adults in each joint category. Estimates were stratified by sex and age category. Analyses were conducted in Stata version 13.1 (StataCorp) using survey commands to account for the sampling design, and full sample interview weights were applied.

Results | We analyzed data from 5923 adults with complete data (98.8% of total). Overall, 25.7% (95% CI, 23.0%-28.5%) reported sitting for more than 8 hours per day and 44.6% (95% CI, 40.2%-49.0%) were inactive. Across joint categories, the greatest proportion of adults reported sitting for 6 to 8 hours per day and being inactive (13.9%; 95% CI, 12.1%-16.0%), followed by sitting for more than 8 hours per day and being inactive (11.4%; 95% CI, 10.5%-12.4%), and sitting for 4 to less than 6 hours per day and being inactive (11.2%; 95% CI, 9.6%-13.0%) (**Figure**). The smallest proportions reported sitting for less than 4 hours per day and being sufficiently active (2.6%; 95% CI, 2.1%-3.2%) or sitting for less than 4 hours per day and being insufficiently active (2.7%; 95% CI, 2.0%-3.6%). Patterns were similar by sex (**Table**). Some differences in the joint distribution of sitting time and leisure-time physical activity were observed between age categories. For example, the joint prevalence of sitting for more than 8 hours per day and being inactive increased with increasing age.

Discussion | These data reveal a substantial prevalence of high sitting time and physical inactivity among US adults: about 1 in 4 sit for more than 8 hours a day, 4 in 10 are physically inactive, and 1 in 10 report both. The limitations of this study include possible bias inherent in self-reported data and that physical activity episodes shorter than 10 minutes may not have been captured.

Both high sedentary behavior and physical inactivity have negative health effects, and evidence suggests that the risk of premature mortality is particularly elevated when they occur together.[1,2] Evidence-based strategies to reduce sitting time, increase physical activity, or both would potentially benefit most US adults, particularly older adults. Practitioners can support efforts to implement programs, practices, and policies where adults live, learn, work, and play to help them sit less and spend more time being physically active.[1,5,6]

Emily N. Ussery, PhD
Janet E. Fulton, PhD
Deborah A. Galuska, PhD
Peter T. Katzmarzyk, PhD
Susan A. Carlson, PhD

Author Affiliations: Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, Atlanta, Georgia (Ussery, Fulton, Galuska, Carlson); Pennington Biomedical Research Center, Louisiana State University, Baton Rouge (Katzmarzyk).

Corresponding Author: Emily N. Ussery, PhD, National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, 4770 Buford Hwy NE, Atlanta, GA 30341 (yzv4@cdc.gov).

Author Contributions: Dr Ussery had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Ussery, Fulton, Katzmarzyk, Carlson.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Ussery.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Ussery, Carlson.
Administrative, technical, or material support: Ussery, Fulton, Carlson.
Supervision: Fulton, Katzmarzyk, Carlson.

Conflict of Interest Disclosures: None reported.

Funding/Support: This research was funded by the Centers for Disease Control and Prevention.

Role of the Funder/Sponsor: The Centers for Disease Control and Prevention supported the staff responsible for the design and conduct of the study; the collection, analysis, and interpretation of the data; the preparation, review, and approval of the manuscript; and the decision to submit the manuscript for publication.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

1. Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington, DC: US Department of Health and Human Services; 2018.

2. Ekelund U, Steene-Johannessen J, Brown WJ, et al; Lancet Physical Activity Series 2 Executive Committee; Lancet Sedentary Behaviour Working Group. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? a harmonised meta-analysis of data from more than 1 million men and women. *Lancet*. 2016;388(10051):1302-1310. doi:10.1016/S0140-6736(16)30370-1

3. Centers for Disease Control and Prevention National Center for Health Statistics. National Health and Nutrition Examination Survey data, 2015-2016. https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2015. Accessed August 1, 2018.

4. US Department of Health and Human Services. *Physical Activity Guidelines for Americans, Second Edition*. Washington, DC: US Dept of Health and Human Services; 2018.

5. US Department of Health and Human Services. *Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities*. Washington, DC: US Dept of Health and Human Services Office of the Surgeon General; 2015.

6. Community Preventive Services Task Force. *Built Environment Approaches Combining Transportation System Interventions With Land Use and Environmental Design: Task Force Finding and Rationale Statement*. December 2016. https://www.thecommunityguide.org/sites/default/files/assets/PA-Built-Environments.pdf. Accessed August 10, 2018.

COMMENT & RESPONSE

Validity of the qSOFA Score in Low- and Middle-Income Countries

To the Editor Dr Rudd and colleagues[1] concluded that the quick Sequential (Sepsis-Related) Organ Failure Assessment (qSOFA) score was superior to the systemic inflammatory response syndrome (SIRS) score and a baseline risk model in predicting in-hospital mortality in low- and middle-income countries (LMICs), an issue that has been debated since its introduction in the Sepsis-3 definitions.[2,3] We are concerned that the treatment of missing data may have introduced significant bias.

More than half the data set was incomplete with respect to human immunodeficiency virus or transfer status (components of the baseline risk model) or white blood cell count (a SIRS component). The authors used the same imputation strategy (substitution of clinically normal values) that was used in the original qSOFA derivation.[3] Simple imputation schemes of this kind are known to potentially yield biased estimates and systematically underestimate uncertainty in estimated parameters,[4] both of which can lead to wrongly concluding that one score is superior. The assumption of clinical normality

could bias downward the predictive ability of the baseline risk and SIRS models, inflating the apparent additive discriminatory ability of the qSOFA model. The evidence for superiority of qSOFA largely disappeared in the sensitivity analyses when excluding these missing variables or using a more sophisticated imputation strategy.[5]

When comparing the performance of the many scores that predict mortality, qSOFA and others share the same deficiency with respect to medical practice in LMICs: they provide neither a basis for specifically directing clinical management nor a foundation for research into improving care. If they are to be useful in practice, strategies to link mortality identification scores to clinical action in LMICs are needed. We suggest that the incremental benefit of disease-specific scores should be weighed against the fragmentation of care for critically unwell patients. The opportunity costs of deploying a scoring system are significant, and especially so where resources are limited. Outcomes in critical illness are poor but might be better addressed by a more broadly applicable but less discriminant score, tied to careful assessment of implementation.

Joseph M. Lewis, MSc, MRCP, DTMH
Marc Henrion, PhD
Jamie Rylance, PhD, MRCP, DTMH

Author Affiliations: Malawi Liverpool Wellcome Clinical Research Programme, Blantyre, Malawi.

Corresponding Author: Joseph M. Lewis, MSc, MRCP, DTMH, Malawi Liverpool Wellcome Clinical Research Programme, Queen Elizabeth Central Hospital, PO Box 30096, Blantyre 3, Malawi (joseph.lewis@lstmed.ac.uk).

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

1. Rudd KE, Seymour CW, Aluisio AR, et al; Sepsis Assessment and Identification in Low Resource Settings (SAILORS) Collaboration. Association of the quick Sequential (Sepsis-Related) Organ Failure Assessment (qSOFA) score with excess hospital mortality in adults with suspected infection in low- and middle-income countries. *JAMA*. 2018;319(21):2202-2211. doi:10.1001/jama.2018.6229

2. Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):801-810. doi:10.1001/jama.2016.0287

3. Seymour CW, Liu VX, Iwashyna TJ, et al. Assessment of clinical criteria for sepsis: for the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):762-774. doi:10.1001/jama.2016.0288

4. Harrell FE Jr. *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis*. New York, NY: Springer; 2015.

5. van Buuren S, Groothuis-Oudshoorn K. Mice: multivariate imputation by chained equations. *J Stat Softw*. 2011;45(3):1-67.

In Reply We agree with Dr Lewis and colleagues that missing data can be an important limitation in clinical research, including our analysis of the predictive validity of the qSOFA score and SIRS criteria.[1] There are 2 issues related to missing data: (1) why missing data are present and (2) the approach to missing data during analysis. First, missing data were present in all 9 cohorts included in the study. Many sites lacked electronic health record systems, had limited medical staff available to collect and record serial vital signs, and were unable to routinely perform laboratory testing for every patient with suspected infection because of limited laboratory and financial resources. Given this reality, the diagnosis of sepsis in LMICs will not always be informed by complete data. Therefore, it is useful for clinicians in low-resource settings to understand the performance of alternative scoring systems in situations in which some variables, though important predictors of clinical outcome, may be missing.

Second, there are multiple statistical methods for the analysis of missing data, all of which may introduce bias. In our primary analysis, we used single normal value imputation, which is standard in clinical risk scores[2-4] and most closely resembles how clinicians would use the score at the bedside. We agree with Lewis and colleagues that this approach can bias downward the predictive ability of models with missing data, but point out that there were missing data among the qSOFA score components as well as the baseline risk and SIRS models. Given concerns for possible bias with this statistical method, we performed many sensitivity analyses focused on the issue of missing data (eTable 7 in the Supplement[1]). While the magnitude of effect sometimes changed in these analyses, all the findings were in the same direction and remained statistically significant.

We believe that the most important way to mitigate the challenges of missing data in some LMIC settings is to address the challenges of poverty and health inequity that lead to missing clinical data in the first place, which will require adequate financial support to fund the health care systems and clinicians that are providing care to these patients. Greater clinical research infrastructure with distributive data networks could also ensure data quality and availability.

Lewis and colleagues raise the broader issue of the utility of the qSOFA score relative to other general risk scores. The qSOFA score was not designed as a mortality prediction tool, but rather one to identify patients with the highest likelihood of sepsis. As such, predictive validity, the foundational approach of the study, is an assessment of how well the qSOFA score performed in terms of selecting patients who may later develop downstream events associated with sepsis. In this case, hospital mortality was used as the downstream event associated with sepsis (as sepsis is by definition life-threatening), but it is only one example of several possible end points. Once patients with sepsis are identified, we agree that strategies for optimal sepsis management in LMIC settings must be better developed.

Kristina E. Rudd, MD, MPH
Christopher W. Seymour, MD, MSc
Derek C. Angus, MD, MPH

Author Affiliations: Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania (Rudd, Seymour, Angus); Associate Editor, *JAMA* (Angus).

Corresponding Author: Kristina E. Rudd, MD, MPH, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, 3550 Terrace St, Scaife Hall, Ste 639, Pittsburgh, PA 15261 (ruddk@pitt.edu).

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Seymour reported receiving grants from the National Institutes of Health and personal fees from Beckman Coulter. No other disclosures were reported.

1. Rudd KE, Seymour CW, Aluisio AR, et al; Sepsis Assessment and Identification in Low Resource Settings (SAILORS) Collaboration. Association of the quick Sequential (Sepsis-Related) Organ Failure Assessment (qSOFA) score with

could bias downward the predictive ability of the baseline risk and SIRS models, inflating the apparent additive discriminatory ability of the qSOFA model. The evidence for superiority of qSOFA largely disappeared in the sensitivity analyses when excluding these missing variables or using a more sophisticated imputation strategy.[5]

When comparing the performance of the many scores that predict mortality, qSOFA and others share the same deficiency with respect to medical practice in LMICs: they provide neither a basis for specifically directing clinical management nor a foundation for research into improving care. If they are to be useful in practice, strategies to link mortality identification scores to clinical action in LMICs are needed. We suggest that the incremental benefit of disease-specific scores should be weighed against the fragmentation of care for critically unwell patients. The opportunity costs of deploying a scoring system are significant, and especially so where resources are limited. Outcomes in critical illness are poor but might be better addressed by a more broadly applicable but less discriminant score, tied to careful assessment of implementation.

Joseph M. Lewis, MSc, MRCP, DTMH
Marc Henrion, PhD
Jamie Rylance, PhD, MRCP, DTMH

Author Affiliations: Malawi Liverpool Wellcome Clinical Research Programme, Blantyre, Malawi.

Corresponding Author: Joseph M. Lewis, MSc, MRCP, DTMH, Malawi Liverpool Wellcome Clinical Research Programme, Queen Elizabeth Central Hospital, PO Box 30096, Blantyre 3, Malawi (joseph.lewis@lstmed.ac.uk).

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

1. Rudd KE, Seymour CW, Aluisio AR, et al; Sepsis Assessment and Identification in Low Resource Settings (SAILORS) Collaboration. Association of the quick Sequential (Sepsis-Related) Organ Failure Assessment (qSOFA) score with excess hospital mortality in adults with suspected infection in low- and middle-income countries. *JAMA*. 2018;319(21):2202-2211. doi:10.1001/jama.2018.6229

2. Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):801-810. doi:10.1001/jama.2016.0287

3. Seymour CW, Liu VX, Iwashyna TJ, et al. Assessment of clinical criteria for sepsis: for the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):762-774. doi:10.1001/jama.2016.0288

4. Harrell FE Jr. *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis*. New York, NY: Springer; 2015.

5. van Buuren S, Groothuis-Oudshoorn K. Mice: multivariate imputation by chained equations. *J Stat Softw*. 2011;45(3):1-67.

In Reply We agree with Dr Lewis and colleagues that missing data can be an important limitation in clinical research, including our analysis of the predictive validity of the qSOFA score and SIRS criteria.[1] There are 2 issues related to missing data: (1) why missing data are present and (2) the approach to missing data during analysis. First, missing data were present in all 9 cohorts included in the study. Many sites lacked electronic health record systems, had limited medical staff available to collect and record serial vital signs, and were unable to routinely perform laboratory testing for every patient with suspected infection because of limited laboratory and financial resources. Given this reality, the diagnosis of sepsis in LMICs will not always be informed by complete data. Therefore, it is useful for clinicians in low-resource settings to understand the performance of alternative scoring systems in situations in which some variables, though important predictors of clinical outcome, may be missing.

Second, there are multiple statistical methods for the analysis of missing data, all of which may introduce bias. In our primary analysis, we used single normal value imputation, which is standard in clinical risk scores[2-4] and most closely resembles how clinicians would use the score at the bedside. We agree with Lewis and colleagues that this approach can bias downward the predictive ability of models with missing data, but point out that there were missing data among the qSOFA score components as well as the baseline risk and SIRS models. Given concerns for possible bias with this statistical method, we performed many sensitivity analyses focused on the issue of missing data (eTable 7 in the Supplement[1]). While the magnitude of effect sometimes changed in these analyses, all the findings were in the same direction and remained statistically significant.

We believe that the most important way to mitigate the challenges of missing data in some LMIC settings is to address the challenges of poverty and health inequity that lead to missing clinical data in the first place, which will require adequate financial support to fund the health care systems and clinicians that are providing care to these patients. Greater clinical research infrastructure with distributive data networks could also ensure data quality and availability.

Lewis and colleagues raise the broader issue of the utility of the qSOFA score relative to other general risk scores. The qSOFA score was not designed as a mortality prediction tool, but rather one to identify patients with the highest likelihood of sepsis. As such, predictive validity, the foundational approach of the study, is an assessment of how well the qSOFA score performed in terms of selecting patients who may later develop downstream events associated with sepsis. In this case, hospital mortality was used as the downstream event associated with sepsis (as sepsis is by definition life-threatening), but it is only one example of several possible end points. Once patients with sepsis are identified, we agree that strategies for optimal sepsis management in LMIC settings must be better developed.

Kristina E. Rudd, MD, MPH
Christopher W. Seymour, MD, MSc
Derek C. Angus, MD, MPH

Author Affiliations: Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania (Rudd, Seymour, Angus); Associate Editor, *JAMA* (Angus).

Corresponding Author: Kristina E. Rudd, MD, MPH, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, 3550 Terrace St, Scaife Hall, Ste 639, Pittsburgh, PA 15261 (ruddk@pitt.edu).

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Seymour reported receiving grants from the National Institutes of Health and personal fees from Beckman Coulter. No other disclosures were reported.

1. Rudd KE, Seymour CW, Aluisio AR, et al; Sepsis Assessment and Identification in Low Resource Settings (SAILORS) Collaboration. Association of the quick Sequential (Sepsis-Related) Organ Failure Assessment (qSOFA) score with

excess hospital mortality in adults with suspected infection in low- and middle-income countries. *JAMA*. 2018;319(21):2202-2211. doi:10.1001/jama.2018.6229

2. Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. *Intensive Care Med*. 1996;22(7):707-710. doi:10.1007/BF01709751

3. Seymour CW, Kahn JM, Cooke CR, Watkins TR, Heckbert SR, Rea TD. Prediction of critical illness during out-of-hospital emergency care. *JAMA*. 2010;304(7):747-754. doi:10.1001/jama.2010.1140

4. Knaus WA, Zimmerman JE, Wagner DP, Draper EA, Lawrence DE. APACHE—acute physiology and chronic health evaluation: a physiologically based classification system. *Crit Care Med*. 1981;9(8):591-597. doi:10.1097/00003246-198108000-00008

Maryland's Hospital Global Budget Program

To the Editor In a Viewpoint, Dr Sharfstein and colleagues assessed the state of evidence on Maryland's hospital global budget program.[1] We agree with much of their synthesis, including that hospital admissions declined in Maryland following the program's implementation, but we are not convinced that these changes can be attributed to global budgets.

Because admissions also decreased in other states, it is important to select an appropriate control population to isolate changes associated with hospital global budgets.[1] The standard assumption is that differences between intervention and control populations would have remained constant without Maryland's policy and, therefore, any differential change from the preintervention to the postintervention period can be interpreted as a policy effect. Evidence of parallel preintervention trends supports this assumption but does not guarantee it holds.[2]

In 2 recent studies of Maryland's program, the standard assumption was not supported because preintervention trends differed on most outcomes.[3,4] In both studies, researchers recognized this problem and made the assumption that, absent the intervention, differences in preintervention trends between Maryland and the control population would have continued into the postintervention period. Although reasonable, this assumption may be violated because differential trends are unlikely to continue indefinitely.

In the study by Roberts et al,[3] this seemingly minor methodological issue was critically important. Under one assumption, Maryland's program may have been associated with changes in admissions, but the conclusion differed under the other assumption. Other issues, such as how to address the increasing use of hospital observation stays, were also important in evaluating the program.

In situations in which methodological choices may affect the conclusion, it is important to conduct sensitivity analyses and to assess the totality of evidence. The sensitivity analyses in the study by Roberts et al[3] suggested that the differential reduction in admissions in Maryland was not uniquely large, and results from a separate study of Maryland's pilot introduction of global budgets in rural hospitals (where treatment and control groups had similar trends before introduction)[5] found no change in hospital utilization due to global budgets.

Based on the totality of evidence, we believe caution is needed in ascribing early changes in utilization to global budgets in Maryland. The inability of researchers to confidently identify early effects of Maryland's program does not imply that this policy failed, nor does it preclude the potential for effects to emerge over time. Continued evaluation and efforts to strengthen Maryland's model, as Sharfstein and colleagues advocated,[1] remain vital next steps.

Eric T. Roberts, PhD
Ateev Mehrotra, MD, MPH
Michael E. Chernew, PhD

Author Affiliations: Department of Health Policy and Management, University of Pittsburgh Graduate School of Public Health, Pittsburgh, Pennsylvania (Roberts); Department of Health Care Policy, Harvard Medical School, Boston, Massachusetts (Mehrotra, Chernew).

Corresponding Author: Eric T. Roberts, PhD, Department of Health Policy and Management, University of Pittsburgh Graduate School of Public Health, 130 De Soto St, A653 Crabtree Hall, Pittsburgh, PA 15261 (eric.roberts@pitt.edu).

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Mehrotra reported receiving a grant from the Commonwealth Fund. No other disclosures were reported.

1. Sharfstein JM, Stuart EA, Antos J. Global budgets in Maryland: assessing results to date. *JAMA*. 2018;319(24):2475-2476. doi:10.1001/jama.2018.5871

2. Ryan AM, Burgess JF Jr, Dimick JB. Why we should not be indifferent to specification choices for difference-in-differences. *Health Serv Res*. 2015;50(4):1211-1235. doi:10.1111/1475-6773.12270

3. Roberts ET, McWilliams JM, Hatfield LA, et al. Changes in health care use associated with the introduction of hospital global budgets in Maryland. *JAMA Intern Med*. 2018;178(2):260-268. doi:10.1001/jamainternmed.2017.7455

4. Haber S, Beil H, Amico P, et al. Evaluation of the Maryland all-payer model: third annual report. https://downloads.cms.gov/files/cmmi/md-all-payer-thirdannrpt.pdf. Accessed June 30, 2018.

5. Roberts ET, Hatfield LA, McWilliams JM, et al. Changes In hospital utilization three years into Maryland's global budget program for rural hospitals. *Health Aff (Millwood)*. 2018;37(4):644-653. doi:10.1377/hlthaff.2018.0112

In Reply Dr Roberts and colleagues are "not convinced" that Maryland's unique approach to paying hospitals was responsible for changes in care and cost in the state.[1] We cited the studies by Roberts and colleagues because they contributed to understanding this question. We also cited other research, including analyses with a similar methodology but with a greater quantity of more recent data that did find significant associations.[2]

Statewide models of health care reform are difficult to evaluate. Not only are there issues with assumptions, as Roberts and colleagues note, but the results are quite dependent on the choice of a comparison group. Thus, a variety of methods for understanding state reform are needed, including both qualitative and quantitative assessments. Investigators should be cautious about asserting that a single approach or study holds the answer to key questions.

Maryland has fundamentally changed financial incentives for hospitals, and these changes may have important effects, potentially both good and bad, on the provision of care and on population health. Researchers and policy makers should work together to learn from the state's ambitious efforts.

Joshua M. Sharfstein, MD
Elizabeth A. Stuart, PhD
Joseph Antos, PhD