

# EXHIBIT N

# Sampling of Populations

Methods and Applications

Fourth Edition

**Paul S. Levy**

*RTI International  
Statistical Research Division  
Research Triangle Park, North Carolina*

**Stanley Lemeshow**

*The Ohio State University  
College of Public Health  
Columbus, Ohio*



WILEY

A JOHN WILEY & SONS, INC., PUBLICATION

Copyright © 2008 by John Wiley & Sons, Inc. All rights reserved.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.  
Published simultaneously in Canada.

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, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at [www.copyright.com](http://www.copyright.com). Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

**Limit of Liability/Disclaimer of Warranty:** While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic format. For information about Wiley products, visit our web site at [www.wiley.com](http://www.wiley.com).

***Library of Congress Cataloging-in-Publication Data:***

Levy, Paul S.

Sampling of populations : methods and applications / Paul S. Levy, Stanley Lemeshow. — 4th ed.  
p. cm.

Includes bibliographical references and index.

ISBN 978-0-470-04007-2 (cloth)

I. Population—Statistical methods. 2. Sampling (Statistics) I. Lemeshow, Stanley. II. Title.

HB849.49.L48 2008

304.601'51952—dc21

2008004934

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

**Table 2.9 Data for the Burn Area Estimates**

Student	Mean (%)	Variance (%) <sup>2</sup>
Dave	37	64
Don	42	9
Virginia	50	9

where  $z$  is the standard normal deviate.

Don's burn measurements are usually high, but it is not often that he would be more than 10 percentage points away from the true value. For Don

$$\Pr(X > 47) + \Pr(X < 27) = \Pr\left(z > \frac{47 - 42}{\sqrt{9}} = 1.67\right) + \Pr(z < -5.00) = .05.$$

Finally, as reflected by her large MSE, the probability that Virginia misses the target burn area by more than 10 percentage points is quite high:

$$\Pr(X > 47) + \Pr(X > 27) = \Pr\left(z > \frac{47 - 50}{\sqrt{9}} = -1\right) + \Pr(z < -7.67) = .84.$$

We have seen in this example that, when evaluating particular estimates, it is important to examine both bias and variance. Both entities play important roles in determining the size of the mean square error.

### 2.4.3 Validity, Reliability, and Accuracy

In earlier sections, we spoke of the desirability of using sample designs that yield reliable and valid estimates. However, we have never defined just what the terms "reliable" and "valid" mean in terms of characteristics of estimates.

We now have developed enough concepts and notation concerning estimates to be able to define these two terms as well as a third term, the "accuracy" of an estimate, which we will see is derived from the validity and reliability.

The *reliability* of an estimated population characteristic refers to how reproducible the estimator is over repetitions of the process yielding the estimator. If we assume that there is no measurement error in the survey, then the reliability of an estimator can be stated in terms of its sampling variance or, equivalently, its standard error. The smaller the standard error of an estimator, the greater is its reliability.

The *validity* of an estimated population characteristic refers to how the mean of the estimator over repetitions of the process yielding the estimate, differs from the true value of the parameter being estimated. Again, if we assume that there is no measurement error, the validity of an estimator can be evaluated by examining the bias of the estimator. The smaller the bias, the greater is the validity.