

Our review shows that interventions aimed at increasing parental cessation to benefit children increase parental and maternal quit rates.

To the best of our knowledge, this is the first meta-analysis to quantify the effect of interventions aimed at increasing cessation among parents of small children. The strategy of quitting for the sake of the children carries several benefits: Adults who quit smoking improve their own health and life expectancy[82]; their children are no longer exposed to the harmful effects of parental tobacco smoke; parents are freed from the worry that they may be harming their children by smoking in their presence; and children of nonsmokers may be less likely to initiate smoking.[9] As previously noted,[83] encouraging cessation for the sake of protecting others' health, particularly children's health, is an important means of combating use.

Our finding of a 4% absolute difference (AD) between parental quit rates in the intervention and control groups compares reasonably well with absolute differences from other recommended methods of encouraging cessation, including brief physician advice (AD = 2.5%), group counseling (AD = 3.1%), and individual counseling

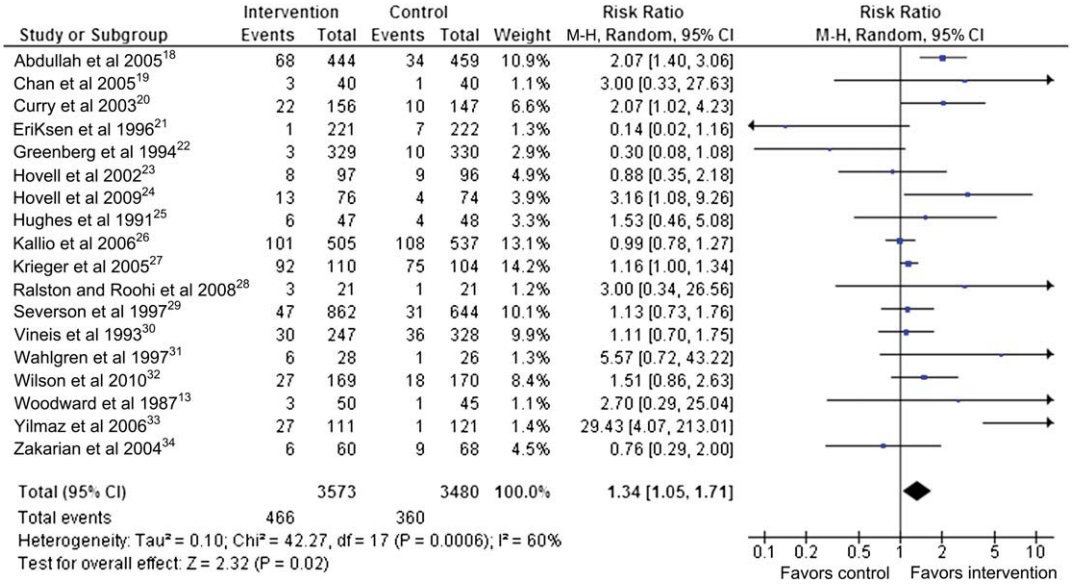


FIGURE 2
Meta-analysis of relative risks of the effects of interventions on parental cessation.

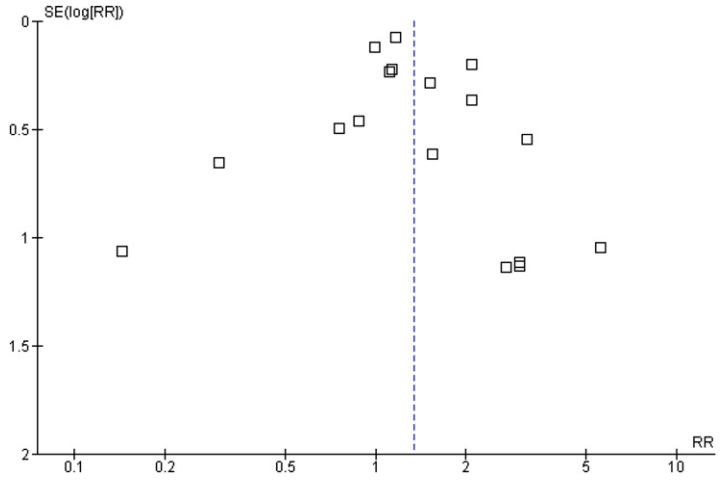


FIGURE 3
Plot to assess presence of publication bias.

(AD = 6.0%).[84(p. 88-90, Tables 6.8 and 6.13)] Because none of the known cessation approaches reach all smokers or have high success rates, additional effective cessation approaches, such as cessation for the sake of one's children, can impact population smoking rates.

Over three-quarters of parents in both intervention and control groups continued to smoke, leaving the overwhelming majority of children potentially exposed to their parents' smoke.

The observed degree of heterogeneity between the results from different studies reveals that not all types of interventions for promoting parental cessation are equally or necessarily effective. In the next section, we focus on promising findings from particular subgroups in an attempt to gain insight regarding possible future research and practice directions.

SUBGROUP ANALYSES

Interventions were effective with children over the age of four. The question of age and intervention effectiveness was raised more than 2 decades ago by Woodward, who targeted parents of newborns in his program, in the belief that those parents may be open to lifestyle change to protect their vulnerable infants. However, his intervention was not effective. He hypothesized that this was because "there was little awareness of risks to the baby from smoking postnatally" and because the mothers wanted to return to smoking after pregnancy. Another possible explanation, from a qualitative study that investigated why mothers continue to smoke around their children, is that "… [these interventions] require mothers to change their caring routine and behaviors at a time when many mothers feel that they are barely coping with existing responsibilities."[85]

Interventions that included the use of medications were effective. Of the 2 included studies in which medications were used, both offered nicotine replacement therapy. One of these was a small study (N = 42)[28] that included parents of hospitalized children with respiratory illness. The second was a somewhat larger study (N = 150)[24] that took place in the home.

Interventions with a primary purpose of getting parents to quit were effective. This may have been influenced by recruitment bias. Previous investigators described difficulties in recruitment and retention of participants in interventions dealing solely with cessation.[54] It is possible that "hardcore" smokers would be unlikely to participate in an intervention aimed only at cessation, but would be willing to participate in an intervention focusing on child protection through changes in patterns of smoking (eg, smoke-free homes and cars). This could lead to better cessation results in those interventions that focus on cessation only.

COMPARISON WITH OTHER REVIEWS

Two previous reviews addressed parental cessation; both of these were conducted using narrative synthesis. Klerman studied maternal cessation and found that most interventions had small but significant effects.[86] Gehrman and Hovell studied the effects of minimal clinical interventions on cessation, and found no significant effect.[87] They noted the original studies' small sample sizes and consequent low power to detect small but clinically important effects. The meta-analysis reported in this article overcomes this problem.[16 (p.98)]

LIMITATIONS AND FUTURE DIRECTIONS

Most included trials were truly randomized, and most had low attrition; these factors contribute to high internal validity of most individual trials. Randomization concealment and blinding of observers were not reported for most trials. If randomization was not concealed, or observers not blinded, the internal validity of individual studies may have been compromised. Adherence to principles of good study design, including implementation and reporting of randomization concealment, blinding of observers, and high fidelity to treatment,[88] will enhance the usefulness of future work.

An analysis of all studies together showed a significant amount of heterogeneity between trial results. Some of the heterogeneity was due to differences between subgroups: When heterogeneity was examined within subgroups,

TABLE 4 Effects of Intervention Programs on Parental Quit Rate Stratified According to Child-Related, Intervention-Related, and Design-Related Subgroup

Analysis	RR (CI)	*P**	No. of Studies	No. of Participants
Age				
Infants (0-1 y)	0.99 (0.6, 1.63)	.98	7	3556
Preschool (2-4 y)	1.14 (0.48, 2.68)	.77	4	1060
Children (4-17 y)	1.57 (1.14, 2.16)	.006*	11	3497
Child cohort				
Well	1.26 (0.83, 1.92)	.29	710	5733
Asthmatic	1.20 (1.00, 1.44)	.05	5	895
Hospital/clinic visit	2.21 (1.16, 4.23)	.02	3	425
Setting				
Well-baby clinic	1.46 (0.92, 2.33)	.11	5	4258
Hospital	1.28 (0.86, 1.90)	.22	5	1818
Pediatric clinic	1.30 (0.23, 7.40)	.77	3	800
Family home	1.16 (0.83, 1.63)	.39	7	1778
Provider				
Nurse	1.69 (0.73, 3.89)	.22	6	1944
Physician	1.04 (0.84, 1.28)	.75	3	2590
Research assistant	1.63 (1.06, 2.50)	.03	7	1948
Clinic staff	0.42 (0.09, 2.10)	.29	2	571
Use of theory in intervention development				
No theory	1.23 (0.93, 1.62)	.14	9	4505
Theory based	1.45 (0.92, 2.30)	.11	9	2548
Use of medicine				
Yes	3.13 (1.19, 8.21)	.02*	2	192
No	1.28 (1.00, 1.63)	.05	16	6861
Length of observation				
<6 mo	1.47 (0.59, 3.66)	.41	6	1091
6 mo	2.74 (0.8, 9.42)	.11	4	1305
12 mo	1.15 (0.87, 1.52)	.33	8	3434
2+ y	1.32 (0.82, 2.10)	.25	4	1821
Primary goal				
Maternal cessation	1.69 (1.2, 2.40)	.003*	5	1903
Reduction of child exposure	1.14 (0.84, 1.55)	.39	8	1777
Reduction of child exposure and maternal cessation	1.51 (0.73, 3.13)	.27	5	3373
Study design				
RCT	1.40 (1.01, 1.92)	.04	14	4782
Quasi-RCT	1.74 (0.61, 5.00)	.3	2	190
CT	1.11 (0.70, 1.75)	.66	1	575
Cluster RCT	1.13 (0.73, 1.76)	.58	1	1506
No. of sessions				
1	2.56 (0.44, 14.78)	.29	5	892
3-4	1.38 (0.84, 2.27)	.21	5	3466
>5	1.16 (0.94, 1.44)	.17	7	2120
Control group received related intervention				
Yes	1.27 (0.91, 1.79)	.16	7	3396
No	2.25 (1.02, 4.98)	.04	5	1843
Percentage follow-up				
60-80	1.07 (0.86, 1.32)	.55	5	3463
81-100	1.64 (1.12, 2.42)	.01*	13	3590
Blinding of assessors				
Yes	1.56 ([0.87, 2.82)	.14	8	2684
No	1.11 (0.99, 1.26)	.08	3	2762
Not reported	1.49 (0.85, 2.59)	.16	7	1607

* P value is significant at the Bonferroni-corrected .05 2-sided level.

nearly 40% of the subgroups had low levels of heterogeneity. Because of the use of a random-effects model, the discovered heterogeneity did not affect the validity of the average effect calculated.

Because of the large number of variables of interest relative to the total number of trials, we were not able to analyze possible interactive effects of intervention and child-related variables.

Time and resources did not permit outreach to authors of excluded studies with missing data.

Further original research is needed to develop more effective programs for getting parents to quit smoking. This may be enhanced by phased development of interventions,[89] beginning with in-depth qualitative research with parents and including intervention piloting.

CONCLUSIONS

Some parents will quit smoking to benefit their children. Policy makers should recommend effective interventions that counsel parents to quit for the benefit of the children, and recommend training of clinicians in this area. More research is needed to build effective interventions for encouraging parental cessation for the benefit of children, to isolate components that best maximize the motivating function of child welfare, and to identify effective interventions for the protection of children from tobacco smoke exposure if parents are not ready or able to quit.

ACKNOWLEDGMENTS

This work was funded by the Flight Attendants' Medical Research Institute (FAMRI) FAMRI Award 072086_YCSA.

We thank Tami Bar for assistance in data extraction.

REFERENCES

1. World Health Organization. Fresh and Alive: MPOWER. WHO Report on the Global Tobacco Epidemic Available www.who.int/tobacco/mpower/2008/en/index.html. Accessed May 12, 2011
2. Jha P, Chaloupka FJ. The economics of global tobacco control. *BMJ*. 2000;321(7257):358–361
3. Fiore MC, Baker TBS. Stealing a march in the 21st century: accelerating progress in the 100-year war against tobacco addiction in the United States. *Am J Public Health*. 2009;99(7):1170–1175
4. Carlson LE, Taenzer P, Koopmans J, Bultz BD. Eight-year follow-up of a community-based

large group behavioral smoking cessation intervention. *Addict Behav*. 2000;25(5):725–741

5. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychol*. 2007; 26(2):136–145
6. Strecher VJ, Kreuter MW, Kobrin SC. Do cigarette smokers have unrealistic perceptions of their heart attack, cancer, and stroke risks? *J Behav Med*. 1995;18(1):45–54
7. Weinstein ND. Accuracy of smokers' risk perceptions. *Ann Behav Med*. 1998;20(2): 135–140
8. Office of the Surgeon General. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General Available at:www.surgeongeneral.gov/library/secondhandsmoke/report/fullreport.pdf. Accessed September 27, 2011
9. Farkas AJ, Gilpin EA, White MM, Pierce JP. Association between household and workplace smoking restrictions and adolescent smoking. *JAMA*. 2000;284(6):717–722
10. Winickoff JP, Friebely J, Tanski SE, et al. Beliefs about the health effects of "thirdhand" smoke and home smoking bans. *Pediatrics*. 2009;123(1):e74–e79
11. World Health Organization. WHO Report on the Global Tobacco Epidemic, 2009: Implementing Smoke-Free Environments. Available at: www.who.int/tobacco/mpower/2009/en/index.html. Accessed May 15, 2011
12. Wipfli H, Avila-Tang E, Navas-Acien A, et al; Famri Homes Study Investigators. Secondhand smoke exposure among women and children: evidence from 31 countries. *Am J Public Health*. 2008;98(4):672–679
13. Woodward A, Owen N, Grgurinovich N, Griffith F, Linke H. Trial of an intervention to reduce passive smoking in infancy. *Pediatr Pulmonol*. 1987;3(3):173–178
14. Priest N, Roseby R, Waters E, et al Family and career smoking control programmes for reducing children's exposure to environmental tobacco smoke. *Cochrane Database Syst Rev*. 2008(4):CD001746.
15. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3): 177–188
16. Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions 4.2.6*, Vol 4. Chichester, UK: John Wiley & Sons, Ltd.; 2006
17. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557–560
18. Abdullah ASM, Mak YW, Loke AY, Lam TH. Smoking cessation intervention in parents of young children: a randomised controlled trial. *Addiction*. 2005;100(11):1731–1740
19. Chan SS, Lam TH, Salili F, et al. A randomized controlled trial of an individualized motivational intervention on smoking cessation for parents of sick children: a pilot study. *Appl Nurs Res*. 2005;18(3):178–181
20. Curry SJ, Ludman EJ, Graham E, Stout J, Grothaus L, Lozano P. Pediatric-based smoking cessation intervention for low-income women: a randomized trial. *Arch Pediatr Adolesc Med*. 2003;157(3):295–302
21. Eriksen W, Sørum K, Bruusgaard D. Effects of information on smoking behaviour in families with preschool children. *Acta Paediatr*. 1996;85(2):209–212
22. Greenberg RA, Strecher VJ, Bauman KE, et al. Evaluation of a home-based intervention program to reduce infant passive smoking and lower respiratory illness. *J Behav Med*. 1994;17(3):273–290
23. Hovell MF, Meltzer SB, Wahlgren DR, et al. Asthma management and environmental tobacco smoke exposure reduction in Latino children: a controlled trial. *Pediatrics*. 2002; 110(5):946–956
24. Hovell MF, Zakarian JM, Matt GE, et al. Counseling to reduce children's secondhand smoke exposure and help parents quit smoking: a controlled trial. *Nicotine Tob Res*. 2009;11(12):1383–1394
25. Hughes DM, McLeod M, Garner B, Goldbloom RB. Controlled trial of a home and ambulatory program for asthmatic children. *Pediatrics*. 1991;87(1):54–61
26. Kallio K, Jokinen E, Hämäläinen M, et al. Impact of repeated lifestyle counselling in an atherosclerosis prevention trial on parental smoking and children's exposure to tobacco smoke. *Acta Paediatr*. 2006;95(3): 283–290
27. Krieger JW, Takaro TK, Song L, Weaver M. The Seattle-King County Healthy Homes Project: a randomized, controlled trial of a community health worker intervention to decrease exposure to indoor asthma triggers. *Am J Public Health*. 2005;95(4):652–659
28. Ralston S, Roohi M. A randomized, controlled trial of smoking cessation counseling provided during child hospitalization for respiratory illness. *Pediatr Pulmonol*. 2008;43(6):561–566
29. Severson HH, Andrews JA, Lichtenstein E, Wall M, Akers L. Reducing maternal smoking and relapse: long-term evaluation of a pediatric intervention. *Prev Med*. 1997;26 (1):120–130
30. Vineis P, Ronco G, Ciccone G, et al. Prevention of exposure of young children to parental tobacco smoke: effectiveness of an educational program. *Tumori*. 1993;79(3): 183–186
31. Wahlgren DR, Hovell MF, Meltzer SB, Hofstetter CR, Zakarian JM. Reduction of environmental tobacco smoke exposure in asthmatic children. A 2-year follow-up. *Chest*. 1997;111(1):81–88
32. Wilson S, Farber H, Knowles S, Lavori P. A randomized trial of parental behavioral counseling and cotinine feedback for lowering environmental tobacco smoke exposure in children with asthma: results of the LET'S Manage Asthma trial. *Chest*. 2011;139 (3):581–590
33. Yilmaz G, Karacan C, Yöney A, Yilmaz T. Brief intervention on maternal smoking: a randomized controlled trial. *Child Care Health Dev*. 2006;32(1):73–79
34. Zakarian JM, Hovell MF, Sandweiss RD, et al. Behavioral counseling for reducing children's ETS exposure: implementation in community clinics. *Nicotine Tob Res*. 2004;6 (6):1061–1074
35. Carlsson N, Johansson A, Hermansson G, Andersson-Gäre B. Child health nurses' roles and attitudes in reducing children's tobacco smoke exposure. *J Clin Nurs*. 2010; 19(3-4):507–516
36. Chan S, Lam TH. Protecting sick children from exposure to passive smoking through mothers' actions: a randomized controlled trial of a nursing intervention. *J Adv Nurs*. 2006;54(4):440–449
37. Chilmonczyk BA, Palomaki GE, Knight GJ, Williams J, Haddow JE. An unsuccessful cotinine-assisted intervention strategy to reduce environmental tobacco smoke exposure during infancy. *Am J Dis Child*. 1992; 146(3):357–360
38. Conway TL, Woodruff SI, Edwards CC, Hovell MF, Klein J. Intervention to reduce environmental tobacco smoke exposure in Latino children: null effects on hair biomarkers and parent reports. *Tob Control*. 2004;13(1): 90–92
39. Emmons KM, Hammond SK, Fava JL, Velicer WF, Evans JL, Monroe AD. A randomized trial to reduce passive smoke exposure in low-income households with young children. *Pediatrics*. 2001;108(1):18–24
40. Fossum B, Arborelius E, Bremberg S. Evaluation of a counseling method for the prevention of child exposure to tobacco smoke: an example of client-centered communication. *Prev Med*. 2004;38(3):295–301
41. Groner JA, Ahijevych K, Grossman LK, Rich LN. The impact of a brief intervention on maternal smoking behavior. *Pediatrics*. 2000; 105(1 pt 3):267–271
42. Halterman JS, Borrelli B, Fisher S, Szilagyi P, Yoos L. Improving care for urban children

with asthma: design and methods of the School-Based Asthma Therapy (SBAT) trial. *J Asthma*. 2008;45(4):279–286

43. Halterman JS, Fagnano M, Conn KM, Lynch KA, DelBalso MA, Chin NP. Barriers to reducing ETS in the homes of inner-city children with asthma. *J Asthma*. 2007;44(2):83–88
44. Hovell MF, Zakarian JM, Matt GE, Hofstetter CR, Bernert JT, Pirkle J. Effect of counselling mothers on their children's exposure to environmental tobacco smoke: randomised controlled trial. *BMJ*. 2000;321(7257):337–342
45. Hovell MF, Zakarian JM, Matt GE, Hofstetter CR, Bernert JT, Pirkle J. Decreasing environmental tobacco smoke exposure among low income children: preliminary findings. *Tob Control*. 2000;(9 suppl 3):III70–III71
46. Irvine L, Crombie IK, Clark RA, et al. Advising parents of asthmatic children on passive smoking: randomised controlled trial. *BMJ*. 1999;318(7196):1456–1459
47. Kimata H. Cessation of passive smoking reduces allergic responses and plasma neurotrophin. *Eur J Clin Invest*. 2004;34(2):165–166
48. Klosky JL, Tyc VL, Lawford J, Ashford J, Lensing S, Buscemi J. Predictors of non-participation in a randomized intervention trial to reduce environmental tobacco smoke (ETS) exposure in pediatric cancer patients. *Pediatr Blood Cancer*. 2009;52(5):644–649
49. McIntosh NA, Clark NM, Howatt WF. Reducing tobacco smoke in the environment of the child with asthma: a cotinine-assisted, minimal-contact intervention. *J Asthma*. 1994;31(6):453–462
50. Pletsch PK. Reduction of primary and secondary smoke exposure for low-income black pregnant women. *Nurs Clin North Am*. 2002;37(2):315–329, viii
51. Röske K, Schumann A, Hannöver W, et al. Postpartum smoking cessation and relapse prevention intervention: a structural equation modeling application to behavioral and non-behavioral outcomes of a randomized controlled trial. *J Health Psychol*. 2008;13(4):556–568
52. Schönberger HJ, Dompeling E, Knottnerus JA, et al. The PREVASC study: the clinical effect of a multifaceted educational intervention to prevent childhood asthma. *Eur Respir J*. 2005;25(4):660–670
53. Sockrider MM, Hudmon KS, Addy R, Dolan Mullen P. An exploratory study of control of smoking in the home to reduce infant exposure to environmental tobacco smoke. *Nicotine Tob Res*. 2003;5(6):901–910
54. Stepans MBF, Wilhelm SL, Dolence K. Smoking hygiene: reducing infant exposure to tobacco. *Biol Res Nurs*. 2006;8(2):104–114
55. Strecher VJ, Bauman KE, Boat B, Fowler MG, Greenberg R, Stedman H. The role of outcome and efficacy expectations in an intervention designed to reduce infants' exposure to environmental tobacco smoke. *Health Educ Res*. 1993;8(1):137–143
56. Van't Hof SM, Wall MA, Dowler DW, Stark MJ. Randomised controlled trial of a postpartum relapse prevention intervention. *Tob Control*. 2000;9:64–66
57. Wakefield M, Banham D, McCaul K, et al. Effect of feedback regarding urinary cotinine and brief tailored advice on home smoking restrictions among low-income parents of children with asthma: a controlled trial. *Prev Med*. 2002;34(1):58–65
58. Wilson SR, Yamada EG, Sudhakar R, et al. A controlled trial of an environmental tobacco smoke reduction intervention in low-income children with asthma. *Chest*. 2001;120(5):1709–1722
59. Borrelli B, McQuaid EL, Novak SP, Hammond SK, Becker B. Motivating Latino caregivers of children with asthma to quit smoking: a randomized trial. *J Consult Clin Psychol*. 2010;78(1):34–43
60. Crain EF, Walter M, O'Connor GT, et al. Home and allergic characteristics of children with asthma in seven U.S. urban communities and design of an environmental intervention: the Inner-City Asthma Study. *Environ Health Perspect*. 2002;110(9):939–945
61. Meltzer SB, Hovell MF, Meltzer EO, Atkins CJ, de Peyster A. Reduction of secondary smoke exposure in asthmatic children: parent counseling. *J Asthma*. 1993;30(5):391–400
62. Murray AB, Morrison BJ. The decrease in severity of asthma in children of parents who smoke since the parents have been exposing them to less cigarette smoke. *J Allergy Clin Immunol*. 1993;91(1 pt 1):102–110
63. Precioso J, Samorinha C, Calheiros JM, Macedo M, Antunes H, Campos H. Second hand smoke (SHS) exposure in children. An evaluation of a preventative measure. *Rev Port Pneumol*. 2010;16(1):57–72
64. Winickoff JP, Hibberd PL, Case B, Sinha P, Rigotti NA. Child hospitalization: an opportunity for parental smoking intervention. *Am J Prev Med*. 2001;21(3):218–220
65. Winickoff JP, McMillen RC, Carroll BC, et al. Addressing parental smoking in pediatrics and family practice: a national survey of parents. *Pediatrics*. 2003;112(5):1146–1151
66. Winkelstein ML, Tarzian A, Wood RA. Parental smoking behavior and passive smoke exposure in children with asthma. *Ann Allergy Asthma Immunol*. 1997;78(4):419–423
67. Woodruff SI, Conway TL, Elder JP, Hovell MF. Pilot study using hair nicotine feedback to reduce Latino children's environmental tobacco smoke exposure. *Am J Health Promot*. 2007;22(2):93–97
68. Crone MR, Reijneveld SA, Willemsen MC, Sing RAH. Parental education on passive smoking in infancy does work. *Eur J Public Health*. 2003;13(3):269–274
69. Keintz MK, Fleisher L, Rimer BK. Reaching mothers of preschool-aged children with a targeted quit smoking intervention. *J Community Health*. 1994;19(1):25–40
70. Cinciripini PM, McClure JB, Wetter DW, et al. An evaluation of videotaped vignettes for smoking cessation and relapse prevention during pregnancy: the Very Important Pregnant Smokers (VIPS) program. *Tob Control*. 2000;9(suppl 3):III61–III63
71. Elder JP, Perry CL, Stone EJ, et al. Tobacco use measurement, prediction, and intervention in elementary schools in four states: the CATCH Study. *Prev Med*. 1996;25(4):486–494
72. Hovell MF, Meltzer SB, Zakarian JM, et al. Reduction of environmental tobacco smoke exposure among asthmatic children: a controlled trial. *Chest*. 1994;106(2):440–446
73. Oncken CA, Dietz PM, Tong VT, et al. Prenatal tobacco prevention and cessation interventions for women in low- and middle-income countries. *Acta Obstet Gynecol Scand*. 2010;89(4):442–453
74. Rodriguez VM, Conway TL, Woodruff SI, Edwards CC. Pilot test of an assessment instrument for Latina community health advisors conducting an ETS intervention. *J Immigr Health*. 2003;5(3):129–137
75. Siddiqi K, Sarmad R, Usmani RA, Kanwal A, Thomson H, Cameron I. Smoke-free homes: an intervention to reduce second-hand smoke exposure in households. *Int J Tuberc Lung Dis*. 2010;14(10):1336–1341
76. Suplee PD. The importance of providing smoking relapse counseling during the postpartum hospitalization. *J Obstet Gynecol Neonatal Nurs*. 2005;34(6):703–712
77. Valanis B, Lichtenstein E, Mullooly JP, et al. Maternal smoking cessation and relapse prevention during health care visits. *Am J Prev Med*. 2001;20(1):1–8
78. Woodruff SI, Candelaria JI, Elder JP. Recruitment, training outcomes, retention, and performance of community health advisors in two tobacco control interventions for Latinos. *J Community Health*. 2010;35(2):124–134
79. Davis SW, Cummings KM, Rimer BK, Sciandra R, Stone JC. The impact of tailored self-help smoking cessation guides on young mothers. *Health Educ Q*. 1992;19(4):495–504

80. Johnston V, Walker N, Thomas DP, et al. The study protocol for a randomized controlled trial of a family-centred tobacco control program about environmental tobacco smoke (ETS) to reduce respiratory illness in Indigenous infants. *BMC Public Health*. 2010;10:114
81. Nuesslein TG, Struwe A, Maiwald N, Rieger C, Stephan V. [Maternal tobacco consumption can be reduced by simple intervention of the paediatrician]. *Klin Padiatr*. 2006;218(5):283–286
82. Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors. *BMJ*. 2004;328(7455):1519–1528
83. Hovell MF, Hughes SC. The behavioral ecology of secondhand smoke exposure: A pathway to complete tobacco control. *Nicotine Tob Res*. 2009;11(11):1254–1264
84. Fiore MC, Jaen CR, Baker TB, et al; 2008 PHS Guideline Update Panel, Liaisons, and Staff. Treating tobacco use and dependence: 2008 update U.S. Public Health Service Clinical Practice Guideline executive summary. *Respir Care*. 2008;53(9):1217–1222
85. Robinson J, Kirkcaldy AJ. 'You think that I'm smoking and they're not': why mothers still smoke in the home. *Soc Sci Med*. 2007;65(4):641–652
86. Klerman LV. Protecting children: reducing their environmental tobacco smoke exposure. *Nicotine Tob Res*. 2004;6(suppl 2):S239–S253
87. Gehrman CA, Hovell MF. Protecting children from environmental tobacco smoke (ETS) exposure: a critical review. *Nicotine Tob Res*. 2003;5(3):289–301
88. Rovniak LS, Hovell MF, Wojcik JR, Winett RA, Martinez-Donate AP. Enhancing theoretical fidelity: an e-mail-based walking program demonstration. *Am J Health Promot*. 2005;20(2):85–95
89. Rosen L, Manor O, Brody D, Shtarkshall R, Engelhard D, Zucker D. From pills to programs: Lessons from medicine for developing effective lifestyle interventions. *Prev Med*. 2009 Aug;49(1):12–28

RECHARGING THE WELL: *How long can one pump water from an aquifer before it runs dry? The question seems a bit like a high school math problem, but the answers are not known and the implications are enormous. Aquifers are wet underground layers of rock or sediments from which water can be extracted by a well. For years, scientists have not had a good way to measure how fast aquifers are recharged by surface water. Commonly used dating tools, such as carbon 14, have been useful in archeology but not so much in understanding the flow of underground water. Now scientists have reported a breakthrough in dating technology using krypton 81. As reported in* The New York Times *(Science: November 21, 2011), krypton 81 is an isotope present in air. Once trapped underground in water that no longer has contact with air, krypton 81 begins to decay by a factor of two every 230,000 years. Capturing krypton 81 is extremely challenging as there is only one molecule of krypton 81 for every quintillion (10^{18}) water molecules. Using sophisticated technology, scientists were able to capture and measure krypton 81 in water samples obtained from deep in the Nubian Aquifer. The results suggest that the Nubian Aquifer has been collecting water for millions of years. The bad news is that the aquifer probably only recharges a little each year; thus, under normal circumstances the water level may only rise a few millimeters a year. While the aquifer still contains a massive amount of water, it is shared by four countries: Egypt, Libya, Chad, and Sudan. Rapid or heavy pumping could lead to both local and international conflicts. Already, some lakes and oases supplied by the aquifer are now dry. While water management is often a political rather than scientific issue, better understanding of the hydrology may make it easier to develop and adhere to water management plans.*

Noted by WVR, MD

Parental Smoking Cessation to Protect Young Children:A Systematic Review and Meta-analysis

Laura J. Rosen, Michal Ben Noach, Jonathan P. Winickoff and Mel F. Hovell

Pediatrics 2012;129;141; originally published online December 26, 2011;
DOI: 10.1542/peds.2010-3209

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Parental Smoking Exposure and Adolescent Smoking Trajectories

Darren Mays, Stephen E. Gilman, Richard Rende, George Luta, Kenneth P. Tercyak and Raymond S. Niaura

Pediatrics 2014;133;983; originally published online May 12, 2014;
DOI: 10.1542/peds.2013-3003

Parental Smoking Exposure and Adolescent Smoking Trajectories

AUTHORS: Darren Mays, PhD, MPH,[a] Stephen E. Gilman, ScD,[b,c] Richard Rende, PhD,[d] George Luta, PhD,[a] Kenneth P. Tercyak, PhD,[a] and Raymond S. Niaura, PhD[a,e,f]

[a]*Lombardi Comprehensive Cancer Center, Georgetown University Medical Center, Washington, District of Columbia;* [b]*Harvard School of Public Health, Boston, Massachusetts;* [c]*Massachusetts General Hospital, Boston, Massachusetts;* [d]*Brown University Medical School, Providence, Rhode Island;* [e]*Schroeder Institute for Tobacco Research and Policy Studies, American Legacy Foundation, Washington, District of Columbia; and* [f]*Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland*

KEY WORDS

cigarette smoking, nicotine dependence, parental smoking, intergenerational smoking

ABBREVIATIONS

CI—confidence interval
CIDI—Composite International Diagnostic Interview
LCGA—latent class growth analysis
NEFS—New England Family Study
OR—odds ratio

Dr Mays contributed to the conceptualization of the study idea, led statistical analyses and interpretation of the data, and drafted the paper; Dr Gilman contributed to the conception and design of the original study, acquisition of data, conceptualization of the study idea, and revision of the paper for important intellectual content; Dr Rende contributed to the conception and design of the original study, acquisition of data, and revision of the paper for important intellectual content; Dr Luta contributed the statistical analysis and revision of the paper for important intellectual content; Dr Tercyak contributed to the revision of the paper for important intellectual content; and Dr Niaura contributed to the conception and design of the original study, acquisition of data, statistical analysis and interpretation, conceptualization of the study idea, and revision of the paper for important intellectual content.

www.pediatrics.org/cgi/doi/10.1542/peds.2013-3003

doi:10.1542/peds.2013-3003

Accepted for publication Feb 26, 2014

Address correspondence to Darren Mays, PhD, MPH, Cancer Prevention & Control Program, Lombardi Comprehensive Cancer Center, Georgetown University Medical Center, 3300 Whitehaven St NW, Suite 4100, Washington, DC 20007. E-mail: dmm239@georgetown.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

(Continued on last page)

WHAT'S KNOWN ON THIS SUBJECT: It is well-established that parental smoking is associated with adolescent smoking initiation and regular tobacco use. However, we know less about how exposure to specific types of parental smoking affect adolescent smoking and progression to regular smoking in young adulthood.

WHAT THIS STUDY ADDS: Among adolescents with parents who are nicotine dependent, each previous year of parental smoking increases the likelihood they will be in a heavy smoking trajectory. Parental smoking cessation early in their children's life is critical to prevent smoking in families.

abstract

NIH FREE

OBJECTIVE: In a multigenerational study of smoking risk, the objective was to investigate the intergenerational transmission of smoking by examining if exposure to parental smoking and nicotine dependence predicts prospective smoking trajectories among adolescent offspring.

METHODS: Adolescents (n = 406) ages 12 to 17 and a parent completed baseline interviews (2001–2004), and adolescents completed up to 2 follow-up interviews 1 and 5 years later. Baseline interviews gathered detailed information on parental smoking history, including timing and duration, current smoking, and nicotine dependence. Adolescent smoking and nicotine dependence were assessed at each time point. Latent Class Growth Analysis identified prospective smoking trajectory classes from adolescence into young adulthood. Logistic regression was used to examine relationships between parental smoking and adolescent smoking trajectories.

RESULTS: Four adolescent smoking trajectory classes were identified: early regular smokers (6%), early experimenters (23%), late experimenters (41%), and nonsmokers (30%). Adolescents with parents who were nicotine-dependent smokers at baseline were more likely to be early regular smokers (odds ratio 1.18, 95% confidence interval 1.05–1.33) and early experimenters (odds ratio 1.04, 95% confidence interval 1.04–1.25) with each additional year of previous exposure to parental smoking. Parents' current non-nicotine–dependent and former smoking were not associated with adolescent smoking trajectories.

CONCLUSIONS: Exposure to parental nicotine dependence is a critical factor influencing intergenerational transmission of smoking. Adolescents with nicotine-dependent parents are susceptible to more intense smoking patterns and this risk increases with longer duration of exposure. Research is needed to optimize interventions to help nicotine-dependent parents quit smoking early in their children's lifetime to reduce these risks. *Pediatrics* 2014;133:983–991

Parental smoking is associated with adolescent smoking uptake and regular smoking, suggesting intergenerational transmission of smoking behavior within families.[1] Research demonstrates that adolescents whose parents smoke are more likely to begin smoking[2,3] and that parental smoking predicts future smoking initiation and regular smoking among adolescents.[4–8] Research also suggests that offspring of parents who quit smoking are less likely to begin smoking and those who already smoke are more likely to quit.[9–12] The intergenerational transmission of smoking within families is likely influenced by multiple factors, such as genetics, observed parental behavior, and the home environment (eg, rules about smoking).[8]

Although many studies have used brief measures that define smoking behavior by using broad categories (eg, any past-month smoking),[2,4,6,8–10] these measures constrain our understanding of how specific types of parental smoking (eg, current versus former) affect adolescent smoking behavior. Few studies have used measures to shed light on how nicotine dependence unfolds within families. Although research suggests intergenerational transmission of nicotine dependence occurs,[13–15] findings of research on the influence of parental nicotine dependence and adolescent smoking remain equivocal.[3,16]

Other evidence demonstrates distinct trajectories of adolescent smoking behavior can be identified.[5,17–21] Few studies, however, have used prospective data to track influences of parental smoking on offspring's smoking behavior from adolescence into young adulthood, a period of risk for developing nicotine dependence.[22] Nicotine-dependent smokers are less successful at quitting and are more likely to quit with intensive cessation interventions.[23] Examining if exposure to parental smoking and nicotine dependence differentially influence offspring's smoking trajectories could help identify adolescents and families in need of more intensive intervention to reduce risks.

Our goal was to investigate the associations between adolescents' exposure to their parents' smoking and prospective trajectories of adolescent smoking into young adulthood. This study builds on a previous investigation of intergenerational smoking from the New England Family Study (NEFS), a multigeneration study of smoking risk within families.[3] The NEFS was designed to understand intergenerational transmission of cigarette smoking by capturing detailed information on parental smoking history and nicotine dependence, and assessing offspring's smoking behavior prospectively. The prior NEFS investigation demonstrated that adolescents' cumulative exposure to active parental smoking, but not former parental smoking, increases the likelihood of adolescent smoking initiation.[3] Prospective NEFS data provide a unique opportunity to gain new knowledge of how offspring's exposure to parental smoking and nicotine dependence early in life influences smoking trajectories.

METHODS

Participants and Procedure

This analysis included data from second- and third-generation NEFS participants.[3,24–26] The NEFS was established to interview adult offspring of pregnant women enrolled between 1959 and 1964 at the Boston, Massachusetts, and Providence, Rhode Island, sites of the National Collaborative Perinatal Project, a birth cohort study of the effects of in utero and early childhood environment on child health.[27] Adult offspring of National Collaborative Perinatal Project participants (second-generation) were selected for participation by using a multistage sampling procedure and contacted by mail at age 40 to enroll in the NEFS.[3] Among NEFS adults residing within 100 miles of the Providence site, adolescent offspring (third-generation) between 12 and 17 years of age were invited to participate in a prospective study on the intergenerational transmission of smoking conducted from 2001 to 2009.[3] Second- and third-generation participants were provided with a modest incentive (eg, $5–$10 cash equivalent) for completing study interviews.

In total, 726 eligible third-generation adolescents were invited to participate; 559 (72%) completed a baseline interview with data on smoking behavior. A complete description of the baseline sample was published previously.[3] Adolescents and, separately, their parents completed a baseline interview in person. Adolescents were contacted for a second interview 1 year later (mean 1.3 years, SD 0.28), and those who were age 18 and older at the 5-year follow-up were contacted for a third interview (mean 5.2 years, SD 0.64). The Brown University Institutional Review Board approved the protocol. Parent consent and adolescent assent were obtained at baseline and reestablished at each follow-up.

The sample for the current study comprised 406 adolescents with data available for 2 or more time points to analyze changes in smoking behavior. Characteristics of the baseline and analytic samples are shown in Table 1. Adolescents in the analytic sample were significantly older than those in the original baseline sample ($P < .001$) because of the age restrictions for the third interview. There were no other statistically significant differences between the samples.

Measures

Adolescent Smoking

Adolescent smoking was captured by using the Lifetime Inventory of Smoking Trajectories, a valid instrument that

TABLE 1 Characteristics of the Baseline and Analytic Samples

	Baseline Sample	Analytic Sample
Adolescent demographics	*n* = 559	*n* = 406
Gender		
Male	267 (47.8)	194 (47.8)
Female	292 (52.2)	212 (52.2)
Race		
Non-Hispanic white	474 (84.8)	350 (86.2)
Nonwhite	85 (15.2)	56 (13.8)
Baseline age, mean (SD)	14.0 (1.7)	14.2 (1.6)
Parent demographics		
Gender		
Male	124 (22.2)	85 (20.9)
Female	435 (77.8)	321 (79.1)
Race		
Non-Hispanic white	474 (84.8)	351 (86.4)
Nonwhite	85 (15.2)	55 (13.6)
Baseline age, mean (SD)	39.6 (1.9)	39.6 (1.9)
Marital status		
Married	402 (71.9)	298 (73.4)
Unmarried	157 (28.1)	108 (26.6)
Educational attainment		
≥College degree	105 (18.8)	70 (17.2)
<College education	454 (81.2)	336 (82.8)
Household income		
<$60 000/y	255 (45.6)	183 (45.1)
≥$60 000/y	304 (54.4)	223 (54.9)
Parental smoking		
Nonsmoker	220 (40.0)	167 (41.7)
Former daily or weekly smoker	176 (31.9)	126 (31.5)
Current, nondependent	71 (12.9)	47 (11.8)
Current, dependent	84 (15.2)	60 (15.0)

Some cells do not at up to the total sample size due to sporadic missing data for <5% of participants for individual variables. Values are *n* (%) unless otherwise noted.

gathers detailed information on smoking initiation, past and current smoking, and susceptibility.[28] Nicotine dependence was assessed based on *Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition,* criteria by using the adapted Composite International Diagnostic Interview (CIDI).[29,30] The CIDI was selected over brief dependence screeners (eg, Fagerström Tolerance Questionnaire) to gather detailed information on clinical dependence symptoms for the NEFS. Smoking status was operationalized to reflect developmentally appropriate transitions from nonsmoking and susceptibility to regular, dependent use.[31] For trajectory analyses, smoking status at each interview used a score with the following values: committed nonsmokers never smoked and indicated they would never try smoking (0); susceptible nonsmokers never smoked but indicated they may try in the future (1); triers smoked only once in their life (2); experimenters smoked more than once, but never daily (3); regular smokers without nicotine dependence smoked daily but did not meet *Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition,* dependence criteria (4); and regular smokers with nicotine dependence smoked daily and met dependence criteria (5).

Parental Smoking

Parental smoking and nicotine dependence also were assessed at baseline by using the Lifetime Inventory of Smoking Trajectories (LIST)[28] and CIDI.[29,30] One parent completed a baseline interview for the study. For analyses, we examined parental smoking in 2 ways. A categorical variable was created based on parents' baseline smoking status: current (daily or weekly) nicotine-dependent smoker, current non-nicotine–dependent smoker, former daily or weekly smoker, or nonsmoker.

The Lifetime Inventory of Smoking Trajectories gathers data on current and prior periods of smoking, including timing and duration, which allowed us to determine adolescents' cumulative years of exposure to parental smoking.[28] We created continuous predictor variables for adolescents' total years of exposure to parental smoking before baseline based on whether their parents were current dependent smokers, current smokers without dependence, or former smokers at baseline.

Covariates

Parent (gender, race/ethnicity, age, educational attainment, household income, marital status) and adolescent (gender, age, race/ethnicity) demographics ascertained at baseline were examined as covariates.

Statistical Analysis

We conducted Latent Class Growth Analysis (LCGA)[32] by using MPlus 7.1 (Muthén & Muthén, Los Angeles, CA) to construct adolescent smoking trajectory classes based on prospective behavior patterns.[19] LCGA has been widely used in studies of adolescent smoking[19,33,34] and similar behaviors.[35] Adolescents who were committed nonsmokers at all time points (*n* = 123, 30%) were defined a priori as a trajectory class.[17,33,34] For the remainder (*n* =283, 70%), LCGA models examined 1 to 4 class solutions. The optimal number of classes was determined based on solutions having a lower Bayesian Information Criteria, higher estimated proportion of participants correctly classified (entropy), and a statistically significant Lo-Mendall-Rubin likelihood ratio χ^2 test comparing fit for a model with K classes

compared with K-1 classes.[32,36,37] Missing data were accommodated using full-information robust maximum likelihood estimation, which uses all available data for analyses.[38]

We examined whether exposure to parental smoking was associated with adolescent smoking trajectories through bivariate analyses (eg, χ^2 tests) and multinomial logistic regression.[39] The NEFS included siblings to investigate aims surrounding smoking risk within families. The sample included 197 singletons (49%), 91 sibling pairs (n = 182, 45%), and 9 sibling triads (n = 27, 7%). Analyses accounted for clustering using survey procedures in SAS 9.3 (SAS Institute, Inc, Cary, NC).

The primary predictor in regression analyses was exposure to parental smoking at baseline. Demographics associated with smoking trajectory classes in bivariate analyses ($P < .05$) were considered as covariates. Two separate models were created. In Model 1, we used the categorical parental smoking status predictor variable, with nonsmokers as the reference group. In Model 2, parental smoking was operationalized as adolescents' total years of exposure to their parents' smoking stratified by parents' baseline smoking status.

RESULTS

Study Sample

Sample characteristics are shown in Table 1. Participants (n = 406) were nearly half girls (52%), and most were white (86%) and averaged 14.2 years (SD 1.6) of age at baseline. The mean (SD) smoking status scores at baseline and each follow-up were 0.93 (1.42), 1.20 (1.53), and 2.41 (1.83), respectively. In total, 15.0% of parents were current dependent smokers, 11.8% were current nondependent smokers, 31.5% were former smokers, and 41.7% were nonsmokers. Parents who were current or former smokers (n = 233) smoked an average of 19.0 (SD 12.5) cigarettes per day. The number of cigarettes smoked per day did not differ significantly by parental smoking status (P = .469). Adolescents of parents who were current dependent smokers were exposed to an average of 1.19 (SD 3.66) years of smoking before baseline, whereas offspring of current nondependent smokers were exposed for 0.89 (SD 2.99) years, and offspring of former smokers were exposed for 1.26 (SD 3.29) years.

Adolescent Smoking Trajectories

Table 2 displays fit statistics for LCGA models. The 3-class solution was optimal based on the joint evaluation of the fit indices and the likelihood ratio χ^2 test compared with the 2-class solution. Combined with the a priori class of nonsmokers, this created a 4-level trajectory class outcome variable.

To describe adolescent trajectory classes, we calculated average smoking status scores over time by class (Fig 1). Classes were labeled as nonsmokers (30%), early experimenters (23%), late experimenters (41%), and early regular smokers (6%). Nonsmokers abstained across all 5 years. Early experimenters tried or smoked nondaily at baseline and year 2, and nearly half (50%) were regular smokers by year 5. Late experimenters typically tried smoking later, and almost 25% were regular smokers by year 5. Early regular smokers smoked regularly at baseline and most (80%) were nicotine-dependent smokers by year 5 or earlier.

TABLE 2 Latent Class Growth Analysis Fit Statistics

K Classes	BIC	Entropy	χ^2 P value
1	2620.7	—	—
2	2374.5	0.846	.005
3	2192.2	0.989	<.001
4	2132.6	0.951	.015

P value based on Lo-Mendall-Rubin likelihood ratio χ^2 test comparing model with K classes to model with K-1 classes. BIC, Bayesian Information Criteria.

Table 3 displays bivariate associations between demographics, parental smoking, and adolescent smoking trajectories. Baseline demographic characteristics associated with adolescents' trajectory class ($P < .05$) that were considered as covariates in logistic models included adolescents' and parents' age, and parents' race, education, marital status, and household income. When both parents' and adolescents' ages were included in the logistic models, only adolescents' age was significant and the results were similar regardless of which age variable was used. Only adolescents' age was included in the models for parsimony. Parents' cigarettes smoked per day did not differ significantly by adolescents' trajectory classes in pairwise comparisons (Table 3), so it was excluded from multivariable analyses.

Parental Smoking and Adolescent Smoking Trajectories

Table 4 displays results of the logistic regression models. Model 1 examined parents' baseline smoking status using a categorical predictor. Adolescents with parents who were current dependent smokers at baseline were significantly more likely to be in the 2 heaviest smoking trajectories: early experimenters (odds ratio [OR] 4.61, 95% confidence interval [CI] 1.52–13.96) and early regular smokers (OR 9.67, 95% CI 1.66–50.67). Adolescents whose parents were current nondependent smokers at baseline were also significantly more likely to be early regular smokers (OR 9.96, 95% CI 1.67–59.44), early experimenters (OR 4.52, 95% CI 1.32–15.42), and late experimenters (OR 2.89, 95% CI 1.16–7.17). Parents' former smoking was not associated with adolescents' trajectory class.

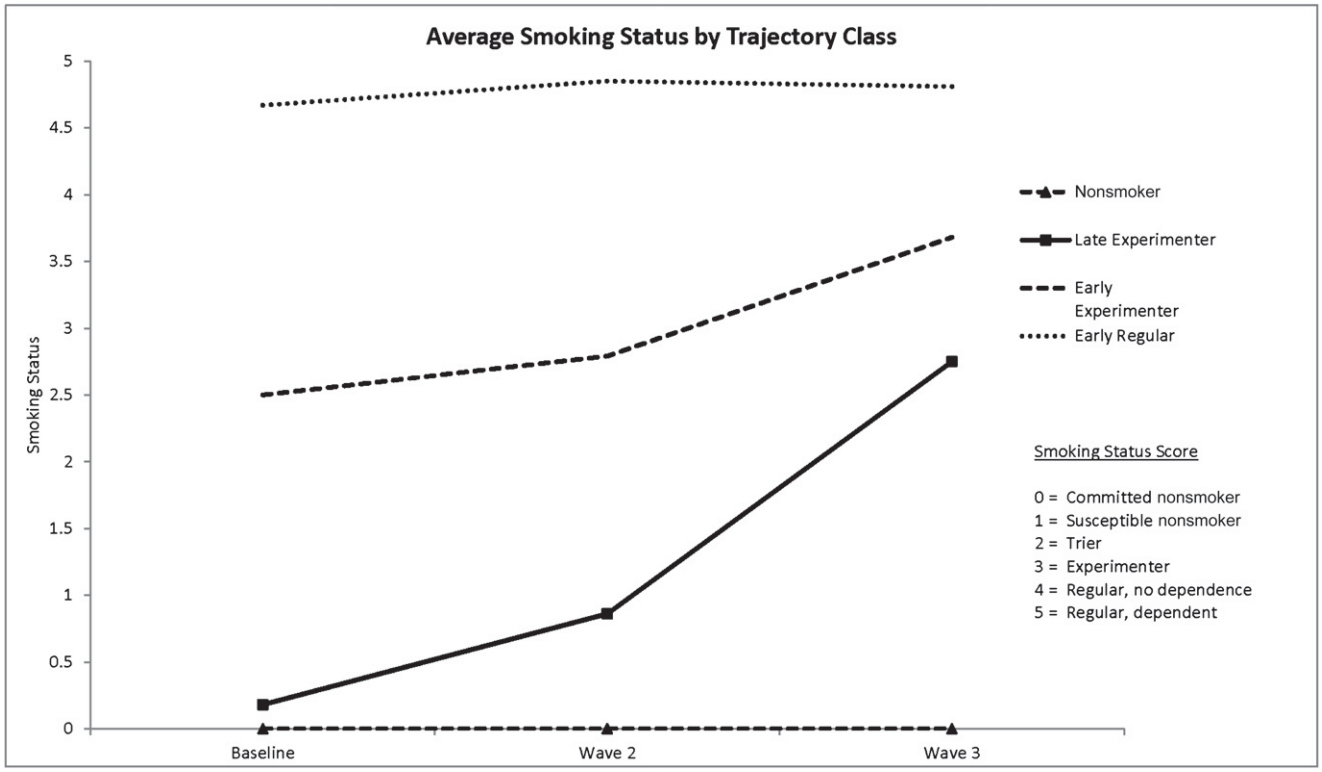


FIGURE 1
Average adolescent smoking status by trajectory class.

Model 2 examined associations between adolescents' years of exposure to parental smoking separated by their parents' smoking status at baseline and smoking trajectory classes. ORs reflect the increase in adolescents' odds of being in a higher smoking trajectory class relative to being a committed nonsmoker with each additional year of exposure to parental smoking before baseline. After adjusting for demographics, each prior year of exposure to parental smoking among adolescents whose parents were nicotine-dependent smokers significantly increased the odds of an adolescent being an early regular smoker (OR 1.18, 95% CI 1.05–1.33) and an early experimenter (OR 1.14, 95% CI 1.04–1.25). Each additional year of exposure among adolescents whose parents were current nondependent smokers also increased the odds of adolescents being an early regular smoker (OR 1.23, 95% CI 1.01–1.50); however, the overall effect of exposure among those whose parents were nondependent current smokers was not significant ($P = .17$).

DISCUSSION

This study adds to the research on intergenerational transmission of smoking by demonstrating that when parents are current, nicotine-dependent smokers, a longer duration of exposure to parental smoking increases the odds that adolescents will be in heavier smoking trajectories. Parents' categorical smoking status proved to be a blunt indicator of risk: exposure to any form of current parental smoking at baseline increased the likelihood that adolescent offspring would be in a heavier smoking trajectory class. Examining adolescents' previous years of exposure to parental smoking stratified by parents' baseline smoking status yielded a more fine-gained assessment of risk. A longer duration of exposure to parental smoking among adolescents whose parents were nicotine dependent increased the odds that adolescents would be in heavier smoking trajectories. These findings indicate that cessation among nicotine-dependent parents early in their offspring's lifetime is critical to reduce the risk of smoking within families.

Using NEFS data, Gilman and colleagues[3] reported that exposure to current parental smoking predicts adolescent smoking initiation at baseline, whereas parental nicotine dependence and former parental smoking were not associated with smoking initiation. Although this study suggests that parental nicotine dependence may not be the most important risk factor for adolescent smoking initiation, our results demonstrate that assessing parental nicotine dependence remains critical

TABLE 3 Bivariate Associations With Adolescents' Smoking Trajectory Class

	Never Smoker *n* = 123	Early Regular *n* = 24	Early Experimenter *n* = 94	Late Experimenter *n* = 165	*P*
Adolescent demographics					
Gender, *n* (%)					.871
Male	55 (44.7)	12 (50.0)	47 (50.0)	80 (48.5)	
Female	68 (55.3)	12 (50.0)	47 (50.0)	85 (51.5)	
Race, *n* (%)					.100
Non-Hispanic white	107 (87.0)	23 (95.8)	74 (78.7)	146 (88.5)	
Nonwhite	16 (13.0)	1 (4.2)	20 (21.3)	19 (11.5)	
Baseline age, mean (SD)	13.6 (1.5)	16.2 (1.1)	14.9 (1.4)	14.0 (1.5)	<.001
Parent demographics					
Gender, *n* (%)					.665
Male	29 (23.6)	4 (17.7)	16 (17.1)	36 (21.8)	
Female	94 (76.4)	20 (83.3)	78 (82.9)	129 (78.2)	
Race, *n* (%)					.050
White	104 (84.6)	23 (95.8)	75 (79.8)	149 (88.5)	
Nonwhite	19 (15.4)	1 (4.2)	19 (20.2)	16 (11.5)	
Baseline age, mean (SD)	40.0 (1.8)	39.3 (1.8)	39.1 (2.0)	39.7 (1.9)	.005
Marital status, *n* (%)					<.001
Married	99 (80.5)	10 (41.7)	51 (54.2)	134 (81.2)	
Unmarried	24 (19.5)	14 (58.3)	43 (45.7)	31 (18.8)	
Educational attainment, *n* (%)					.003
≥College	30 (24.4)	1 (4.2)	7 (7.4)	32 (19.4)	
<College	93 (75.6)	23 (95.8)	87 (92.6)	133 (80.6)	
Household income, *n* (%)					.008
<$60 000/y	57 (46.3)	15 (62.5)	52 (55.3)	59 (35.8)	
≥$60 000/y	66 (53.7)	9 (37.5)	42 (44.7)	106 (64.2)	
Parental smoking					
Smoking status, *n* (%)					<.001
Current, dependent	9 (7.4)	10 (41.7)	24 (26.1)	17 (10.4)	
Current, nondependent	7 (5.7)	6 (25.0)	14 (15.2)	20 (12.3)	
Former daily or weekly smoker	36 (29.5)	3 (12.5)	28 (30.4)	59 (36.2)	
Nonsmoker	69 (57.0)	5 (20.8)	26 (28.3)	67 (41.1)	
Cigarettes/d, mean (SD)[a]	8.4 (12.0)	15.7 (13.5)	13.0 (11.0)	11.2 (15.2)	.012
Years of exposure before baseline by parents' baseline smoking status, mean (SD)					
Current, dependent	0.46 (2.2)	4.8 (6.6)	2.1 (4.7)	0.7 (2.8)	.047
Current, nondependent	0.34 (1.8)	1.8 (3.9)	1.1 (3.2)	1.0 (3.2)	.030
Former daily or weekly	1.0 (2.9)	0.2 (1.0)	1.7 (4.0)	1.3 (3.3)	.314

Some cells do not at up to the total sample size due to sporadic missing data for <5% of participants for individual variables.

[a] Although the main effect for parental cigarettes smoked per day was statistically significant, no pairwise mean comparisons of adolescent smoking trajectories differed at $P < .05$.

to identify adolescents at risk for heavier smoking over time. In line with the findings of Gilman and colleagues,[3] our results showed that exposure to parental smoking when parents had quit before baseline was not associated with adolescent smoking. These data support the hypothesis that intergenerational smoking transmission occurs, in part, through social learning where adolescent smoking is influenced by observation of parental smoking.[3,8]

Our analysis yielded smoking trajectory classes consistent with previous studies using similar methods, supporting the validity of our findings.[18,19,40,41] An important contribution of our study is the attention to nicotine dependence in identifying adolescent smoking trajectories. One study examined how nicotine-dependence symptoms develop among adolescent smokers, concluding that parental smoking increases the risk of early-onset dependence.[13] Our results were similar, and, taken together, sharpen the focus on using trajectory-based definitions of adolescent smoking that incorporate nicotine dependence to identify adolescents at risk rather than relying only on brief measures, such as those used in prior studies.[2,4,6,9,10] Trajectory-based approaches using measures of nicotine dependence yield more fine-grained information to understand how intergenerational transmission of smoking occurs, timing and duration, and what aspects of parental smoking predict high-risk adolescent smoking behavior.[13]

Screening and counseling adolescents and their parents in pediatric clinical settings for tobacco use is a recommended strategy to reduce youth

TABLE 4 Multinomial Logistic Regression Analysis of Adolescent Smoking Trajectories Based on Exposure to Parental Smoking at Baseline, Defined as a Category or Duration of Adolescents' Previous Years of Exposure to Parental Smoking

	Model 1: Parents' Baseline Smoking Status Category				Model 2: Years of Exposure to Parental Smoking Before Baseline by Parents' Baseline Smoking Status			
	Trajectory Group				Trajectory Group			
	Early Regular *n* = 24	Early Experimenter *n* = 94	Late Experimenter *n* = 165	*P* Value	Early Regular *n* = 24	Early Experimenter *n* = 94	Late Experimenter *n* = 165	*P* Value
Demographics								
Adolescent baseline age	3.86	1.75	1.20	<.001	3.68	1.71	1.20	<.001
	2.44–6.10	1.43–2.14	1.00–1.45		2.41–5.62	1.40–2.09	0.99–1.44	
Parent white race	7.82	1.04	1.60	.163	10.18	0.38	1.80	.149
	0.90–66.24	0.44–2.47	0.76–3.38		0.91–114.54	0.16–0.87	0.86–3.76	
Parent college education	0.32	0.42	0.77	.162	0.34	0.38	0.71	.103
	0.06–1.91	0.18–0.98	0.41–1.42		0.51–2.25	0.16–0.87	0.38–1.33	
Parents married	0.46	0.32	0.88	.034	0.36	0.28	0.84	.015
	0.10–2.14	0.13–0.77	0.41–1.86		0.08–1.63	0.11–0.69	0.40–1.78	
Income >$60 000/y	1.42	1.95	1.81	.148	1.41	0.84	1.94	.119
	0.37–5.50	0.89–4.28	1.04–3.16		0.37–5.34	0.40–1.78	0.89–4.25	
Parental smoking								
Current, dependent	9.16	4.61	1.94	.016	1.18	1.14	1.06	.010
	1.66–50.67	1.52–13.96	0.68–5.56		1.05–1.33	1.04–1.25	0.96–1.17	
Current, nondependent	9.96	4.52	2.89	.034	1.23	1.15	1.14	.174
	1.67–59.44	1.32–15.42	1.16–7.17		1.01–1.50	0.98–1.34	0.99–1.30	
Former daily/weekly	0.76	1.84	1.57	.256	0.80	1.05	1.03	.426
	0.13–4.45	0.83–4.06	0.90–2.73		0.56–1.14	0.94–1.18	0.96–1.12	

In Model 1, parental smoking is defined categorically based on parents' baseline smoking status. In Model 2, parental smoking is defined as adolescents' total years of exposure to parental smoking before baseline separated by their parents' smoking status at baseline. ORs and 95% CIs displayed. The reference group for ORs is adolescents who were never smokers (*n* = 123).

smoking risk.[42,43] This study adds to evidence supporting the need to address smoking among both adolescents and their parents in pediatric clinical settings.[42,43] Although some studies have shown that offspring of parents who had quit smoking are less likely to smoke,[9–12] to our knowledge there has been no clinical trial to determine whether interventions for parental smoking cessation have a downstream impact on their adolescent offspring. Although there are obvious benefits to eliminating secondhand smoke exposure by helping parents quit,[44] this is an important topic of investigation for future studies.

Recent reviews indicate tobacco control interventions administered in the clinical setting can be impactful for preventing youth smoking[45] and advocate for strategies, such as the 5 A's (Ask, Advise, Assess, Assist, Arrange), to identify parents who smoke and deliver cessation advice.[43] Parental cessation counseling interventions administered in pediatric settings have had a modest impact,[46] and despite such interventions, most parents do not quit.[44] Our data suggest this could be because counseling interventions do not fully attend to parental nicotine dependence. Dependence symptoms are a strong predictor of quitting smoking above other known factors (eg, motivation to quit),[23] and pharmacotherapies are often critical to increase the likelihood of successfully quitting among dependent smokers.[47]

Our findings highlight the importance of screening parents for nicotine dependence in pediatric settings and referring them to evidence-based cessation resources. An efficient approach to put these findings into practice could be for pediatric providers to use brief nicotine-dependence screening instruments that have well-established validity to identify dependent parents.[48] These brief screening instruments could be dovetailed with parent-directed counseling interventions emphasizing quitting for the health of their children to motivate cessation[44] and pharmacotherapy to treat dependence. Another approach that deserves additional research is Ask, Advise, Connect, where clinicians ask parents about smoking, provide brief cessation advice, and refer parents who smoke to evidence-based cessation resources, such as telephone quit lines.[49] An approach integrating nicotine-dependence screening, provider advice that parents quit for their children's health, and referral for cessation support and dependence treatment may be optimal and should be examined in future research.

Our findings should be interpreted in light of important limitations. Baseline interviews were conducted with only 1 parent, limiting our ability to investigate differences based on maternal and paternal smoking. Parental smoking was assessed at baseline only, therefore we could not examine how prospective patterns of parental smoking influence adolescent smoking. We did not examine smokeless or other noncigarette tobacco use, which could

be an important avenue for future research to understand the role of nicotine dependence given the increasing use of newer tobacco products (eg, snus, electronic cigarettes). All measures were self-report, smoking was not verified biochemically, and we did not control for other risk factors for smoking (eg, peer smoking).

CONCLUSIONS

This study demonstrates that among adolescents with parents who are nicotine dependent, each previous year of exposure to parental smoking increases the likelihood that adolescents will be in a higher-risk smoking trajectory and progress to regular smoking. Adolescents' cumulative exposure to parental smoking may provide a clearer indicator of risk than often-used categorical indicators of parental smoking alone. Interventions to identify nicotine-dependent parents and link them with evidence-based cessation resources to quit smoking early in the life of their offspring may help reduce the risk of smoking within families.

REFERENCES

1. Avenevoli S, Merikangas KR. Familial influences on adolescent smoking. *Addiction*. 2003;98(suppl 1):1–20
2. den Exter Blokland EA, Engels RC, Hale WW III, Meeus W, Willemsen MC. Lifetime parental smoking history and cessation and early adolescent smoking behavior. *Prev Med*. 2004;38(3):359–368
3. Gilman SE, Rende R, Boergers J, et al. Parental smoking and adolescent smoking initiation: an intergenerational perspective on tobacco control. *Pediatrics*. 2009;123(2). Available at: www.pediatrics.org/cgi/content/full/123/2/e274
4. Bricker JB, Peterson AV Jr, Sarason IG, Andersen MR, Rajan KB. Changes in the influence of parents' and close friends' smoking on adolescent smoking transitions. *Addict Behav*. 2007;32(4):740–757
5. Chassin L, Presson CC, Pitts SC, Sherman SJ. The natural history of cigarette smoking from adolescence to adulthood in a midwestern community sample: multiple trajectories and their psychosocial correlates. *Health Psychol*. 2000;19(3):223–231
6. Hill KG, Hawkins JD, Catalano RF, Abbott RD, Guo J. Family influences on the risk of daily smoking initiation. *J Adolesc Health*. 2005;37(3):202–210
7. Mahabee-Gittens EM, Xiao Y, Gordon JS, Khoury JC. The dynamic role of parental influences in preventing adolescent smoking initiation. *Addict Behav*. 2013;38(4):1905–1911
8. Vuolo M, Staff J. Parent and child cigarette use: a longitudinal, multigenerational study. *Pediatrics*. 2013;132(3). Available at: www.pediatrics.org/cgi/content/full/132/3/e568
9. Bricker JB, Leroux BG, Peterson AV Jr, et al. Nine-year prospective relationship between parental smoking cessation and children's daily smoking. *Addiction*. 2003;98(5):585–593
10. Bricker JB, Rajan KB, Andersen MR, Peterson AV Jr. Does parental smoking cessation encourage their young adult children to quit smoking? A prospective study. *Addiction*. 2005;100(3):379–386
11. Chassin L, Presson CC, Todd M, Rose JS, Sherman SJ. Maternal socialization of adolescent smoking: the intergenerational transmission of parenting and smoking. *Dev Psychol*. 1998;34(6):1189–1201
12. Chassin L, Presson C, Rose J, Sherman SJ, Prost J. Parental smoking cessation and adolescent smoking. *J Pediatr Psychol*. 2002;27(6):485–496
13. Hu MC, Griesler PC, Schaffran C, Wall MM, Kandel DB. Trajectories of criteria of nicotine dependence from adolescence to early adulthood. *Drug Alcohol Depend*. 2012;125(3):283–289
14. Kandel DB, Hu MC, Griesler PC, Schaffran C. On the development of nicotine dependence in adolescence. *Drug Alcohol Depend*. 2007;91(1):26–39
15. Selya AS, Dierker LC, Rose JS, Hedeker D, Mermelstein RJ. Risk factors for adolescent smoking: parental smoking and the mediating role of nicotine dependence. *Drug Alcohol Depend*. 2012;124(3):311–318
16. Lieb R, Schreier A, Pfister H, Wittchen HU. Maternal smoking and smoking in adolescents: a prospective community study of adolescents and their mothers. *Eur Addict Res*. 2003;9(3):120–130
17. Audrain-McGovern J, Rodriguez D, Tercyak KP, Cuevas J, Rodgers K, Patterson F. Identifying and characterizing adolescent smoking trajectories. *Cancer Epidemiol Biomarkers Prev*. 2004;13(12):2023–2034
18. Bernat DH, Erickson DJ, Widome R, Perry CL, Forster JL. Adolescent smoking trajectories: results from a population-based cohort study. *J Adolesc Health*. 2008;43(4):334–340
19. Costello DM, Dierker LC, Jones BL, Rose JS. Trajectories of smoking from adolescence to early adulthood and their psychosocial risk factors. *Health Psychol*. 2008;27(6):811–818
20. Miles JN, Weden MM. Is the intergenerational transmission of smoking from mother to child mediated by children's behavior problems? *Nicotine Tob Res*. 2012;14(9):1012–1018
21. Weden MM, Miles JN. Intergenerational relationships between the smoking patterns of a population-representative sample of US mothers and the smoking trajectories of their children. *Am J Public Health*. 2012;102(4):723–731
22. Breslau N, Johnson EO, Hiripi E, Kessler R. Nicotine dependence in the United States: prevalence, trends, and smoking persistence. *Arch Gen Psychiatry*. 2001;58(9):810–816
23. Hyland A, Li Q, Bauer JE, Giovino GA, Steger C, Cummings KM. Predictors of cessation in a cohort of current and former smokers followed over 13 years. *Nicotine Tob Res*. 2004;6(suppl 3):S363–S369
24. Gilman SE, Martin LT, Abrams DB, et al. Educational attainment and cigarette smoking: a causal association? *Int J Epidemiol*. 2008;37(3):615–624
25. Graham AL, Papandonatos GD, DePue JD, et al. Lifetime characteristics of participants and non-participants in a smoking cessation trial: implications for external validity and public health impact. *Ann Behav Med*. 2008;35(3):295–307
26. Kahler CW, Strong DR, Papandonatos GD, et al. Cigarette smoking and the lifetime alcohol involvement continuum. *Drug Alcohol Depend*. 2008;93(1-2):111–120
27. Hardy JB. The Collaborative Perinatal Project: lessons and legacy. *Ann Epidemiol*. 2003;13(5):303–311
28. Colby SM, Clark MA, Rogers ML, et al. Development and reliability of the lifetime interview on smoking trajectories. *Nicotine Tob Res*. 2012;14(3):290–298

29. Cottler LB, Robins LN, Grant BF, et al. The CIDI-core substance abuse and dependence questions: cross-cultural and nosological issues. The WHO/ADAMHA Field Trial. *Br J Psychiatry*. 1991;159:653–658
30. Dierker LC, Donny E, Tiffany S, Colby SM, Perrine N, Clayton RR; Tobacco Etiology Research Network. The association between cigarette smoking and DSM-IV nicotine dependence among first year college students. *Drug Alcohol Depend*. 2007;86(2-3):106–114
31. Turner L, Mermelstein R, Flay B. Individual and contextual influences on adolescent smoking. *Ann N Y Acad Sci*. 2004;1021:175–197
32. Jung T, Wickrama KAS. An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass*. 2008;2(1):302–317
33. Chassin L, Presson C, Seo DC, et al. Multiple trajectories of cigarette smoking and the intergenerational transmission of smoking: a multigenerational, longitudinal study of a Midwestern community sample. *Health Psychol*. 2008;27(6):819–828
34. Orlando M, Tucker JS, Ellickson PL, Klein DJ. Developmental trajectories of cigarette smoking and their correlates from early adolescence to young adulthood. *J Consult Clin Psychol*. 2004;72(3):400–410
35. Brook JS, Lee JY, Brown EN, Finch SJ, Brook DW. Developmental trajectories of marijuana use from adolescence to adulthood: personality and social role outcomes. *Psychol Rep*. 2011;108(2):339–357
36. Lo Y, Mendell NR, Rubin DB. Testing the number of components in a normal mixture. *Biometrika*. 2001;88(3):767–778
37. Nagin DS. Analyzing developmental trajectories: a semiparametric, group-based approach. *Psychological Methods*. 1999;4(2):139–157
38. Enders CK, Bandalos DL. The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Struct Equ Modeling*. 2001;8(3):430–457
39. Tabachnick BG, Fidell LS. *Using Multivariate Statistics*. 5th ed. Boston, MA: Allyn & Bacon; 2006
40. Colder CR, Mehta P, Balanda K, et al. Identifying trajectories of adolescent smoking: an application of latent growth mixture modeling. *Health Psychol*. 2001;20(2):127–135
41. Hampson SE, Tildesley E, Andrews JA, Barckley M, Peterson M. Smoking trajectories across high school: sensation seeking and Hookah use. *Nicotine Tob Res*. 2013;15(8):1400–1408
42. Sims TH; Committee on Substance Abuse. From the American Academy of Pediatrics: Technical report—Tobacco as a substance of abuse. *Pediatrics*. 2009;124(5). Available at: www.pediatrics.org/cgi/content/full/124/5/e1045
43. Winickoff JP, Berkowitz AB, Brooks K, et al; Tobacco Consortium, Center for Child Health Research of the American Academy of Pediatrics. State-of-the-art interventions for office-based parental tobacco control. *Pediatrics*. 2005;115(3):750–760
44. Rosen LJ, Noach MB, Winickoff JP, Hovell MF. Parental smoking cessation to protect young children: a systematic review and meta-analysis. *Pediatrics*. 2012;129(1):141–152
45. Patnode CD, O'Connor E, Whitlock EP, Perdue LA, Soh C, Hollis J. Primary care-relevant interventions for tobacco use prevention and cessation in children and adolescents: a systematic evidence review for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2013;158(4):253–260
46. Priest N, Roseby R, Waters E, et al. Family and carer smoking control programmes for reducing children's exposure to environmental tobacco smoke. *Cochrane Database Syst Rev*. 2008;(4):CD001746
47. Silagy C, Lancaster T, Stead L, Mant D, Fowler G. Nicotine replacement therapy for smoking cessation. *Cochrane Database Syst Rev*. 2004;(3):CD000146
48. Kozlowski LT, Porter CQ, Orleans CT, Pope MA, Heatherton T. Predicting smoking cessation with self-reported measures of nicotine dependence: FTQ, FTND, and HSI. *Drug Alcohol Depend*. 1994;34(3):211–216
49. Vidrine JI, Shete S, Cao Y, et al. Ask-Advise-Connect: a new approach to smoking treatment delivery in health care settings. *JAMA Intern Med*. 2013;173(6):458–464

(Continued from first page)

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Supported by National Institutes of Health Transdisciplinary Tobacco Research Center award CA084719 and by the Biostatistics and Bioinformatics Shared Resource of Georgetown Lombardi Comprehensive Cancer Center through Comprehensive Cancer Center support grant P30CA051008. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

Parental Smoking Exposure and Adolescent Smoking Trajectories

Darren Mays, Stephen E. Gilman, Richard Rende, George Luta, Kenneth P. Tercyak and Raymond S. Niaura

Pediatrics 2014;133;983; originally published online May 12, 2014;
DOI: 10.1542/peds.2013-3003

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People.™

PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY

ORIGINAL RESEARCH Volume 10 — June 27, 2013

Use and Effectiveness of Quitlines for Smokers With Diabetes: Cessation and Weight Outcomes, Washington State Tobacco Quit Line, 2008

Gillian L. Schauer, MPH; Terry Bush, PhD; Barbara Cerutti; Lisa Mahoney, MS; Juliet R. Thompson; Susan M. Zbikowski, PhD

Suggested citation for this article: Schauer GL, Bush T, Cerutti B, Mahoney L, Thompson JR, Zbikowski SM. Use and Effectiveness of Quitlines for Smokers With Diabetes: Cessation and Weight Outcomes, Washington State Tobacco Quit Line, 2008. Prev Chronic Dis 2013;10:120324. DOI: http://dx.doi.org/10.5888/pcd10.120324.

PEER REVIEWED

Abstract

Introduction
Having diabetes and smoking increases the risk of morbidity and mortality. However, cessation-related weight gain, a common side effect during quitting, can further complicate diabetes. Evidence-based telephone quitlines can support quitting but have not been studied adequately in populations with chronic diseases such as diabetes. The purpose of this study was to evaluate the use and effectiveness of a tobacco quitline among tobacco users with diabetes. Cessation-related weight concerns and weight gain were also assessed.

Methods
We administered a telephone-based follow-up survey to tobacco users with and without diabetes 7 months after their enrollment in a quitline. We collected and analyzed data on demographics, tobacco use, dieting, weight concern, quitting success (7- and 30-day point prevalence), and weight gain. We computed summary statistics for descriptive data, χ^2 and *t* tests for bivariate comparisons, and multivariable analyses to determine correlates of cessation.

Results
Tobacco users with diabetes used the quitline in a greater proportion than they were represented in the general population. Quit rates for those with and without diabetes did not differ significantly (24.3% vs 22.5%). No significant differences existed between groups for weight gain at follow-up, regardless of quit status. However, participants with diabetes reported more weight gain in previous quit attempts (34.2% vs 22.4% gained >20 lbs, $P = .03$). Weight concern was a significant correlate of continued smoking, regardless of diabetes status.

Conclusions
Results suggest that quitlines are effective for participants with diabetes, but tailored interventions that address weight concerns during cessation are needed.

Introduction

People with diabetes smoke at the same rate as people in the general population, despite excess health morbidity and mortality (1,2). In people with diabetes, cigarette smoking increases the risk of macrovascular complications, including circulatory, cardiovascular, and coronary heart disease (3,4), and microvascular complications, including kidney disease (5). Quitting smoking is essential to reduce the onset and exacerbation of diabetes (6).

However, weight gain is a potential barrier to successful quitting. It is common for people to gain 10 to 15 pounds after quitting (7,8) and those who are heavy smokers or are already overweight can gain considerably more (7,8). People with diabetes are more likely than those without diabetes to be overweight or obese (9), so excessive weight gain during cessation can present a substantial health hazard (10). In addition to actual weight gain, concern about gaining weight after quitting is common (11,12), and both hinder cessation (13,14). Although weight gain and weight concern are

important factors in the initiation and continuation of smoking, few data exist on the effect of weight-related issues on cessation in tobacco users with diabetes.

Numerous evidence-based resources exist to support successful quitting, including pharmacotherapy and counseling provided through state tobacco quitlines (15). Toll-free, telephone-based tobacco quitlines are 1 of the most cost-effective treatment resources, yet even among the general population, they typically reach only 1% to 3% of smokers nationwide (16). Formative research suggests that people with diabetes have low awareness and use of effective cessation treatments including medication and quitlines (17). Although most cessation research has focused on the general population or related disease groups such as cardiovascular or lung disease (4), no published research has evaluated the use of a tobacco cessation quitline in a population of smokers with diabetes.

The primary purpose of this study was to describe the reach and effectiveness of a tobacco quitline among a sample of people with diabetes compared with those without the disease. A secondary aim was to assess the impact that concerns about weight gain have on quitting success.

Methods

Sample

Participants for this study were tobacco users aged 18 or older who called the Washington State Tobacco Quit Line (the quitline) from May through September 2008. For this cross-sectional study, we surveyed a census of tobacco users who reported a diagnosis of diabetes at the time of quitline registration and met other eligibility criteria and compared them with a matched group who registered for quitline services during the same period but did not report having diabetes. To control for differences that might affect quit rates (the dependent variable), we matched participants by sex, insurance status, and smoking dependence. Only 1 participant per household was included in the study; pregnant women were excluded because of the possibility of a pregnancy-related diabetes diagnosis.

At the time of data collection, the quitline offered free cessation services to any state resident aged 18 or older, including an initial counseling call of up to 30 minutes, self-management materials mailed to the caller, provision of nicotine patch or gum medication (if indicated), and referral to community-based cessation resources. The number of follow-up counseling calls (1 call vs up to 5 calls) and the amount of medication (2 vs 8 weeks) varied by population; uninsured, Medicaid-insured, and those referred from Veterans Affairs and Indian Health Services received the most intensive treatment options. Data on the Medicaid-insured population were available only for May and June because the state began offering separate Medicaid-only quitline services in July 2008. However, the separate Medicaid-only quitline services were available only for Medicaid fee-for-service participants. Other Medicaid participants may have been eligible for quitline services (and thus study recruitment) during the study period. This study was conducted by Alere Wellbeing in collaboration with the Washington State Department of Health with approval from the Western Institutional Review Board.

Data came from 1) information collected via telephone at the time of quitline registration, 2) a 7-month follow-up telephone survey, 3) automated process data collected at Alere Wellbeing (eg, number of counseling calls completed) and 4) comparison data from the 2008 Washington State Behavioral Risk Factor Surveillance System (BRFSS) survey. The 7-month follow-up telephone survey was administered from December 2008 through April 2009 by trained survey staff. To increase the survey response rate, a prenotification letter was mailed to participants about 10 days before survey administration. Participants were also offered a $20 gift card for completing the survey. If the interviewer could not reach a participant after 11 attempts, the survey was considered unanswered.

Measures and definition of concepts

Quitline registration data included participant demographics, tobacco use and cessation history, stage of readiness to quit, and prior use of pharmacotherapy. Chronic disease status was assessed by asking “Have you been diagnosed with any of the following chronic conditions: Asthma? Chronic obstructive pulmonary disease or emphysema? Diabetes? Heart disease?” Diabetes status was further clarified by asking participants if they had ever been told by a doctor that they had diabetes, a core question from the Centers for Disease Control and Prevention’s (CDC’s) 2007 Behavioral Risk Factor Surveillance System Survey (http://www.cdc.gov/brfss/). Participants who were prediabetic or were diagnosed with diabetes only during pregnancy were excluded from analyses.

Seven-day and 30-day tobacco point-prevalence quit rates were based on a respondent’s self-report of being tobacco-free for the last 7 days or more, or 30 days or more at the time of the 7-month survey (18). Abstinence rates were computed by using both the responder and intent-to-treat methodology. Among continued smokers, intention to quit and reduction in amount of cigarettes smoked were also assessed.

Quitline use among tobacco users with diabetes was measured by a “reach effect ratio” based on the proportion of smokers aged ≥18) with diabetes who enrolled in quitline services in 2008 divided by the proportion of smokers with diabetes in the state (19). A reach ratio of 1.0 indicates that the quitline reaches the subgroup proportionally to its

distribution in the smoking population in that state; ratios less than 1 indicate lower reach and greater than 1 indicate higher reach.

Self-reported height and weight, physical activity, dieting, level of concern about gaining weight, perceived risk for relapse if they were to gain weight, prior weight gain due to quitting, perceived weight and change in weight, and postcessation weight change (among those who quit) were also measured.

Self-reported depression was assessed by using the Patient Health Questionnaire-2 (20): "Over the last 2 weeks how often have you been bothered by the following problems? 1- Having little interest or pleasure in doing things? 2- Feeling down, depressed or hopeless?" A mean score on the 2 items was computed, with the recommended cut point of 3 or more describing clinically significant depression (20). The mean score on 1 item was used to determine self-reported anxiety symptoms: "Over the last 2 weeks how often have you been bothered by: feeling nervous, anxious, or on the edge?" Panic was assessed with a yes/no question: "During the past 2 weeks did you have any episodes of panic or fear?"

Statistical analysis

Summary statistics were computed for descriptive data. Those who completed the survey were compared with those who did not to assess differences in individual characteristics. Chi-square and *t* tests were used for bivariate comparisons between groups. We conducted multiple logistic regression analyses by using SAS version 9.2 (SAS Institute Inc, Cary, North Carolina) to test for independent associations between the 2 groups in quit rates after controlling for demographic and tobacco use characteristics. Correlates of quitting were identified for the total sample and for the subsample with diabetes. Despite matching, sex was included in the multivariable analyses to control for possible selection bias (21), since both diabetes status (the key independent variable) and tobacco abstinence (the outcome variable) have been found to differ by sex (22). Less than 10% of responses were "do not know" or missing. These were omitted from the analyses. Significance was set at $\alpha = .05$ for all analyses.

Results

Quitline use

According to the weighted prevalence rates from the 2008 BRFSS in Washington State, 15.7% (95% confidence interval [CI] = 15.0–16.4) of residents aged 18 or older smoked. No statistical difference in diabetes prevalence was found between adults who smoked and the general adult population in Washington (6.1% vs 6.0%, excluding those diagnosed only during pregnancy). Quitline registrations from 2008 showed that 8.3% (n = 1,077) of all adults who registered for quitline services reported a diagnosis of diabetes. This represents a quitline reach effect ratio of 1.36 (8.3%/6.1%), indicating that in Washington State, smokers with diabetes used the quitline in a higher proportion than they were represented in the general population of smokers.

Sample characteristics

Six hundred eligible tobacco users who registered for services with the quitline between May 1, 2008, and September 30, 2008, were eligible to participate in the 7-month survey (261 participants with diabetes and 339 participants without diabetes) (Figure). After launching the survey, we learned that approximately 19% of identified participants had either disconnected or wrong telephone numbers. The survey response rate was 40.3%, yielding a final sample of 242 participants (111 with diabetes, 131 without diabetes). Few differences existed between respondents and nonrespondents. Participants with diabetes were just as likely to complete the 7-month survey as those without diabetes ($P = .34$). Compared to nonrespondents, survey respondents were older (47.5 years vs 42.6 years; $P < .001$), less likely to be uninsured (10.7% vs 20.4%; $P < .003$), and more likely to have smoked for 20 years or more (75.6% vs 64.5%, $P < .01$).

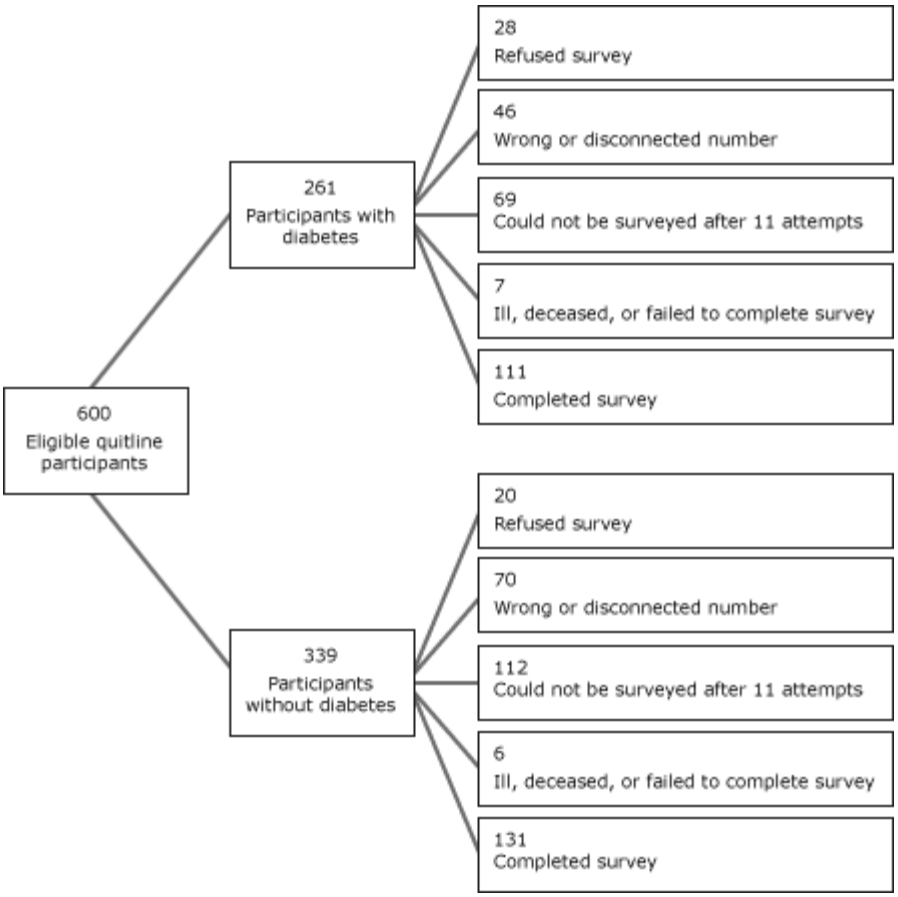


Figure. Recruitment process for survey of eligible tobacco users who sought help from the Washington State Quit Line, May 2008–September 30, 2008. [A text description of this figure is also available.]

Respondents with diabetes were similar to those without diabetes in sex, race/ethnicity, education, insurance status, and current level of anxiety or panic (Table 1). Those with diabetes were older and more likely to report having significant depressive symptoms. Of the smokers with diabetes, 13% reported a diagnosis of type 1 diabetes, 78.9% reported a diagnosis of type 2 diabetes, and 8.2% reported they did not know. Both groups reported that the primary reason for calling the quitline was their desire or need to quit smoking, followed by advice to quit by family or health professionals.

Participants with diabetes did not differ from those without diabetes on the type of counseling call program (one call vs multiple calls); 41% of participants with diabetes and 45% of those without the disease enrolled in the multiple proactive counseling call program (up to 5 proactive counseling calls). No significant difference was found between groups in their satisfaction with quitline services or with their use of or satisfaction with quitline-provided nicotine replacement therapy (NRT). Approximately 68% of quitline users with diabetes used NRT compared with about 76% quitline users without diabetes.

Tobacco use characteristics

Most participants reported smoking cigarettes rather than other forms of tobacco (Table 1). Most were heavy, established smokers and more than half reported having their first cigarette of the day within 5 minutes of waking. Many also reported having other chronic diseases such as asthma, chronic obstructive pulmonary disease, or heart disease. Participants with diabetes reported smoking for significantly more years than those in the comparison group (86.2% vs 66.0% reported ≥20 years of smoking, $P < .001$) (Table 1).

Weight concern characteristics

Compared with participants without diabetes, participants with the disease were significantly more likely to be obese (56.9% vs 35.8% with BMI >30, $P < .001$) and to rate themselves as being very overweight (29.6% vs 12.7%, $P < .001$) (Table 1). Participants with diabetes did not differ from those without diabetes in dieting behaviors or physical activity levels. Although no differences in weight concern or perceived risk of relapse due to weight gain after quitting existed between participants with and without diabetes, nearly two-thirds of participants with diabetes were worried about

possible weight gain, although less than one-third thought they would return to smoking if they gained excessive weight after cessation.

Tobacco cessation outcomes

In bivariate analyses, participants with diabetes reported quit rates that were similar to those of participants without diabetes (24.3% vs 22.5%, 30-day respondent quit rate; $P = .73$) (Table 2). A separate analysis that further segmented those without diabetes by other chronic disease status (with vs without other chronic disease) found no significant difference in quit rates (diabetes group, 24.3%; group with other chronic disease, 26.5%; group without chronic disease, 20.0%; $P = .84$).

However, participants with diabetes reported more weight gain in prior quit attempts than those without diabetes (34.2% vs 22.2% reported gaining >20 lbs; $P < .05$). Participants with diabetes who were successful in quitting smoking through the quitline were more likely to report weight gain than those who were successful and did not have diabetes, although results were not significant ($P = .43$). Amount of weight gained was also higher but not significantly so (23.2 lbs vs 14.7 lbs; $P = .20$) (Table 2).

Consistent with the bivariate results, multivariable results revealed that participants with diabetes had similar odds of reporting tobacco abstinence at either 7 or 30 days compared with those without diabetes (OR, 0.8; 95% CI, 0.38–1.55 and OR, 0.7, 95% CI, 0.36–1.55, respectively) after adjusting for BMI, age, sex, NRT use, weight concern, and mean depression score (Table 3).

The only correlate of 7-day and 30-day tobacco abstinence among the total sample was weight concern; those who expressed greater perceived risk of relapse due to weight gain were less likely to report abstinence (7-day OR, 0.8; 95% CI, 0.65–0.88; 30-day OR, 0.8; 95% CI, 0.67–0.91). However, when analysis was restricted to the subsample with diabetes, weight concern was not a significant predictor of quitting (OR, 0.8; 95% CI, 0.66–1.03; data not shown).

Discussion

Although tobacco quitline use is low among the general population (16), results from this study indicate that the proportion of tobacco users with diabetes who used the quitline was greater than their representation in the general statewide population. This finding is important, given that diabetes prevalence is increasing nationally and smoking is a behavioral risk factor that contributes both to causing and complicating the disease (23). Higher proportional use of the quitline among those with diabetes as compared with the general population may be the result of a concerted effort by the Washington State Department of Health to integrate cessation treatment referrals into state chronic disease systems (24). Another factor may be that diagnosis of a chronic condition, especially one related to smoking (eg, diabetes), has been shown to create an impetus to quit smoking (25).

In addition to use, a major finding of this study is that having diabetes did not affect quit rates, even after adjusting for individual differences such as age, sex, weight concern, depression, use of NRT, and BMI. Furthermore, participants with diabetes had similar odds of reporting tobacco abstinence compared with those without diabetes after adjusting for the existence of other chronic diseases, supporting evidence that chronic disease does not hinder successful cessation (25).

Although participants with diabetes were older, had smoked longer, and were more likely to be depressed than those without diabetes, these factors did not decrease their likelihood of quitting. This may be because people with diabetes typically have high health care use, which could mean increased contact with the health care system (26). It may also be due to increased pressure from providers to quit.

The perceived risk of relapse due to weight gain was associated with lower odds of reporting tobacco abstinence, even after controlling for differences in incidence of depression. Findings from this study indicated that participants with diabetes were no more likely than the comparison group to gain weight over time. However, among participants who reported successfully quitting smoking, those with diabetes were more likely to report that they gained weight than were quitters who did not have diabetes. This weight gain may be attributable to the increased prevalence of obesity and depression in the diabetes arm. People with diabetes have been shown to have higher rates of depression (27), and depression and diabetes have both been associated with reduced self-care, including nonadherence to diet, exercise, and medication (28). Adding smoking cessation to the equation may further increase weight gain.

Although depression can impede successful quitting (29), those with diabetes were able to quit smoking at same level as the comparison group, despite having elevated levels of depression. These findings suggest that depression may not directly impact successful quitting in those with diabetes. However, since those with and without diabetes reported significantly different weight gain during prior quit attempts, the relationship between depression and quitting may be moderated by weight changes. Given that lower levels of weight concern were a significant predictor of successful quitting in this study, a full mediation and moderation analysis is warranted to clarify the relationship between

depression, weight gain, weight concern, and quitting. When taken together, these weight-related findings suggest that greater efforts are needed to address weight gain in cessation treatment.

Numerous limitations should be considered when interpreting these results. First, results may not be generalizable to people outside of Washington State or to people who attempt to quit smoking through other treatment resources. Second, because the purpose of the study was to evaluate differences in use and quit rates, we matched by sex, insurance status, and cigarettes per day, thus limiting our ability to assess differences in these variables. Third, although only 6% to 10% of the initial sample refused to participate in the survey, the additional 26% to 33% who were located but not reached after 11 attempts might be considered passive refusals. Because of the low contact rate, it should also be noted that responder quit rates are tentative. Although the response rate for this study is lower than that of many clinical trials, it is comparable to completion rates from other telephone-based studies of quitline participants (12). Fourth, Medicaid fee-for-service data were not available for the entire study period. Although there is no reason to believe that the inclusion of additional Medicaid data would have changed these results, this is a limitation of the current study. Finally, diabetes diagnoses were self-reported and may underestimate the true population of quitline participants who have diabetes.

Despite these potential limitations, these data make an important contribution to the literature, suggesting that people with diabetes use the quitline and succeed at quitting at rates equal to those without diabetes, but that quit rates may be further enhanced by addressing weight concern and weight gain.

Acknowledgments

We thank Marcelle Thurston and Jeanne Harmon from the Washington State Diabetes Prevention and Control Program for their assistance in the survey design. None of the authors (Ms Schauer, Dr Bush, Ms Cerutti, Ms Mahoney, Ms Thompson, and Dr Zbikowski) have any conflicts of interest to disclose or cite. This study was approved by the Western Institutional Review Board and was funded by the Washington State Department of Health Tobacco Prevention and Control Program.

Author Information

Corresponding Author: Gillian L. Schauer, MPH, Department of Behavioral Sciences and Health Education, Emory University, 1518 Clifton Rd NE, GCR 430, Atlanta, GA 30322. Telephone: 206-819-9391. E-mail: gillian.schauer@emory.edu.

Author Affiliations: Terry Bush, Lisa Mahoney, Susan M. Zbikowski, Alere Wellbeing, Clinical and Behavioral Sciences, Seattle, Washington; Barbara Cerutti, Imperial College London and Imperial College Healthcare National Health Service Trust, London, UK; Juliet R. Thompson, Washington State Department of Health, Tobacco Prevention and Control Program, Tumwater, Washington.

References

1. Ford ES, Mokdad AH, Gregg EW. Trends in cigarette smoking among US adults with diabetes: findings from the Behavioral Risk Factor Surveillance System. Prev Med 2004;39(6):1238–42. CrossRef PubMed
2. CDC. Age-adjusted percentage of adults aged 18 years or older with diagnosed diabetes who currently smoke, United States, 1994-2010. 2012. http://www.cdc.gov/diabetes/statistics/comp/table7_1d.htm. Accessed April 16, 2013.
3. Meigs JB, Singer DE, Sullivan LM, Dukes KA, D'Agostino RB, Nathan DM, et al. Metabolic control and prevalent cardiovascular disease in non-insulin-dependent diabetes mellitus (NIDDM): The NIDDM Patient Outcome Research Team. Am J Med 1997;102(1):38–47. CrossRef PubMed
4. Haire-Joshu D, Glasgow RE, Tibbs TL. Smoking and diabetes. Diabetes Care 1999;22(11):1887–98. CrossRef PubMed
5. Mühlhauser I, Bender R, Bott U, Jörgens V, Grüsser M, Wagener W, et al. Cigarette smoking and progression of retinopathy and nephropathy in type 1 diabetes. Diabet Med 1996;13(6):536–43. CrossRef PubMed
6. Willi C, Bodenmann P, Ghali WA, Faris PD, Cornuz J. Active smoking and the risk of type 2 diabetes: a systematic review and meta-analysis. JAMA 2007;298(22):2654–64. CrossRef PubMed
7. Eisenberg D, Quinn BC. Estimating the effect of smoking cessation on weight gain: an instrumental variable approach. Health Serv Res 2006;41(6):2255–66. CrossRef PubMed
8. Klesges RC, Winders SE, Meyers AW, Eck LH, Ward KD, Hultquist CM, et al. How much weight gain occurs following smoking cessation? A comparison of weight gain using both continuous and point prevalence abstinence. J Consult Clin Psychol 1997;65(2):286–91. CrossRef PubMed

9. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. JAMA 2003;289(1):76–9. CrossRef PubMed
10. Yeh HC, Duncan BB, Schmidt MI, Wang NY, Brancati FL. Smoking, smoking cessation, and risk for type 2 diabetes mellitus: a cohort study. Ann Intern Med 2010;152(1):10–7. CrossRef PubMed
11. Clark MM, Hurt RD, Croghan IT, Patten CA, Novotny P, Sloan JA, et al. The prevalence of weight concerns in a smoking abstinence clinical trial. Addict Behav 2006;31(7):1144–52. CrossRef PubMed
12. Bush T, Levine MD, Deprey M, Cerutti B, Zbikowski SM, McAfee T, et al. Prevalence of weight concerns and obesity among smokers calling a quitline. J Smok Cessat 2008;4(5):74–8. PubMed
13. Aubin HJ, Berlin I, Smadja E, West R. Factors associated with higher body mass index, weight concern, and weight gain in a multinational cohort study of smokers intending to quit. Int J Environ Res Public Health 2009;6(3):943–57. CrossRef PubMed
14. Pisinger C, Jorgensen T. Weight concerns and smoking in a general population: the Inter99 study. Prev Med 2007;44(4):283–9. CrossRef PubMed
15. 2008 PHS Guideline Update Panel, Liaisons, and Staff. Treating tobacco use and dependence: 2008 update U.S. Public Health Service Clinical Practice Guideline executive summary. Treating tobacco use and dependence: 2008 update U.S. Public Health Service Clinical Practice Guideline executive summaryRespir Care 2008;53(9):1217-22. PubMed
16. McAfee TA. Quitlines a tool for research and dissemination of evidence-based cessation practices. Am J Prev Med 2007;33(6 Suppl):S357–67. CrossRef PubMed
17. Gill GV, Morgan C, MacFarlane IA. Awareness and use of smoking cessation treatments among diabetic patients. Diabet Med 2005;22(5):658–60. CrossRef PubMed
18. Campbell HS, Ossip-Klein D, Bailey L, Saul J; North American Quitline Consortium. Minimal dataset for quitlines: a best practice. Tob Control 2007;16(Suppl 1):i16–20. CrossRef PubMed
19. North American Quitline Consortium. Increasing the reach of tobacco cessation quitlines: a review of the literature and promising practices. http://c.ymcdn.com/sites/www.naquitline.org/resource/resmgr/issue_papers/naqc_issuepaper_increasingre.pdf. Accessed April 29, 2013.
20. Kroenke K, Spitzer RL, Williams JB. The Patient Health Questionnaire-2: validity of a two-item depression screener. Med Care 2003;41(11):1284–92. CrossRef PubMed
21. Schoenbach VJ, Rosamond WD. Understanding the fundamentals of epidemiology. Chapel Hill (NC): University of North Carolina; 2000.
22. Gritz ER, Nielsen IR, Brooks LA. Smoking cessation and gender: the influence of physiological, psychological, and behavioral factors. J Am Med Womens Assoc 1996;51(1-2):35–42. PubMed
23. Haire-Joshu D, Glasgow RE, Tibbs TL; American Diabetes Association. Smoking and diabetes. Diabetes Care 2004;27(Suppl 1):S74–5. CrossRef PubMed
24. Daniel DM, Norman J, Davis C, Lee H, Hindmarsh MF, McCulloch DK, et al. A state-level application of the chronic illness breakthrough series: results from two collaboratives on diabetes in Washington State. Jt Comm J Qual Saf 2004;30(2):69–79. PubMed
25. Twardella D, Loew M, Rothenbacher D, Stegmaier C, Ziegler H, Brenner H. The diagnosis of a smoking-related disease is a prominent trigger for smoking cessation in a retrospective cohort study. J Clin Epidemiol 2006;59 (1):82–9. CrossRef PubMed
26. Harris MI. Health care and health status and outcomes for patients with type 2 diabetes. Diabetes Care 2000;23 (6):754–8. CrossRef PubMed
27. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes Care 2001;24(6):1069–78. CrossRef PubMed
28. Gonzalez JS, Peyrot M, McCarl LA, Collins EM, Serpa L, Mimiaga MJ, et al. Depression and diabetes treatment nonadherence: a meta-analysis. Diabetes Care 2008;31(12):2398–403. CrossRef PubMed
29. Hitsman B, Borrelli B, McChargue DE, Spring B, Niaura R. History of depression and smoking cessation outcome: a meta-analysis. J Consult Clin Psychol 2003;71(4):657–63. CrossRef PubMed

Tables

Return

Table 1. Demographics and Tobacco Use and Weight-Related Characteristics Among Quitline Participants With and Without Diabetes, Washington State, 2008

Return

Characteristic	Diabetes			No Diabetes		
	n	%	Mean (SD)	n	%	Mean (SD)
Sex, n (%)						
Female	111	67.6	NA	131	67.9	NA
Age[a], y						
18-25		1.8			12.2	
26-40	111	13.5	51.0 (11.07)	131	27.5	44.6 (13.6)
41-60		69.4			45.8	
>60		15.3			14.5	
Race/ethnicity						
Hispanic	109	2.7	NA	128	4.7	NA
Non-Hispanic		97.3			95.3	
White	110	79.1		129	86.0	
Nonwhite		20.9			14.0	
Education						
High school graduate or less	106	50.0	NA	129	52.7	NA
More than high school graduate		50.0			47.3	
Mental health status[b]						
Depression scale (range, 0-6)	108	45.4	2.4 (1.9)	127	30.2[b]	1.8 (2.0)[b]
Depressive symptoms (score >3)						
Anxiety scale		30.6	1.1 (1.1)		29.9	1.0 (1.1)
Percentage with panic (yes/no scale)						
Other chronic diseases						
Asthma	111	32.4	NA	131	19.0[b]	NA
Chronic obstructive pulmonary disease		30.6			19.9[b]	
Heart disease		15.3			11.5	
>1 of the above		8.7			10.7[b]	
Tobacco type reported at enrollment						
Cigarettes	108	96.3	NA	128	97.7	NA
Other tobacco type		3.7			2.3	
Smoking level (no. of cigarettes per day)						
Light (1-14)	111	23.4	NA	131	29.0	NA
Moderate (15-20)		41.4			34.3	
Heavy (≥21)		35.2			36.7	
No. of years used tobacco						
<20	94	13.8	NA	103	34.0	NA
≥20		86.2			66.0	
Time to first cigarette						

Characteristic	Diabetes			No Diabetes		
	n	%	Mean (SD)	n	%	Mean (SD)
≤5 min after waking	109	54.1	NA	129	52.7	NA
Use of nicotine replacement therapy						
Yes	111	67.6	NA	131	75.6	NA
Body mass index (BMI)[c]						
Obese (BMI ≥30)		56.9			35.8	
Overweight (BMI 25.0-29.9)	102	30.4	33.5 (9.5)	121	267.6	28.4 (7.7)
Normal weight or underweight (BMI 18.0-24.9)		12.7			36.6	
Perceived body weight						
Very overweight		29.6			12.7[a]	
Overweight	108	50.0	NA	126	43.6	NA
Normal weight or underweight		20.4			43.7	
Dieting status						
Not currently dieting		50.5			60.9	
Currently dieting to lose weight	99	27.3	NA	120	18.3	NA
Currently dieting to keep weight as it is		22.2			20.8	
Physical activity level						
Days per week of moderate physical activity	101	NA	3.23 (2.87)	121	NA	3.90 (2.48)
Concerns about weight gain after quitting[d]						
Scored ≥5 on a 1 to 10 Likert scale[e]	83	62.6	NA	97	52.6	NA
Likelihood of relapse due to weight gain						
Scored ≥5 on a 1 to 10 Likert scale[e]	102	28.4	NA	115	29.6	NA

Abbreviations: SD, standard deviation; NA, not available.
[a] $P < .001$.
[b] $P < .05$.
[c] BMI was calculated as weight divided by height squared multiplied by 703 ([lb/in2] × 703).
[d] Among those who continued to smoke.
[e] Where 1 = not concerned, and 10 = very concerned.

Table 2. Unadjusted Quit Rates and Weight Changes Among Participants With and Without Diabetes, Washington State, 2008

Return

Unadjusted Quit Rates	Diabetes		No Diabetes	
Respondent 7-day quit rate	**n**	**% or mean (SD)**	**n**	**% or mean (SD)**
Quit	111	28.8	129	26.4
Intent-to-treat 7-day quit rate				
Quit	261	12.3	339	10.0
Respondent 30-day quit rate				
Quit	111	24.3	129	22.5
Intent-to-treat 30-day quit rate				
Quit	261	10.3	339	8.5
Weight gain in prior quit attempts[a]				

Unadjusted Quit Rates	Diabetes		No Diabetes	
Respondent 7-day quit rate	**n**	**% or mean (SD)**	**n**	**% or mean (SD)**
Mean (SD)		16.9 (24.21)		10.29 (18.0)[b]
Gained <20 lbs	80	65.8	99	77.8
Gained ≥20 lbs		34.2		22.2[b]
Weight change since calling the quitline				
No change in weight		41.7		45.2
Gained weight	108	34.3	126	32.6
Lost weight		24.1		22.2
Weight gained, lbs, mean (SD)		19.2 (15.9)		15.4 (9.7)
Range, lbs		3–75		5–40
Weight change among quitters				
No change in weight		29.0		36.4
Gained weight	31	51.6	33	36.4
Lost weight		19.3		27.3
Weight gained, lbs, mean (SD)		23.2 (22.1)		14.7 (8.0)

[a] Among those who made a prior quit attempt.
[b] $P < .05$.

Table 3. Correlates of Tobacco Cessation Among the Total Sample With and Without Diabetes, Washington State, 2008

Return

Selected Characteristic	Diabetes	No Diabetes
	7-Day Tobacco Abstinence, OR (95% CI)	**30-Day Tobacco Abstinence, OR (95% CI)**
Diabetes status (diabetes vs no diabetes)	0.8 (0.38–1.55)	0.7 (0.36–1.55)
BMI[a] (normal vs overweight or obese)	1.5 (0.97–2.25)	1.3 (0.84–2.00)
Age	1.0 (0.98–1.04)	1.0 (0.98–1.04)
Sex (female vs male)	2.3 (1.09–4.82)	2.0 (0.94–4.43)
NRT use	1.4 (0.63–2.93)	1.3 (0.57–2.86)
Weight concern (≥5 vs <5, on a 10 point scale)	0.8 (0.65–0.88)	0.8 (0.67–0.91)
PHQ-2 Depression score (<3 vs >3)[b]	1.1 (0.56–2.26)	0.9 (0.44–1.84)

Abbreviations: OR, odds ratio; CI, confidence interval; BMI, body mass index; NRT, nicotine replacement therapy.
[a] BMI was calculated as weight divided by height squared multiplied by 703 ($lb/in^2 \times 703$).
[b] Response options to the 2 PHQ-2 items are on a 0-3 severity scale. We computed the mean score (0 minimum possible, 6 maximum possible).

bibliographic management applications such as EndNote, Reference Manager, and ProCite. A free trial download is available at each application's web site.

For Questions About This Article Contact pcdeditor@cdc.gov
Page last reviewed: June 27, 2013
Page last updated: June 27, 2013
Content source: National Center for Chronic Disease Prevention and Health Promotion

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348 - Contact CDC–INFO

L.A. Care HEALTH PLAN

Tobacco Cessation Resources

Below is a list of organizations that can give you help you quit smoking. Ask your doctor, pharmacist, and/or educator to help you find others. Often your local hospital may have support groups.

AcuHope
5953 Laurel Cyn Blvd. Ste C Valley Village, CA 91607
818-708-1698, Joanne
www.acuhope.com
Type of Service: Use Acupuncture treatment to help smokers stop smoking
Accepts most insurances

AcuHope
18740 Ventura Blvd. Ste 204 Tarzana, CA 91356
818-708-1698, Joanne
www.acuhope.com
Type of Service: Use Acupuncture treatment to help smokers stop smoking
Accepts most insurances

American Lung Association-Not on Tobacco
2025 Weswind Dr Ste C. Bakersfield, CA 93301
800-586-4872 Opt 1; 661-847-4700; 310-735-9175
Tammy or Jill
www.lung.org/california
Type of Service: Classes, group sessions and telephonic counseling

American Lung Assoc.-Freedom from Smoking
3325 Wilshire Blvd Ste 900 Los Angeles, CA 90010
800-586-4872 Opt 1; 213-384-5864 or 310-735-9175
Reyna
www.lung.org/california
Type of Service: Class and telephonic counseling

American Lung Association of California
3326 Wilshire Blvd Ste 901 Los Angeles, CA 90010
1-800-548-8252; 213-384-5864 Opt 0, Hector
www.lung.org/california
Type of Service: Helpline, Telephonic counseling

Buddhist Tzu Chi Community Clinic
1000 S Garfield Ave. Alhambra, CA 91801
626-281-3383, Yng
www.tzuchimedicalfoundation.org
Type of Service: Information and classes

Buddhist Tzu Chi Community Clinic
10414 Vacco St. S El Monte, CA 91733
626-281-3383
www.tzuchimedicalfoundation.org
Type of Service: Classes, group sessions and telephonic counseling

California Smokers Helpline
1-800-NO-BUTTS (1-800-662-8887)
Type of Service: Helpline, Telephonic Counseling

Center for Disease Control and Prevention
Office on Smoking and Health
1-800-784-8669 (1-800-QUIT-NOW)
Type of Service: Helpline, Telephonic Counseling

Glendale Adventist Medical Center
1509 Wilson Terrace Glendale, CA 92106
818-409-8042; 323-255-9030 Opt 2, Michael
www.adventisthealth.org/glendale
Type of Service: Classes, group sessions and telephonic counseling

Kaiser Permanente-Freedom from Smoking
5105 Goldleaf Cr. Los Angeles, CA 90056
866-402-4320, 216-265-6800, Katrina
866-862-4295-Wellness Coaching by Phone
www.kp.org/quitsmoking
Type of Service: Classes, group sessions and telephonic counseling

National Cancer Institute
1-877-444U-QUIT (1-877-448-7848)
Type of Service: Help line, Telephonic counseling

National Council on Alcoholism and Drug Dependence (NCADD) South Bay Area
1334 Post Ave. Torrance, CA 90501
310-328-1460, Vanessa
http://ncadd.org/
Type of Service: Classes and group sessions

National Council on Alcoholism and Drug Dependence (NCADD) of the East San Gabriel and Pomona Valleys
4625 N Grand Ave, Covina, CA 91724
800-622-2255; 626-331-5316, Gaby
http://ncadd.org/
Type of Service: Classes and group sessions

Nicotine Anonymous
351 E. 6th St. Long Beach, CA 90802
Flossie Center
800-642-0666: 562-435-7350, Monica
www.scina.org
Type of Service: Group sessions

Nicotine Anonymous
1260 18th St. Santa Monica, CA 90404
Unitarian Church Cottage
800-642-0666; 310-780-6380, Marjorie
www.scina.org
Type of Service: Group sessions, Thursdays 7:30pm

Nicotine Anonymous
346 Termino Ave. Long Beach, CA 90814
All Saints Episcopal Church, Pre-school room
1-800-642-0666, 562-427-8595
www.scina.org
Type of Service: Group sessions, Mondays 6pm

Nicotine Anonymous
1509 Wilson Terrace Glendale, CA 92106
Glendale Adventist Medical Center @ 2 & 134 fwys
1-800-642-0666, Steve
www.scina.org
Type of Service: Group sessions, Mondays 6:15pm

Nicotine Anonymous
626 Robertson West Hollywood, CA 90069
West Hollywood Recovery - Big Room
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Mondays 6:30pm

Nicotine Anonymous
3333 Skypark Drive, Torrance, CA
McMillan Medical Center, Room 300
1-800-642-0666, Lance
www.scina.org
Type of Service: Group sessions, Mondays 7pm

Nicotine Anonymous
23621 S Main St. Carson, CA 90745
Kaiser Foundation, Carson CDRP, Room A
800-642-0666; 310-513-6707 Opt 2, Karla
www.scina.org
Type of Service: Group sessions, Tuesdays 6pm

Nicotine Anonymous
14722 Clark Ave. Bellflower, CA 90706
Calvary Baptist Church-Family Center Room
1-800-642-0666, 562-644-5225, Joseph
www.scina.org
Type of Service: Group sessions, Tuesdays 7pm

Nicotine Anonymous
397 W. 104th St. Inglewood, CA 90303
Christian Church Inglewood Southside
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Wednesdays 6pm

Nicotine Anonymous
1161 E. Covina Blvd., Covina, CA
Aurora Charter Oak Hospital, Group Room
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Wednesdays 6:30pm

Nicotine Anonymous
9449 Imperial Highway Downey, CA 90242
Kaiser Imperial Medical Center, Room Q22
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Wednesdays 7pm

Nicotine Anonymous
512 Main St., El Segundo, CA
upstairs and look for gnome
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Thursdays 7pm

Nicotine Anonymous
1260 18th St., Santa Monica, CA
Unitarian Church Room 6 – cottage
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Thursdays 7:30pm

Nicotine Anonymous
4445 Nobles Ave, Sherman Oaks, CA
Sherman Oaks Presbyterian Nursery School
800-642-0666
www.scina.org
Type of Service: Group sessions, Thursdays 8pm

Nicotine Anonymous
14722 Clark Ave. Bellflower, CA 90706
9416 Club
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Fridays 3pm

Nicotine Anonymous
2900 Sunset @ Parkman, Los Angeles, CA
Café Tropical Back Room
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Fridays 6:30pm

Nicotine Anonymous
5881 Cherry Ave. Long Beach, CA 90805
Intercity Fellowship; Main Meeting Room
1-800-642-0666, 562-206-6020
www.scina.org
Type of Service: Group sessions, Saturdays 9am

Nicotine Anonymous
12720 Washington Blvd. Culver City, CA 90066
Marina Center
1-800-642-0666, 310-396-3525, Jack
www.scina.org
Type of Service: Group sessions, Saturdays 5pm

Nicotine Anonymous
12355 Moorpark Ave. Studio City, CA
Unitarian Universalist Church
1-800-642-0666
www.scina.org
Type of Service: Group sessions, Sundays 4:30pm

Save Our Selves
1540 East Colorado St. Glendale, CA 92105
Didi Hisrch Community Mental Health Center
323-666-4295, Jim
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions, Fridays 7pm, Sundays 12pm to 1:30pm

Save Our Selves
425 South Broadway, Los Angeles CA 90068
2nd Floor
323-666-4295
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions, Mondays 7:30pm, Wednesdays 7:30pm, Friday 7:30pm

Save Our Selves
6666 Green Valley Circle Los Angeles, CA 90066
SHARE Center
323-666-4295, Jim
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions, Thursdays, 8pm

Save Our Selves
7621 Canoga Park Ave. Canoga Park, CA 91301
West Valley Mental Health Center
323-666-4295
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions

Save Our Selves
27955 Sloan Canyon Rd. Castaic, CA 91310
Warm Springs Library
323-666-4295, Joseph
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions, every 1st Saturday 5:45pm

Save Our Selves
4773 Hollywood Blvd. Hollywood, CA 90027
323-666-4295, Jim
www.cfiwest.org/sos; www.sossobriety.org
Type of Service: Group sessions, Tuesdays 8pm

Torrance Memorial Medical Center
3333 Skypark Dr. Ste. 300, Torrance, CA
McMillan Medical Center
310-325-9110, Vicky
www.torrencememorial.org
Type of Service: 6 or 8 week Breathe Freely classes

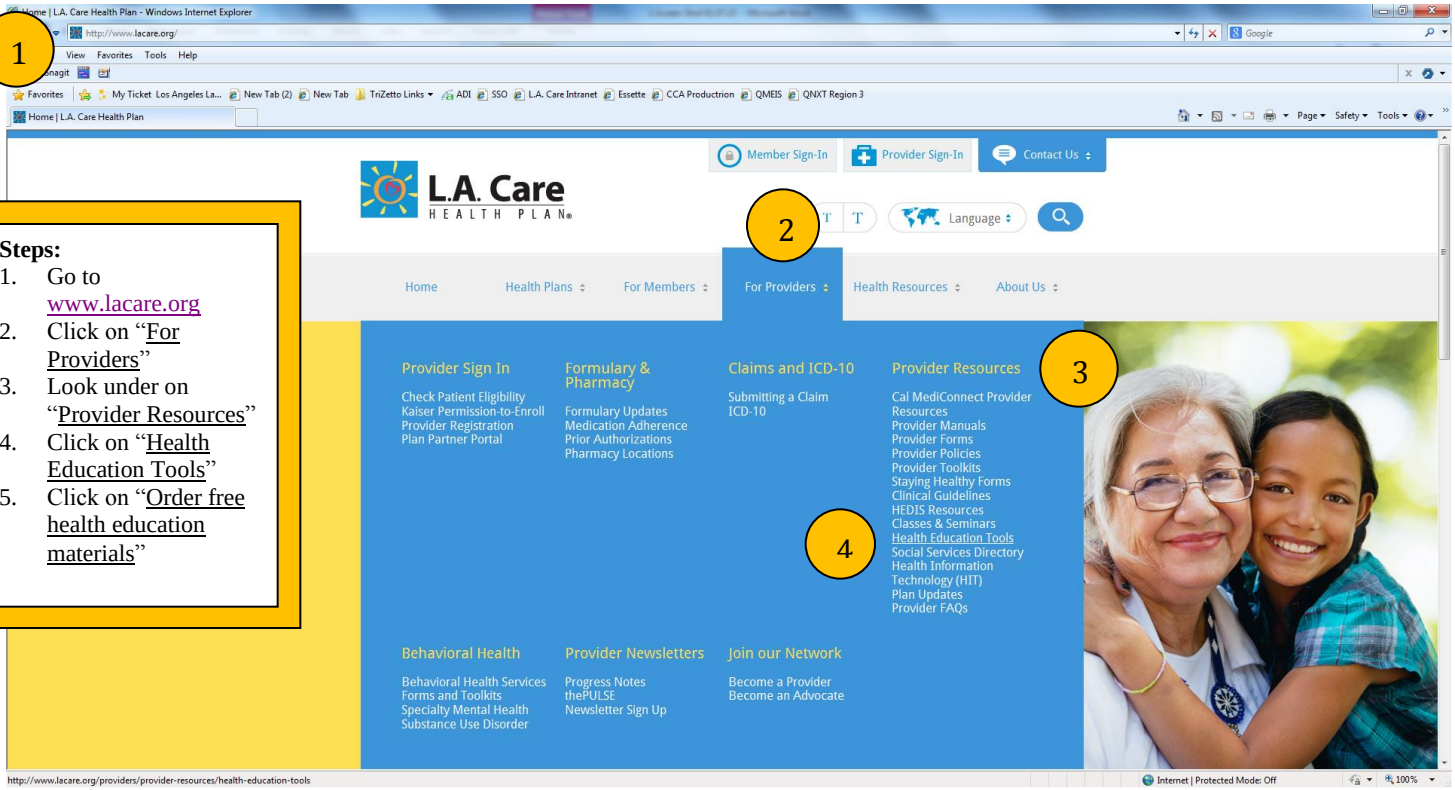
UCLA
200 UCLA Medical Plaza Building L.A, CA 90095
Suite 204
310-825-0014
Type of Service: Freedom From Smoking classes, 8 week course, Tuesday evenings, 4pm - 6pm
Cost: $100 for UCLA employees, $150 for non-UCLA employees

Watts Healthcare Corp. Preventive Health Services
10300 S. Compton Blvd. Los Angeles CA 90002
Watts Health Center
323-357-6628
Type of Service: Classes, Tuesdays 10am, English and Spanish; Teens and Adults

Online Health Education Materials Order Form

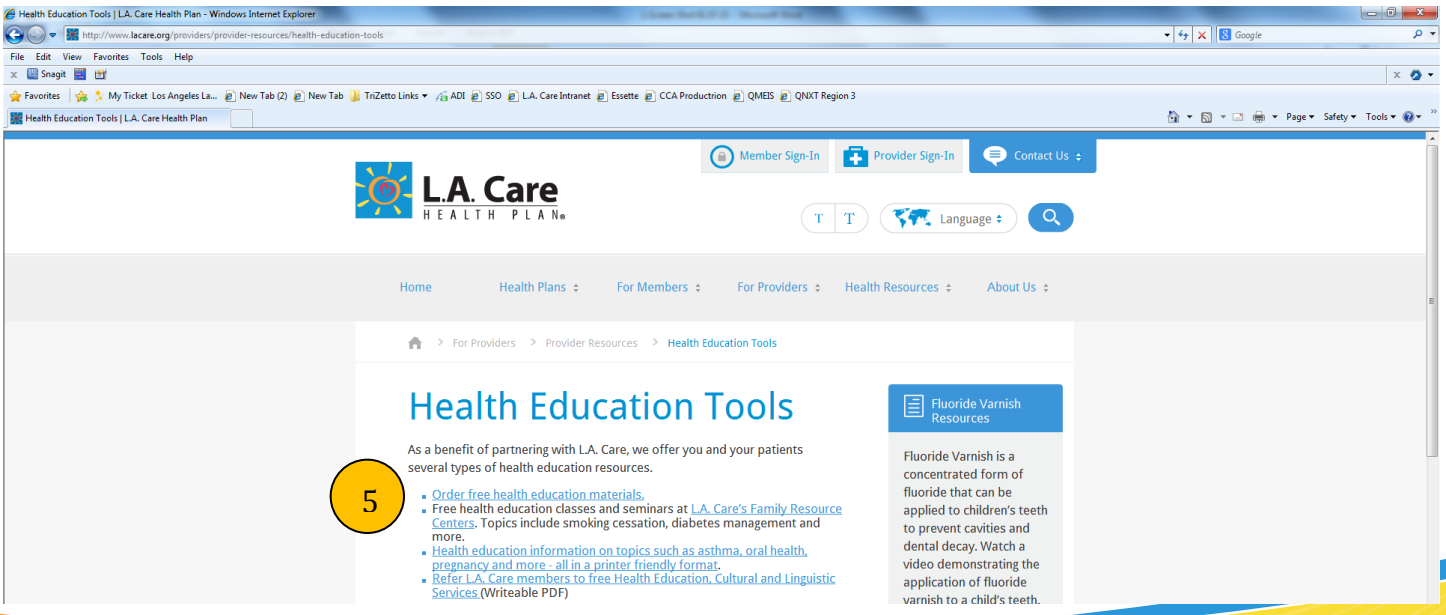
L.A. Care offers free Member Materials that can be ordered through our online portal:
Access directly at: **http://www.lacare.org/providers/resources/healtheducation/order-form**
Or follow the directions below:

Screen Shot

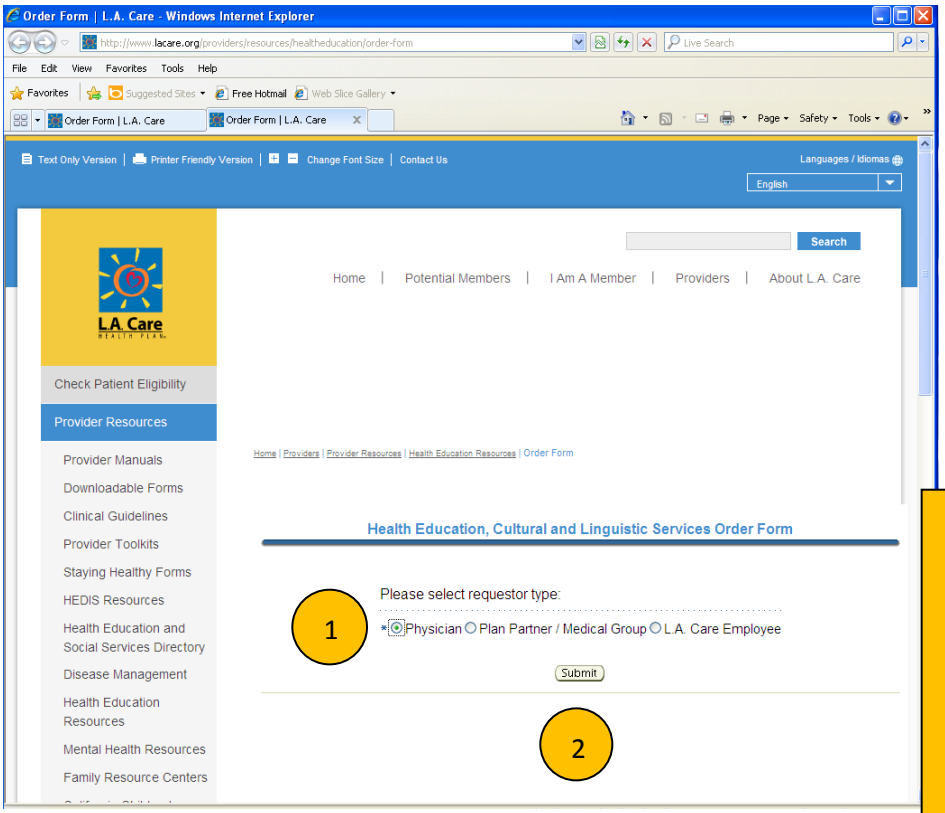


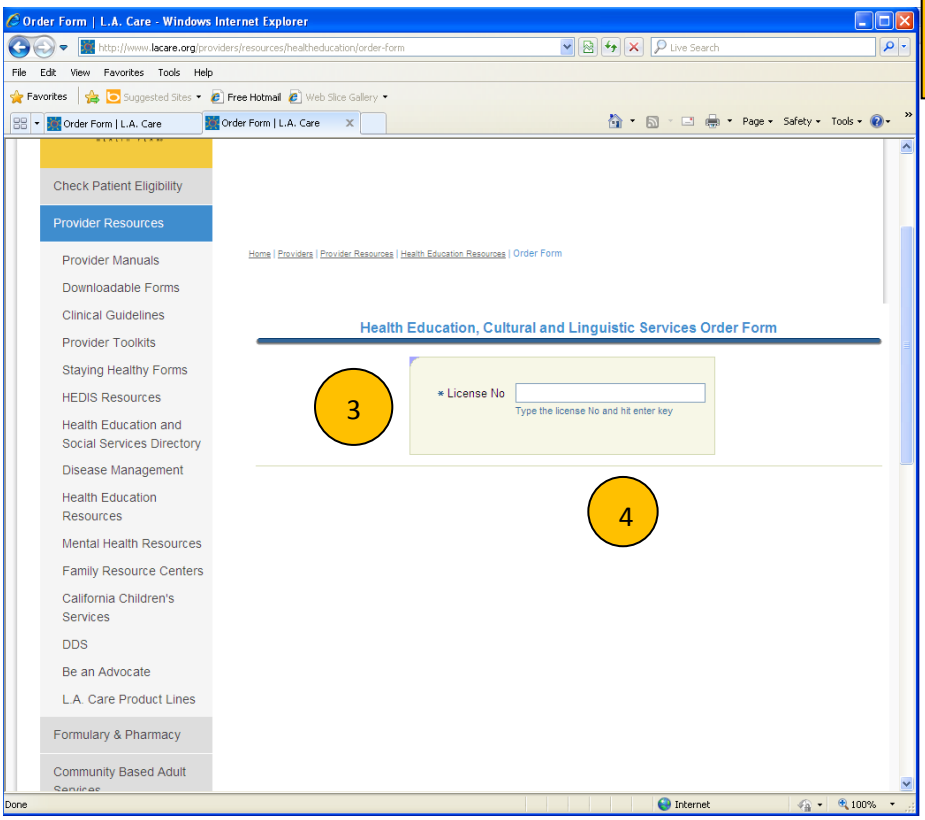
Steps:

1. Go to www.lacare.org
2. Click on "For Providers"
3. Look under on "Provider Resources"
4. Click on "Health Education Tools"
5. Click on "Order free health education materials"



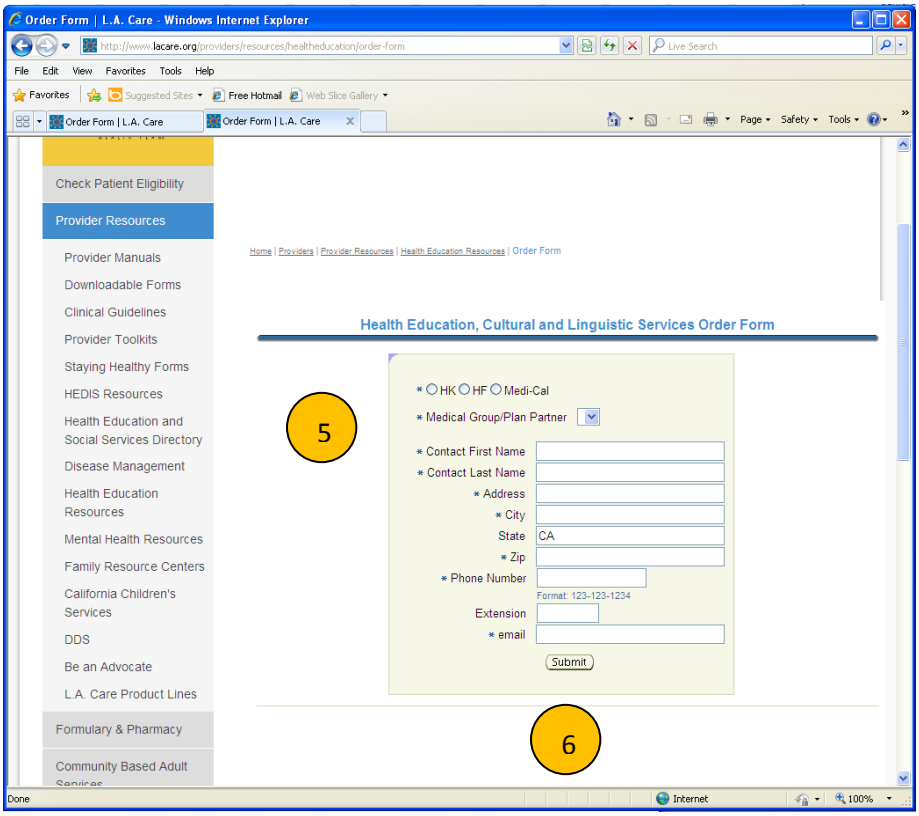
Online Health Education Materials Order Form – Online Portal





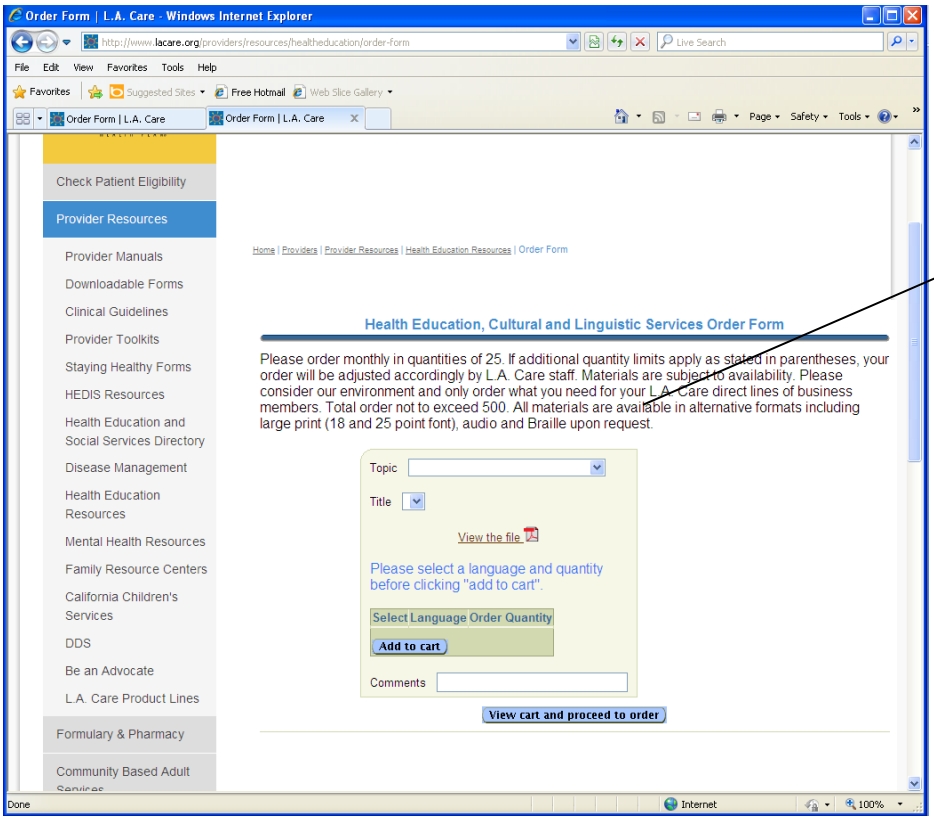
Steps:

1. Select if you are a "Physician" or "Plan Partner/Medical Group"
2. Click on "Submit" button
3. If you are physician, you will be asked to enter your "License Number"
4. Press "Enter"



Steps (cont.):

5. Fill out all of the contact information on the form
6. Click "Submit"



Steps:

1. Select the "Topic"
2. Select the "Title"
3. Select the language(s) you'd like the material in from the list provided
4. Input the quantity
5. Click "Add to Cart"
6. Either "Continue to order" other materials or "View cart and proceed to order"

Dear Member,

We want you to feel good and stay healthy. If you are a smoker, quitting smoking is one of the best ways to do this. If you want to quit, we can help.

The California Smokers' Helpline is a **free** phone-based counseling service. It can help you quit for good. You may get a **$20 gift card** when you join. Call **1-800-NO-BUTTS (1-800-662-8887)** to learn more.

L.A. Care also covers **medications** that can help you quit smoking.

- Nicotine Patches
- Nicotine Gum
- Nicotine Lozenges
- Nicotine Nasal Spray
- Nicotine Inhaler
- Bupropion (Zyban)
- Bupropion SR (Wellbutrin)
- Varenicline (Chantix)

Please call your doctor for a prescription if you feel you need medication to help you quit.

With this letter you will also find:

- Health education material: "*Live Smoke Free…One day at a Time*"
- California Smokers' Helpline flyer on how to get a **free** **$20 gift card**

You have the best chance of quitting if you use both counseling and medication from your doctor. If you'd like a list of resources near you to help you quit, please call me at the number below.

Sincerely,

Marlene Rivera
Health Education Resource Coordinator
213.694.1250 ext. 4927

ML0112 11/14_EN

Medi-Cal Members:
Want to Stop Smoking?

Get a FREE $20 gift card when you call the California Smokers' Helpline.

1-800-NO-BUTTS
(1-800-662-8887)

Here's how:

- Have your Medi-Cal ID ready.
- Call one of the phone numbers below.
- Ask for the $20 gift card.*
- Talk to a friendly person to create a free "stop smoking" plan.

Call today!

English	1-800-NO-BUTTS
Español	1-800-45-NO-FUME
中文	1-800-838-8917
Tiếng Việt	1-800-778-8440
한국어	1-800-556-5564

*Made possible by a grant from the Centers for Medicare and Medicaid Services under the Medicaid Incentives for Prevention of Chronic Diseases program. Some conditions apply. One gift card per person. While supplies last. Medi-Cal Managed Care plans may offer additional tobacco cessation services.

Another reason quitting is hard is because it becomes a habit. A habit is something you do without thinking about it, like smoking when you have your morning coffee.

You may need to change your daily routine to break your smoking habit. List the changes you will make here.

Example:

I will drink tea instead of coffee in the morning.

1 _____

2 _____

What is in a cigarette?

Nicotine is one of the drugs found in cigarettes. It is addictive. This means your body starts to crave and need it. Addiction is one reason why quitting is so hard. You may need medication to help you. Talk to your doctor about the right medicine for you. Whether you choose a patch, nasal spray or gum, you must use it exactly the right way.

As an L.A. Care member you can go to free health workshops just for you. Call **1-888-839-9909** (TTY/TDD **1-866-522-2731**) to learn more about L.A. Care's Health in Motion™ program.

L.A. Care members can also talk to a nurse 24 hours a day, 7 days a week, at no cost to you. The Nurse Advice Line phone number is listed on your health plan ID card.

L.A. Care offers free health classes in the community at our Family Resource Centers. For a location near you call **1-877-287-6290**.

L.A. Care HEALTH PLAN®

For a Healthy Life

LA0771 12/12

L.A. Care HEALTH PLAN®

Live Smoke Free . . .

One day at a time

The first step to living smoke free is to take some time to think about why you want to quit. Be as specific as you can.

Good: I want to quit for my health.

Better: I want to quit so I can play with my kids in the park.

My reasons for quitting:

1. _____

2. _____

The key to quitting is to have a plan.

Set a quit date. Pick a day that has meaning to you.

My Quit Date: _____

I will plan for my quit day by:

- ☐ Throwing away all my cigarettes.
- ☐ Getting my teeth cleaned.
- ☐ Cleaning my clothes, house and car.
- ☐ Telling my friends and family I am quitting.
- ☐ Calling the California Smoker's Helpline. This is a **free** telephone program that can help me quit. I will call 1-800-NO-BUTTS or go to **http://www.californiasmokershelpline.org**.

On your quit day be ready to do something else when you want to smoke.

Instead of smoking I will:

- ☐ Take 10 deep breaths
- ☐ Drink a glass of water
- ☐ Chew gum (sugarless is best)
- ☐ Brush my teeth
- ☐ Take a walk
- ☐ Call a friend
- ☐ Repeat "I am a non-smoker" 10 times in front of a mirror
- ☐ Read my list of reasons for quitting

Lots of good things happen when you stop smoking. You will:

- ✓ Feel better
- ✓ Breathe easier
- ✓ Have whiter teeth and a healthier mouth
- ✓ Taste and smell food better
- ✓ Not expose your kids or grandkids to second hand smoke

One of the best things is you save money.

A pack of cigarettes in California costs about $5.71. If you smoke a pack a day, that's $40 a week, $160 a month and $1,919 a year! What else you could do with this money?

How I will spend the money I save:

1. _____

2. _____

Estimado miembro:

Deseamos que se sienta bien y se mantenga saludable. Si es fumador, dejar de fumar es una de las mejores maneras de lograrlo. Si desea dejar de consumir tabaco, podemos ayudarle.

La Línea de Ayuda para Fumadores de California es un servicio **gratuito** de asesoría telefónica, que puede ayudarle a dejar de fumar para siempre. Puede obtener una **tarjeta de regalo de $20** al inscribirse. Llame al **1-800-45-NO FUME (1-800-456-6386)** para obtener más información.

L.A. Care también cubre **medicamentos** que pueden ayudarle a dejar de fumar.

- Parches de nicotina
- Goma de mascar de nicotina
- Pastillas de nicotina
- Aerosol nasal de nicotina
- Inhalador de nicotina
- Bupropión (Zyban)
- Bupropión SR (Wellbutrin)
- Vareniclina (Chantix)

Llame a su médico para pedirle una receta si cree que necesita un medicamento que le ayude a dejar de fumar.

Junto con esta carta, también encontrará lo siguiente:

- Material de educación de la salud: "*Viva sin fumar… un día a la vez*".
- Volante de la Línea de Ayuda para Fumadores de California, con información sobre cómo obtener **una tarjeta de regalo gratuita de $20**.

Tendrá más probabilidades de dejar de fumar si usa en forma conjunta la asesoría y los medicamentos indicados por su médico. Si desea una lista de los recursos cercanos para ayudarle a dejar de fumar, llámeme al número que figura a continuación.

Atentamente,

Marlene Rivera
Coordinadora de Recursos de Educación de la Salud
213.694.1250, ext. 4927

ML
011
2
11/
14_
EN
_SP

Miembro de Medi-Cal:
¿Quiere Dejar de Fumar?

Reciba GRATIS una tarjeta de regalo de $20 dólares cuando llame a la Línea de Ayuda para Fumadores de California.

1-800-45-NO-FUME
(1-800-456-6386)

Siga estos pasos:

- **Tenga su número de tarjeta de Medi-Cal listo.**
- **Llame a uno de los números de teléfono de abajo.**
- **Pida la tarjeta de regalo de $20 dólares.***
- **Hable con un amable asesor para crear un "plan para dejar de fumar" gratis.**

¡Llame hoy mismo!

Español

1-800-45-NO-FUME

Inglés

1-800-NO-BUTTS

*Financiado por *Centers for Medicare and Medicaid Services* bajo el programa *Medicaid Incentives for Prevention of Chronic Diseases.* Algunas condiciones aplican. Una tarjeta de regalo por persona. Esta oferta es válida hasta agotar existencias. Los planes de salud de Medi-Cal pueden ofrecer servicios adicionales para dejar el tabaco.

-SPANISH-

Otra razón por la que cual es difícil dejar de fumar es porque se convierte en un hábito. Un hábito es algo que usted hace sin pensarlo, como fumar cuando toma una taza de café en la mañana.

Es posible que tenga que cambiar su rutina diaria para dejar el hábito de fumar. Enumere los cambios que hará aquí.

Ejemplo:

Tomaré té en vez de café en la mañana.

1 _____

2 _____

¿Qué se encuentra en un cigarro?

La nicotina es una sustancia que se encuentra en los cigarros. Es adictiva. Eso significa que su organismo empieza a desearla y necesitarla. La adicción es una razón por la dejar de fumar es tan difícil. Es posible que necesite la ayuda de medicamentos. Hable con su médico sobre el tipo de medicamento adecuado para usted. Ya sea que elija el método del parche, el aerosol nasal o la goma de mascar, debe usarlo de la forma correcta.

Como miembro de L.A. Care puede participar en talleres de la salud gratuitos. Llame al **1-888-839-9909** (TTY/TDD **1-866-522-2731**) para obtener más información sobre el programa Health in Motion™ de L.A. Care.

Los miembros de L.A. Care también pueden hablar con una enfermera las 24 horas del día, los 7 días de la semana, sin costo alguno. El número de teléfono de la Línea de Enfermería se encuentra en su tarjeta de identificación del plan de salud.

L.A. Care ofrece clases de salud gratuitas para la comunidad en nuestros Centro de Recurso Familiar. Para encontrar un centro cerca de usted llame al **1-877-287-6290**.

L.A. Care HEALTH PLAN

Por Una **Vida Sana**

LA0771 SP 12/12

L.A. Care HEALTH PLAN

Viva sin fumar . . .

Día a día

El primer paso para vivir sin fumar es dedicar unos minutos a pensar por qué desea dejar de fumar. Sea lo más específico que pueda.

Bien: Deseo dejar de fumar por mi salud.

Mejor: Deseo dejar de fumar para poder jugar con mis hijos en el parque.

Mis razones para dejar de fumar son:

1. _____

2. _____

La clave para dejar de fumar es tener un plan.

Fije una fecha para dejar de fumar. Elija un día que sea importante para usted.

Mi día para dejar de fumar: _____

Este es mi plan para el día que deje de fumar:

- ☐ Tirar todos mis cigarros a la basura.
- ☐ Hacerme una limpieza dental.
- ☐ Lavar mi ropa, y limpiar la casa y el automóvil.
- ☐ Decirles a mis amigos y familiares que estoy dejando de fumar.
- ☐ Llamar a la Línea de Ayuda para Fumadores de California (California Smoker's Helpline). Este es un programa telefónico gratuito que puede ayudarme a dejar de fumar. Llamaré al 1-800-NO-BUTTS o visitaré **http://www.californiasmokershelpline.org**.

El día que deje de fumar, esté listo para hacer otra cosa cuando tenga deseos de fumar.

En vez de fumar haré lo siguiente:

- ☐ Respirar profundamente 10 veces
- ☐ Tomar un vaso de agua
- ☐ Masticar goma de mascar (preferiblemente sin azúcar)
- ☐ Cepillarme los dientes
- ☐ Caminar
- ☐ Llamar a un amigo
- ☐ Repetir "No soy un fumador" 10 veces frente a un espejo
- ☐ Leer mi lista de razones para dejar de fumar

Cuando deja de fumar le suceden muchas cosas buenas. Usted:

- ✓ Se sentirá mejor
- ✓ Respirará con mayor facilidad
- ✓ Tendrá dientes más blancos y una boca más sana
- ✓ Podrá saborear y oler mejor los alimentos
- ✓ No expondrá a sus hijos o nietos al humo de cigarro

Una de las mejores cosas es que ahorrará dinero.

Un paquete de cigarros en California cuesta unos $5.71. Si usted fuma un paquete al día, ¡son $40 a la semana, $160 al mes y $1,919 al año! ¿Qué otra cosa podría hacer con este dinero?

Cómo gastaré el dinero que ahorre:

1. _____

2. _____

Quitting Smoking During Pregnancy

When you're pregnant you breathe for both you and your baby. Smoking fills your body with chemicals, such as nicotine and tar. These get passed on to your baby. Smoking also reduces oxygen and blood flow to your baby. Your baby could be born too soon or at a low birth weight. Even if you've tried to quit before, don't give up.

Your baby will thank you.

Know Your Triggers

Triggers are things, times or events that make you want to smoke.

What are your triggers? _____

_____

_____

Instead of smoking I will: _____

_____

_____

Think about how quitting will help you and your baby. Changing your daily habits may help avoid your smoking triggers. If you smoke after meals, chew some gum instead or go for a walk.

Tips to Quit

- ✓ **Make a plan.** Set a quit date. Pick a day that is meaningful. Write it on a calendar or tell someone your quit date.
- ✓ **Prepare for your quit date.** Throw away your cigarettes. Clean your house, clothes and car.
- ✓ **Plan to do something else instead of smoke.** Take a walk. Call a friend. When the urge to smoke is strong, remind yourself of why you want to quit.

My Quit Date: _____

Beating Withdrawal

Nicotine is addictive. You may have withdrawal symptoms when you quit such as headaches, trouble sleeping, or feeling irritable. Luckily, these feelings pass.

Try:

- **Deep breathing.** This will help you relax and calm the urge to smoke.
- **Drink water.** This keeps your mouth fresh and flushes nicotine from your body. It's also good for your baby.
- **Do something else.** Go for a walk. Take up a craft. Prepare the baby's room. Anything is better than smoking.
- **Delay.** Put off smoking. The urge to smoke doesn't usually last long. Distract yourself until the urge passes.

Get Support

You may find it easier to quit when you have support from family or friends. Other types of support include:

- **CA Smoker's Helpline** offers telephone counseling. 1-800-NO-BUTTS (English); 1-800-45-NO-FUME (Spanish); 1-800-838-8917 (Chinese); 1-800-556-5564 (Korean); 1-800-778-8440 (Vietnamese).
- **Support** groups for people trying to quit smoking.
- **Your doctor** can help you find the best way to quit. This may include counseling, support groups, or medication.
- **Visit www.lacare.org** for a list of community resources in your area.

Cómo dejar de fumar durante el embarazo

Cuando usted está embarazada, respira tanto por usted como por su bebé. Fumar hace que su cuerpo se llene de sustancias químicas, como la nicotina y el alquitrán. Estas sustancias se pasan a su bebé. Además, fumar reduce el flujo de oxígeno y de sangre hacia el bebé. El bebé podría nacer antes de tiempo o con bajo peso. Incluso si ya ha intentado dejar de fumar antes, no se rinda.

Su bebé se lo agradecerá.

Conozca sus detonantes

Los detonantes son las cosas, los momentos o los acontecimientos que hacen que a usted le den ganas de fumar.

¿Cuáles son sus detonantes? _____

_____

_____

En lugar de fumar voy a: _____

_____

_____

Piense en cómo dejar de fumar les ayudará a usted y al bebé. Cambiar sus hábitos diarios puede ayudarle a evitar los detonantes que hacen que fume. Si fuma después de las comidas, mastique una goma de mascar en su lugar o salga a caminar.

Consejos para dejar de fumar

- ✓ **Haga un plan.** Establezca una fecha para dejar de fumar. Escoja un día que sea significativo. Escríbalo en un calendario o dígale a alguien su fecha para dejar de fumar.
- ✓ **Prepárese para la fecha en que dejará de fumar.** Tire a la basura sus cigarros. Limpie la casa, la ropa y el automóvil.
- ✓ **Planee hacer otra cosa en lugar de fumar.** Salga a caminar. Llame a un amigo. Cuando las ganas de fumar sean fuertes, recuerde por qué quiere dejar de fumar.

Mi fecha para dejar de fumar:

_____

Cómo vencer la abstinencia

La nicotina es adictiva. Es posible que tenga síntomas de abstinencia al dejar de fumar, como dolores de cabeza, problemas para dormir o irritabilidad. Afortunadamente, estas sensaciones se quitan.

Pruebe esto:

- **La respiración profunda.** Esto le ayudará a relajarse y a calmar las ganas de fumar.
- **Beba agua.** Esto mantiene la boca fresca y elimina la nicotina de su cuerpo. Además, es bueno para el bebé.
- **Haga otra cosa.** Salga a caminar. Practique un pasatiempo. Prepare la habitación del bebé. Cualquier cosa es mejor que fumar.
- **Aplácelo.** Posponga el acto de fumar. Las ganas de fumar generalmente duran poco. Distráigase hasta que pasen las ganas.

Reciba apoyo

Es posible que le resulte más fácil dejar de fumar si tiene el apoyo de familiares o amigos. Otros tipos de apoyo pueden ser:

- **La Línea de Ayuda para Fumadores** de California ofrece consejería por teléfono. 1-800-NO-BUTTS (en inglés); 1-800-45-NO-FUME (en español); 1-800-838-8917 (en chino); 1-800-556-5564 (en coreano); 1-800-778-8440 (en vietnamita).
- **Un grupo de apoyo** para dejar de fumar.
- **Su médico** puede ayudarle a encontrar la mejor manera de dejar de fumar. Esto puede incluir consejería, grupos de apoyo o medicamentos.
- **Visite www.lacare.org/es** para obtener una lista de recursos comunitarios en su área.

It's Never Too Late to Quit

There are benefits to quitting smoking no matter your age. When you quit:

- Circulation improves right away.
- Risk of heart disease, stroke, lung disease and cancer goes down.
- Lungs begin to repair.
- Quitting can add years to your life and save you money.

Know Your Triggers

Over the years, you have built up your own patterns around smoking. It is time to break these patterns. Think about when and why you smoke. There may be some things you do while smoking, like drinking coffee. These are your "triggers."

What are your triggers? _____

_____

_____

Overcoming Challenges

You may have tried to quit in the past. Don't be discouraged. Each time you quit is a chance to learn what works and what doesn't. Think about what caused you to start smoking again. Make a plan to avoid these things.

At this point in your life, you are well prepared to take on the challenge of quitting smoking.

Tips to Quit

- ✓ **Remind yourself why you want to quit.** Write down your reasons. Put them on the fridge. Remembering why you are doing this will help you when the urge to smoke is strong.
- ✓ **Prepare for your quit date.** Pick a date and mark it on a calendar. Throw away your cigarettes. Stock up on sugar free gum or hard candy.
- ✓ **Plan to do something else instead of smoke.** Take a walk. Call a friend. Read a magazine or do a crossword puzzle.
- ✓ **Change your routine.** Move your favorite chair or sit in a different chair. Small changes in routine can be a big help.

My Quit Date: _____

Instead of smoking I will: _____

_____

_____

Get Support

You may find it easier to quit when you have support from family or friends. Other types of support include:

- **CA Smoker's Helpline** offers telephone counseling. 1-800-NO-BUTTS (English); 1-800-45-NO-FUME (Spanish); 1-800-838-8917 (Chinese); 1-800-556-5564 (Korean); 1-800-778-8440 (Vietnamese).
- **Support** groups for people trying to quit smoking.
- **Your doctor** can help you find the best way to quit. This may include counseling, support groups, or medication.
- **Visit www.lacare.org** for a list of community resources in your area.

Nunca es demasiado tarde para dejar de fumar

Dejar de fumar le traerá beneficios sin importar la edad que tenga. Cuando se deja de fumar:

- La circulación mejora de inmediato.
- Los pulmones comienzan a repararse.
- Se reduce el riesgo de desarrollar una enfermedad coronaria, un derrame cerebral, una enfermedad pulmonar y cáncer.
- Dejar de fumar puede agregar años a su vida y ahorrarle dinero.

Conozca sus detonantes

Con los años, usted ha desarrollado sus propios patrones relacionados con el acto de fumar. Es hora de romper esos patrones. Piense en cuándo y por qué fuma. Tal vez hay cosas que usted hace mientras fuma, como beber café. A eso se le llama "detonantes".

¿Cuáles son sus detonantes? _____

_____

_____

Cómo superar los retos

Es posible que haya intentado dejar de fumar en el pasado. No se desanime. Cada vez que lo intenta es una oportunidad para aprender qué funciona y qué no. Piense en lo que hizo que usted empezara a fumar de nuevo. Haga un plan para evitar esas cosas.

En este punto de su vida, usted está bien preparado para asumir el reto de dejar de fumar.

Consejos para dejar de fumar

- ✓ **Recuérdese a usted mismo por qué quiere dejar de fumar.** Escriba sus motivos. Péguelas al refrigerador. Recordar por qué está haciendo esto le ayudará cuando las ganas de fumar sean fuertes.
- ✓ **Prepárese para la fecha en que dejará de fumar.** Escoja una fecha y márquela en un calendario. Tire a la basura sus cigarros. Tenga a la mano gomas de mascar o caramelos sin azúcar.
- ✓ **Planee hacer otra cosa en lugar de fumar.** Salga a caminar. Llame a un amigo. Lea una revista o haga un crucigrama.
- ✓ **Cambie su rutina.** Mueva su silla favorita o siéntese en una silla diferente. Hacer pequeños cambios en la rutina puede ser de gran ayuda.

Mi fecha para dejar de fumar:

_____

En lugar de fumar voy a: _____

_____

_____

Reciba apoyo

Es posible que le resulte más fácil dejar de fumar si tiene el apoyo de familiares o amigos. Otros tipos de apoyo pueden ser:

- **La Línea de Ayuda para Fumadores de California** ofrece consejería por teléfono. 1-800-NO-BUTTS (en inglés); 1-800-45-NO-FUME (en español); 1-800-838-8917 (en chino); 1-800-556-5564 (en coreano); 1-800-778-8440 (en vietnamita).
- **Un grupo de apoyo** para dejar de fumar.
- **Su médico** puede ayudarle a encontrar la mejor manera de dejar de fumar. Esto puede incluir consejería, grupos de apoyo o medicamentos.
- **Visite www.lacare.org/es** para obtener una lista de recursos comunitarios en su área.

The Truth About Smoking

Smoking is addictive. Even if you only smoke once in a while, you can still get hooked. Once that happens, it's very hard to stop.

You may think all your friends smoke. The truth is, most teens don't!

Smoking is toxic. Some of the chemicals in cigarettes are even used in rat poison!

Smoking is deadly. One out of every 3 teens who starts smoking will later get sick and die of a smoking-related disease.

Why teens DON'T smoke

"I don't smoke because I love playing sports. Smoking just slows you down. Plus, my coach would kick me off the team if I did."

-Daniel, age 15

"Smoking smells bad. Have you ever talked to someone who smokes? Their breath is bad and the smell stays on their clothes for a long time after. Gross!"

-Tanisha, age 19

"My boyfriend says he could never be serious about someone who smokes. He also says it's like kissing an ashtray."

-Veronica, age 17

"My grandpa died of lung cancer. He started smoking when he was 14. I miss him. Sometimes I wonder if he would still be around if he hadn't started smoking. I don't want to end up like that."

-Tran, age 16

My Reasons for Not Smoking

Example: I want to play on the basketball team at school OR I don't want to waste the money I make from babysitting on cigarettes.

1. _____
   _____
   _____

2. _____
   _____
   _____

I will not start smoking because: _____
_____
_____

Get Support

If you, your friends or family want to quit smoking, these resources can help:

- **CA Smoker's Helpline** offers telephone counseling. 1-800-NO-BUTTS (English); 1-800-45-NO-FUME (Spanish); 1-800-838-8917 (Chinese); 1-800-556-5564 (Korean); 1-800-778-8440 (Vietnamese).
- **Support** groups for people trying to quit smoking.
- **Your doctor** can help you find the best way to quit. This may include counseling, support groups, or medication.
- **Visit www.lacare.org** for a list of community resources in your area.

La verdad sobre fumar

Fumar es adictivo. Incluso si solo fumas de vez en cuando, puedes quedar atrapado. Una vez que esto sucede, es muy difícil dejarlo.

Tal vez piensas que todos tus amigos fuman. ¡La verdad es que la mayoría de los adolescentes no lo hacen!

Fumar es tóxico. ¡Algunas de las sustancias químicas que contienen los cigarrillos se utilizan incluso en veneno para ratas!

Fumar es mortal. Uno de cada 3 adolescentes que empieza a fumar se enfermará y morirá más adelante por una enfermedad relacionada con el tabaco.

¿Por qué los adolescentes NO fuman?

"Yo no fumo porque me encanta practicar deportes. Fumar disminuye tu rendimiento. Además, mi entrenador me sacaría del equipo si yo fumara".

-Daniel, 15 años

"Fumar huele feo. ¿Alguna vez has hablado con alguien que fuma? Su aliento huele feo y el olor se queda en su ropa durante mucho tiempo. ¡Qué asco!"

-Tanisha, 19 años

"Mi novio dice que nunca podría pensar en tener una relación seria con alguien que fuma. Además dice que es como besar un cenicero".

-Verónica, 17 años

"Mi abuelo murió de cáncer de pulmón. Empezó a fumar cuando tenía 14 años. Lo extraño. A veces pienso que tal vez él seguiría vivo si no hubiera empezado a fumar. Yo no quiero acabar así".

-Tran, 16 años

Mis motivos para no fumar

Ejemplo: Quiero jugar en el equipo de baloncesto de la escuela O no quiero gastar en cigarros el dinero que gano como niñera.

1. _____
   _____
   _____

2. _____
   _____
   _____

No voy a empezar a fumar porque: _____

_____

_____

Recibe apoyo

Si tú, tus amigos o tus familiares quieren dejar de fumar, estos recursos pueden ayudarles:

- **La Línea de Ayuda para Fumadores de California** ofrece consejería por teléfono. 1-800-NO-BUTTS (en inglés); 1-800-45-NO-FUME (en español); 1-800-838-8917 (en chino); 1-800-556-5564 (en coreano); 1-800-778-8440 (en vietnamita).
- **Un grupo de apoyo** para dejar de fumar.
- **Un médico** puede ayudarles a encontrar la mejor manera de dejar de fumar. Esto puede incluir consejería, grupos de apoyo o medicamentos.
- **Visiten www.lacare.org/es** para obtener una lista de recursos comunitarios en su área.