



American Journal of EPIDEMIOLOGY

Founded 1920 by
W. H. Welch and
W. H. Howell as the
American Journal of Hygiene

Copyright © 2008 by The Johns Hopkins
Bloomberg School of Public Health
Sponsored by the Society for Epidemiologic Research
Published by Oxford University Press

BOARD OF EDITORS

MOYSES SZKLO, *Editor-in-Chief*
DONNA K. ARNETT
TIM BYERS
HARVEY CHECKOWAY
FRANCESCA DOMINICI
JANICE S. DORMAN
MANNING FEINLEIB
AARON R. FOLSOM
GARY D. FRIEDMAN
ROBERT J. GLYNN
ICHIRO KAWACHI
MUIN J. KHOURY
MARK KLEBANOFF
MARTHA S. LINET
POLLY MARCHBANKS
POLLY NEWCOMB
GEORGE G. RHOADS
DONNA SPIEGELMAN
DAVID VLAHOV
CLARICE WEINBERG

BOARD OF OVERSEERS

MICHAEL J. KLAG, *Chairman*
SHELLEY ANDREWS
MICHAEL B. BRACKEN
SHERMAN JAMES
NOEL R. ROSE
JONATHAN M. SAMET

EDITOR-IN-CHIEF EMERITUS, IN MEMORIAM

GEORGE W. COMSTOCK

ASSOCIATE EDITOR IN RESIDENCE

SHRUTI H. MEHTA

EDITORIAL PROJECT MANAGERS

DEBORAH J. ANDERSON
SANDRA L. BRYANT
AMY W. REDMON-NORWOOD

ADMINISTRATOR

HARRIETT TELLJOHANN

ADMINISTRATIVE ASSISTANT

CYNTHIA A. BARBRE

REVIEW COORDINATOR

Gayle Fini

ASSOCIATE EDITORS

ANTHONY ALBERG, *Charleston, SC*
ALBERTO ASCHERIO, *Boston, MA*
BRAD ASTOR, *Baltimore, MD*
OLGA BASSO, *Research Triangle Park, NC*
EDWARD J. BOYKO, *Seattle, WA*
ROBERT F. BREIMAN, *Atlanta, GA*
GERMAINE M. BUCK, *Rockville, MD*
KENNETH P. CANTOR, *Bethesda, MD*
WONG-HO CHOW, *Bethesda, MD*
JOHN D. CLEMENS, *Bethesda, MD*
STEPHEN COLE, *Baltimore, MD*
GLINDA S. COOPER, *Research Triangle Park, NC*
JOSEF CORESH, *Baltimore, MD*
STEVEN S. COUGHLIN, *Atlanta, GA*
ROSA M. CRUM, *Baltimore, MD*
RALPH B. D'AGOSTINO, JR., *Winston-Salem, NC*
RALPH B. D'AGOSTINO, SR., *Boston, MA*
CONSTANTINE DASKALAKIS, *Philadelphia, PA*
ANA V. DIEZ-ROUX, *Ann Arbor, MI*
BRENDA ESKENAZI, *Berkeley, CA*
GUY D. ESLICK, *Sydney, Australia*
EDUARDO FAERSTEIN, *Rio de Janeiro, Brazil*
KATHERINE M. FLEGAL, *Hyattsville, MD*
BETSY FOXMAN, *Ann Arbor, MI*
LIN FRITSCHI, *Crawley, Australia*
SANDRO GALEA, *Ann Arbor, MI*
MARILIE D. GAMMON, *Chapel Hill, NC*
PETER J. GERGEN, *Rockville, MD*
RICHARD F. GILLUM, *Hyattsville, MD*

EDWARD GIOVANNUCCI, *Boston, MA*
MARLENE B. GOLDMAN, *Boston, MA*
ELISEO GUALLAR, *Baltimore, MD*
M. ELIZABETH HALLORAN, *Atlanta, GA*
BERNARD L. HARLOW, *Minneapolis, MN*
PATRICIA HARTGE, *Rockville, MD*
MAUREEN C. HATCH, *Bethesda, MD*
RICHARD B. HAYES, *Bethesda, MD*
MIGUEL A. HERNÁN, *Boston, MA*
LISA HERRINTON, *Oakland, CA*
IRVA HERTZ-PICCIOTTO, *Davis, CA*
JANE A. HOPPIN, *Research Triangle Park, NC*
LILLIAN INGSTER, *Hyattsville, MD*
JOUNI JAAKKOLA, *Birmingham, United Kingdom*
STEVEN J. JACOBSEN, *Pasadena, CA*
KONRAD JAMROZIK, *Nedlands, Australia*
STANISLAV V. KASL, *New Haven, CT*
JOHN L. KIELY, *Hyattsville, MD*
FREYA KAMEL, *Research Triangle Park, NC*
JAY S. KAUFMAN, *Chapel Hill, NC*
WILLIAM C. KNOWLER, *Phoenix, AZ*
ALAN R. KRISTAL, *Seattle, WA*
MICHAEL F. LEITZMANN, *Bethesda, MD*
DE-KUN LI, *Oakland, CA*
RONGLING LI, *Memphis, TN*
MARC LIPSITCH, *Boston, MA*
JULIAN LITTLE, *Aberdeen, United Kingdom*
MATTHEW P. LONGNECKER, *Research Triangle Park, NC*

GERALD MCGWIN, JR., *Birmingham, AL*
JOSEPH K. MCLAUGHLIN, *Rockville, MD*
LORENE M. NELSON, *Stanford, CA*
ROBERTA B. NESS, *Pittsburgh, PA*
CRAIG J. NEWSCHAFER, *Philadelphia, PA*
ANDREW OLSHAN, *Chapel Hill, NC*
NANCY PADIAN, *San Francisco, CA*
JULIE R. PALMER, *Brookline, MA*
JULIE PARSONNET, *Stanford, CA*
WENDY S. POST, *Baltimore, MD*
NANCY POTISCHMAN, *Bethesda, MD*
ERIC B. RIMM, *Boston, MA*
HARVEY A. RISCH, *New Haven, CT*
LESLIE ROBISON, *Minneapolis, MN*
KARIN ROSENBLATT, *Champaign, IL*
AUDREY F. SAFTLAS, *Iowa City, IA*
GLEN A. SATTEN, *Atlanta, GA*
ENRIQUE F. SCHISTERMAN, *Bethesda, MD*
THOMAS A. SELLERS, *Tampa, FL*
EYAL SHAHAR, *Tucson, AZ*
A. RICHEY SHARRETT, *Baltimore, MD*
COLIN L. SOSKOLNE, *Edmonton, Canada*
MEIR STAMPFER, *Boston, MA*
SHOLOM WACHOLDER, *Bethesda, MD*
DOUGLAS L. WEED, *Bethesda, MD*
SCOTT T. WEISS, *Boston, MA*
PHYLLIS A. WINGO, *Atlanta, GA*
JUN ZHANG, *Bethesda, MD*

American Journal of Epidemiology

The *American Journal of Epidemiology* (ISSN 0002-9262) publishes twice a month, 24 times a year, in Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sept., Oct., Nov., and Dec. by Oxford University Press, 2001 Evans Road, Cary, NC 27513-2009, for the Johns Hopkins Bloomberg School of Public Health and is sponsored by the Society for Epidemiologic Research. Information for authors appears on the *Journal's* home page at www.aje.oxfordjournals.org. Authors should consult these instructions before submitting manuscripts.

Oxford University Press is a department of the University of Oxford. It furthers the University's objective of excellence in research, scholarship, and education by publishing worldwide.

Subscriptions: A subscription to the *American Journal of Epidemiology* comprises 24 issues. Prices include postage; for subscribers outside the Americas, issues are sent air freight.

Annual subscription rate (Volumes 167 and 168, 24 issues, 2008): **Institutional:** Print and online \$709/£473/€709, Online only \$674/£449/€674, and Print only \$674/£449/€674; **Personal:** (Combination: the *Journal* and *Epidemiologic Reviews*) Online only \$330/£220/€330, and Print only \$347/£231/€347. Please note: UK£ rate applies to UK and Rest of World, except US (\$) and Europe (€). There may be other subscription rates available. For a complete listing please see: www.oxfordjournals.org/our_journals/aje/access_purchase/price_list.html.

Full pre-payment in the correct currency is required for all orders. Payment should be in US dollars for orders being delivered to the USA or Canada; Euros for orders being delivered within Europe (excluding the UK); GBP sterling for orders being delivered elsewhere (i.e. not being delivered to USA, Canada, or Europe). All orders should be accompanied by full payment and sent to your nearest Oxford Journals office. Subscriptions are accepted for complete volumes only. Orders are regarded as firm, and payments are not refundable. Our prices include Standard Air as postage outside of the UK. Claims must be notified within four months of despatch/order date (whichever is later). Subscriptions in the EEC may be subject to European VAT. If registered, please supply details to avoid unnecessary charges. For subscriptions that include online versions, a proportion of the subscription price may be subject to UK VAT. Subscribers in Canada, please add GST to the prices quoted.

Personal rate subscriptions are only available if payment is made by personal cheque or credit card, delivery is to a private address, and is for personal use only.

Methods of payment: (i) Check (payable to Oxford University Press, mailed to Oxford University Press, Cashiers Office, Great Clarendon Street, Oxford OX2 6DP, UK) in GB£ Sterling (drawn on a UK bank), US\$ Dollars (drawn on a US bank), or EU€ Euros.

(ii) Bank transfer to Barclays Bank Plc, Oxford Group Office, Oxford (bank sort code 20-65-18) (UK), overseas only Swift code BARC GB 22 (GB£ Sterling to account no. 70299332, IBAN GB89BARC20651870299332; US\$ Dollars to account no. 66014600, IBAN GB27BARC20651866014600; EU€ Euros to account no. 78923655, IBAN GB16BARC20651878923655).

(iii) Credit card (Mastercard, Visa, Switch or American Express).

Back issues: The current year and two previous years' issues are available from Oxford University Press. Previous volumes can be obtained online at <http://www.periodicals.com/oxford.html> or from the Periodicals Service Company, 11 Main Street, Germantown, NY 12526, USA. E-mail: psc@periodicals.com. Tel: (518) 537-4700. Fax: (518) 537-5899.

For further information, please contact: Journals Customer Service, Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, UK. Telephone (& answer-phone outside normal working hours): +44 (0) 1865 353907, Fax: +44 (0) 1865 353485, E-mail: jnls.cust.serv@oxfordjournals.org. In the US, please contact: Journals Customer Service, Oxford University Press, 2001 Evans Road, Cary, NC 27513, USA. Telephone (& answer-phone outside normal working hours): 800-852-7323 (toll-free in USA/

Canada), fax: 919-677-1714, e-mail: jnlorders@oxfordjournals.org. In Japan, please contact: Journals Customer Service, Oxford University Press, 1-1-17-5F, Mukogaoka, Bunkyo-ku, Tokyo, 113-0023, Japan. Telephone: (03) 3813 1461, Fax: (03) 3818 1522, e-mail: oujnl@po.ijnet.or.jp.

Advertising: Advertising, inserts, and artwork enquiries should be addressed to Advertising and Special Sales, Oxford Journals, Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, UK. Telephone: +44 (0) 1865 353329. Fax: +44 (0) 1865 353774. E-mail: jnlsadvertising@oxfordjournals.org.

Digital Object Identifiers: For information on *dois* and how to resolve them, please visit www.doi.org.

Oxford Journals Environmental and Ethical Policies: Oxford Journals is committed to working with the global community to bring the highest quality research to the widest possible audience. Oxford Journals will protect the environment by implementing environmentally friendly policies and practices wherever possible. Please see <http://www.oxfordjournals.org/ethicalpolicies.html> for further information on Oxford Journals' environmental and ethical policies.

Requests for permissions, reprints, and photocopies: All rights reserved; no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without either prior written permission of the publisher (Oxford University Press, Rights and Business Development Journals Division, Great Clarendon St., Oxford OX2 6DP, UK. Tel. +44 1865 354490/353695; Fax: +44 1865 353485; E-mail: journals.permissions@oxfordjournals.org; Web: www.oxfordjournals.org/jnls/permissions) or a license permitting restricted copying, issued in the US by the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 (Fax: 978-750-4470) or in the UK by the Copyright Licensing Agency Ltd., 90 Tottenham Court Road, London W1P 9HE, UK. Reprints of individual articles are available only from the authors.

It is a condition of publication in the *Journal* that authors grant an exclusive license to the Johns Hopkins Bloomberg School of Public Health. However, requests for permission to reprint material found in the *Journal* should be submitted to Oxford University Press. This ensures that requests from third parties to reproduce articles are handled efficiently and consistently and will also allow the article to be disseminated as widely as possible. As part of the license agreement, authors may use their own material in other publications provided that the *Journal* is acknowledged as the original place of publication and Oxford University Press is notified in writing in advance.

The author(s) of each article appearing in this *Journal* is/are solely responsible for the content thereof; the publication of an article shall not constitute or be deemed to constitute any representation by the Editors, the Johns Hopkins Bloomberg School of Public Health, or the Society for Epidemiologic Research that the data presented therein are correct or sufficient to support the conclusions reached or that the experiment design or methodology is adequate.

The *American Journal of Epidemiology* is printed on acid-free paper that meets the minimum requirements of ANSI Standard Z39.48-1984 (Permanence of Paper).

The *Journal* is indexed or abstracted in *Index Medicus*, the *Science Citation Index*, *Current Contents: Life Sciences*, and the *BIOSIS* database.

Copyright © 2008 by the Johns Hopkins Bloomberg School of Public Health.

The *American Journal of Epidemiology* (ISSN 0002-9262) is published semimonthly by Oxford University Press, 2001 Evans Road, Cary, NC 27513-2009. Periodical Postage paid at Cary, NC and at additional post offices.

Postmaster: Send address changes to: *American Journal of Epidemiology*, Journals Customer Service Department, Oxford University Press, 2001 Evans Road, Cary, NC 27513-2009.

Please visit the *Journal's* World Wide Web site at www.aje.oxfordjournals.org
For more information about Oxford University Press please visit us at www.oxfordjournals.org