A Strategic Framework for Utilizing Late-Stage (T4) Translation Research to Address Health Inequities

Maria Lopez-Class, PhD, MPH, MS[1]; Emmanuel Peprah, PhD[1];
Xinzhi Zhang, MD, PhD[2]; Peter G. Kaufmann, PhD[3];
Michael M. Engelgau, MD, MS[1]

Achieving health equity requires that every person has the opportunity to attain their full health potential and no one is disadvantaged from achieving this potential because of social position or other socially determined circumstances. Inequity experienced by populations of lower socioeconomic status is reflected in differences in health status and mortality rates, as well as in the distribution of disease, disability and illness across these population groups. This article gives an overview of the health inequities literature associated with heart, lung, blood and sleep (HLBS) disorders. We present an ecological framework that provides a theoretical foundation to study late-stage T4 translation research that studies implementation strategies for proven effective interventions to address health inequities. *Ethn Dis.* 2016;26(3):387-394; doi:10.18865/ed.26.3.387

[1]Center for Translation Research and Implementation, National Institutes of Health
[2]National Institute on Minority Health and Health Disparities, National Institutes of Health
[3]Division of Cardiovascular Sciences, National Heart, Lung and Blood Institute, National Institutes of Health

Address correspondence to Maria Lopez Class, Center for Translation Research and Implementation; 6701 Rockledge Drive; Bethesda, MD 20817; 301.496.1051; lopezclassm@mail.nih.gov.

The Concept of Health Inequity

Equity stems from distributive justice of goods or services that are allocated fairly within society.[1] Health equity reflects a lack of disparities in health across groups at different levels of social-economic status defined by social position, gender, race/ethnicity, and geography.[2] Racial and ethnic disparities in health care tend to occur in the context of social and economic inequality often created by bias, stereotypes, prejudice and structural discrimination of health care systems and health care providers.[3] Healthy People 2020 defines health equity as "attainment of the highest level of health for all people" and the elimination of health disparities.[4]

Health inequity refers to the proportion of observed disparities in health that result from circumstances over which the individual has no control due to social, economic, environmental, infrastructure and policy conditions. For example, people of lower socioeconomic status (SES) can experience health inequities due to inadequate access to health care or cultural and language barriers in seeking care. Such factors contribute to differences in cholesterol screening rates between Whites, Blacks, and Hispanics.[5] Similarly, Blacks, women and those living in the southern United States (eg, Oklahoma, Texas, southern Alabama, and Louisiana) experience higher rates of preventable hospitalization than those who live elsewhere, primarily driven by inadequate access to quality and timely outpatient care.[6] Thus, health inequity stems not only from contextual, historical and contemporary differences in the attitudes among different ethnic/racial groups, but from the social (eg, societal norms or laws), physical (eg, neighborhood), institutional and geographic environments in which people reside, work, and play. Unequal distribution of power, prestige and resources among groups in society worsen the outcomes of many treatable diseases in low SES populations. This pattern can give rise to persistent health inequities[7] that can be exacerbated further by upstream factors such as cultural barriers and segregation.[8,9] The combined effects of such influences result in considerable disparities in morbidity and mortality among various population subgroups.[10]

The purpose of this article is to

first characterize several examples of persistent inequities among heart, lung, blood and sleep (HLBS) diseases and disorders that could be addressed using T4 translation research (T4TR), ie, late stage translation research designed to find implementation strategies that, when scaled up, can have population impact. Subsequently, an ecological framework is presented to identify key themes for T4 health inequities research. Finally, the article concludes by discussing the importance of the ecological framework in operationalizing T4TR to address health inequities in HLBS diseases and disorders.

AN ECOLOGICAL FRAMEWORK FOR T4TR FOR HEALTH INEQUITIES

Building on the work of others, the current description of the translational research spectrum includes five phases of translation research including: T0 representing fundamental discoveries; T1 noting initial translation of fundamental discovery to humans; T2 noting translation to patients, usually involving well-controlled efficacy trials; T3 notes translation to clinical practices focused on external validity; and T4 translation as the final step, which focuses on translation of findings to real-world settings.[11] Each translation step bridges a different knowledge gap: T0, basic, foundational, or theoretical knowledge; T1, proof of concept knowledge; T2, efficacy knowledge; T3, effectiveness knowledge; and T4, context-specific applied knowl-

edge.[12,13] Late stage T4TR tackles these complex real-world settings with innovative study designs and analytic methods primarily focused on implementation research outcomes (eg, acceptability, adoption, appropriateness, sustainability, costs, etc.)[14] and differs from early translation stages such as T3 research where the primary focus is on clinical outcome (eg, hypertension control, acute myocardial

---

The purpose of this article is to first characterize several examples of persistent inequities among heart, lung, blood and sleep (HLBS) diseases and disorders that could be addressed using T4 translation research…

---

infarction, stroke, mortality, etc.). Too often proven effective interventions are delivered far less frequently than needed to have important population impact. In the past, Americans have received only 50% of the recommended preventive, acute and long-term health care interventions.[15] The challenges of delivering recommended care reside at many different levels including the patient, the provider, the health

system, the community and its context, and with policies at the local, regional and national levels– both within and outside the health sector. Dissemination and implementation strategies require the application of a framework that is multifaceted and includes all of these levels.[16] Social ecological frameworks provide visual depictions of dynamic relationships and interactions between individuals, groups and the environment and can be useful to understand strategic areas where T4TR can target health inequities.

The Ecological Framework

The modified version of the Golden et al framework[17] illustrates social determinants of health as drivers of inequities across diverse populations. Our proposed framework identifies key determinants of health inequities that are critical components of T4TR needed to address inequities in HLBS disorders. The framework allows exploration of the relationship between health outcomes and complex social-institutional forces. This approach considers individuals' environmental contexts and the interactions between them.[18]

Figure 1 describes pathways through which risks and health outcomes may be shaped by social determinants (eg, education, race and ethnicity, gender, income). The framework suggests the multifaceted, multi-level elements of an integrated approach are needed to tackle health inequities at the individual, socio-cultural, physical environment, and policy levels. The key social determinants giving rise to health inequities across spe-

cific population groups are points where T4TR can be targeted. Undoubtedly the biological factors and pathways interact with the other domains, but because they are directly associated with diseases they may not be the best primary target for T4 interventions seeking to eliminate health inequities.

Individual Risks and Behavioral Factors

In Figure 1, Individual Risks and Behavioral Factors include personal characteristics such as age, education, income, lifestyle, race/ethnicity and gender. Since racial identity has no useful counterpart in genetic or biological underpinnings but,

rather, serves primarily as a social construct, it is subsumed under the social context element in the model.

Racial/ethnic minority populations and low SES communities experience worse health outcomes than majority populations and those who are affluent.[19, 20] For example, coronary heart disease is the lead-
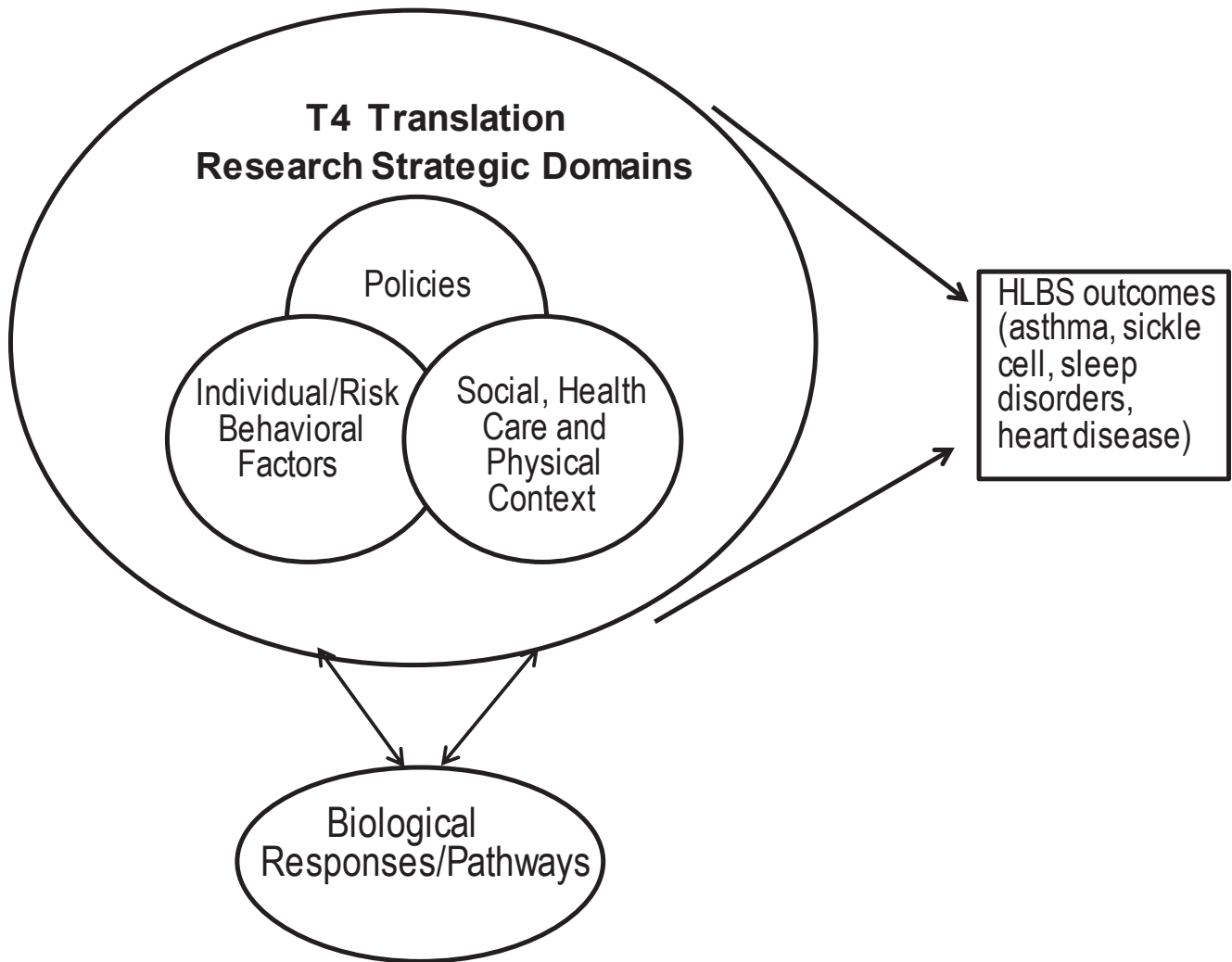

Figure 1. Ecological framework for heart, lung, blood, and sleep disorders

 Strategic T4 domains include individual, context, and policy level influences

- Individual: age, socioeconomic status, education, acculturation, language barriers

- Social, Health Care, and Physical Context: neighborhood stability, food availability, parks, collective efficacy, social networks, health literacy, patient-provider relationships

- Policy: poverty, prejudice, culture, discrimination

- Biological: allostatic load, genetics, genetic ancestry

HLBS outcomes result from both T4 domains and biological pathways.

ing cause of cardiovascular disease (CVD) death in the United States [21] for both men and women. However, compared with Whites, Blacks, and in particular Black women, have a higher age-adjusted relative risk of dying from heart disease.[22] Significant geographical disparities also exist. For example, in the southern United States, a higher rate of negative outcomes of cardiovascular diseases are found than in other regions in the United States.[23] Lifestyle factors, including low physical activity, poor diet, together with smoking, uncontrolled hypertension and obesity account for 80% of ischemic heart disease mortality and 50% of stroke mortality in the US.[24] It is forecasted that CVD race disparities will remain, especially between non-Hispanic Blacks and Whites.[25] The current trends for cardiovascular disease and other heart-related risk factors (diet, tobacco use) are on the rise with widening disparities on the basis of geography and individual level factors (eg, economic, race).[26,27] A recent study suggests environmental and region-based risk factors for mortality causes, including increasing the life expectancy for Black and Whites in cardiovascular disease.[27] Population-level policies targeting major CVD risk factors with significant disparities may be more effective in reducing inequalities than individual-level actions. Given the alarming evidence for the higher prevalence of certain conditions among specific racial groups, and the current guidelines recommending treatment (eg, aspirin intake to reduce strokes), research on how to increase the uptake of prov-

en effective interventions are needed for specific population groups.

Social, Physical and Health Care Context

The *Social, Physical and Health Care Context* represents additional settings and societal factors, such as schools, workplaces, clinics, neighborhoods, and geography (eg urban vs rural) that contribute to inequities and lead to differences in health outcomes. Differences in exposure to environmental factors including air, water and soil pollution from industry or proximity to transportation routes or quality of housing contribute to health inequities among population subgroups. A recent study suggests that asthma is influenced by poverty and poor housing, and exposure to mold, fungi, dust mites, mice, etc. found in lower standard living environments.[28] Even, when genetic underpinnings of asthma are controlled in regression modelling studies, the prevalence of asthma and its association with SES remains significant. For example, the National Health Interview Survey found asthma prevalence in 2013 was higher for Blacks (9.9%) than Whites (7.4%).[29] Because industrial facilities are located in proximity to the necessary workforce along with transportation/commercial routes,[30] individuals in lower SES communities are exposed to a large extent to higher levels of environmental hazards than those living in higher SES communities.[19,31] In particular, long-term exposures to environmental pollutants have been linked with higher prevalence of CVD risk factors, inflam-

matory and coagulation factors.[32]

Living in low SES neighborhoods results in greater environmental exposures to tobacco, allergens, and pollutants that may influence sleep (eg, duration and quality) leading to greater prevalence of extreme sleep deprivation found among Blacks and Hispanics. Data suggest that compared with Whites, Blacks may experience earlier onset and severe patterns of obstructive sleep apnea that contributes to the well-documented risk for cardiovascular disease.[33] A systemic review of 17 studies found associations between discrimination and sleep quality highlighting its contribution to health inequities across the life course.[34]

Social and cultural norms or factors that cultivate economic or social inequities among immigrants are also important. Cumulative stressors (marginalization, discrimination, racism) found in a new culture have been described to increase cardiovascular risk for Ethiopians,[35] Asians[36] and perhaps other immigrant groups who might be new to the cultural practices and lifestyles in the United States. Time elapsed since migrating has been associated with the development of atherosclerosis for immigrants of European, Chinese and South Asian origin.[37] Greater carotid atherosclerotic burden is evident among those with greatest time since immigration (>30 years) compared with non-immigrants. This health burden occurs without regard to age or ethnic background, suggesting that increased length of time in a new country setting (immigration) may pose a unique risk for CVD.[37]

Health inequities in communities can persist and be transmitted across generations, suggesting that contextual characteristics and modifiable risk factors may have played important roles.[38] In short, context plays a pivotal role in testing evidence-based interventions in order to move findings toward practice.[39]

Finally, many conditions in life, such as lack of transportation and whether a provider accepts a patient's

---

The T4TR framework can potentially provide understanding of optimal and sustainable strategies using evidence-based approaches for delivering quality health care that considers complex systems and key contextual factors.

---

health care coverage, or that they even have health care coverage can limit access to health care. In terms of health care, among groups with incomes ≤200% of the federal poverty level or less, roughly 25% have no health care insurance compared to roughly 10% among the populations with great means.[40] These life conditions can be assessed in three phases: detection; understanding; and potential solutions to inform strategies that promote translation of evi-

denced-based intervention and policy changes for vulnerable populations.[41]

Policy

Policy in Figure 1 refers not only to legislation but includes any regulatory or policy-making actions at any societal level that have the potential to affect inequities. These may be formal statutory actions taken by local, state or federal government as well as policies or rules with schools, workplaces or health care settings. In the United States, health policy significantly affects sickle cell disease (SCD) treatment and social norms of inclusion also stigmatize the non-African American population with the same genetic disorder. T4TR can be used to address adoption and scale-up of evidence-based interventions mitigating this health inequity that exists for SCD and thereby addressing social stigmatization.

Biological Pathways

Biological pathways are not the best primary targets for T4TR that focuses on health inequities. Rather, biological pathways result from an evolutionary process that can sometimes explain genetic predisposition and/or gene-environment interactions. Biological factors can be especially important when the distribution of genetic polymorphisms predominantly affects one population or subpopulation, as is the case for SCD, which occurs primarily in African Americans.[42]

Utility of T4 and the Ecological Framework

Utilization of a theory-based framework is an important strategy

for program success. This framework provides a roadmap for strategic T4TR efforts to develop and evaluate appropriate interventions serving vulnerable populations, implementing and translating evidence-based interventions into health care systems, and finally promoting policy changes to reduce health inequities.[41] The ecological framework is context-based, which allows delving into many factors pertinent to underserved populations, eg, the provision of quality health care. Just having health technologies available and an increased number of doctors does not always ensure better access. Financial barriers and social or policy level determinants, such as co-payments and accessible transportation services, may also have significant impact on health equities. T4TR can potentially provide understanding of optimal and sustainable strategies using evidence-based approaches for delivering quality health care that considers complex systems and key contextual factors.

Conclusion

Contextual factors such as community characteristics (eg, rural vs urban, quality of air and water, and density of housing), social networks, and societal and policy-level influences all play important roles in health inequities[43] especially for vulnerable population groups (eg, low SES, immigrants, physical and mentally disabled individuals). Differences in disease outcomes among various population groups have been associated with attributes of

their local environment,[44,45] which can affect health patterns across the life span.[46] However, we recognize that optimal implementation of the conceptual framework requires multi-level interventions that address several targets, including health care systems and policy. Only rarely have such interventions been described in the biomedical literature. A notable exception is the REACH 2010 Charleston and Georgetown Diabetes Coalition project[47] that implemented coordinated individual, community health systems and advocacy interventions to reduce health disparities in diabetes in rural as well as urban communities, with good results.[48] The outcome should not be surprising. In their analysis of the balance between new discoveries and implementation of existing treatments, Woolf and Johnson[49] argue that implementing existing advances in medicine for the disadvantaged and minority populations that contribute to health disparities, although challenging, would result in great strides toward reducing inequities. The challenge for late-stage T4TR is to investigate systematically how to accomplish this goal.

This ecological framework offers a potential pathway to understand macro- and micro-level changes needed to improve health for all. T4TR for populations affected by inequities needs to consider the social ecological context and its effect on the delivery and adoption of evidence-based approaches.[11] Responding to the inter-connected social, environmental and economic conditions that influence our ability to address health inequities requires a broad agenda including policy, systems, organizational change interventions, community engagement strategies, and leveraging partnerships and collaborations.

Conflict of Interest

No conflicts to report.

Disclaimer

Author Contributions

Research concept and design: Lopez-Class, Zhang, Engelgau; Acquisition of data: Engelgau; Data analysis and interpretation: Peprah, Engelgau; Manuscript draft: Lopez-Class, Peprah, Zhang, Kaufmann Engelgau; Administrative: Lopez-Class, Peprah, Zhang, Engelgau; Supervision: Kaufmann, Engelgau

References

1. Braveman P. Health disparities and health equity: concepts and measurement. *Annu Rev Public Health*. 2006;27(1):167-194. http://dx.doi.org/10.1146/annurev.publhealth.27.021405.102103. PMID:16533114.

2. Braveman P, Gruskin S. Defining equity in health. *J Epidemiol Community Health*. 2003;57(4):254-258. http://dx.doi.org/10.1136/jech.57.4.254. PMID:12646539.

3. B. D. Smedley AYS. *A. R. Nelson Institute of Medicine Committee on Eliminating, Racial & Ethnic Disparities in Health.* Washington, DC: National Academies Press; 2003.

4. Developing Healthy People 2020. Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020. Phase I report: Recommendations for the framework and format of Healthy People 2020. 2010. http://www.healthypeople.gov/sites/default/files/PhaseI_0.pdf, Accessed March 2, 2016.

5. Kenik J, Jean-Jacques M, Feinglass J. Explaining racial and ethnic disparities in cholesterol screening. *Prev Med*. 2014;65:65-69. http://dx.doi.org/10.1016/j.ypmed.2014.04.026. PMID:24806331.

6. Will JC, Nwaise IA, Schieb L, Zhong Y. Geographic and racial patterns of preventable hospitalizations for hypertension: medi-care beneficiaries, 2004-2009. *Public Health Rep*. 2014;129(1):8-18. PMID:24381355.

7. Marmot M; Commission on Social Determinants of Health. Achieving health equity: from root causes to fair outcomes. *Lancet*. 2007;370(9593):1153-1163. http://dx.doi.org/10.1016/S0140-6736(07)61385-3. PMID:17905168.

8. Newman L, Baum F, Javanparast S, O'Rourke K, Carlon L. Addressing social determinants of health inequities through settings: a rapid review. *Health Promot Int*. 2015;30(suppl 2):ii126-ii143. http://dx.doi.org/10.1093/heapro/dav054. PMID:26420808.

9. Bowen SA, Williams EM, Stoneberg-Cooper CM, Glover SH, Williams MS, Byrd MD. Effects of social injustice on breast health-seeking behaviors of low-income women. *Am J Health Promot*. 2013;27(4):222-230. http://dx.doi.org/10.4278/ajhp.110505-QUAL-189. PMID:23448411.

10. Murray CJ, Kulkarni SC, Michaud C, et al. Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States. *PLoS Med*. 2006;3(9):e260. http://dx.doi.org/10.1371/journal.pmed.0030260. PMID:16968116.

11. Sampson UK, Chambers D, Riley W, Glass RI, Engelgau MM, Mensah GA. Implementation research: the fourth movement of the unfinished translation research symphony. *Glob Heart*. 2016;11(1):153-158. http://dx.doi.org/10.1016/j.gheart.2016.01.008. PMID:27102036.

12. Khoury MJ, Gwinn M, Yoon PW, Dowling N, Moore CA, Bradley L. The continuum of translation research in genomic medicine: how can we accelerate the appropriate integration of human genome discoveries into health care and disease prevention? *Genet Med*. 2007;9(10):665-674. http://dx.doi.org/10.1097/GIM.0b013e31815699d0. PMID:18073579.

13. Institute of Translational Health Sciences, T-Phases of Translational Health Research. https://www.iths.org/investigators/definitions/translational-research/, Accessed June 14, 2016.

14. Proctor E, Silmere H, Raghavan R, et al. Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda. *Adm Policy Ment Health*. 2011;38(2):65-76. http://dx.doi.org/10.1007/s10488-010-0319-7. PMID:20957426.

15. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348(26):2635-2645. http://dx.doi.org/10.1056/NEJMsa022615. PMID:12826639.

16. Gonzales R, Handley MA, Ackerman S, O'Sullivan PS. A framework for training

health professionals in implementation and dissemination science. *Acad Med*. 2012;87(3):271-278. PMID:22373617.

17. Golden SH, Ferketich A, Boyington J, et al. Transdisciplinary cardiovascular and cancer health disparities training: experiences of the centers for population health and health disparities. *Am J Public Health*. 2015;105(S3)(suppl 3):S395-S402. http://dx.doi.org/10.2105/AJPH.2014.302489. PMID:25905828.

18. Lopez-Class M, Gomez-Duarte J, Graves K, Ashing-Giwa K. A contextual approach to understanding breast cancer survivorship among Latinas. *Psychooncology*. 2012;21(2):115-124. http://dx.doi.org/10.1002/pon.1998. PMID:21674680.

19. Subramanian SV, Acevedo-Garcia D, Osypuk TL. Racial residential segregation and geographic heterogeneity in black/white disparity in poor self-rated health in the US: a multilevel statistical analysis. *Soc Sci Med*. 2005;60(8):1667-1679. http://dx.doi.org/10.1016/j.socscimed.2004.08.040. PMID:15686800.

20. Thorpe RJ Jr, Brandon DT, LaVeist TA. Social context as an explanation for race disparities in hypertension: findings from the Exploring Health Disparities in Integrated Communities (EHDIC) Study. *Soc Sci Med*. 2008;67(10):1604-1611. http://dx.doi.org/10.1016/j.socscimed.2008.07.002. PMID:18701200.

21. Go AS, Mozaffarian D, Roger VL, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics--2014 update: a report from the American Heart Association. *Circulation*. 2014;129(3):399-410. http://dx.doi.org/10.1161/01.cir.0000442015.53336.12. PMID:24446411.

22. Jiaquan Xu J, Sherry L, Murphy S, Kochanek K, Bastian B. Deaths: Final Data for 2013. National Vital Statistical Reports. 2016; 64(2).

23. Centers for Disease Control and Prevention (CDC). Vital signs: avoidable deaths from heart disease, stroke, and hypertensive disease - United States, 2001-2010. *MMWR Morb Mortal Wkly Rep*. 2013;62(35):721-727. PMID:24005227.

24. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL, eds. *Global Burden of Disease and Risk Factors*. Washington, DC: World Bank The International Bank for Reconstruction and Development/The World Bank Group; 2006. http://dx.doi.org/10.1596/978-0-8213-6262-4.

25. Pearson-Stuttard J, Guzman-Castillo M, Penalvo JL, et al. Modeling future cardiovascular mortality in the United States: National Trends and Racial and Ethnic Disparities. *Circulation*. 2016;133(10):967-

978. http://dx.doi.org/10.1161/CIRCULATIONAHA.115.019904. PMID:26846769.

26. Cooper R, Cutler J, Desvigne-Nickens P, et al. Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. *Circulation*. 2000;102(25):3137-3147. http://dx.doi.org/10.1161/01.CIR.102.25.3137. PMID:11120707.

27. Harper S, MacLehose RF, Kaufman JS. Trends in the black-white life expectancy gap among US states, 1990-2009. *Health Aff (Millwood)*. 2014;33(8):1375-1382. http://dx.doi.org/10.1377/hlthaff.2013.1273. PMID:25092839.

28. Ownby DR, Tingen MS, Havstad S, Waller JL, Johnson CC, Joseph CL. Comparison of asthma prevalence among African American teenage youth attending public high schools in rural Georgia and urban Detroit. *J Allergy Clin Immunol*. 2015;136(3):595-600.e3. http://dx.doi.org/10.1016/j.jaci.2015.02.007. PMID:25825215.

29. Centers for Disease Control, Data, Statistics, and Surveillance, Asthma Surveillance Data. 2013. http://www.cdc.gov/asthma/asthmadata.htm. Accessed March 2, 2016.

30. Silva RA, Adelman Z, Fry MM, West JJ. The Impact of Individual Anthropogenic Emissions Sectors on the Global Burden of Human Mortality due to Ambient Air Pollution. *Environ Health Perspect*. 2016. http://dx.doi.org/10.1289/EHP177. PMID:27177206.

31. Gee GC, Payne-Sturges DC. Environmental health disparities: a framework integrating psychosocial and environmental concepts. *Environ Health Perspect*. 2004;112(17):1645-1653. http://dx.doi.org/10.1289/ehp.7074. PMID:15579407.

32. Viehmann A, Hertel S, Fuks K, et al; Heinz Nixdorf Recall Investigator Group. Long-term residential exposure to urban air pollution, and repeated measures of systemic blood markers of inflammation and coagulation. *Occup Environ Med*. 2015;72(9):656-663. http://dx.doi.org/10.1136/oemed-2014-102800. PMID:26163546.

33. Jackson CL, Redline S, Emmons KM. Sleep as a potential fundamental contributor to disparities in cardiovascular health. *Annu Rev Public Health*. 2015;36(1):417-440. http://dx.doi.org/10.1146/annurev-publhealth-031914-122838. PMID:25785893.

34. Slopen N, Lewis TT, Williams DR. Discrimination and sleep: a systematic review. *Sleep Med*. 2016;18:88-95. PMID:25770043.

35. Zlotnick C, Goldblatt H, Shadmi E, Birenbaum-Carmeli D, Taychaw O. A qualitative study assessing cardiovascular risk factors: the accumulative stressors influencing societal integration of teenage African immigrants. *BMC Public Health*.

2015;15(1):785. http://dx.doi.org/10.1186/s12889-015-2122-6. PMID:26276020.

36. Gee GC, Ro A, Shariff-Marco S, Chae D. Racial discrimination and health among Asian Americans: evidence, assessment, and directions for future research. *Epidemiol Rev*. 2009;31(1):130-151. http://dx.doi.org/10.1093/epirev/mxp009. PMID:19805401.

37. Lear SA, Humphries KH, Hage-Moussa S, Chockalingam A, Mancini GB. Immigration presents a potential increased risk for atherosclerosis. *Atherosclerosis*. 2009;205(2):584-589. http://dx.doi.org/10.1016/j.atherosclerosis.2008.12.037. PMID:19181317.

38. Fiscella K, Williams DR. Health disparities based on socioeconomic inequities: implications for urban health care. *Acad Med*. 2004;79(12):1139-1147. http://dx.doi.org/10.1097/00001888-200412000-00004. PMID:15563647.

39. Neta G, Glasgow RE, Carpenter CR, et al. A Framework for Enhancing the Value of Research for Dissemination and Implementation. *Am J Public Health*. 2015;105(1):49-57. http://dx.doi.org/10.2105/AJPH.2014.302206. PMID:25393182.

40. Agency for Healthcare Research and Quality, 2015 National Healthcare Quality and Disparities Report and 5th Anniversary on the National Quality Strategy. http://www.ahrq.gov/research/findings/nhqrdr/nhqdr15/index.html. Accessed June 14, 2016.

41. Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. *Am J Public Health*. 2006;96(12):2113-2121. http://dx.doi.org/10.2105/AJPH.2005.077628. PMID:17077411.

42. Martin C, Pialoux V, Faes C, Charrin E, Skinner S, Connes P. Does physical activity increase or decrease the risk of sickle cell disease complications? *Br J Sports Med*. 2015;bjsports-2015-095317. http://dx.doi.org/10.1136/bjsports-2015-095317. PMID:26701924.

43. Krieger N. *Epidemiology and The People's Health: Theory and Context*. New York: Oxford University Press; 2011. http://dx.doi.org/10.1093/acprof:oso/9780195383874.001.0001.

44. Cooper LA, Ortega AN, Ammerman AS, et al. Calling for a bold new vision of health disparities intervention research. *Am J Public Health*. 2015;105(S3)(suppl 3):S374-S376. http://dx.doi.org/10.2105/AJPH.2014.302386. PMID:25905830.

45. Berkman K. *Neighbourhoods and Health*. New York: Oxford University Press Inc; 2003.

46. Bernard P, Charafeddine R, Frohlich KL, Daniel M, Kestens Y, Potvin L. Health inequalities and place: a theoretical con-

ception of neighbourhood. *Soc Sci Med*. 2007;65(9):1839-1852. http://dx.doi.org/10.1016/j.socscimed.2007.05.037. PMID:17614174.

47. Jenkins C. REACH 2010: charleston and Georgetown Diabetes Coalition approaches to reducing disparities for African Americans with diabetes. *S C Nurse*. 2003;10(1):16-19. PMID:12629837.

48. Jenkins C, McNary S, Carlson BA, et al. Reducing disparities for African Americans with diabetes: progress made by the REACH 2010 Charleston and Georgetown Diabetes Coalition. *Public Health Rep*. 2004;119(3):322-330. http://dx.doi.org/10.1016/j.phr.2004.04.011. PMID:15158111.

49. Woolf SH, Johnson RE. The break-even point: when medical advances are less important than improving the fidelity with which they are delivered. *Ann Fam Med*. 2005;3(6):545-552. http://dx.doi.org/10.1370/afm.406. PMID:16338919.