

Transdisciplinary Data Science to Address Minority Health and Health Disparities Chanita Hughes Halbert, PhD Medical University of South Carolina

### Vision for Minority Health and Health Care



Promote quality health care and health outcomes through effective approaches for early detection, prevention, and treatment

# **Determinants of Minority Health and Health Disparities**

		Levels of Influence*				
		Individual	Interpersonal	Community	Societal	
	Biological      Biological Vulnerability and Mechanisms      Caregiver-Child Interaction Family Microbiome		Caregiver–Child Interaction Family Microbiome	Community Illness Exposure Herd Immunity	Sanitation Immunization Pathogen Exposure	
<b>of Influence</b> Lifecourse)	Behavioral	Health Behaviors Coping Strategies	Family Functioning School/Work Functioning	Community Functioning	Policies and Laws	
	Physical/Built Environment	Personal Environment	Household Environment School/Work Environment	Community Environment Community Resources	Societal Structure	
Domains ( Over the	Sociocultural Environment	Sociodemographics Limited English Cultural Identity Response to Discrimination	Social Networks Family/Peer Norms Interpersonal Discrimination	Community Norms Local Structural Discrimination	Social Norms Societal Structural Discrimination	
	Health Care System	Insurance Coverage Health Literacy Treatment Preferences	Patient–Clinician Relationship Medical Decision-Making	Availability of Services Safety Net Services	Quality of Care Health Care Policies	
Health Outcomes		A Individual Health	Family/ Organizational Health	合 Community 合合 Health	Population	

National Institute on Minority Health and Health Disparities Research Framework



National Institute on Minority Health and Health Disparities

### The Science of Minority Health and Health Disparities



Thomas SB et al. Annu Rev Public Health. 2011;32:399-416

# **DATA SCIENCE**

The ability to take data — to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it — that's going to be a hugely important skill in the next decades." Hal Varian, chief economist at Google and UC Berkeley professor of information sciences, business, and economics  $\frac{3}{2}$ 



#### **SOCIAL DETERMINANTS** FACTORS THAT INFLUENCE YOUR HEALTH

The conditions in which you live, learn, work and age affect your health. Social determinants such as these can influence your lifelong health and well-being.



#### The NATION'S HEALTH

www.thenationshealth.org/sdoh

Social determinants of health should be obtained from patients, documented in electronic health records, and used to address unmet social needs







### **Clinical and Public Health Priorities for Social Determinants of Health**

- Standardized, measurable, and actionable social determinants need to be obtained and documented in the electronic health record
- Clinical workflows need to be established to ensure that patients with social risk factors are referred to services
- Acceptance of social referrals and patient outcomes need to be measured

#### Medical University of South Carolina Transdisciplinary Collaborative Center in Precision Medicine and Minority Men's Health



- Multi-regional consortium
- Translational research on biological, social, psychological, and clinical factors
- Dissemination and implementation
- Data integration

Chanita Hughes-Halbert, PhD Stephen Ethier, PhD, Michael Lilly, MD U54MD010706

Low Country AHEC National Black Leadership Initiative on Cancer Hope Institute, LLC Southeastern Health Equity Council

# **Rationale for Focusing on Minority Men's Health**

#### Article

#### Ever and Annual Use of Prostate Cancer Screening in African American Men

American lournal of Men's Health © The Author(s) 2015 Reprints and permissions: sagepub.com/iournalsPermissions.nav DOI: 10.1177/1557988315596225 ajmh sagepub.com **S**SAGE

Chanita Hughes Halbert, PhD<sup>1,2</sup>, Sebastiano Gattoni-Celli, MD<sup>1,2</sup>, Stephen Savage, MD<sup>1,2</sup>, Sandip M. Prasad, MD<sup>1,2</sup>, Rick Kittles, PhD<sup>3</sup>, Vanessa Briggs, MBA<sup>4</sup>, Ernestine Delmoor, MPH<sup>5</sup>, LaShanta J. Rice, PhD<sup>1</sup>, Melanie Jefferson, MPH<sup>1</sup>, and Jerry C. Johnson, MD<sup>6</sup>

Psycho-Oncology Psycho-Oncology (2009) Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/pon.1574

#### Sociocultural determinants of men's reactions to prostate cancer diagnosis

Chanita Hughes Halbert<sup>1\*</sup>, Glenda Wrenn<sup>2</sup>, Benita Weathers<sup>3</sup>, Ernestine Delmoor<sup>4</sup>, Thomas Ten Have<sup>5</sup> and James C. Coyne

<sup>1</sup>Department of Psychiatry and Abramson Cancer Center, University of Pennsylvania, Philadelphia, PA, USA <sup>2</sup>Department of Psychiatry and Robert Wood Johnson Clinical Scholars Program, University of Pennsylvania, Philadelphia, PA, USA

<sup>3</sup>Department of Psychiatry, University of Pennsylvania, Philadelphia, PA, USA

<sup>4</sup>Philadelphia Chapter, National Black Leadership Initiative on Cancer, Philadelphia, PA, USA <sup>5</sup>Department of Biostatistics and Epidemiology, University of Pennsylvania, Philadelphia, PA, USA





Health Outcomes Research

#### **Racial Differences in Quality of Life Following Prostate Cancer Diagnosis**

Chanita H. Halbert, James Coyne, Benita Weathers, Brandon Mahler, Ernestine Delmoor, David Vaughn, S. Bruce Malkowicz, David Lee, and Andrea Troxel













**Triumphant Living Collaborative** West Philadelphia Consortium to Address Disparities

#### MUSC Transdisciplinary Collaborative Center in Precision Medicine and Minority Men's Health Medicine



- Minority men experience unique acute and chronic stressors
- Social and psychological stressors impact biological processes involved in the initiation and progression of disease
- Allostatic load is a marker of how much social and psychological stressors impact biological functioning
- Racial disparities in allostatic load exist
- Need to understand the effects of allostatic load on disease processes and outcomes

### **MUSC TCC Precision Medicine Projects**

#### How does psychosocial stress influence cellular stress?

**Project 1:** Sociobiological Responses to Stress in Prostate Cancer Survivors (*M. Lilly, C. Hughes-Halbert, Co-Leads*). Examine the effects of stress reactions and allostatic load on immune responses to a prostate cancer vaccine among survivors at high risk for recurrence

*Project 2:* Defining an Integrated Allostatic Load Index with Immune and Tumor Microenvironment Factors (*R. Drake, Co-Leads*). Identify novel biomarkers for prostate cancer based on metabolites, glycans, and immune modulators in prostate tissue samples. Characterize the distribution of these biomarkers based on allostatic load, racial background, social factors, and psychological characteristics

*Project 3*: Integrating Genomic and Sociobiological Data to Inform the Development of Prostate Cancer Treatment (S. Savage Lead). Evaluate the effects of Vitamin D supplementation on molecular changes in the prostate cancer. Examine the effects of Vitamin D on HPA axis functioning and allostatic load biomarkers to determine individual response to supplementation



South Carolina is a proving ground for precision medicine because it reflects social, economic, and geographic challenges in the US

#### MUSC TCC Data Integration Core Transdisciplinary Data Science



## **MUSC TCC Data Integration Core**

Develop Natural Language Processing (NLP) tools to identify and extract data on social determinants from clinical notes in the electronic health record to leverage the clinical information that is stored in clinical narratives

#### **Behavioral Science**

- What social determinants are most important to identify and extract
- How are these domains likely to be represented in clinical narratives

#### Machine Learning/Informatics

- Expertise to develop algorithms for NLP and deep learning
- Evaluation of how the tools perform
- GIS expertise to obtain community level data on social determinants

#### **Behavioral Science: Social Determinants Survey**

Socioeconomic Stressors	
Income level Employment status Education level Marital status	Financial toxicity Financial strain
Disease-related Stressors	
Stage Grade PSA Treatment type	Co-morbidities Primary Appraisal Secondary Appraisal
Perceived Stress Scale	
Difficulty dealing with unexpected events Feeling a lack of control or that things are outside of one's control Feeling stress or stressed Managing or handling personal problems	Difficulty coping with responsibilities Difficulty controlling irritability or irritations Difficulty staying on top of things Responsibilities piling up
Social Isolation	
Lask componienship	

Lack companionship Feel left out Feel isolated from others

### Machine Learning/Informatics: Data Source and NLP Process

#### **Data Source**

- MUSC Research Data Warehouse (RDW): a copy of MUSC Epic data warehouse for research
- Cohort sample: 4,195 MUSC prostate cancer patients with age >= 18 years
  - Training set: 3,138 subjects (197,346 notes)
  - $\succ$  Test set: 1,057 subjects (72,040 notes)
- Time period: July 1, 2014 until May 31, 2017



# **Social Isolation Lexicon**

- Developed by transdisciplinary MUSC
  TCC team
- Conceptual models of population health and behavioral science
- Concordance with validated instruments

Zhu et al. BMC Medical Informatics and Decision Making (2019) 19:43 https://doi.org/10.1186/s12911-019-0795-y

BMC Medical Informatics and Decision Making

#### **RESEARCH ARTICLE**

Automatically identifying social isolation from clinical narratives for patients with prostate Cancer

Vivienne J Zhu<sup>1\*</sup>, Leslie A Lenert<sup>1</sup>, Brian E Bunnell<sup>1</sup>, Jihad S Obeid<sup>1</sup>, Melanie Jefferson<sup>2</sup> and Chanita Hughes Halbert<sup>2</sup>



**Open Access** 

Zhu et al., 2019

# Natural Language Processing for Social Isolation

Terms of social isolation	Frequency		Terms of social isolation	Frequency		I2E Pre-negation	
lack of social support	52	19.5%	Limited social support	3	1.1%	but *	3
lonely	41	15.4%	feel isolated	3	1.1%	all family*	2
no friends	35	13.2%	no family support	3	1.1%	her husband	1
loneliness	29	10.9%	isolation and loneliness	2	0.8%	Discussed*	1
Social withdraw	26	9.8%	Socially withdrawn	2	0.8%	However*	1
socially isolated	22	8.3%	socially isolating	2	0.8%	is still*	1
social isolation	9	3.4%	Social isolation	2	0.8%	still has*	1
feels isolated	8	3.0%	Limited social support	2	0.8%	But*	1
Lonely	6	2.3%	limited social connection	1	0.4%		
lack of social supports	6	2.3%	Limited social network	1	0.4%		
no social support	5	1.9%	lack in social support	1	0.4%		
Loneliness	4	1.5%	loss of social network	1	0.4%		

Clinical Negations v	social isolation	Post-Negation no	#Docs	Doc	#Hits	Hit
>	no friends		12>	<u>25949</u>	1	He reports having <mark>no friends</mark> in very little social support
>	loneliness		10>	<u>98861</u>	2>	$\dots$ , lack of concentration, ${\color{black} \textit{loneliness}},$ grandiosity, impulsive thinking $\dots$
>	lack of social support		23 >	<u>18692</u>	1	cardiac transplantation d/t lack of social support.
>	loneliness		8>	<u>108619</u>	2>	he has felt anger and loneliness almost to the point of
>	feels isolated		6>	<u>66779</u>	1	lives nearby, Mr. Turner feels isolated, helpless, lonely,
>	socially isolated		7>	<u>13912</u>	1	He is socially isolated and uses avoidance as a
>	lack of social support		3>	<u>70647</u>	1	and Adams about Mr. Ackerman's lack of social support.
>	lonely		3>	<u>132977</u>	1	Pt appears to be very lonely.
	socially isolated		2>	80865	2>	He is increasingly socially isolated, stating that he "
>	limited social network		1	<u>135392</u>	1	$\dots$ pain, financial stress, limited social network $\mbox{Axis V: GAF-current: }\dots$
>	Loneliness		1	<u>64980</u>	1	Conflict/arguments with others ${\small \mbox{Loneliness}}\x$ Boredom Physical pain Fatigue
BUT	no friends		1	<u>124847</u>	1	leaving him alone at home <mark>BUT</mark> so far <mark>no friends</mark> or fami members have been
	social isolation		1	<u>146849</u>	1	decreased appetite, irritability, social isolation, guilt and anhedonia.

### **Data Science for Allostatic Load**

#### Allostatic load reflects physiological responses to stress





#### Allostatic Load Biomarkers in Prostate Cancer Survivors Electronic Health Records (n=409)

Clinical Characteristics	Allostatic Load Variables			
34.2% African American	BMI = 30.4 (13.9)			
PSA Mean (SD) = 8.5 (8.8)	Systolic Blood Pressure = 136.7 (18.4) Diastolic Blood Pressure = 79.5 (10)			
71.7% Stage T1/T2 Heart Rate = 73.4 (12.9)				
Allostatic Load = 1.26 (1.15)				

Jefferson M, Drake RR, Lilly M, Savage SJ, Tucker Price S, Hughes Halbert C. Co-morbidities in a Retrospective Cohort of Prostate Cancer Patients. Ethn Dis. 2020;30:185-192.

### **Allostatic Load in Prostate Cancer Survivors**



Allostatic Load: Social Determinants Model (n=117)						
Variable	Level	OR	95% CI (p-value)			
Race	African American White	0.52	0.15, 1.79 (0.30)			
PSA	***	1.003	0.94, 1.06 (0.93)			
Age	***	0.93	0.86, 1.00 (0.06)			
Stage	T2 T3	0.58	0.22, 1.53 (0.27)			
Income	LT <sub>\$35,000</sub> GT \$35,000	0.36	0.12, 1.08 (0.07)			
Education	≥ Some college ≤ High school	0.57	0.20, 1.64 (0.30)			
Social Isolation	***	0.49	0.27, 0.88 (0.02)			
QOL	***	0.92	0.82, 1.03 (0.16)			
			21			

#### **Allostatic Load Characteristics among Veterans**

Variable	Mean (SD)
Body Mass Index	29.6 (6.0)
Systolic Blood Pressure	137.3 (18.3)
Diastolic Blood Pressure	81.3 (9.3)
HBA1C	5.83 (1.1)
Cholesterol	184 (40.6)

86% have at least one chronic condition

#### Correlation between Allostatic Load and Clinical and Psychosocial Stressors among Veterans

	African American	White
PSA	-0.17 (0.16)	0.29 (0.04)
Gleason score	-0.008 (0.98)	0.08 (0.59)
Financial toxicity	0.06 (0.81)	-0.45 (0.04)
Perceived stress	-0.32 (0.11)	0.28 (0.20)
Social isolation	0.06 (0.77)	0.23 (0.31)

#### Resiliency

#### **Resiliency:** The ability to recover from challenges, stressors, and difficulties



- Allostatic load is greater among men who report resiliency
  - Bounceback: 3.31 vs. 2.14
  - $\circ~$  Adapation: 2.90 vs. 2.06

### **Conclusions and Future Directions**

- Racial disparities in allostatic load exist among prostate cancer patients, but race may be less important within the context of other social determinants
- Resiliency efforts among men may have adverse physiological consequences
- Insights about social and clinical factors and outcomes of allostatic load result from transdisciplinary data science
  - > Standardize measurement and data collection strategies for social determinants
  - Develop strategies to address social risk factors
  - Examine health care quality and outcomes based on documented social determinants

# MUSC Transdisciplinary Collaborative Center in Precision Medicine and Minority Men's Health Medicine

- Claudia Baquet, MD
- Ernestine Delmoor, MPH
- Richard Drake, PhD
- Stephen Ethier, PhD
- Chanita Hughes-Halbert, PhD
- Melanie Jefferson, PhD
- Les Lenert, MD
- Michael Lilly, MD
- Gayenell Magwood, PhD
- Cathy Melvin, PhD
- Stephen Savage, MD
- Vivienne Zhu, MD

#### **Pilot Research Program Investigators and Trainees**

- Wole Babatunde, PhD, MUSC
- Bridgette Brawner, PhD, University of Pennsylvania
- Jay Pandey, PhD, MUSC
- Caitlin Allen, PhD, Emory University/MUSC

