Session 39PD, Social Determinants of Health: An Actuarial Perspective

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Social determinants of health: An actuarial perspective

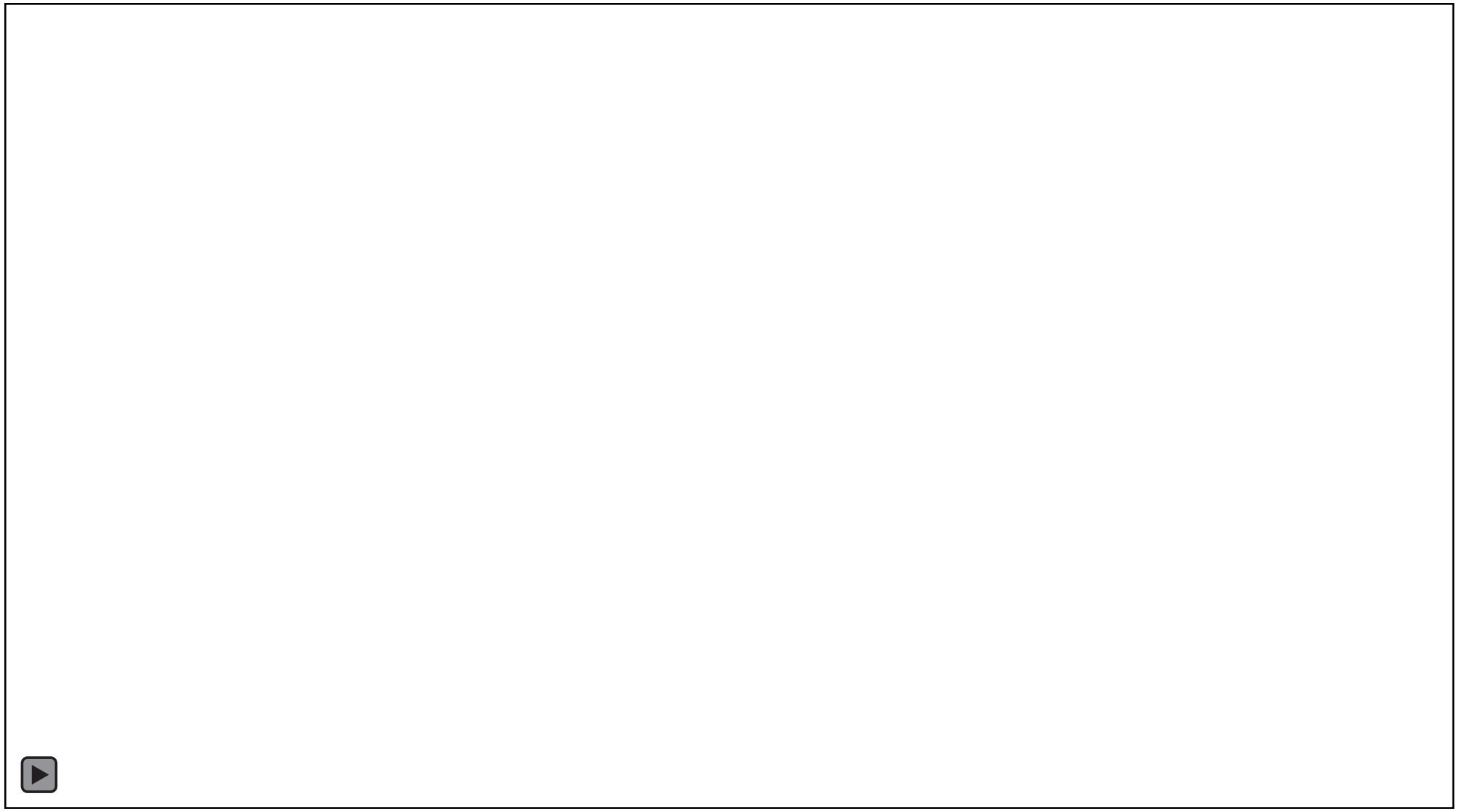
Ralph J. Perfetto Jr., Ph.D.; Mason Roberts, ASA; MAAA, MBA; Ksenia Whittal, FSA, MAAA

June 25, 2018

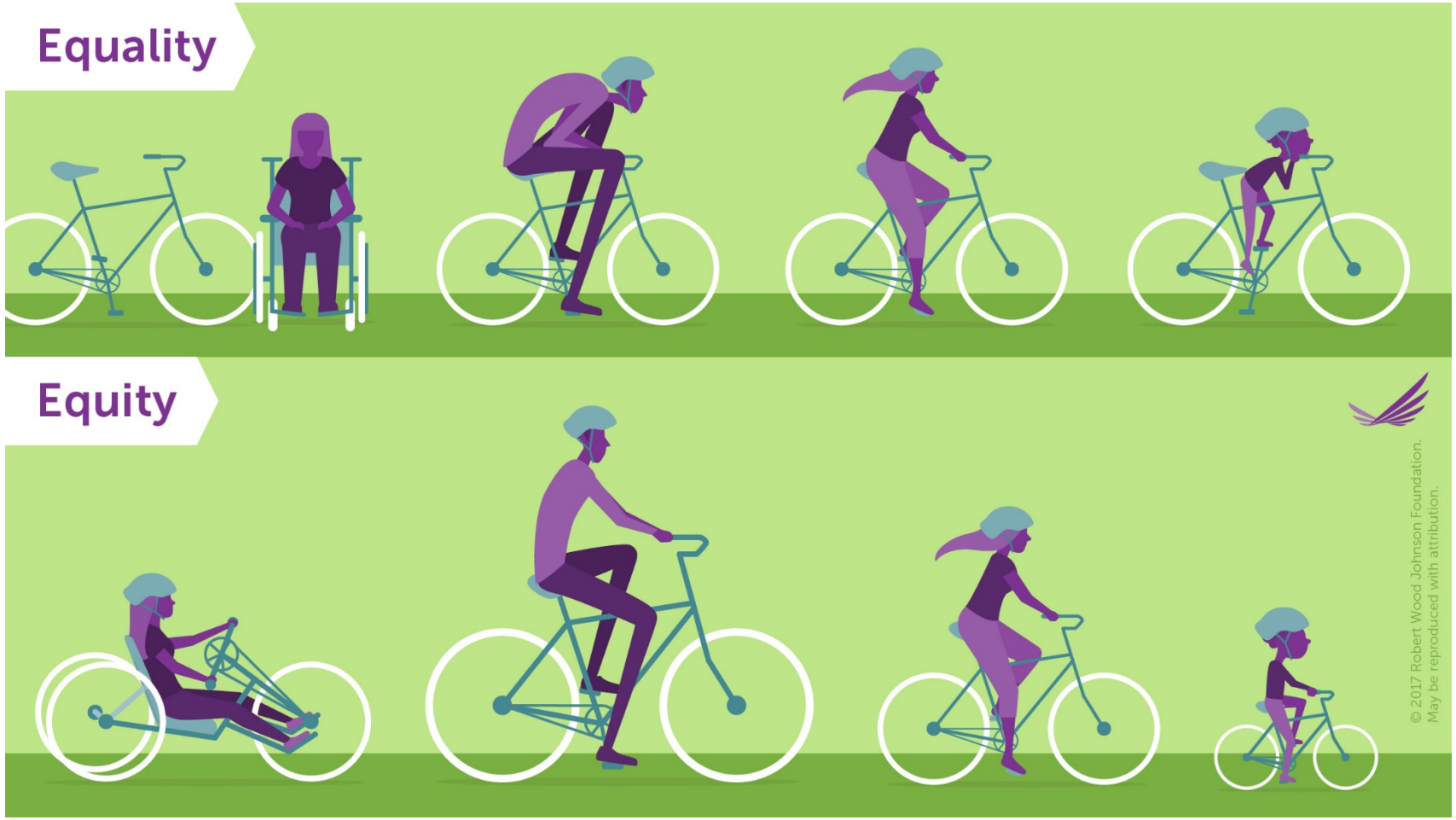
Agenda

- What are Social Determinants of Health (SDoH)?
- Discuss relationship between SDoH, MARA, health Outcomes and Utilization
- Discuss SDoH program evaluation

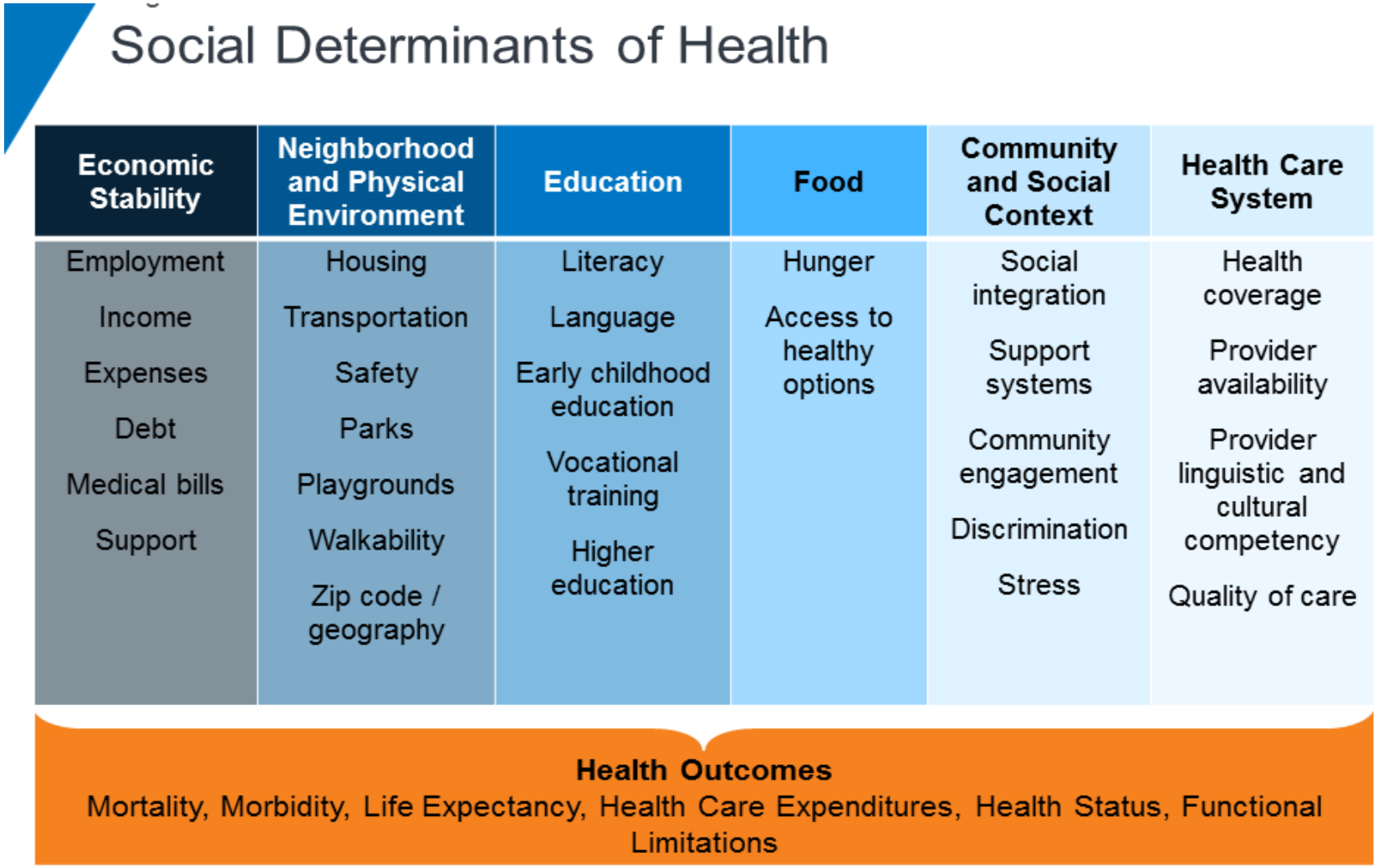
Introduction



Health Equity



What are social determinants of health?



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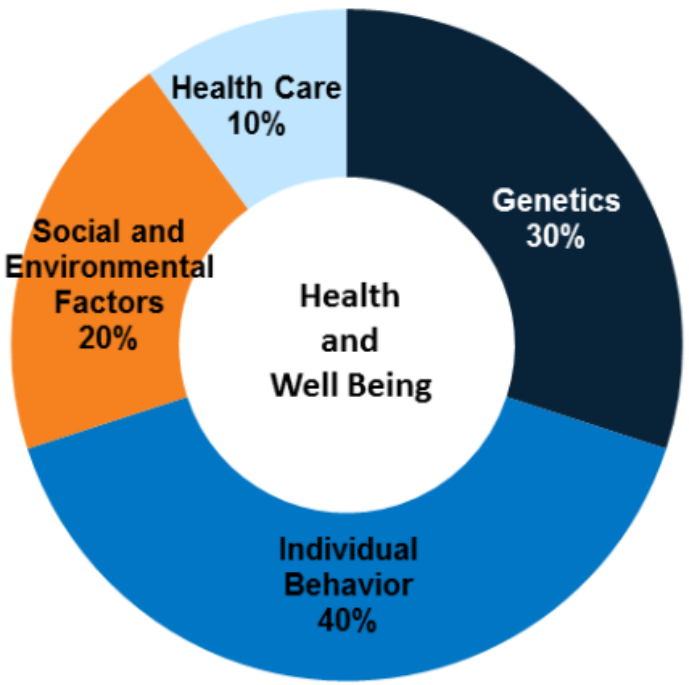
You have probably seen these statistics…



SOURCE: Schroeder, SA. (2007). We Can Do Better — Improving the Health of the American People. *NEJM*. 357:1221-8.

Figure 2: Impact of Different Factors on Risk of Premature Death

Actual Causes of Death in the United States in 1990

Cause	Deaths: Estimated No.*	Deaths: Percentage of Total Deaths
Tobacco	400 000	19
Diet/activity patterns	300 000	14
Alcohol	100 000	5
Microbial agents	90 000	4
Toxic agents	60 000	3
Firearms	35 000	2
Sexual behavior	30 000	1
Motor vehicles	25 000	1
Illicit use of drugs	20 000	<1
Total	**1 060 000**	50

Source: JAMA, Nov 10, 1993 – Vol 280 No 18

Causes of death (top 10) [NCHS, National Vital Statistics System, Mortality]	Age Adj. Death Rate per 100k, 2015
Heart Disease	168.5
Cancer	158.5
Respiratory diseases	41.6
Injuries	43.2
Stroke	37.6
Alzheimer's	29.4
Diabetes	21.3
Influenza, Pneumonia	15.2
Kidney disease	13.4
Suicide	13.3

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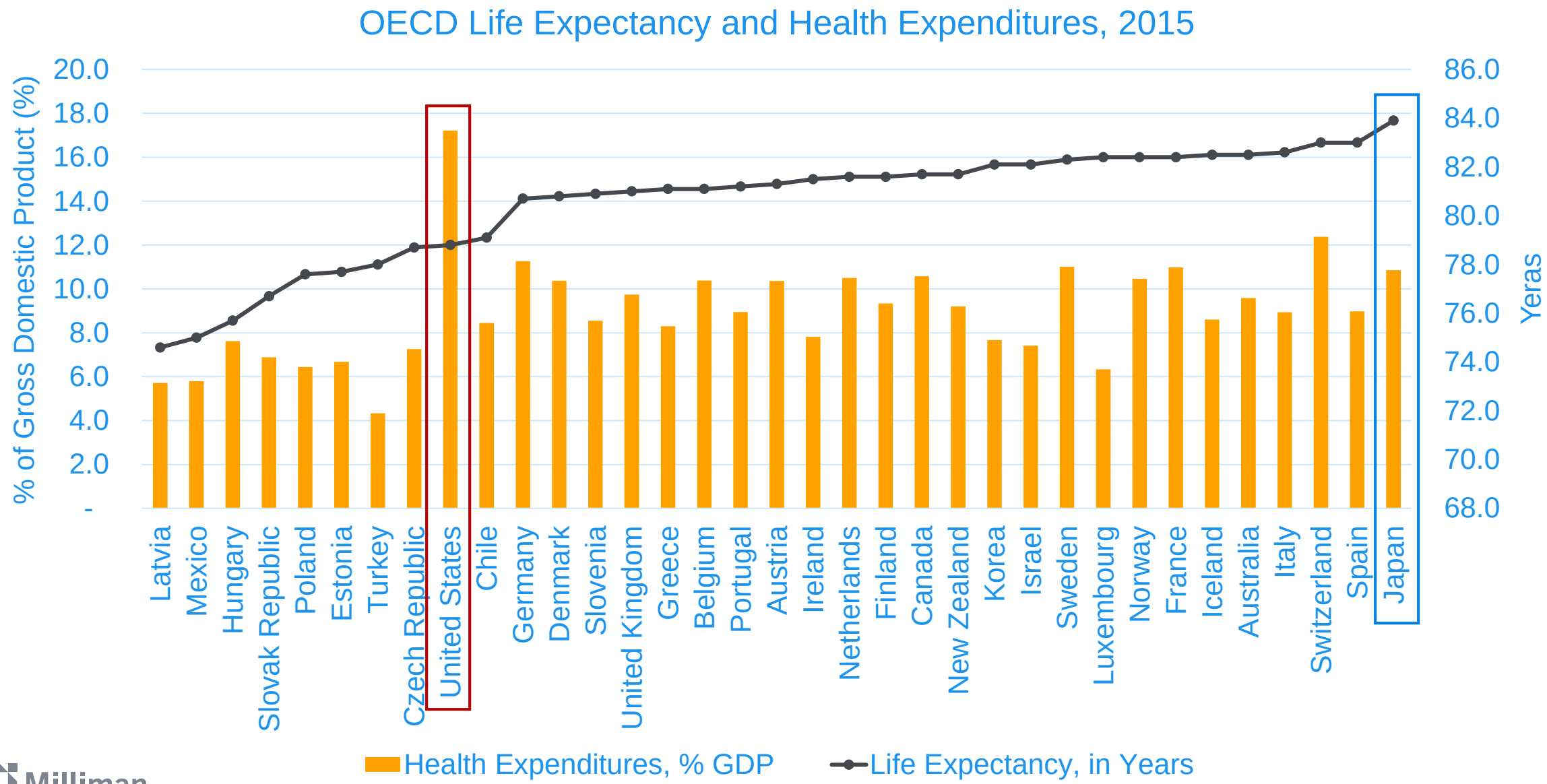
Why should we pay attention to SDOH?



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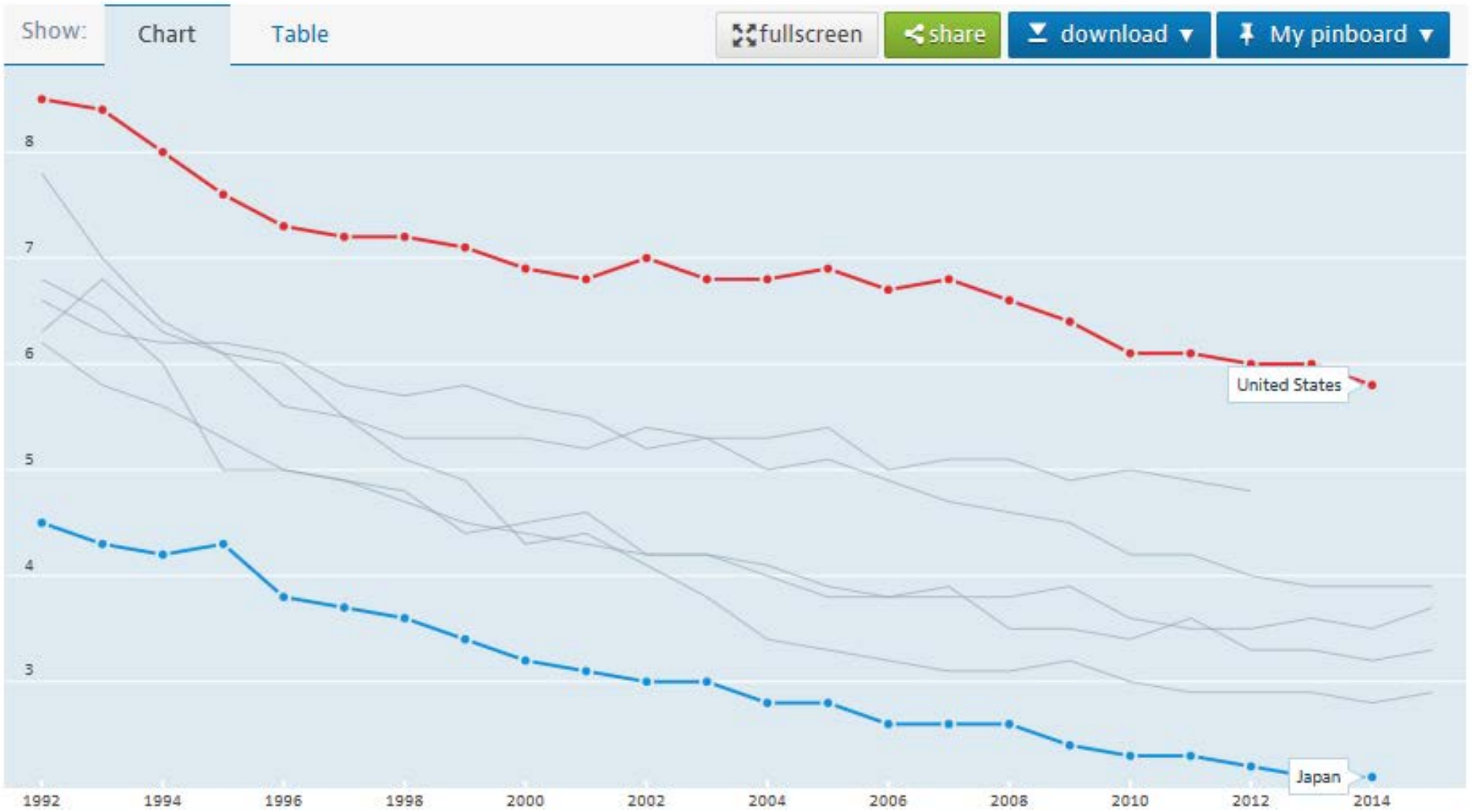
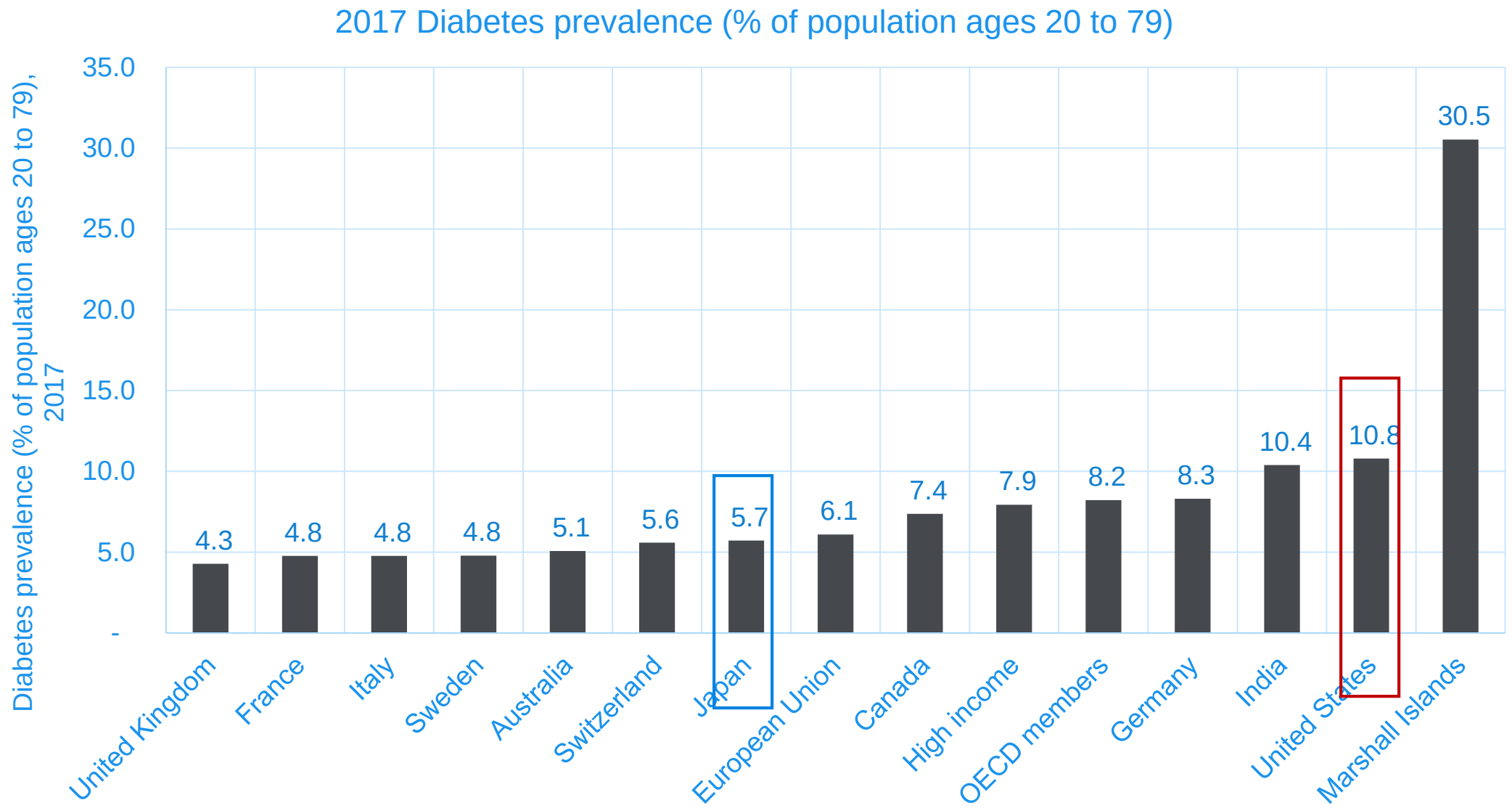
Infant mortality rates

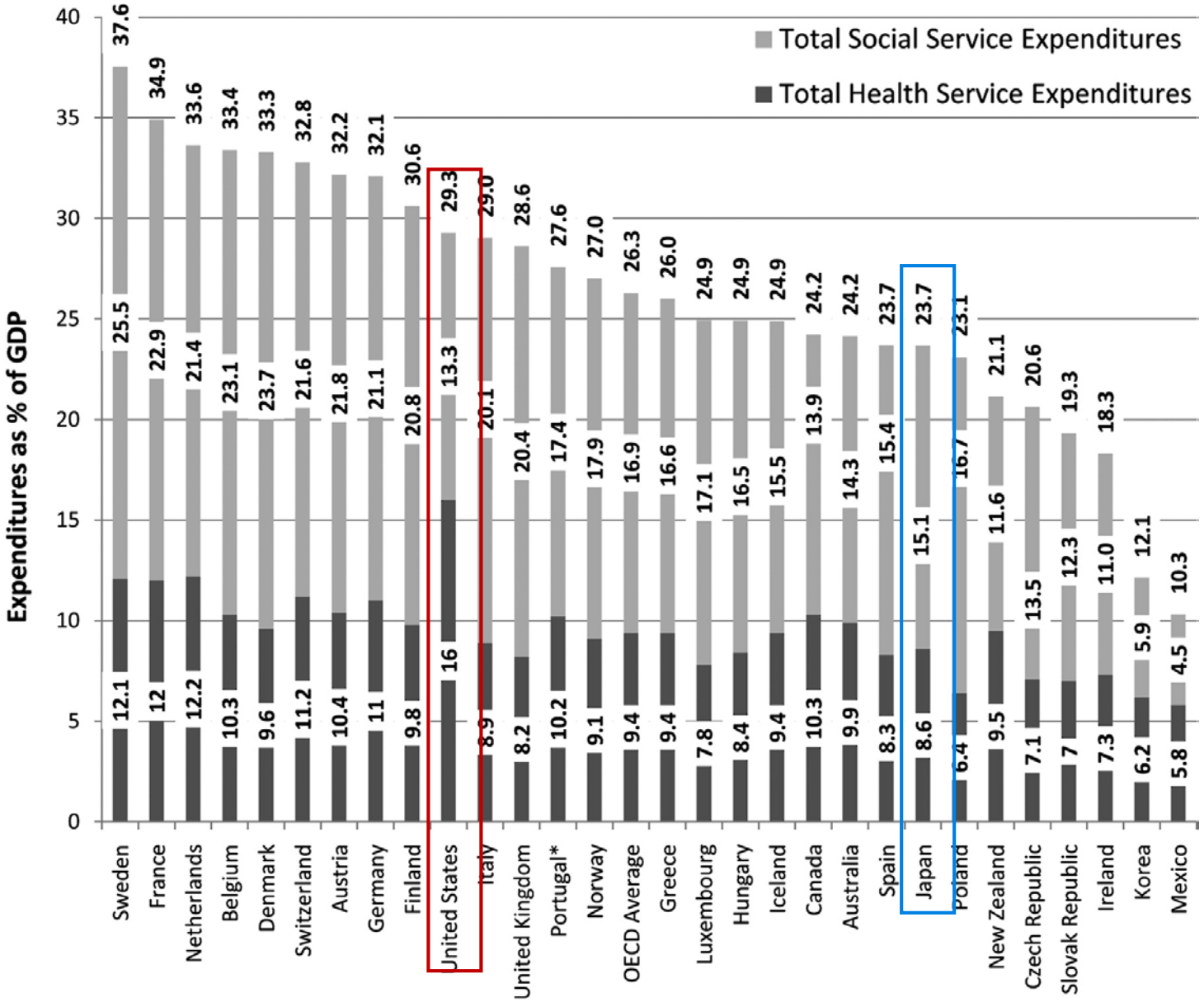
Total, Deaths/1 000 live births, 1992 – 2015

Source: Health status




2017 Diabetes prevalence (% of population ages 20 to 79)
Diabetes prevalence (% of population ages 20 to 79), 2017
35.0
30.0
25.0
20.0
15.0
10.0
5.0
-
4.3
4.8
4.8
4.8
5.1
5.6
5.7
6.1
7.4
7.9
8.2
8.3
10.4
10.8
30.5
United Kingdom
France
Italy
Sweden
Australia
Switzerland
Japan
European Union
Canada
High income
OECD members
Germany
India
United States
Marshall Islands

Total health-service and social-services expenditures for OECD countries, 2005



	Life expectancy	
	Coefficient (SE)	p Value
Model 3		
Intercept	27.24 (1.22)	<0.001
Social/health ratio	0.40 (0.19)	0.03
Health Spending	0.33 (0.05)	<0.001
(GDP)	4.66 (0.11)	<0.001

The natural logarithm of GDP was included in all models.
*As a percentage of gross domestic product (GDP).

Elizabeth H Bradley et al. BMJ Qual Saf 2011;20:826-831

SDoH and health outcomes

Chronic Diseases and Social Determinants

Food insecurity associated with higher prevalence of diabetes, hypertension, hyperlipidemia

TABLE 2 Prevalence and crude and adjusted odds ratios for the association between food security and chronic disease among low-income NHANES participants

	Hypertension		Hyperlipidemia		Diabetes	
Assessment of diagnosis	Self-report, *n* = 4957	Clinical,[1] *n* = 4627	Self-report, *n* = 1930	Clinical,[2] *n* = 4559	Self-report, *n* = 5089	Clinical,[3] *n* = 2239
Food secure						
Unadjusted prevalence, %	20.2	18.6	33.3	19.8	6.8	7.4
Food insecure						
Unadjusted prevalence, %	24.6	22.4	43.3	21.7	8.3	10.2
CRR (95% CI)[4]	1.20 (1.05–1.38)	1.21 (1.03–1.42)	1.31 (1.10–1.56)	1.09 (0.90–1.33)	1.21 (0.92–1.59)	1.51 (1.04–2.19)
ARR (95% CI)[4]	1.20 (1.04–1.38)	1.21 (1.04–1.41)	1.30 (1.09–1.55)	1.09 (0.90–1.33)	1.19 (0.89–1.58)	1.48 (0.94–2.32)

[1] Clinical hypertension is defined as SBP >140 mm Hg, DBP >90 mm Hg, or taking antihypertensive medication.
[2] Clinical hyperlipidemia is defined as a total cholesterol ≥240 mg/dL (6.22 mmol/L), LDL cholesterol ≥160 mg/dL (4.14 mmol/L), or taking cholesterol-lowering medication.
[3] Clinical diabetes is defined as a fasting plasma glucose ≥126 mg/dL (6.99 mmol/L) or taking insulin and/or a hypoglycemic medication.
[4] Relative risk is for food-insecure adults compared with food-secure adults. CRR is adjusted for age, gender, and race/ethnicity. ARR is adjusted for age, gender, race/ethnicity, educational attainment, and income as both a continuous and an ordinal variable.

Source: The Journal of Nutrition, 140: 304-310, Seligman et al. 2010

Mental Health and Social Determinants

Food insecurity associated with poor mental health

Table 4. Multiple Logistic Regression Analyses of the Association of Food Insecurity With Psychosocial Conditions and Experiences

	Physical and mental health conditions and experiences									
Variable	**Experience physical pain, OR (95% CI)**	**Experience worry, OR (95% CI)**	**Experience sadness, OR (95% CI)**	**Experience stress, OR (95% CI)**	**Experience anger, OR (95% CI)**	**Feel well-rested, OR (95% CI)**	**Treated with respect, OR (95% CI)**	**Smile or laugh a lot, OR (95% CI)**	**Learn or do something interesting, OR (95% CI)**	**Experience enjoyment, OR (95% CI)**
n	140,351	140,351	140,351	140,351	140,351	140,351	139,339	139,391	140,351	140,351
Food insecurity										
Food secure (ref)	–	–	–	–	–	–	–	–	–	–
Mild	**1.6***** (1.5, 1.6)	**2.1***** (2.0, 2.2)	**1.9***** (1.8, 2.0)	**1.8***** (1.7, 1.9)	**1.6***** (1.5, 1.7)	**0.64***** (0.60, 0.68)	**0.61***** (0.56, 0.65)	**0.60***** (0.57, 0.64)	**0.72***** (0.68, 0.75)	**0.60***** (0.56, 0.64)
Moderate	**2.1***** (2.0, 2.2)	**3.1***** (2.9, 3.3)	**2.9***** (2.7, 3.2)	**2.6***** (2.4, 2.8)	**2.3***** (2.1, 2.4)	**0.49***** (0.45, 0.52)	**0.48***** (0.44, 0.52)	**0.50***** (0.47, 0.54)	**0.62***** (0.57, 0.67)	**0.46***** (0.43, 0.50)
Severe	**2.5***** (2.4, 2.7)	**4.2***** (3.9, 4.6)	**4.3***** (3.9, 4.8)	**3.5***** (3.1, 4.0)	**3.1***** (2.8, 3.4)	**0.41***** (0.38, 0.45)	**0.37***** (0.33, 0.42)	**0.43***** (0.39, 0.47)	**0.56***** (0.51, 0.60)	**0.38***** (0.34, 0.42)

Note: Boldface indicates statistical significance of the partial regression coefficients (*$p<0.05$; **$p<0.01$; ***$p<0.001$). Values are ORs and 95% CIs from separate multiple logistic regression equations. All models control for urbanicity, age, sex, education level, and employment status of respondent, number of children in household, quintiles of annual household income, and country fixed effects. SEs and variance–covariance matrices of the estimators were adjusted for within-country correlations. All of the psychosocial conditions and experiences shown are constituent questions from the Gallup Negative Experience and Positive Experience Indices (Appendix Table 3, available online).

Jones / Am J Prev Med 2017;53(2):264–273

Source: American Journal of Preventive Medicine, "Food Insecurity and Mental Health Status: A Global Analysis of 149 Countries." Jones, 2017;53(2):264–273.

Examples of savings and outcomes

Program	Outcome	Entity
Employment support	18% reduction in ED use, 28% decreased OP spend, increased Rx adherence	Life Services / CareSource
Community based-programs and services (removing social barriers, coordinating support services)	17% decrease in ED use, 26% reduction in ED spending, 53% decrease in IP spending, 23% decrease in OP spending, $3,200 PMPY cost reduction; 3.47 ROI	WellCare CommUnity
Food access, education (Fresh Food Farmacy)	Reduced A1C (18%), glucose (27%), cholesterol (10%) BP and weight	Geisinger
Housing support, integrated services	$7,083 PMPM savings, 1.57 ROI	Health Plan of San Mateo Housing Pilot
Nutritional program for at risk employees	Reduced weight, blood pressure, BMI, cholesterol, triglycerides	Whole Foods

Examples of Programs

- CO Access
- HealthNet
- LifeServices @ CareSource
- Aetna
- Humana
- UPMC
- Highmark
- Presbyterian Healthcare Services of NM
- LA Care Health Plan
- CareOregon
- BC Idaho
- Geisinger Fresh Food Farmacy
- LifeBridge Health
- Marshfiled Clinic Health System
- BayCare Health System
- Carolinas Healthcare System
- Novant Health
- Denver Health Plan
- CareMore
- New York City LegalHealth
- OneCity Health
- Health Plan of San Mateo
- WellCare CommUnity Health
- Molina Healthcare
- MN, MA, RI State Medicaid programs
- Anthem
- CMS Innovation - Accountable Health Communities Model
- Align For Health (http://aligningforhealth.org/news/) - 2018

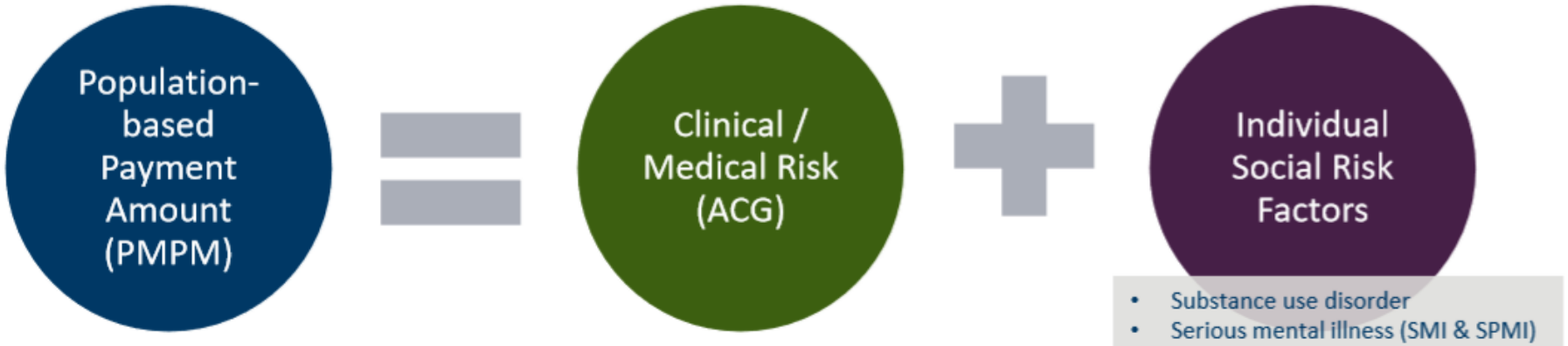
SDoH in Medicaid Programs - Massachusetts

- Risk adjustment incorporates homelessness and neighborhood stress in MCO payments

Table 1: Variables Included in Massachusetts Medicaid Payment Model[18]	
Diagnostic Risk Scores	DxCG v 4.2
Age	0-1, 2-5, 6-12, 13-17, 18-24, 25-34, 35-44, 45-54, 55-59, 60+, male and female
Additional Diagnostic Variables	Mental illness, substance use disorders
State Agency Affiliation	Department of Mental Health, Department of Developmental Services
Disability	Entitled to Medicaid due to disability
Unstable Housing	Three or more addresses in single year or ICD-code for homeless on claim[19]
Neighborhood Stress Score	Composite measure from seven census data variables: • % families with incomes < 100% FPL • % < 200% FPL • % adults unemployed • % households receiving public assistance • % households with no cars • % single parent households • % adults 25+ with no high school degree

SDoH in Medicaid Programs - Minnesota

- Adjustment in payments



Relationships Between SDoH and Health Outcomes

Self-Reported SDoH and Health Concerns

Worse **EMOTIONAL HEALTH** vs. last year

Worse **PHYSICAL HEALTH** vs. last year

Worry about having a place to **LIVE**, enough to **EAT**, **SAFETY**

BARRIERS:
Discomfort
Transportation
Cost/Money
No Doctor

Concerns about LIFE NECESSITIES

Poor **OVERALL HEALTH** in past month

Social and Environment Factors

Lower HEDIS Rates

Impacts Utilization

Suboptimal resource deployment

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Social Determinants of Health

In a recent study conducted by Eliza…..

- 40% of respondents reported having some difficulty getting to the doctor's office
- 35% of respondents were concerned about the cost of the tests
- People who report concerns about life necessities were 2x more likely to report poor health than very good health
- People with self-reported '**life problems'** also reported that their health negatively impacts their work functioning by nearly 2.5x more than those without life problems

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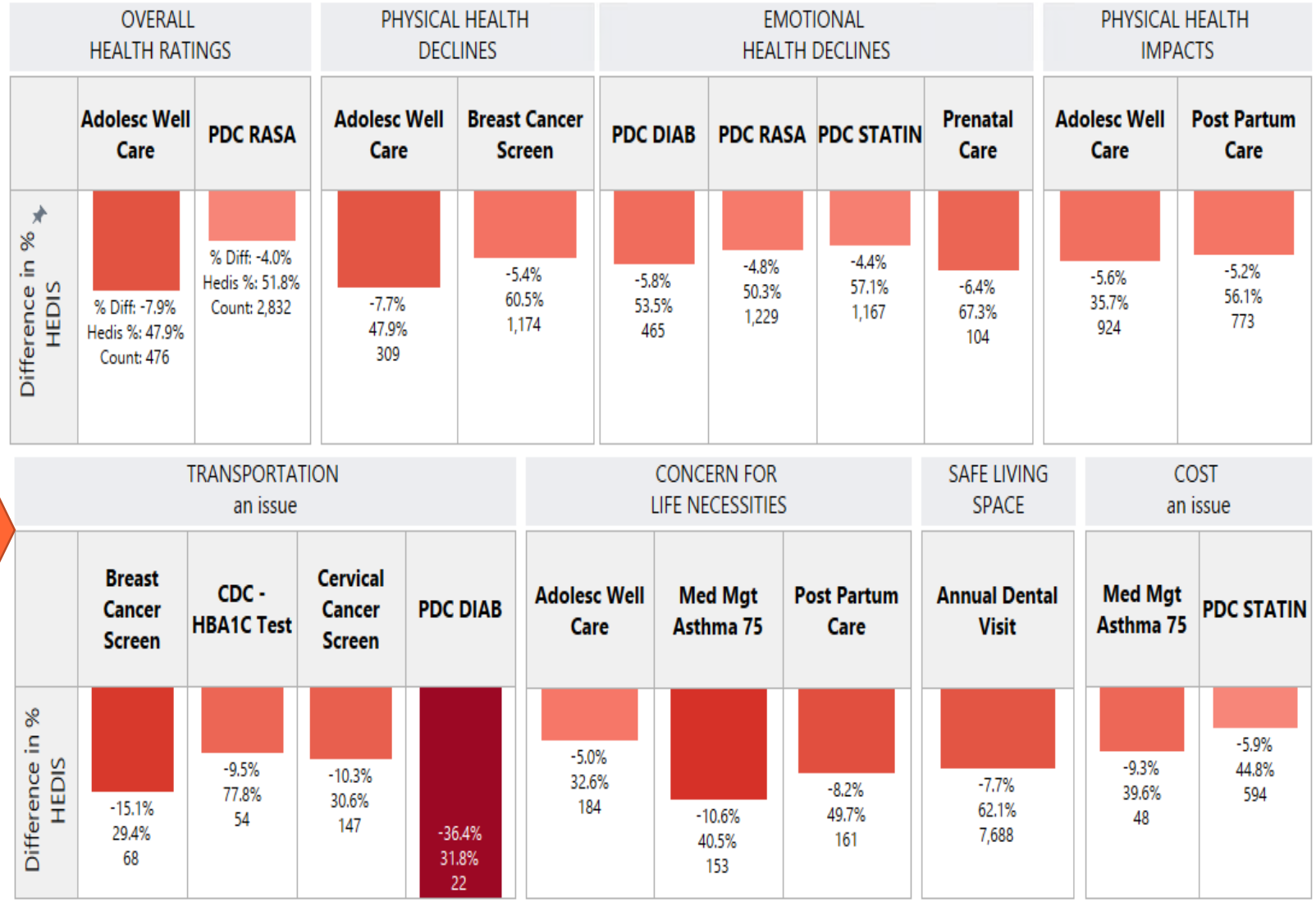
Impact on Clinical Outcomes (Medicaid)

- Poor OVERALL HEALTH impacts adolescent well care visits (AWC) and RASA med adherence
- Concern for LIFE NECESSITIES impacts AWC, Asthma med adherence (MMA) and Postpartum care
- Change in PHYSICAL HEALTH impacts AWC and breast cancer screening
- Changes in EMOTIONAL HEALTH impacts med adherence and Prenatal care
- Impact of PHYSICAL PROBLEMS impacts AWC and Postpartum care
- Not living in a SAFE ENVIRONMENT impacts annual dental visit (ADV)
- COST an issue for med adherence measures
- MISTRUST in medical advice (believing flu shot causes flu) impacts HbA1c testing, asthma and statin med adherence
- TRANSPORTATION issues impacts breast and cervical cancer screening, HbA1C testing, and diabetes med adherence



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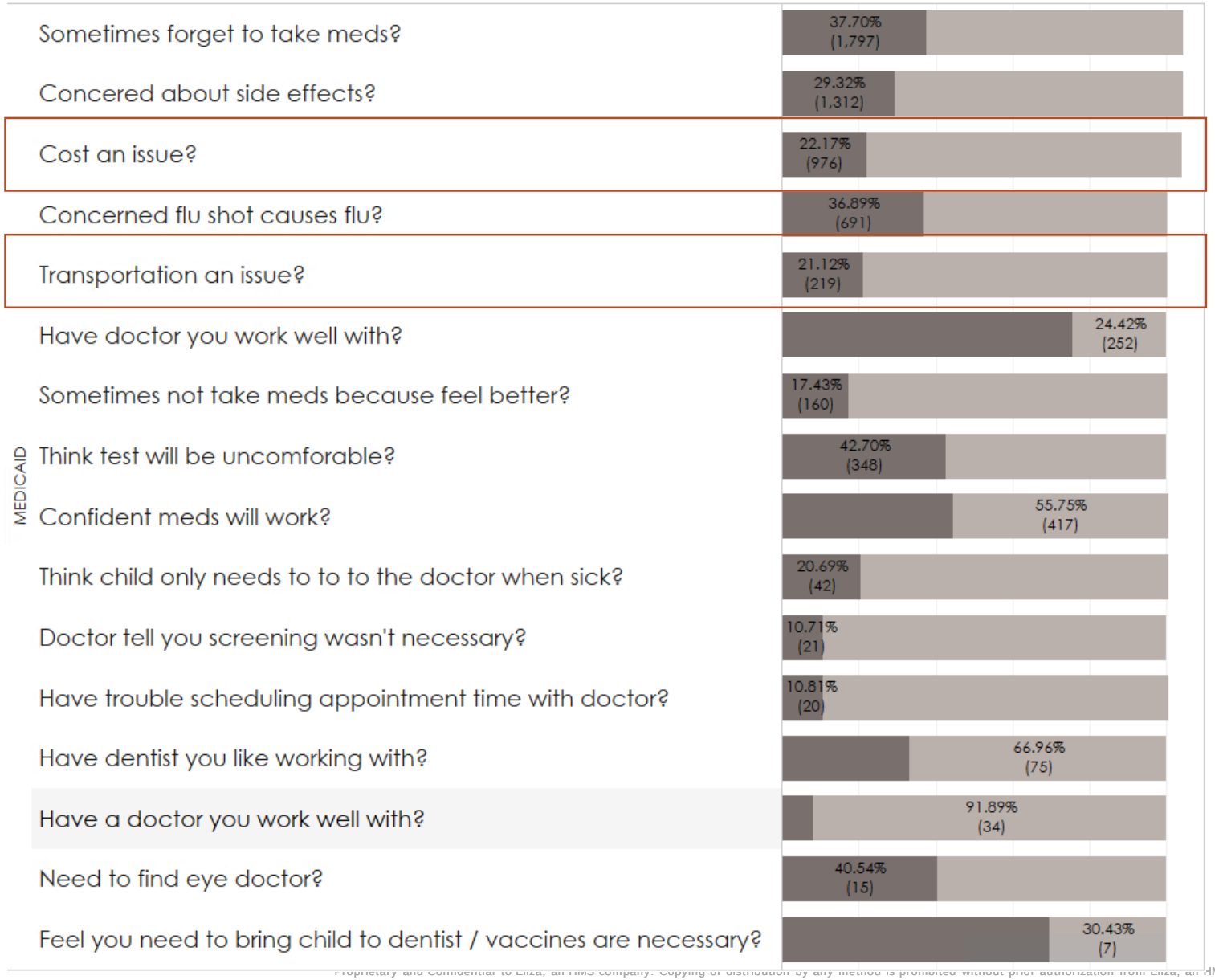
Identifying Members with Barriers (Medicaid)



Immediate support through in-call education and immediate transfers

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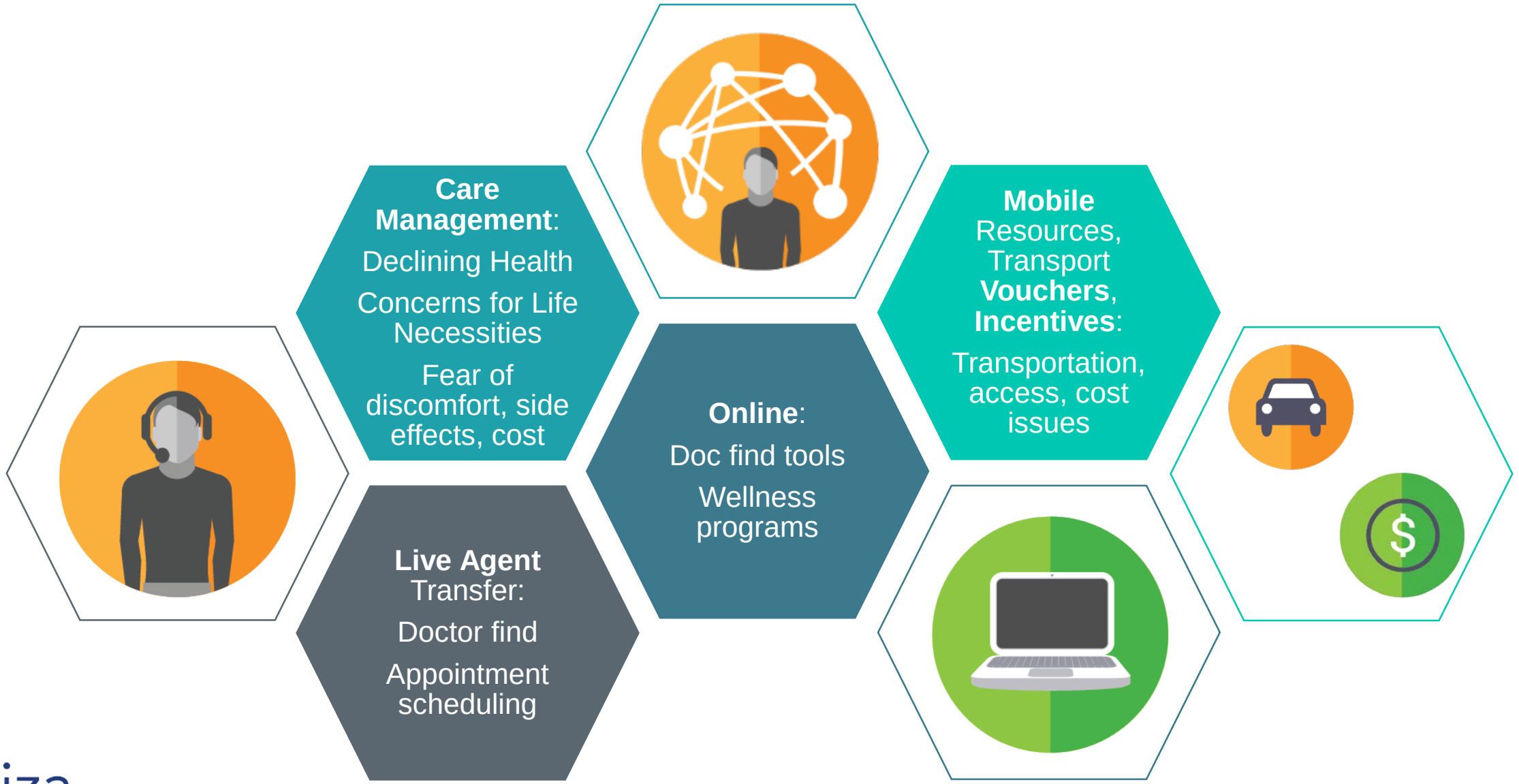
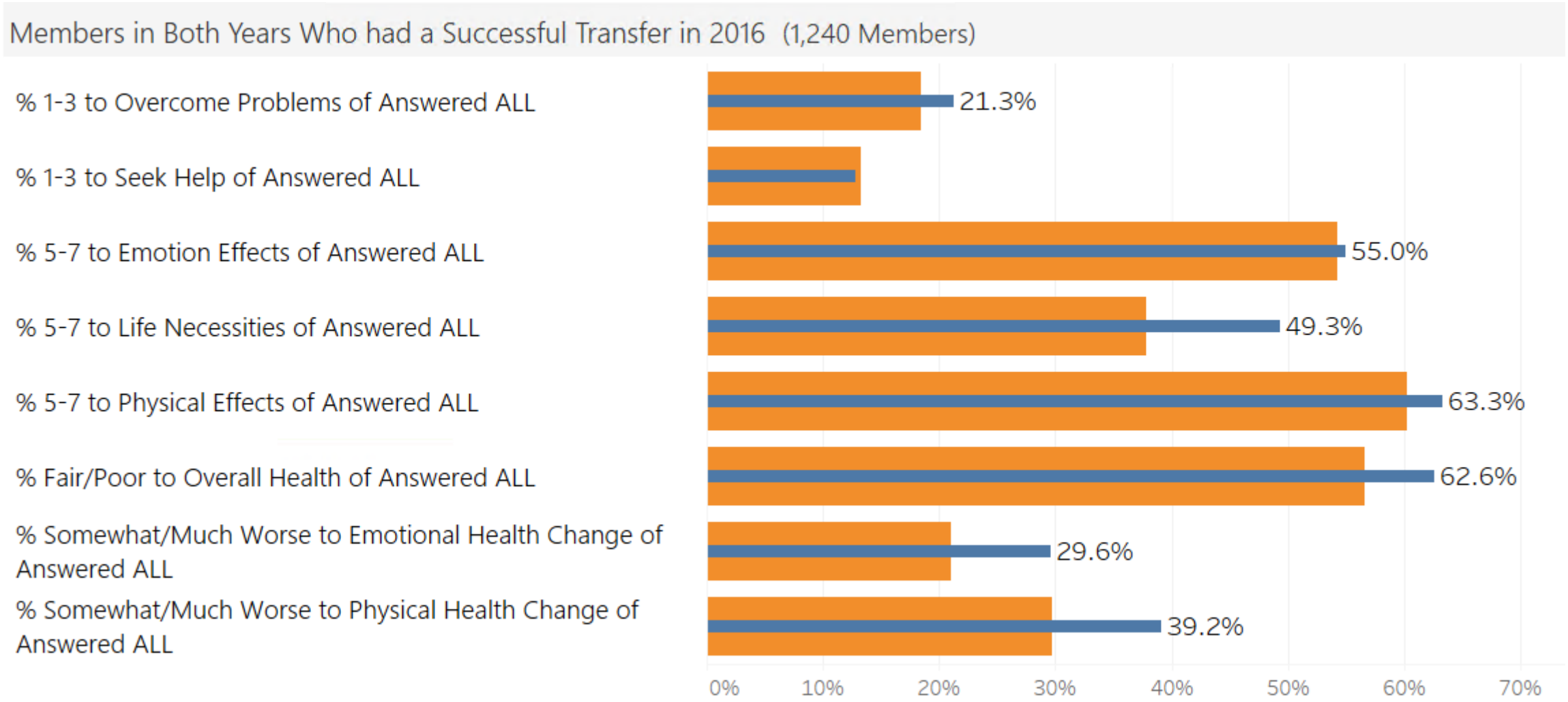
Matching Resources to Need



Transferred in 2016 Report Improved Status in 2017



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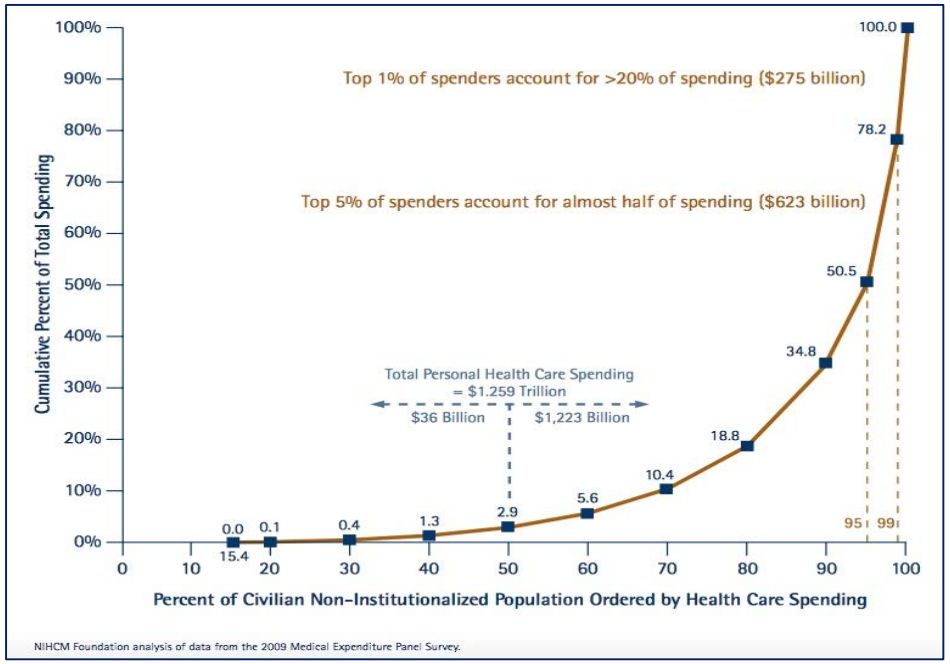
Actuarial Perspective:
Do SDoH Measure Align with Clinical Risk, Cost and Health Status?

Small percent of healthcare consumers (about 20%) consume a large portion of healthcare resources in a year

Many patients <u>were not high cost in the prior year</u>



* NIHCM Foundation analysis of data from 2009 Medical Expenditure Panel

Do Life Concerns and SDoH Impact Utilization and Increase Costs?

Study Overview

<u>Northeastern Insurance Plan</u>

- Medicaid and Dual eligible Population
- Total Number of Members – 229,788
- Claims, Rx, Enrollment data
- Age range (limited) – 1 to 65
- Gender:
  - F=128,118,
  - M=101,670

<u>SDoH Variables</u>

- Life Necessities
- Safe Living
- Overcome Problems
- Barriers
- Income
- Age
- Household Size
- Housing Type
- Marital Status (support)

<u>Self-Reported Health Change*</u>

- Health Status Change (Overall, Emotional & Physical)

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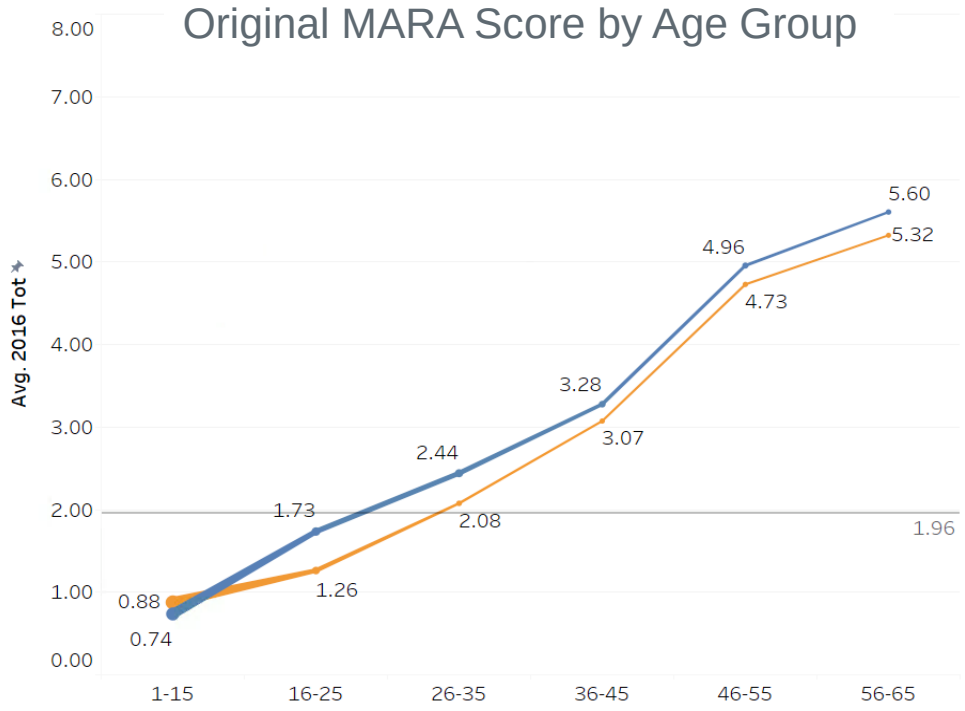
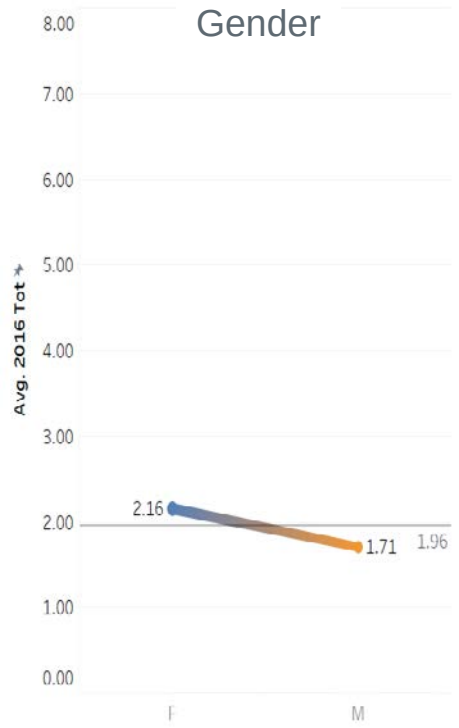
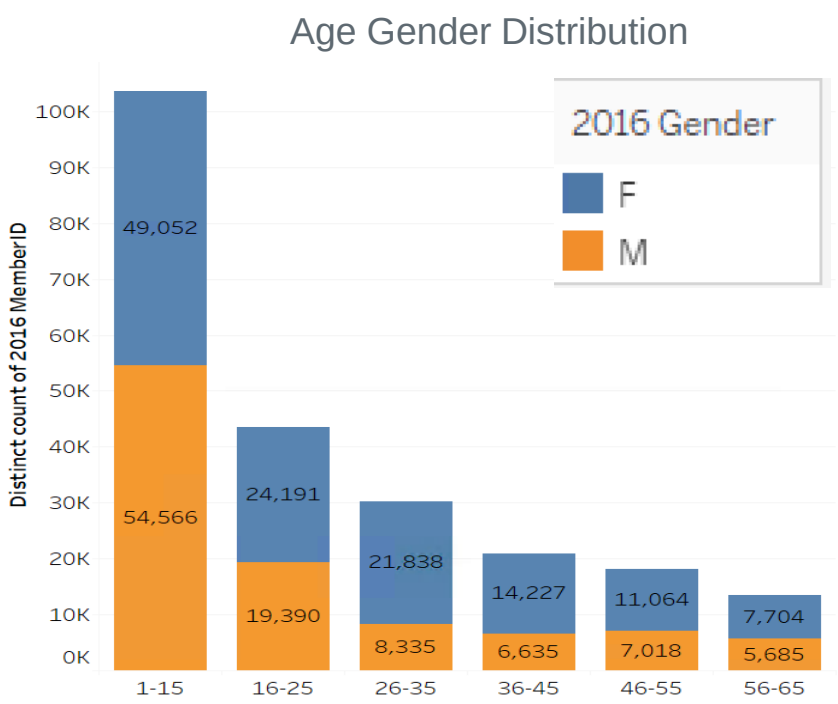
* Wherry, Laura R., Marguerite E. Burns, and Lindsey Jeanne Leininger. "Using Self-Reported Health Measures to Predict High-Need Cases among Medicaid-Eligible Adults." Health Services Research 49, no. S2 (December 2014): 2147–72. doi:10.1111/1475-6773.12222.

Population Level Overview: MARA Scores by Age/Gender







Northeastern Insurance Plan

- Medicaid and Dual eligible Population
- Total Number of Members – 229,788
- Claims, Rx, Enrollment data
- Age range (limited) – 1 to 65
- Gender:
  - F=128,118,
  - M=101,670

Overall Stats

Avg. 2016 Tot	1.96
Avg. 2016 Adjusted Mara	1.93
Avg. 2016 Cost PMPM	$1,131.94
Avg. 2016 AG Adj PMPM	1,123.02
Avg. 2017 Cost PMPM	$1,057.10
Avg. 2017 AG Adj PMPM	1,041.66
Distinct count of 2016 MemberID	229,705

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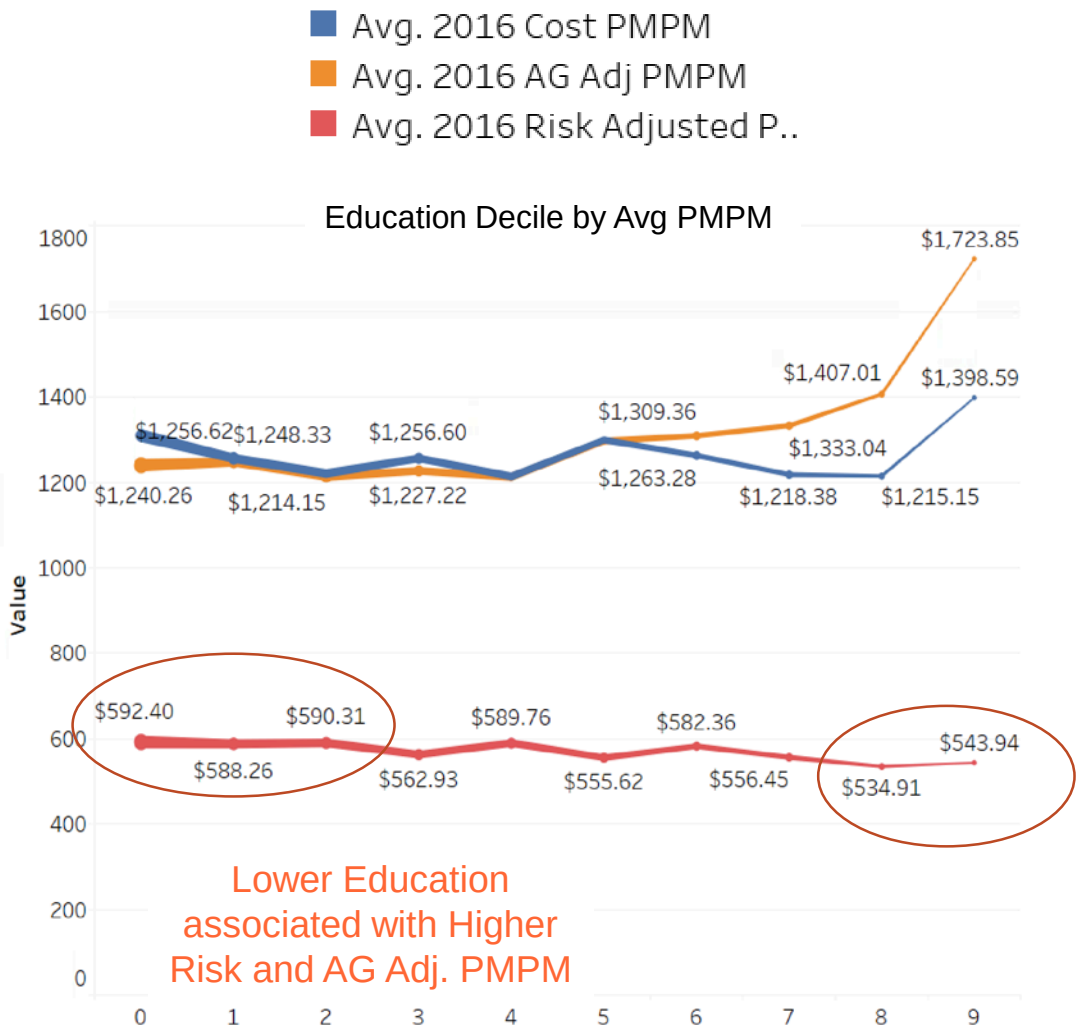
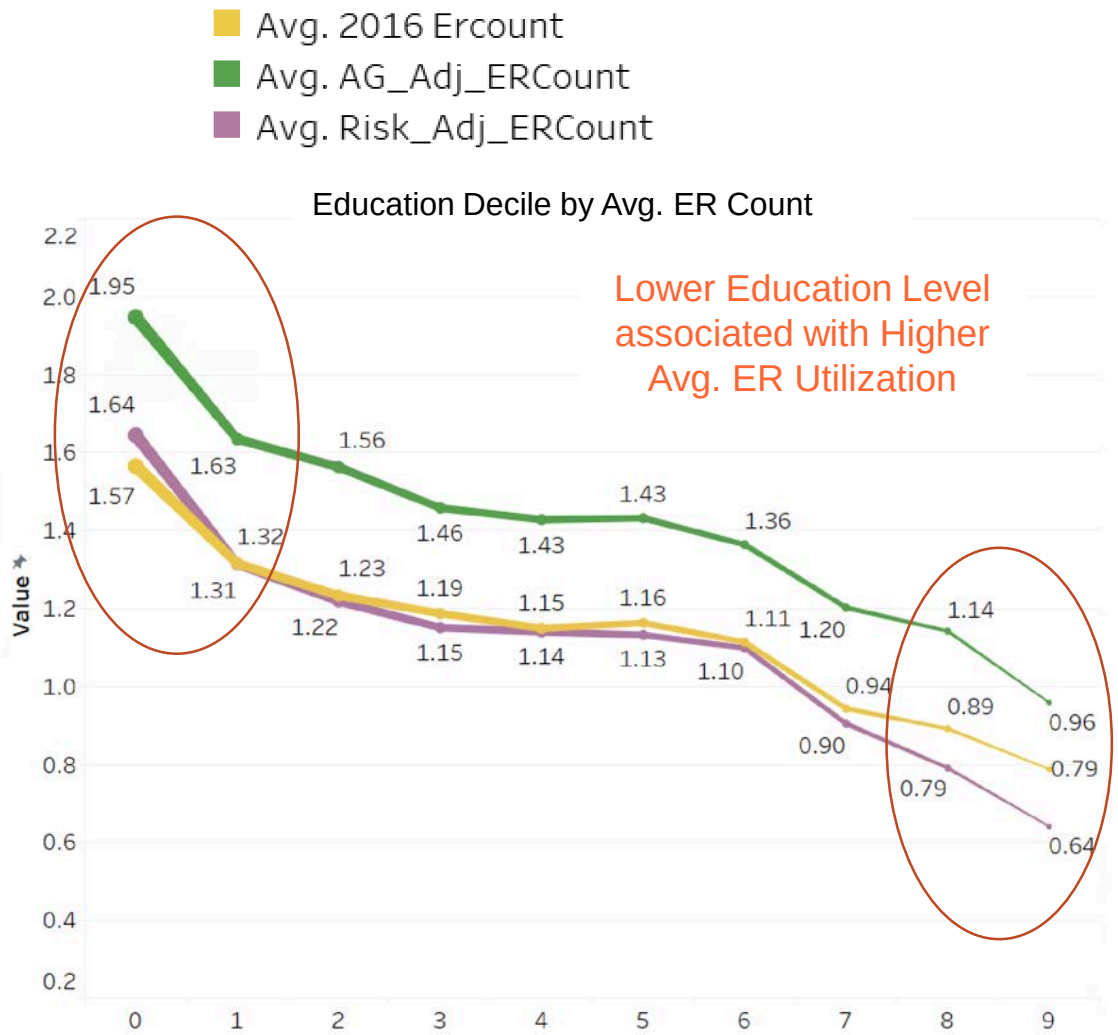
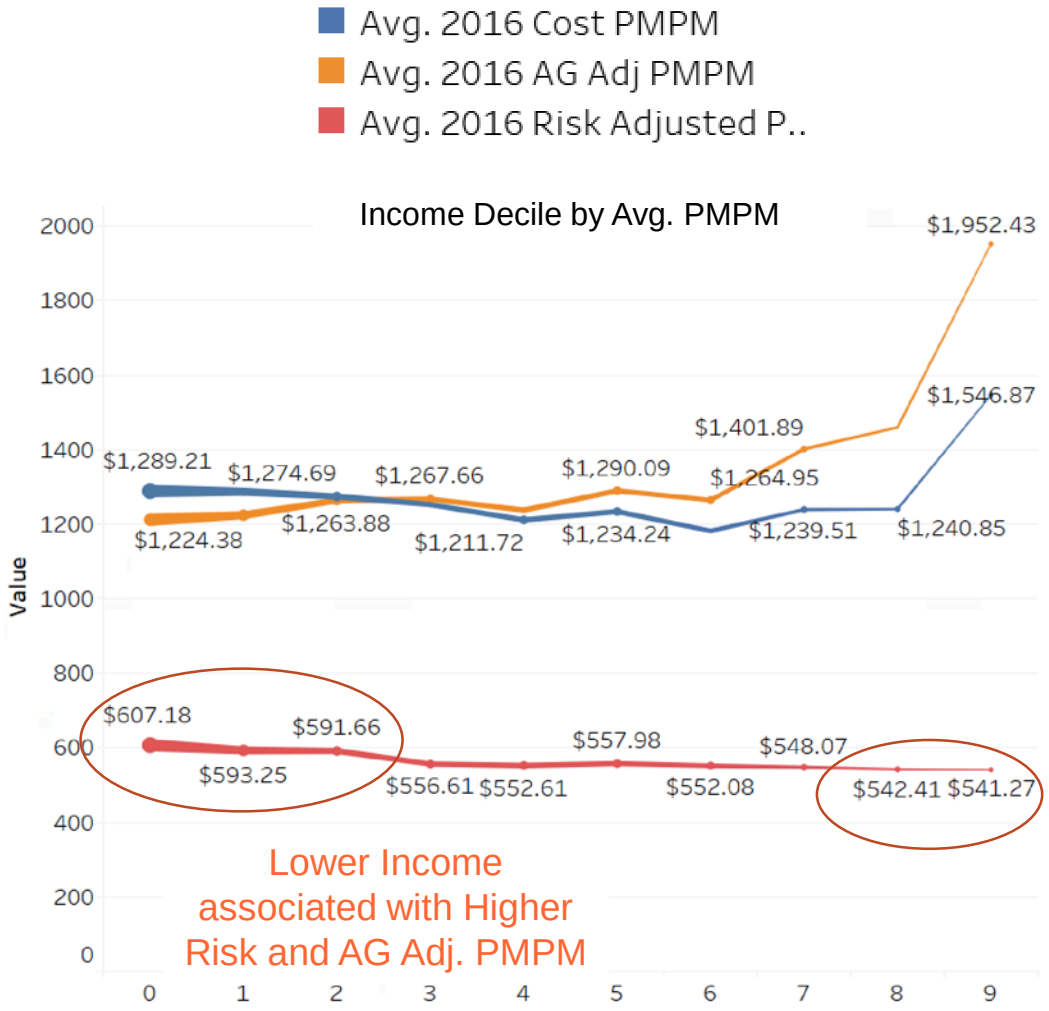
EDUCATION (decile) vs Avg. PMPM and Avg. ER Utilization

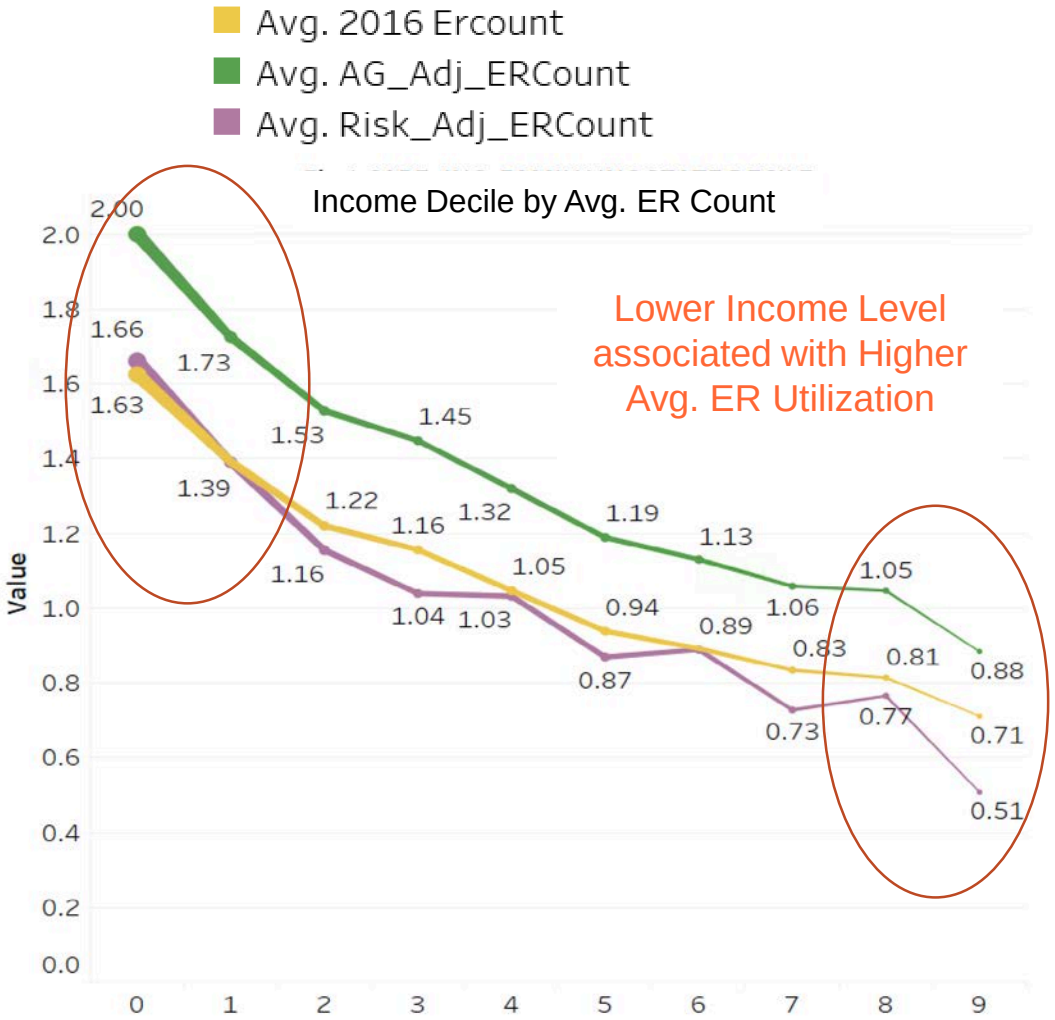




N= 146,610

INCOME (decile) vs Avg. PMPM and Avg. ER Utilization





N= 138,039

SDoH Z59 Claims vs Adjusted MARA & PMPM

Do Z59 claims correlate with MARA Scores and PMPM Costs?

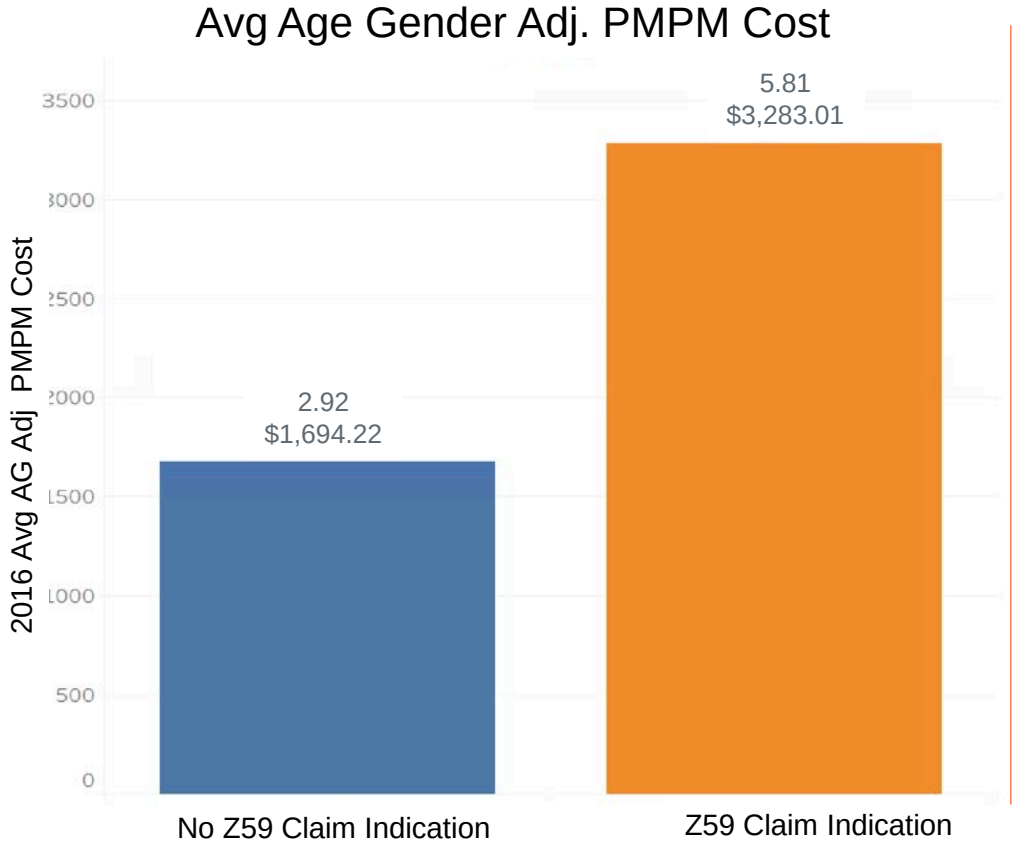
Z Flag includes codes

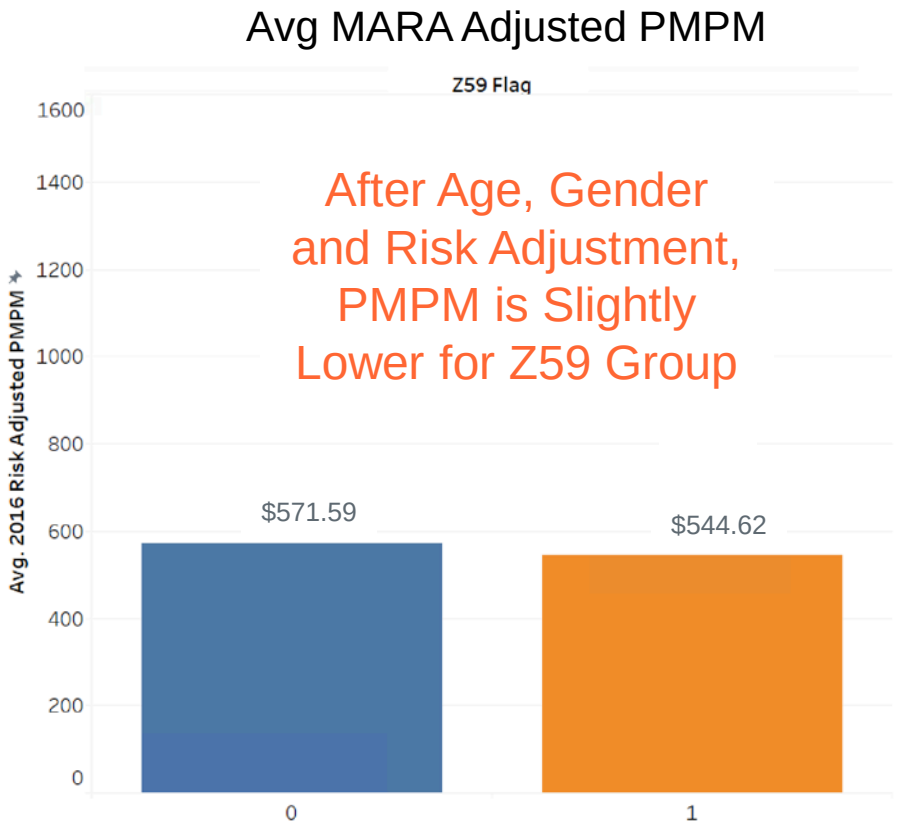
Z59 Problems related to housing and economic circumstances

Z59.0 Homelessness
Z59.1 Inadequate Housing
Z59.2 Discord wit landlord
Z59.4 Lack of adequate food and safe water
Z59.5 Extreme Poverty
Z59.6 Low Income
Z59.7 Insufficient social insurance and welfare support
Z59.8 Other problems related to housing and economic circumstance
Z59.9 Problems related to housing and economic circumstances.

Z59 Claim Flag

Grp 0 -> No Z59 Claim
Grp 1 -> Z59 Claim





After Age, Gender and Risk Adjustment, PMPM is Slightly Lower for Z59 Group

Z59 Claims	n=	Avg_Orig_MARA_Score	Avg_Adj_MARA_Score	Avg_PMPM	AG Adj PMPM	Avg_2016_Risk_Adjusted_PMPM
0	2,917	2.82	2.81	1,648.81	1,656.07	571.59
1	504	10.00	5.79	5,512.34	3,177.58	544.62

Grp 1 vs 0 sig @ P<0.001

Sample N= 3421
- At Least one claim
- Random Sample of non-z59 claims

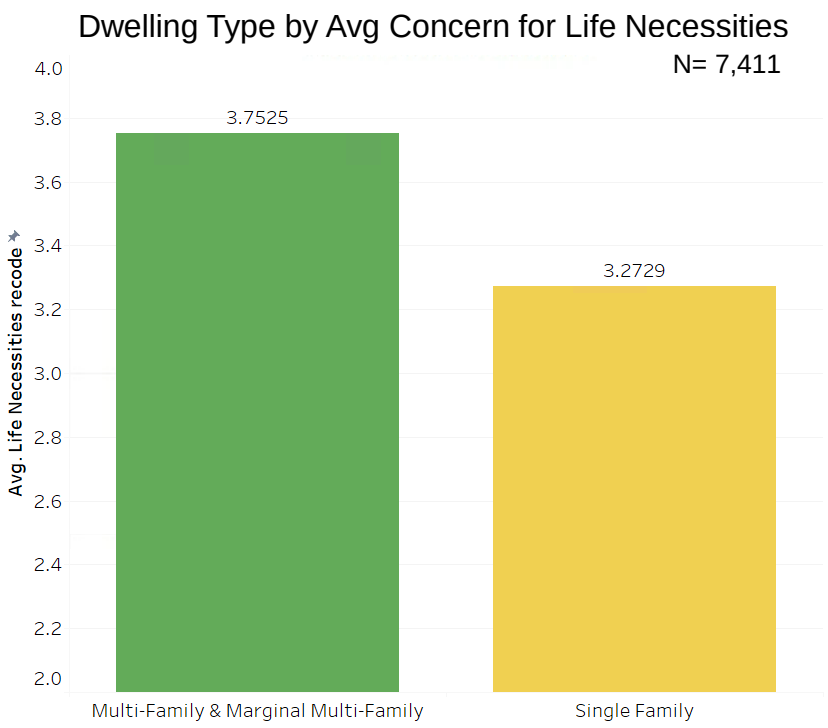
Dwelling Type vs Concerns for Life Necessities and Living Place

In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

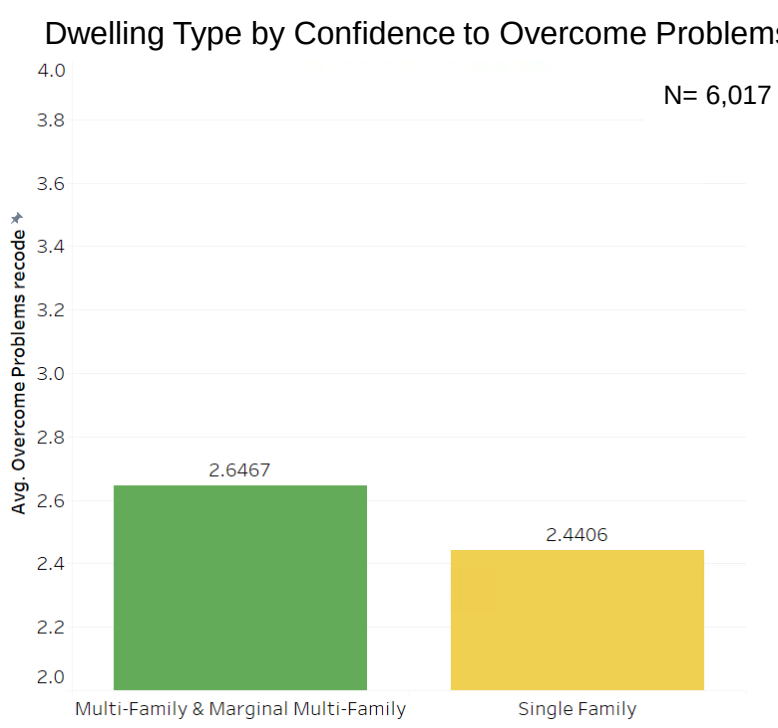
1 = Not at All
….

7 = Very Much Concerned

Single Family Dwelling associated with Lower Avg. Concerns for Life Necessities



Marginal Multi-Family Dwelling associated with Less Confidence to Overcome Problems



ON A SCALE FROM 1 TO 7, WHERE 1 IS VERY SURE AND 7 IS VERY UNSURE, HOW SURE ARE YOU THAT YOU CAN DEAL WITH PROBLEMS THAT COME UP IN YOUR LIFE?

Reverse Scored

1 = Very Sure
….

7 = Very Unsure

Overall PMPM spend by Dwelling Type

First DWELLING..	Avg. 2016 Cost PMPM	Avg. 2016 AG Adj PMPM	Avg. 2016 Risk Adjusted PMPM
Multi-Family & ..	$1,389.46	$1,165.89	$536.20
Single Family	$1,070.35	$1,115.95	$515.07

N= 179,351

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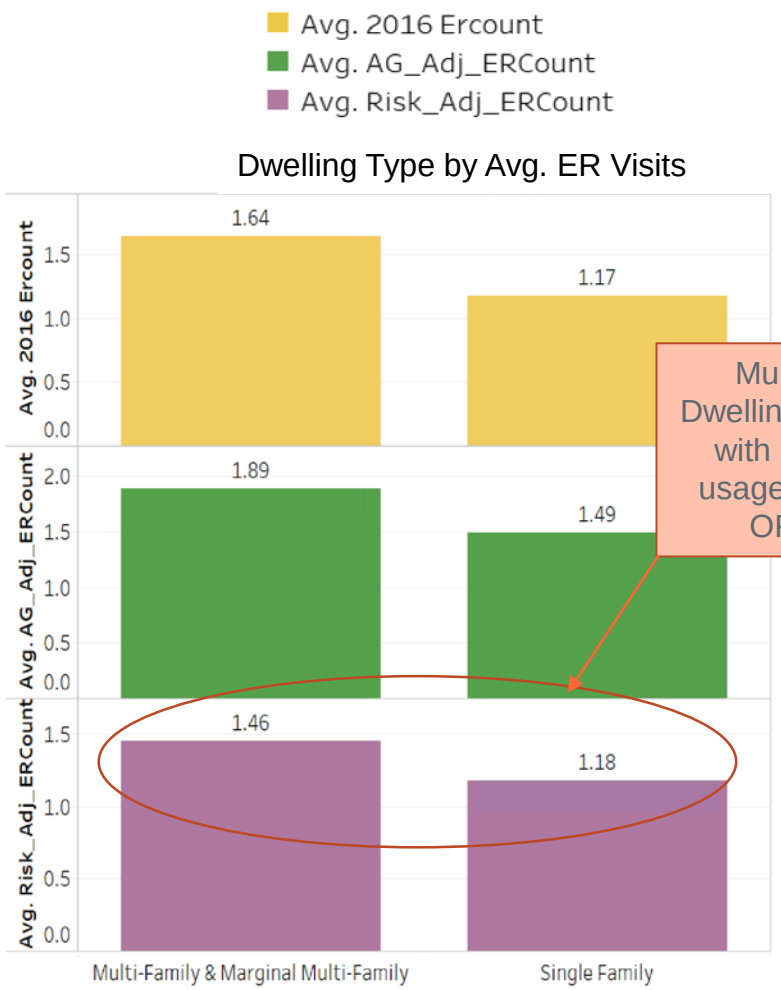
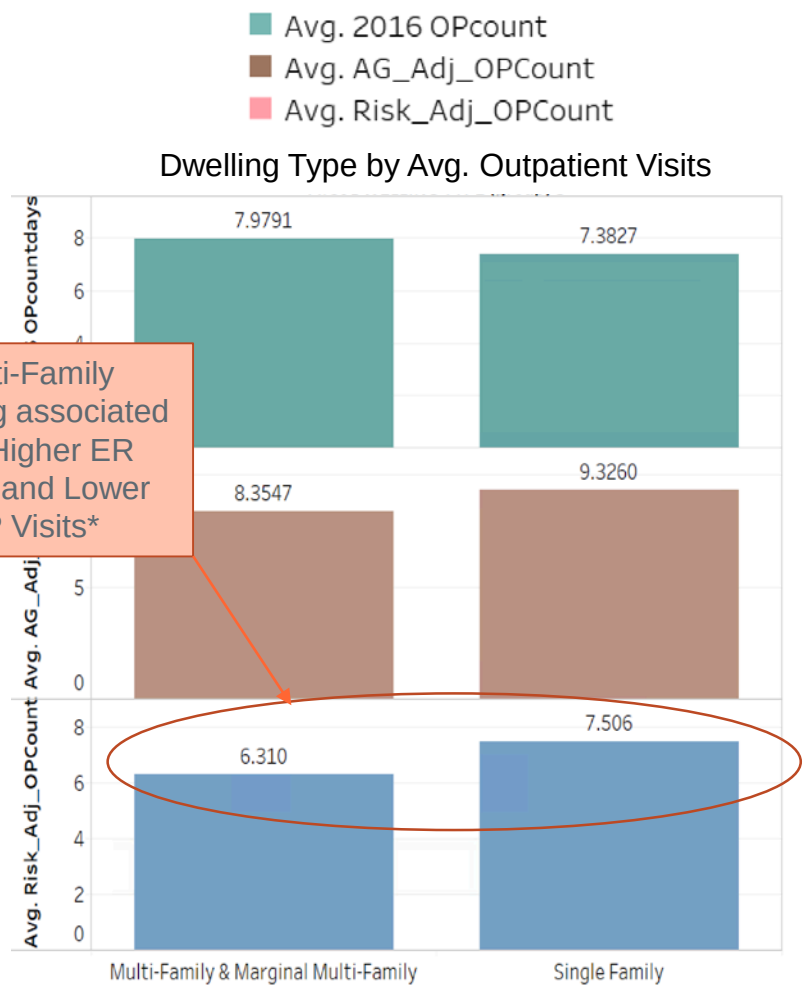
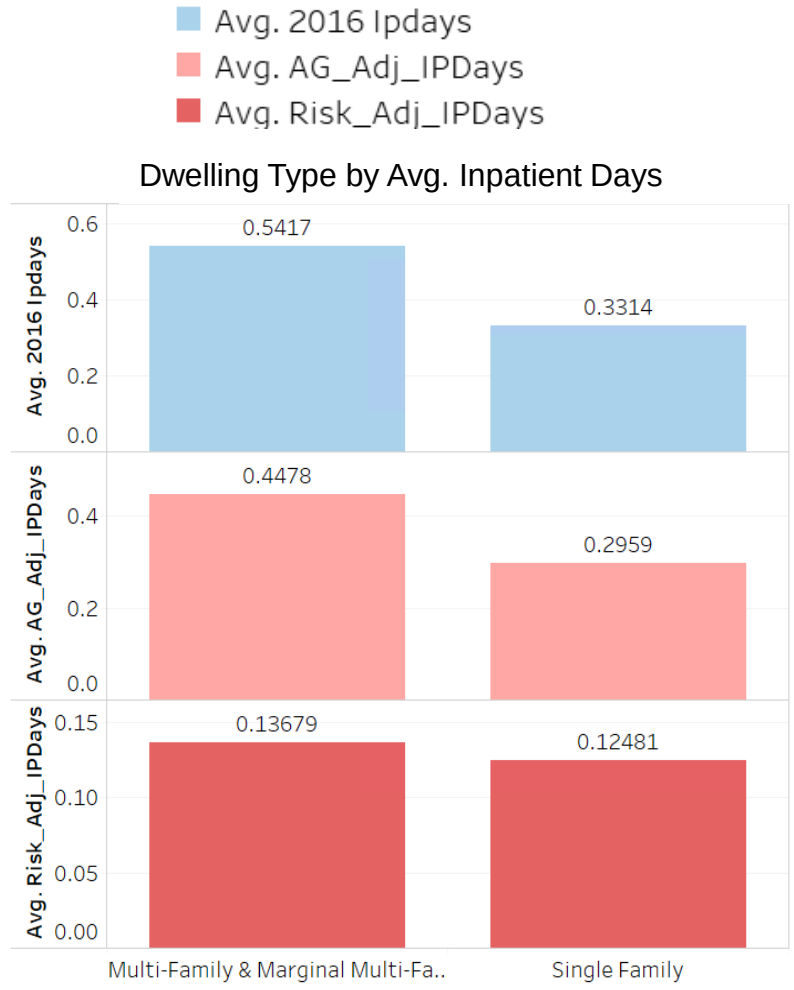
Dwelling Type vs Avg. ER and OP Utilization





Multi-Family Dwelling associated with Higher ER usage and Lower OP Visits*



N= 159,125

*Adjusted for Risk, Age and Gender

**OP Count limited to one per day

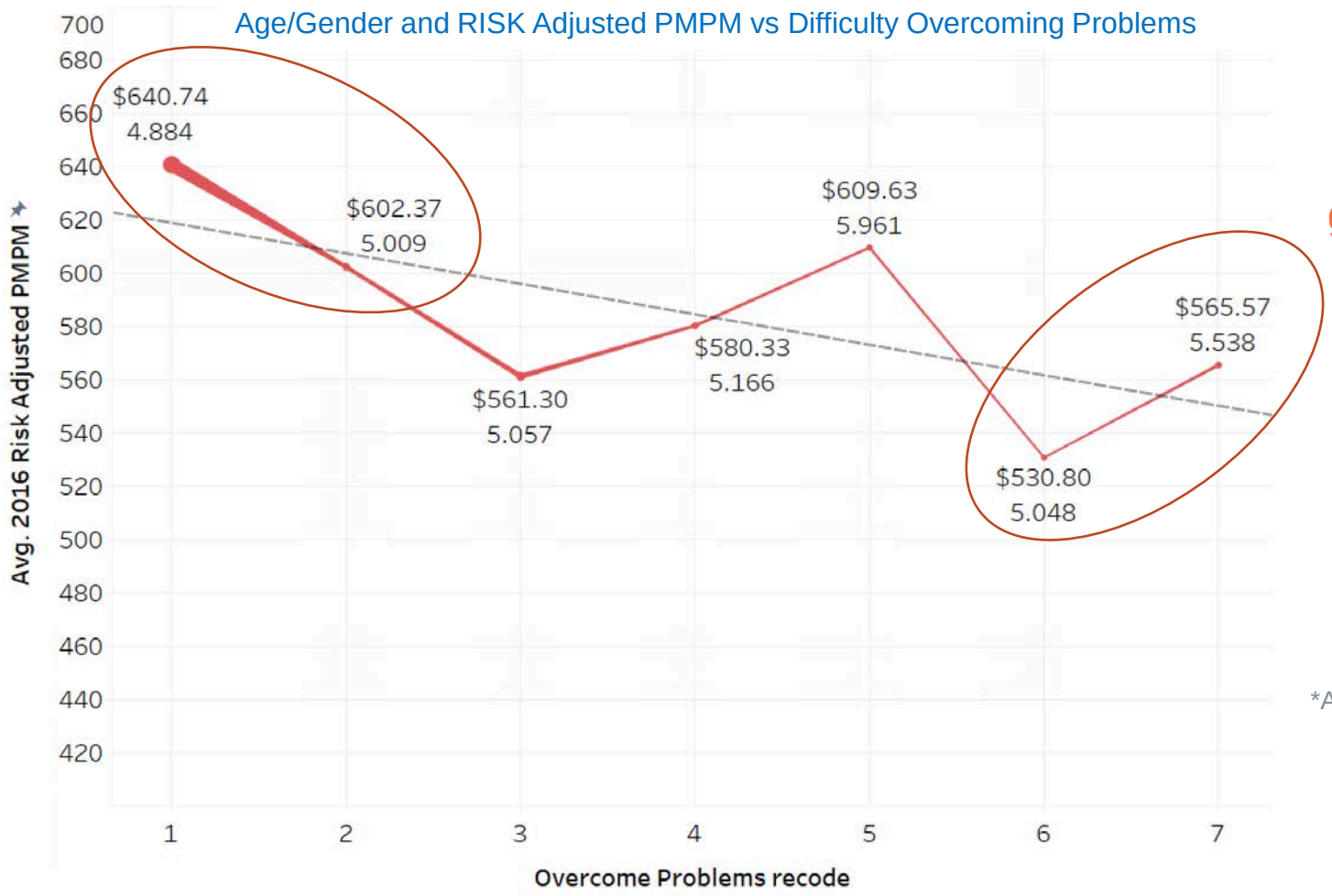
Difficulty Overcoming Problems

Does Difficulty Overcoming Problems align with Utilization?

ON A SCALE FROM 1 TO 7, WHERE 1 IS VERY SURE AND 7 IS VERY UNSURE, HOW SURE ARE YOU THAT YOU CAN DEAL WITH PROBLEMS THAT COME UP IN YOUR LIFE?

1 = Not at All
….

7 = Very Much Unsure



People with greater Difficulty Overcoming Problems are associated with Lower Avg Risk Adjusted PMPM*

*Adjusted for Age, Gender and Morbidity

** Original Mara Scores Shown

N= 9,476

Welch's two sample t-test P <=0.05

Concerns for Living Place

Do concerns about having a Place to Live align with Utilization?

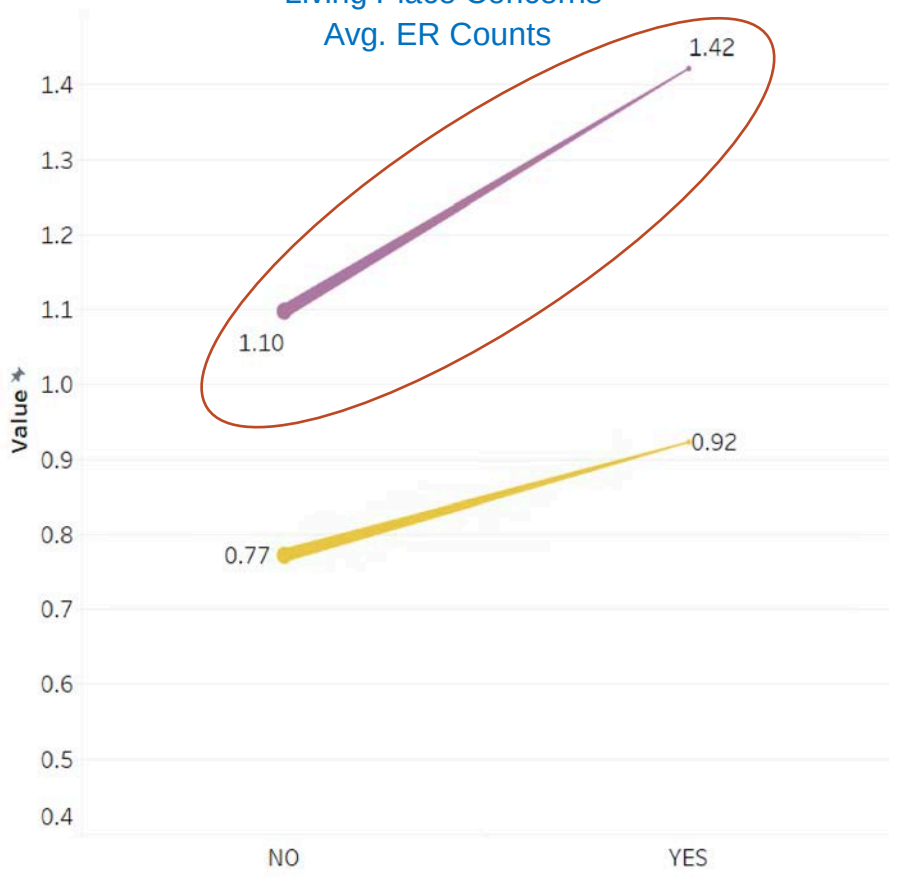
Please Say YES OR NO, IN THE PAST MONTH, HAS HAVING A PLACE TO LIVE BEEN A PROBLEM FOR YOUR FAMILY?

0 = NO

1 = YES

People with greater Concerns for having a Place to Live are associated with Lower Avg Adjusted ER Usage and Higher Avg OP Visits

Living Place Concerns
Avg. ER Counts



Living Place Concerns
Avg. Outpatient Counts

Avg. 2016 Ercount
Avg. Risk_Adj_ERCount
Avg. 2016 OPcount
Avg. Risk_Adj_OPCount

* Primarily Well-child Programs

N= 6,363

Welch's two sample t-test P <=0.05

Concerns for Family Environment

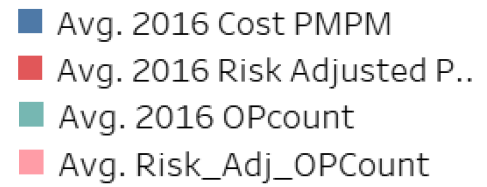
Do concerns about having a Safe Family Environment align with Utilization?

PLEASE SAY YES OR NO, IN GENERAL, DO YOUR CHILDREN LIVE IN A SAFE ENVIRONMENT?

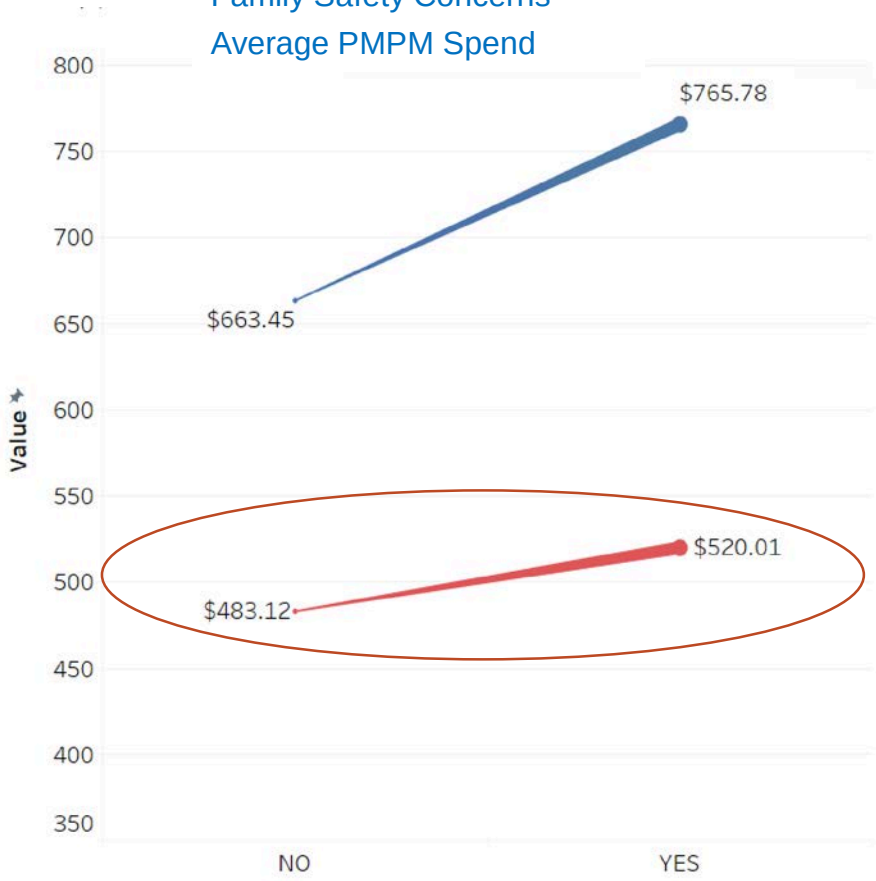
0 = NO

1 = YES

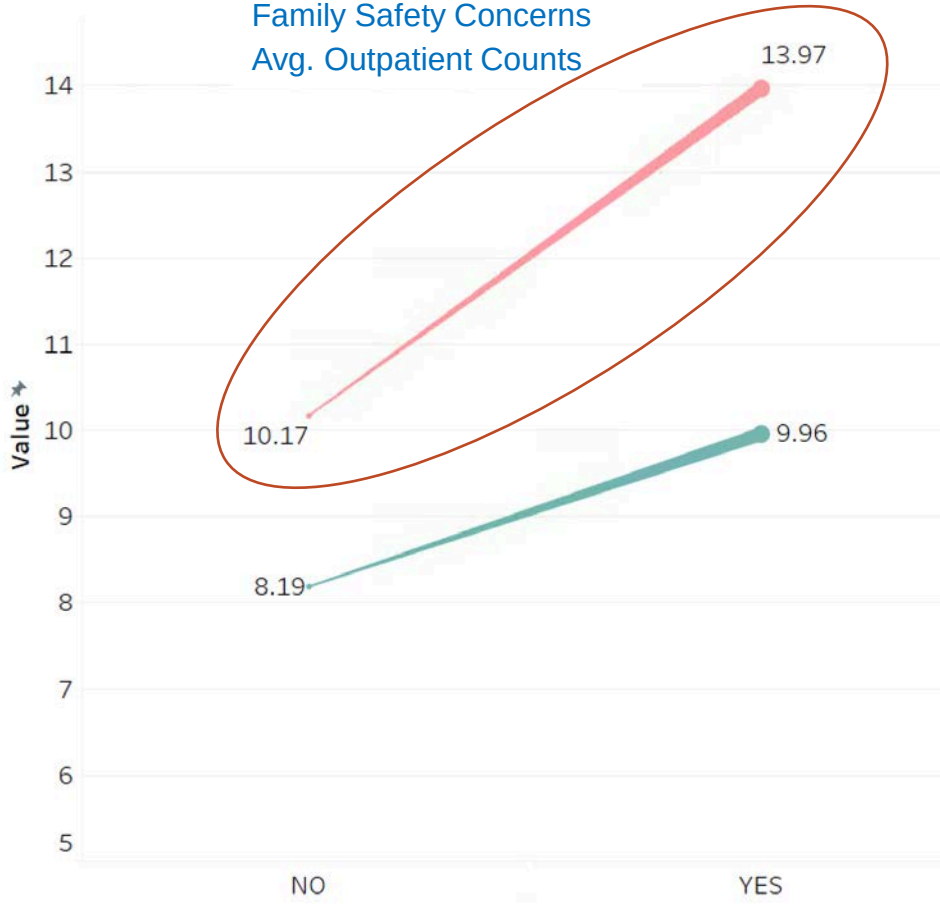
People with greater concerns for a Safe Living Environment are associated with Lower average Adjusted PMPM and Lower Avg. Adjusted OP Visit



Family Safety Concerns
Average PMPM Spend



Family Safety Concerns
Avg. Outpatient Counts



* Primarily Well-child Programs

N= 6,393

Welch's two sample t-test P <=0.05

Concerns for Life Necessities

Do concerns about Life Necessities align with Utilization?

In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

1 = Not at All
….

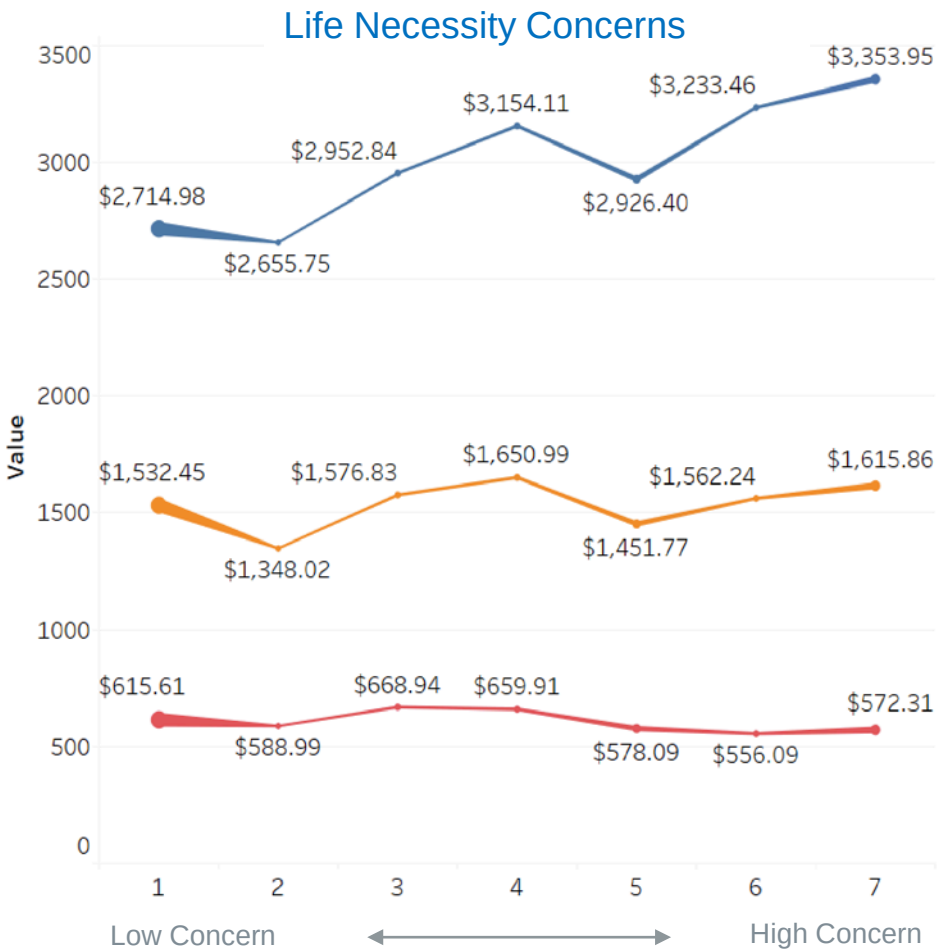
7 = Very Much Concerned

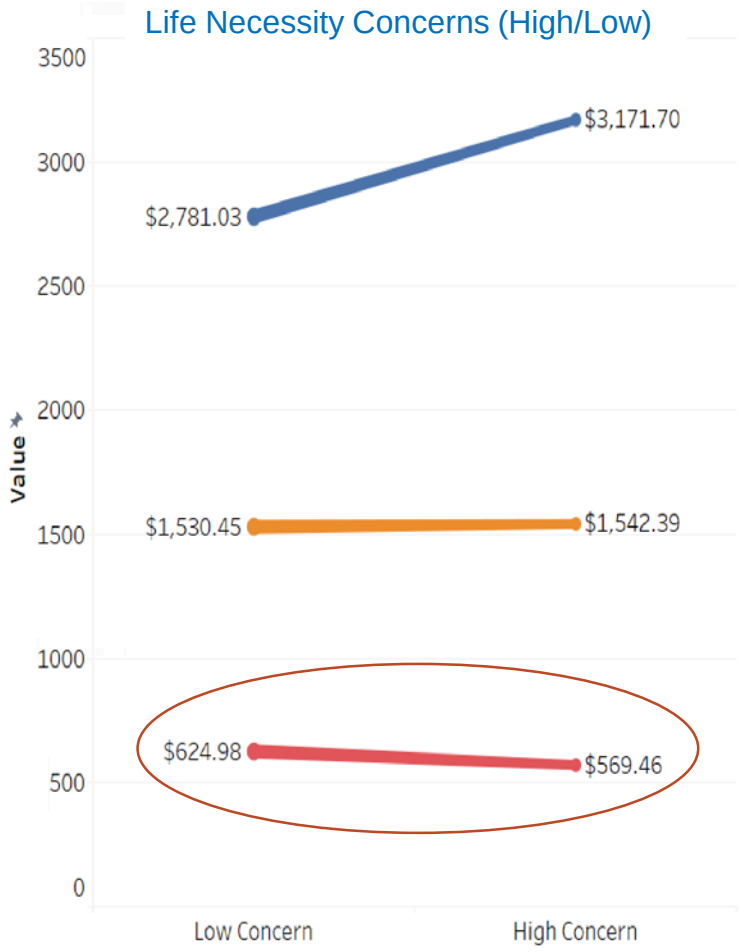
*T-test for two groups

Grp 0 = 1-3 – No/Low Concern

Grp 1 = 4-7, Mod to High Concern

People with greater Concerns for Life Necessity are associated with Lower Avg. Age/Gender/Risk Adjusted PMPM





N= 9,476

Welch's two sample t-test p <=0.05

Concerns for Life Necessities

Do concerns about Life Necessities Impact HEDIS Quality Outcomes?

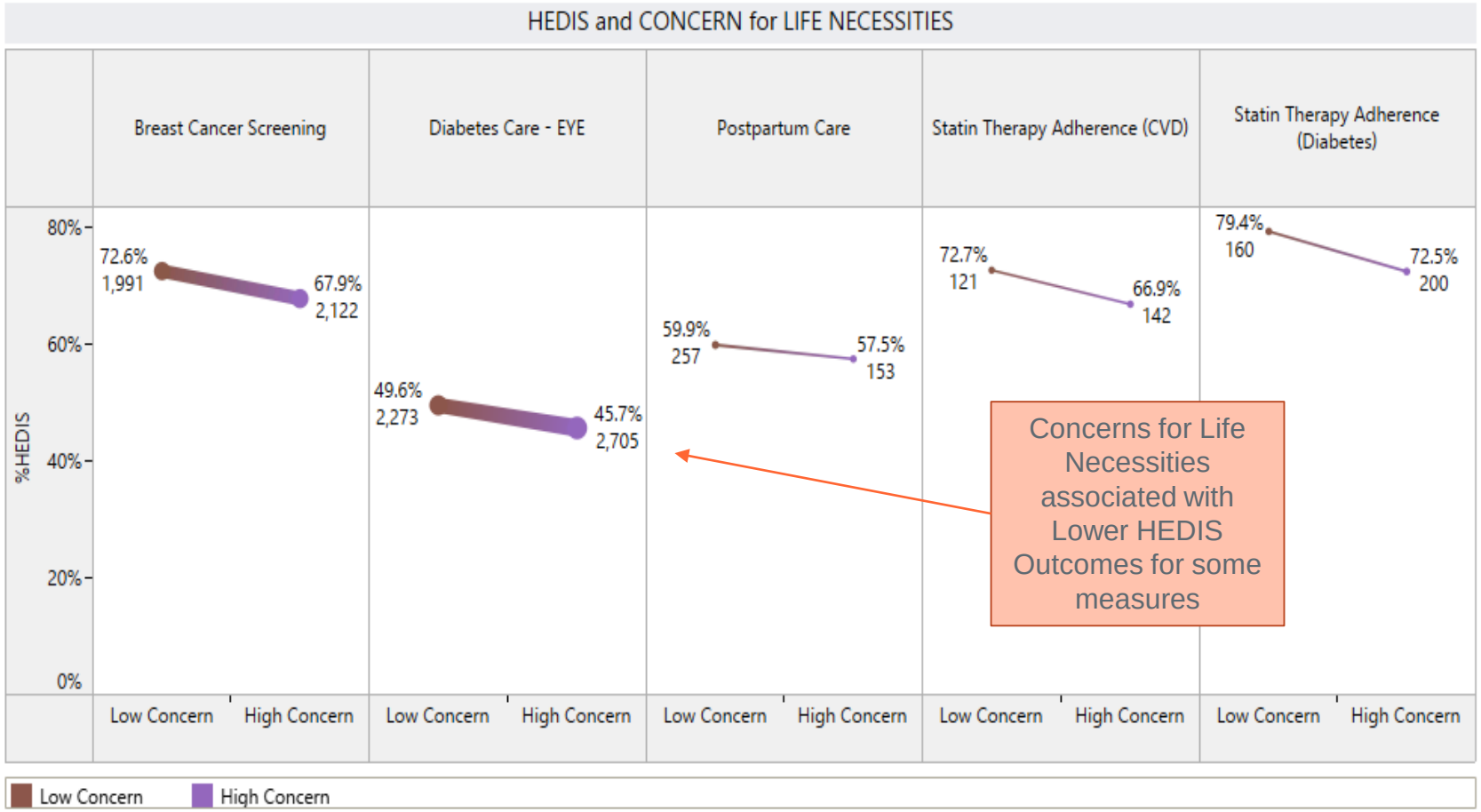
In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

1 = Not at All
….

7 = Very Much Concerned

Grp 0 = 1-3 – No/Low Concern

Grp 1 = 4-7, Mod to High Concern



N= 9,476

Welch's two sample t-test P <=0.05

Concerns for Life Necessities vs Health Status

Do concerns about Life Necessities align with Health Status?

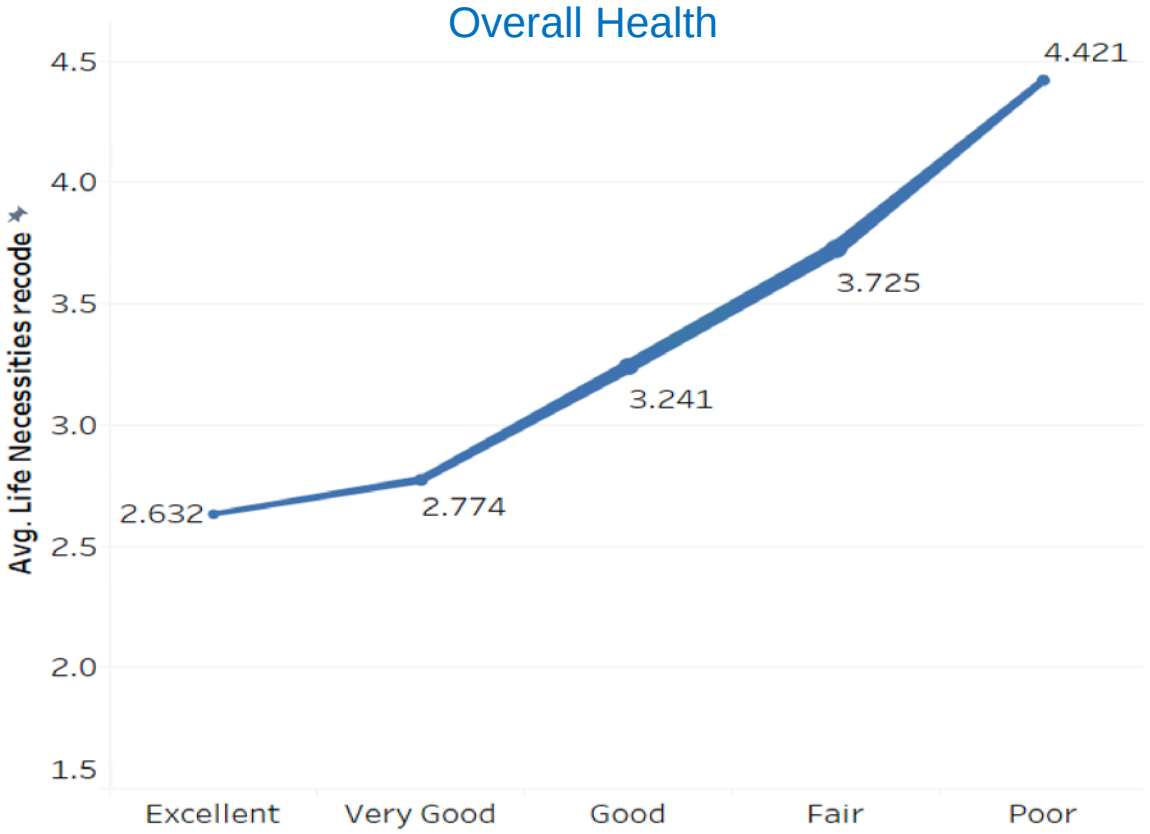
In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

1 = Not at All
….

7 = Very Much Concerned

OVERALL HEALTH RATING

1 -> EXCELLENT
2 -> VERY GOOD
3 -> GOOD
4 -> FAIR
5 -> POOR



People with Life Necessity Concerns also report Poor Overall Health

N= 8,591

Welch's Two Sample t-test(s) of Life_Necessities_recode by Overall_Health_recode

Test	t-Statistic	Degrees of Freedom	p-Value
5 vs 3	-14.1596	2393.8	9.0485e-44
5 vs 4	-8.50525	2297.8	3.2142e-17
5 vs 2	-18.0996	2480.3	7.1501e-69
5 vs 1	-16.9865	1858.2	2.878e-60

Overall Health	n=	Orig MARA	Age Gen Adj MARA	Orig Cost PMPM	AgeGen Adj PMPM	Avg Life Necessities
1	868	2.52	1.65	1,394.03	948.19	2.63
2	1,377	2.80	1.81	1,673.86	1,039.88	2.77
3	2,407	3.85	2.07	2,241.67	1,211.42	3.24
4	2,746	6.09	2.98	3,412.70	1,704.65	3.73
5	1,193	8.48	3.91	4,827.13	2,237.91	4.42

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Overall Health Status vs AG Adjusted MARA & PMPM

Do self-perceptions of Overall Health Status align with MARA Scores and PMPM Costs?

'HOW WOULD YOU RATE YOUR OVERALL HEALTH IN THE PAST MONTH?

1 -> EXCELLENT
2 -> VERY GOOD
3 -> GOOD
4 -> FAIR
5 -> POOR

*T-test for two groups

Grp 0 = Good-Excellent

Grp 1 = Fair to Poor

CURRENT YEAR
Age/Gen Adj Mara Score x Overall Health

FUTURE (Next) YEAR
Age/Gen Adj Mara Score x Overall Health

All Sig at P<0.05

N= 12,128

Overall Health vs Morbidity, Age, Gender Adj. PMPM

Do self-perceptions of Overall Health Status align with MARA Scores and PMPM Costs?

'HOW WOULD YOU RATE YOUR OVERALL HEALTH IN THE PAST MONTH?

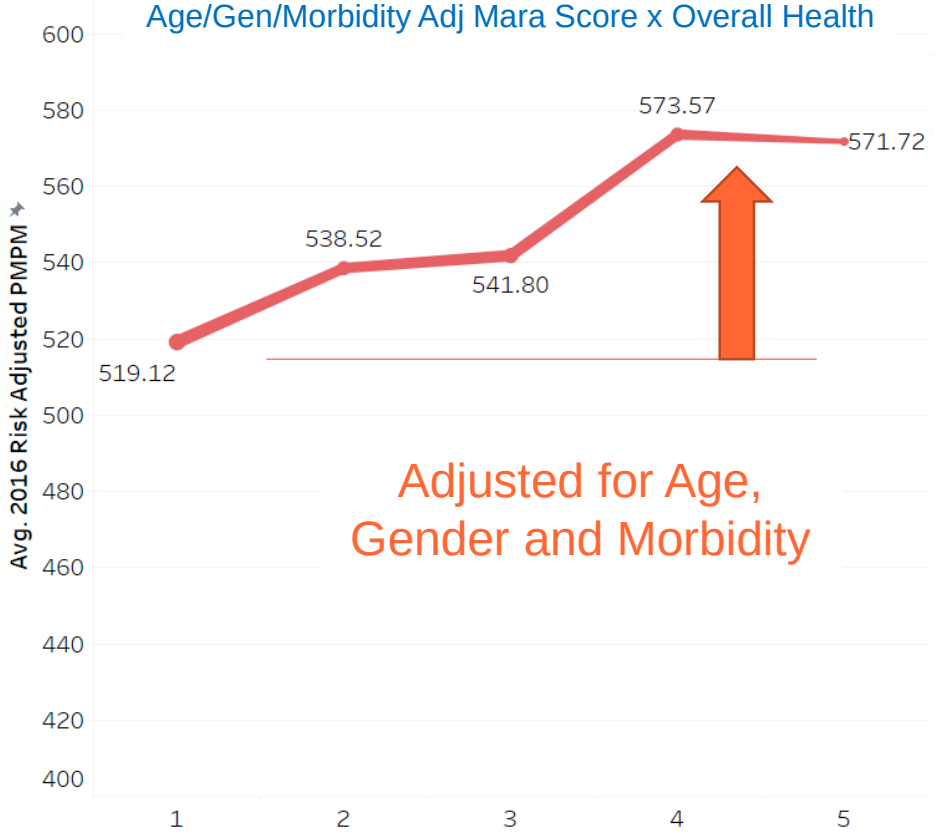
1 -> EXCELLENT
2 -> VERY GOOD
3 -> GOOD
4 -> FAIR
5 -> POOR

*T-test for two groups

Grp 0 = Good-Excellent

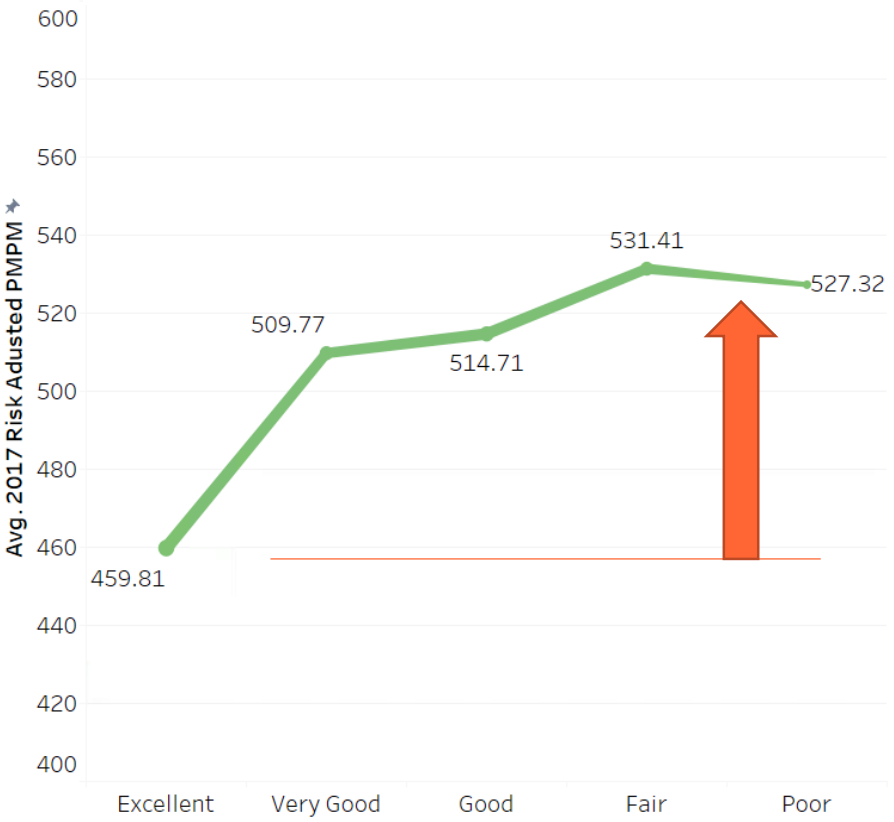
Grp 1 = Fair to Poor

CURRENT YEAR
Age/Gen/Morbidity Adj Mara Score x Overall Health



Adjusted for Age, Gender and Morbidity

NEXT YEAR
Age/Gen/Morbidity Adj Mara Score x Overall Health



All Sig at P<0.05

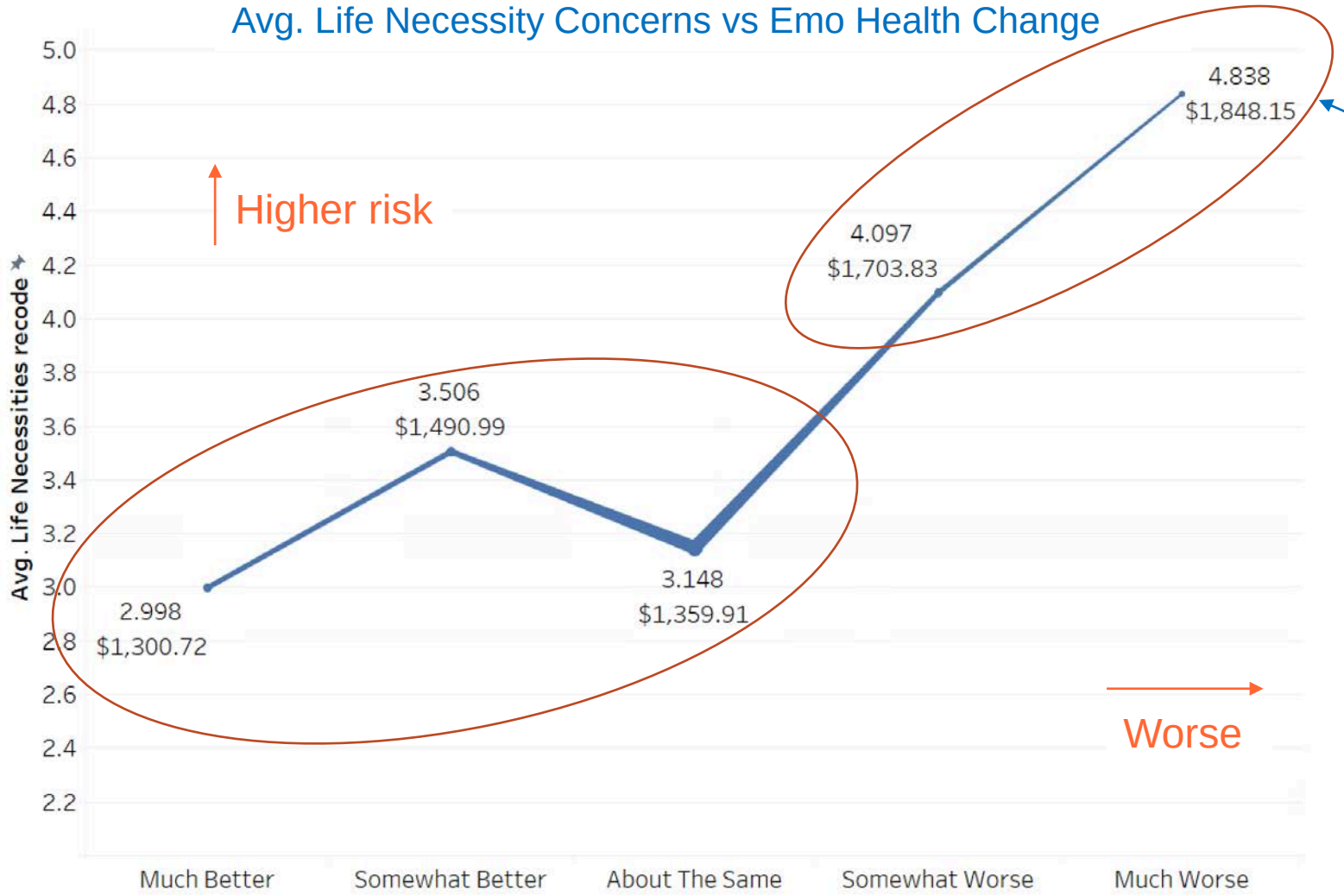
N= 12,128

Life Concerns vs Emotional Health Change

Do self-perceptions of Emotional Health Change align with Life Necessity Concerns

<u>Emotional Health Change</u>
Compared to one year ago, How would you rate your overall emotional health today?

1 -> MUCH BETTER
2 -> SOMEWHAT BETTER
3 -> ABOUT THE SAME
4 -> SOMEWHAT WORSE
5 -> MUCH WORSE



Age/Gender Adjusted PMPM

People who self-report Emotional Health decline associated with higher risk and higher cost

Grp 1 vs 0 sig @ P<0.05

N= 11,755

Life Necessity Concerns w/ Emotional Problems (Adults)

In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

1 = Not at All
….

7 = Very Much Concerned

Grp 0 = 1-3 – No/Low Concern

Grp 1 = 4-7, Mod to High Concern

Concerns for Life Necessities

Milliman Classification (..	Less Concerned	Very Concerned
Alchoholism	45.45%	54.55%
Anorexia Nervosa & Anor..	38.46%	61.54%
Bipolar Disorder	45.06%	54.94%
Bulimia	50.00%	50.00%
Depression	47.13%	52.87%
Drug Abuse, Opioid	45.45%	54.55%
Drug Abuse, Specified & ..	41.76%	58.24%
Emotional Disturbance	50.00%	50.00%
Lifestyle Related	45.77%	54.23%
Nuerotic Disorders	47.69%	52.31%
Schizophrenia, Psychosis	48.16%	51.84%
Grand Total	**46.53%**	**53.47%**

Higher proportion of people with emotional conditions have high concerns for Life Necessities

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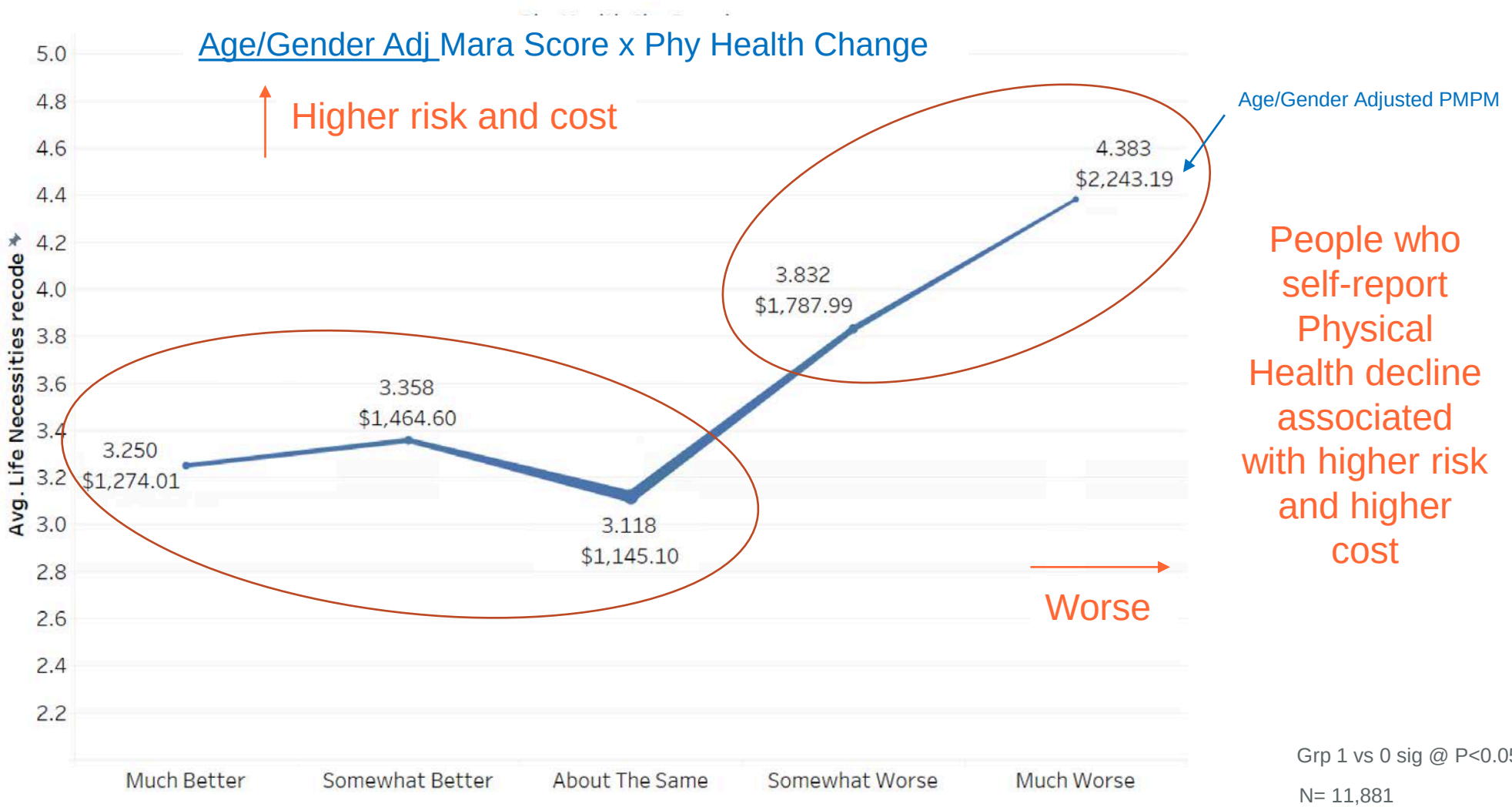
Physical Health Change vs Adjusted MARA & PMPM

Do self-perceptions of Physical Health Change align with MARA Scores and PMPM Costs?

Physical Health Change
Compared to one year ago, How would you rate your overall physical health today?

1 -> MUCH BETTER
2 -> SOMEWHAT BETTER
3 -> ABOUT THE SAME
4 -> SOMEWHAT WORSE
5 -> MUCH WORSE



People who self-report Physical Health decline associated with higher risk and higher cost

Grp 1 vs 0 sig @ P<0.05

N= 11,881

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Concerns for Life Necessities w/ other Major Conditions (Adults)

In the Past Month, how much have concerns about life necessities like having a place to live, having enough to eat, or feeling like you are safe bothered you?

1 = Not at All
….

7 = Very Much Concerned

Grp 0 = 1-3 – No/Low Concern

Grp 1 = 4-7, Mod to High Concern

Concerns for Life Necessities

Milliman Classification (group) 1	Not Concerned	Concerned
CHF	44.76%	55.24%
COPD & COPD Related	45.35%	54.65%
Cor Artery Disease & Cor Artery Dis..	46.57%	53.43%
Diabetes Insipidus, Diabetes Relate..	49.08%	50.92%
Hypertension	48.16%	51.84%
Lifestyle Related	45.77%	54.23%
Obesity	51.33%	48.67%
Osteoarthritis	45.46%	54.54%
Osteoporosis	49.08%	50.92%
Renal Failure Stg 1, Renal Failure St..	49.85%	50.15%
Grand Total	**48.22%**	**51.78%**

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Enhanced Model: Predicting ER Visits MARA+ SDoH

Next Year

Sample Characteristics:

N= 55,722
Matched census
Non-null records

Model Inputs
MARA IP Score
Age
Gender
Income Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (years)
Urban/Rural
Marital Status

Removed:
Income Decile (correlated with Educ.)

Predicted Outcome
Log Transformation (ER Visits)

N= 6,054

Regression Statistics

R SQUARED **0.187**	ADJUSTED R SQUARED **0.187**
MEAN ABSOLUTE ERROR **0.179**	MEAN ABSOLUTE PERCENT ERROR **Inf**
MEAN SQUARED ERROR **0.051**	ROOT MEAN SQUARED ERROR **0.226**
F-STATISTIC **1603.43 on 8 and 55713 degrees of freedom**	RESIDUAL STANDARD ERROR **0.226 on 55714 degrees of freedom**

Variable	Estimate	Confidence	Std. Error	t value	Pr(>|t|)
(Intercept)	0.102791	***	2.42e-03	42.439	0.00e+00
X2016_Age	0.000565	***	5.96e-05	9.488	2.45e-21
X2016_ER	1.148355	***	1.18e-02	97.213	0.00e+00
X2016_GenderM	-0.030416	***	1.97e-03	-15.476	6.52e-54
First_LENGTH.OF.RESIDENCE	-0.001034	***	1.00e-04	-10.291	8.11e-25
Income_Flag1	-0.034301	***	2.38e-03	-14.416	4.96e-47
Dwelling_Flag1	0.018340	***	3.09e-03	5.927	3.11e-09
Marital_StatusS	0.031457	***	2.16e-03	14.537	8.58e-48
Urban_Flag1	0.001514		6.84e-03	0.221	8.25e-01

Enhanced Model: Predicting Inpatient Days MARA+ SDoH

Next Year

Sample Characteristics:

N= 55,722
Matched census
Non-null records

Model Inputs
MARA IP Score
Age
Gender
Income Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (years)
Urban/Rural
Marital Status

Removed:
Income Decile (correlated with Educ.)

Predicted Outcome
Log Transformation (Count of This year IP Days

N= 6,054

Regression Statistics

R SQUARED **0.153**	ADJUSTED R SQUARED **0.152**
MEAN ABSOLUTE ERROR **0.029**	MEAN ABSOLUTE PERCENT ERROR **Inf**
MEAN SQUARED ERROR **0.006**	ROOT MEAN SQUARED ERROR **0.076**
F-STATISTIC **1254.09 on 8 and 55713 degrees of freedom**	RESIDUAL STANDARD ERROR **0.076 on 55714 degrees of freedom**

Variable	Estimate	Confidence	Std. Error	t value	Pr(>|t|)
(Intercept)	1.07e-03		8.07e-04	1.330	1.84e-01
X2016_Age	3.54e-04	***	2.02e-05	17.508	1.91e-68
X2016_GenderM	-4.81e-03	***	6.60e-04	-7.287	3.20e-13
X2016_Ip	1.92e-02	***	2.15e-04	89.269	0.00e+00
First_LENGTH.OF.RESIDENCE	-9.52e-05	**	3.38e-05	-2.819	4.82e-03
Income_Flag1	-9.27e-04		8.00e-04	-1.158	2.47e-01
Dwelling_Flag1	2.29e-03	*	1.04e-03	2.203	2.76e-02
Marital_StatusS	1.84e-03	*	7.28e-04	2.533	1.13e-02
Urban_Flag1	-1.73e-03		2.30e-03	-0.752	4.52e-01

Base Model: Predicting ER Utilization Using MARA (survey sample)

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Prior Yr MARA ER Score (unadjusted)
Age
Gender

Predicted Outcome
Flag (0/1) - Next year ER Use >= 1 event

Logistic Regression Statistics

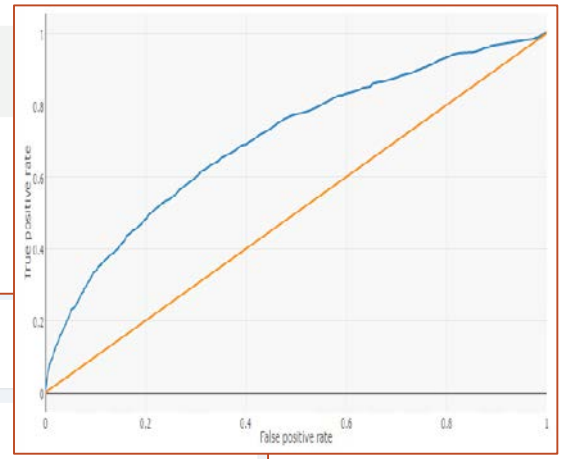
Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.869094	0.090093	-9.6466	< 2.2e-16 ***
X2016_Age	-0.001556	0.001839	-0.8459	0.39762
X2016_ER	8.026796	0.376661	21.3104	< 2.2e-16 ***
X2016_GenderM	-0.239673	0.056165	-4.2673	2e-05 ***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial taken to be 1)

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 8013.9 on 6500 degrees of freedom
McFadden R-Squared: 0.08613, AIC: 8022



N= 6,054

ACCURACY	0.656
PRECISION	0.565
RECALL	0.633
F1	0.597
OPTIMAL PROBABILITY CUTOFF	0.359

Actual	Actual Positive	Actual Negative
Predicted Positive	1658 (56.5%)	1277 (43.5%)
Predicted Negative	962 (27%)	2607 (73%)

SDoH + Health Status Model (survey sample)

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Age
Gender
Life Necessity (1-4) vs (5-7)
Overall Health (1-3) vs (4-5)
Physical/Emotional Health (1-3) vs (4-5)
Education Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (Int)

Removed:
Income Decile (correlated with Educ.)

Predicted Outcome
Flag (0/1) - Next year ER Use >= 1 event

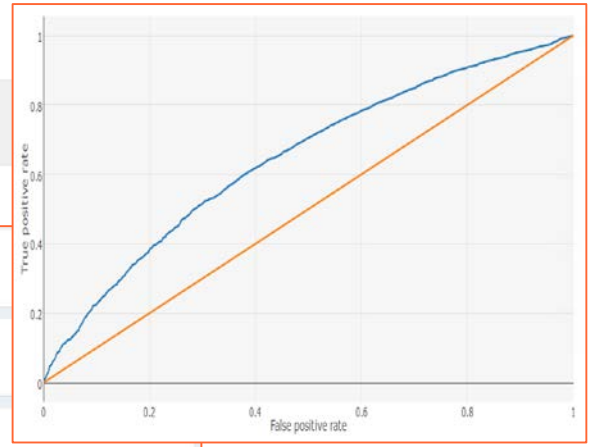
Logistic Regression Statistics

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-0.381498	0.092018	-4.146	3e-05	***
X2016_Age	-0.005798	0.001903	-3.047	0.00231	**
X2016_GenderM	-0.289532	0.054991	-5.265	1.40e-07	***
First_LENGTH.OF.RESIDENCE	-0.009411	0.002269	-4.149	3e-05	***
Life_Nec_Flag1	0.135580	0.055151	2.458	0.01396	*
Educ_Flag1	-0.185345	0.053163	-3.486	0.00049	***
Overall_Hlth_FLag1	0.500538	0.059622	8.395	< 2.2e-16	***
Emo_Chg_Flag1	0.299357	0.069871	4.284	2e-05	***
Phy_Chg_Flag1	0.373592	0.066290	5.636	1.74e-08	***
Dwelling_Flag1	0.379476	0.068058	5.576	2.46e-08	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Dispersion parameter for binomial taken to be 1)

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 8359.4 on 6494 degrees of freedom
McFadden R-Squared: 0.04673, AIC: 8379



ACCURACY **0.611**
PRECISION **0.515**
RECALL **0.609**
F1 **0.558**
OPTIMAL PROBABILITY CUTOFF **0.393**

Actual	Actual Positive	Actual Negative
Predicted Positive	1596 (51.5%)	1505 (48.5%)
Predicted Negative	1024 (30.1%)	2379 (69.9%)

N= 6,054

Enhanced Model: Predicting ER Utilization Using MARA + SDoH + Health Status (survey sample)

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Prior Yr MARA 'ER' Score (unadjusted)
Age
Gender
Life Necessity (1-4) vs (5-7)
Overall Health (1-3) vs (4-5)
Physical/Emotional Health (1-3) vs (4-5)
Education Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (Int)

Removed:
Income Decile (correlated with Educ.)

Predicted Outcome
Flag (0/1) - Next year ER Use >= 1 event

Logistic Regression Statistics

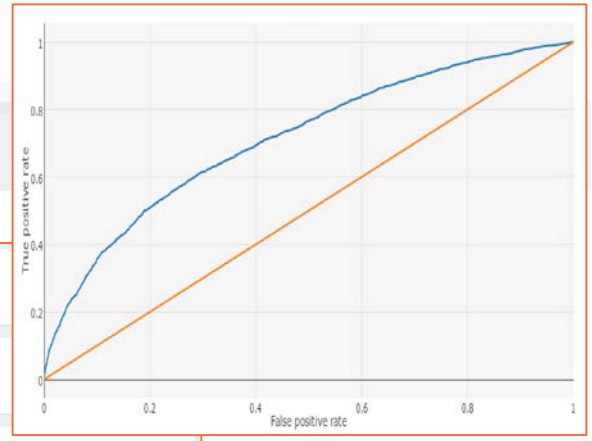
Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-0.779418	0.097196	-8.019	1.06e-15	***
X2016_Age	-0.006606	0.001967	-3.358	0.00079	***
X2016_ER	6.929124	0.381998	18.139	< 2.2e-16	***
X2016_GenderM	-0.209015	0.057213	-3.653	0.00026	***
First_LENGTH.OF.RESIDENCE	-0.007626	0.002350	-3.245	0.00118	**
Life_Nec_Flag1	0.132635	0.057396	2.311	0.02084	*
Educ_Flag1	-0.158430	0.055176	-2.871	0.00409	**
Overall_Hlth_FLag1	0.282612	0.062667	4.510	1e-05	***
Emo_Chg_Flag1	0.224720	0.073270	3.067	0.00216	**
Phy_Chg_Flag1	0.212776	0.069830	3.047	0.00231	**
Dwelling_Flag1	0.346193	0.070842	4.887	1.02e-06	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Dispersion parameter for binomial taken to be 1)

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 7866.7 on 6493 degrees of freedom
McFadden R-Squared: 0.1029, AIC: 7889

18% Improvement over base Model



ACCURACY
0.669

PRECISION
0.585

RECALL
0.61

F1
0.598

OPTIMAL PROBABILITY CUTOFF
0.386

Actual	Actual Positive	Actual Negative
Predicted Positive	1599 (58.5%)	1132 (41.5%)
Predicted Negative	1021 (27.1%)	2752 (72.9%)

N= 6,054

Summary

- Claims-based risk prediction is a useful and effective way to identify near-term risk, however;
  - Absence of claims does not imply health
  - Under-utilization due to SDoH concerns can mask potential risks
- People can prioritize Life Concerns over routine health services until it becomes chronic or catastrophic
- Factors, such as income, education, household size, marital status and dwelling type and urban/rural factors can improve utilization prediction
  - Although actual length of time before catastrophic impact is unclear
- Self-reported health status is a useful way to identify risk in the absence of historical claims
  - People who self-report poor may health consumer services in excess of their actual level of illness

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Limitations

- Survey collection not part of a ‘controlled study’
- Claims censored to max $250k
- Analysis based on members willing to engage in IVR outreach and willing to answer SDoH questions
- SDoH questions include various recall period (30 days to 1 yr)
- Different Survey Questions administered to different age groups
  - Life Necessity, Overcome Problems and Seek Help questions only administered during Adult programs
  - Living Place, Safety and Eating concerns only administered during adolescent/child programs.

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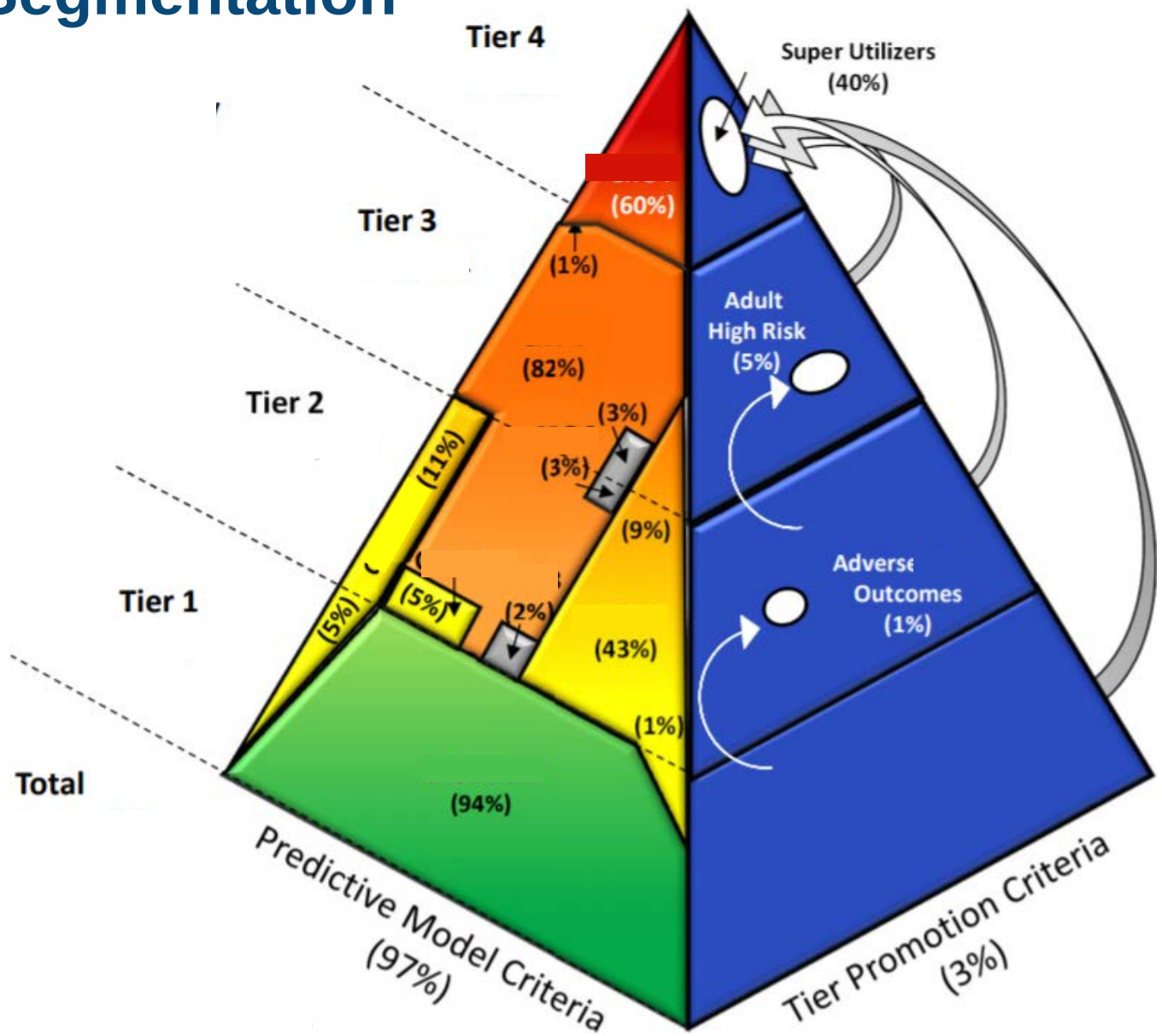
Discuss SDoH Program Evaluation

Actuaries and Healthcare Interventions

Population Segmentation



Intervention Evaluation

Evaluation of interventions is critical

Evaluations **must be** thoughtfully designed

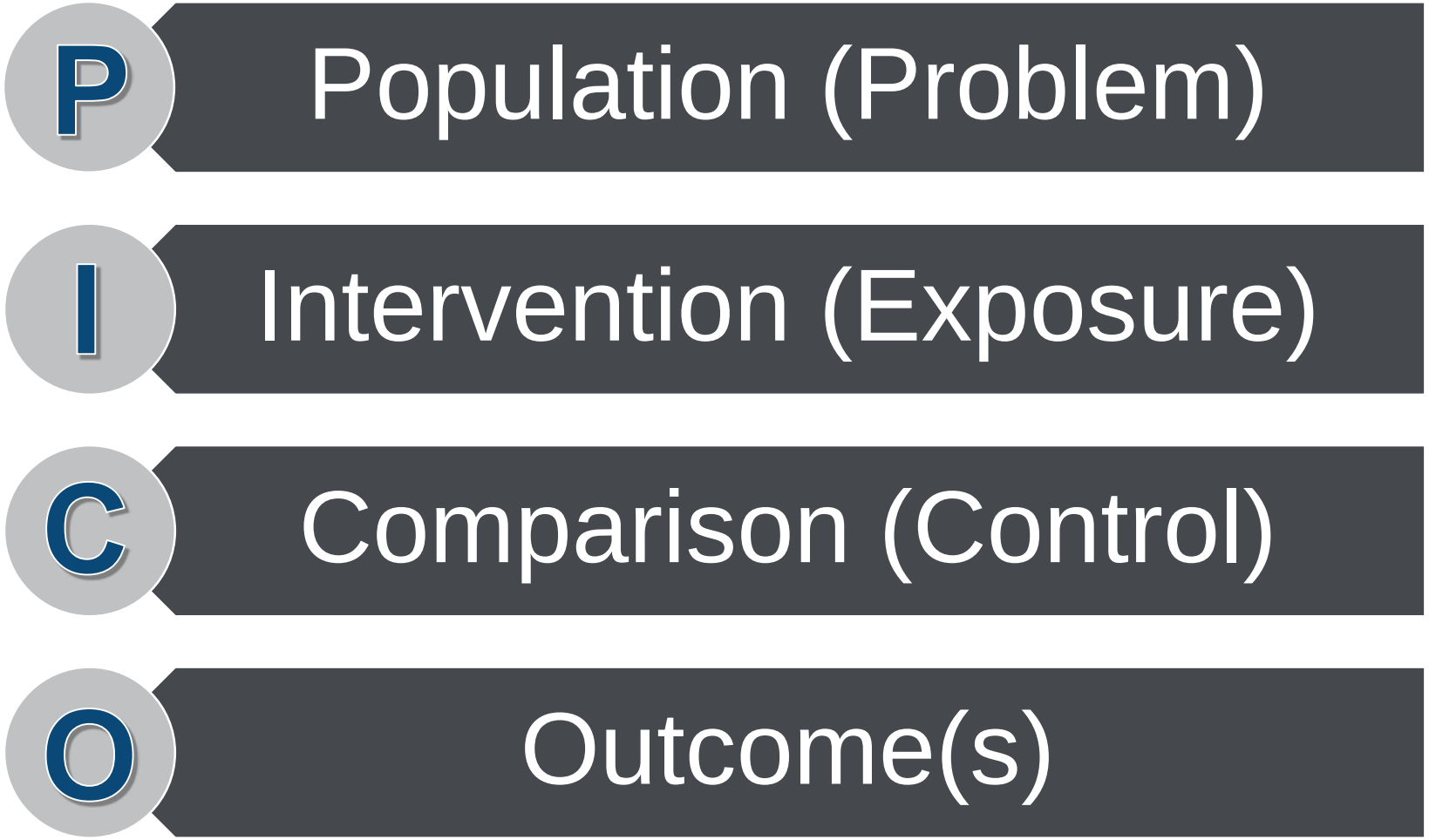
Actuaries should be involved in evaluations

Evaluation is Crucial

Thoughtful Design of Evaluations

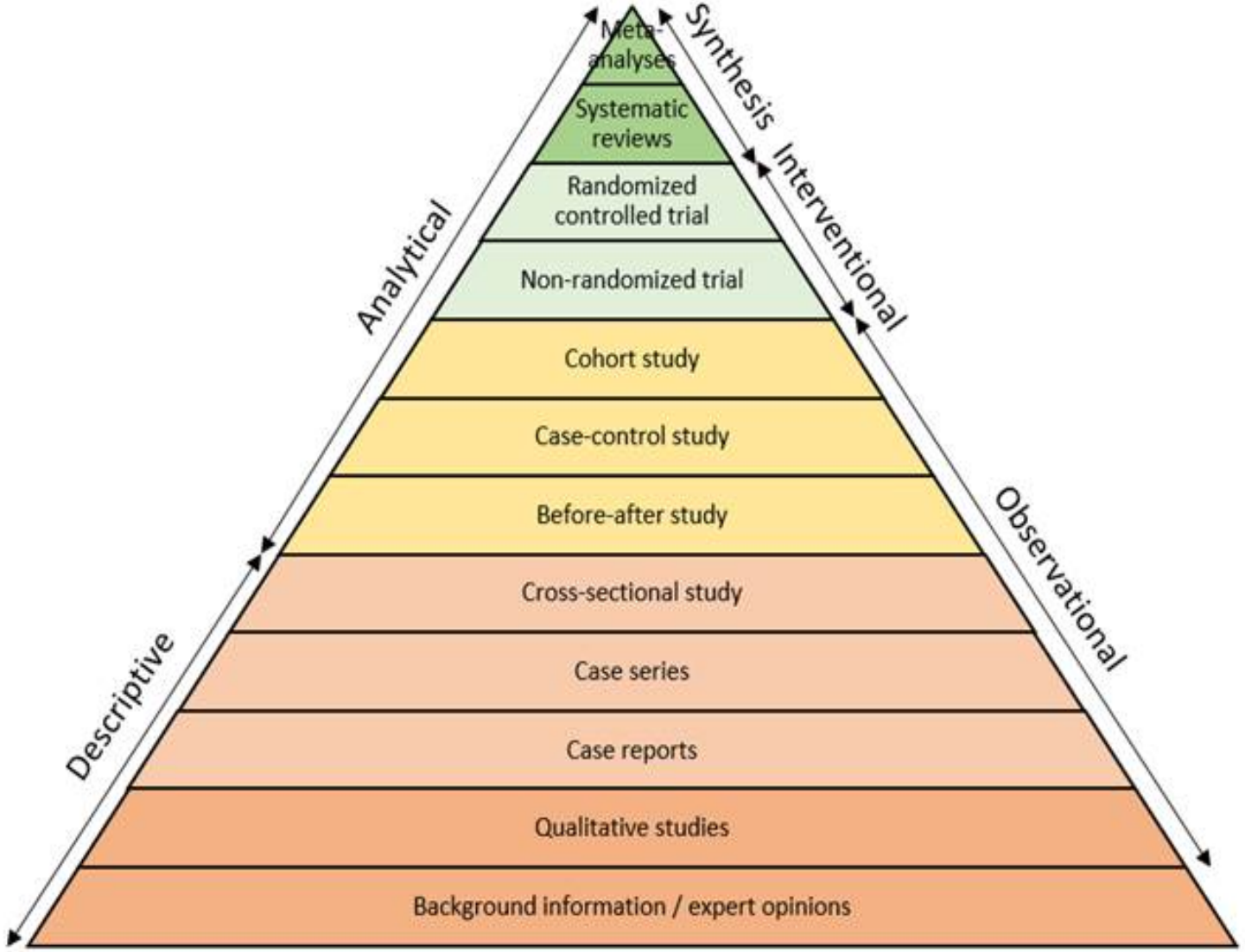
Actuaries are Qualified Evaluators

Designing Intervention Evaluations



Designing Intervention Evaluations

Designing Intervention Evaluations



Designing Intervention Evaluations

Discussion and Questions

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Appendix

Age/Gender Risk and PMPM Adjustments

Avg. Age/Gender PMPM

2016 Gender	Age Grp 1-15	16-25	26-35	36-45	46-55	56-65	Grand Total
F	$420.24	$1,090.83	$1,499.94	$1,921.89	$2,772.79	$3,049.98	$1,259.22
M	$503.07	$740.88	$1,198.03	$1,749.29	$2,635.18	$2,961.33	$971.55
Grand Total	$463.86	$935.13	$1,416.54	$1,866.99	$2,719.38	$3,012.34	$1,131.94

Avg. Age/Gender PMPM Ratio

2016 Gender	Age Grp 1-15	16-25	26-35	36-45	46-55	56-65	Grand Total
F	0.37	0.96	1.32	1.69	2.44	2.68	1.11
M	0.44	0.65	1.05	1.54	2.32	2.60	0.85
Grand Total	0.41	0.82	1.24	1.64	2.39	2.65	1.00

Adjusted Age/Gender PMPM

2016 Gender	Age Grp 1-15	16-25	26-35	36-45	46-55	56-65	Grand Total
F	$1,099.64	$1,135.98	$1,138.71	$1,137.37	$1,139.38	$1,139.38	$1,123.18
M	$1,116.35	$1,120.23	$1,132.70	$1,139.38	$1,139.38	$1,139.38	$1,122.81
Grand Total	$1,108.44	$1,128.97	$1,137.05	$1,138.01	$1,139.38	$1,139.38	$1,123.02

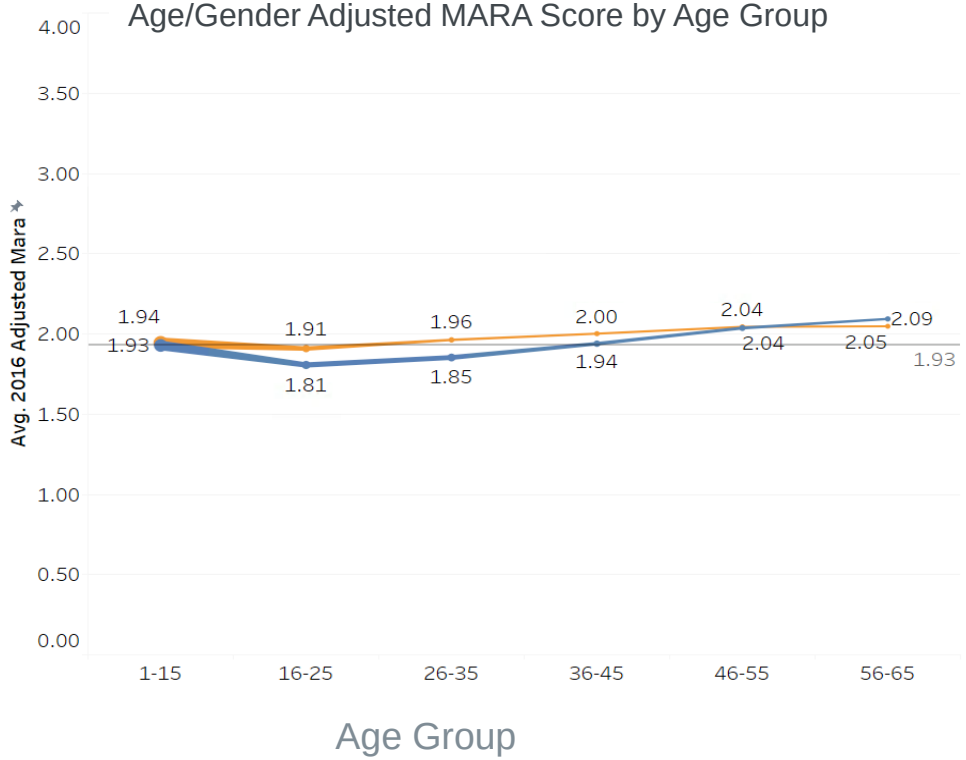
MARA Adjusted PMPM

2016 Gender	Age Grp 1-15	16-25	26-35	36-45	46-55	56-65	Grand Total
F	$465.29	$661.60	$606.45	$533.27	$526.63	$530.35	$543.20
M	$485.77	$471.80	$479.79	$482.85	$488.65	$482.59	$482.44
Grand Total	$476.07	$577.15	$571.47	$517.23	$511.89	$510.07	$516.32

Overall Stats

Avg. 2016 Tot	1.96
Avg. 2016 Adjusted Mara	1.93
Avg. 2016 Cost PMPM	$1,131.94
Avg. 2016 AG Adj PMPM	1,123.02
Avg. 2017 Cost PMPM	$1,057.10
Avg. 2017 AG Adj PMPM	1,041.66
Distinct count of 2016 MemberID	229,705

Age/Gender Adjusted MARA Score by Age Group



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Base Model: Predicting ER Utilization Using MARA

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Prior Yr MARA ER Score (unadjusted)
Age
Gender

Predicted Outcome
Next year ER Use >1 event

Regression Statistics

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.4695533	0.0319881	14.6790	< 2.2e-16	***
X2016_Age	-0.0003304	0.0006933	-0.4766	0.63369	
X2016_ER	1.9979884	0.1071603	18.6449	< 2.2e-16	***
X2016_Med	0.0035433	0.0021973	1.6126	0.10689	

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

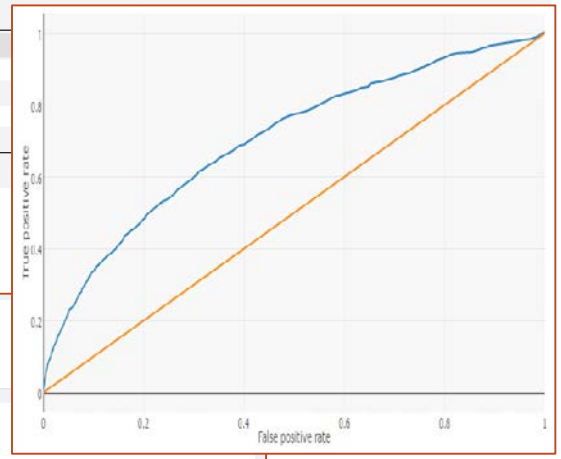
Residual standard error: 0.79234 on 6500 degrees of freedom
Multiple R-squared: 0.1079, Adjusted R-Squared: 0.1075
F-statistic: 262 on 3 and 6500 DF, p-value: < 2.2e-16

Type II ANOVA Analysis

Response: ER_CCount_Bin

	Sum Sq	DF
X2016_Age	0.14	1
X2016_ER	218.24	1
X2016_Med	1.63	1
Residuals	4080.69	6500

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1



N= 6,054

ACCURACY
0.656

PRECISION
0.565

RECALL
0.633

F1
0.597

OPTIMAL PROBABILITY CUTOFF
0.359

Actual	Actual Positive	Actual Negative
Predicted Positive	1658 (56.5%)	1277 (43.5%)
Predicted Negative	962 (27%)	2607 (73%)

Enhanced Model: SDoH + Health Status

Regression Statistics

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Age
Gender
Life Necessity (1-4) vs (5-7)
Overall Health (1-3) vs (4-5)
Physical/Emotional Health (1-3) vs (4-5)
Education Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (Int)

Removed:
Income Decile (correlated with Educ.)

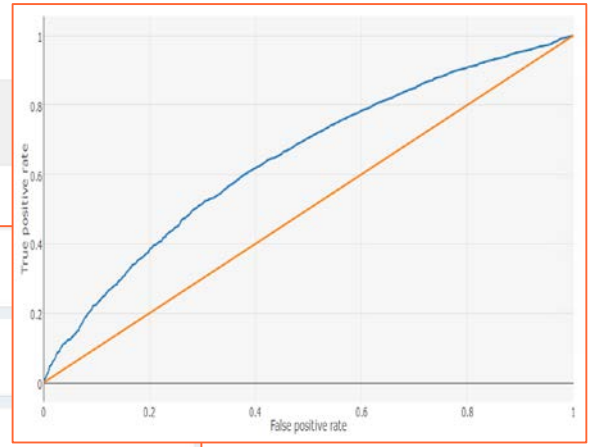
Predicted Outcome
Next year ER Use >= 1 event

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-0.381498	0.092018	-4.146	3e-05	***
X2016_Age	-0.005798	0.001903	-3.047	0.00231	**
X2016_GenderM	-0.289532	0.054991	-5.265	1.40e-07	***
First_LENGTH.OF.RESIDENCE	-0.009411	0.002269	-4.149	3e-05	***
Life_Nec_Flag1	0.135580	0.055151	2.458	0.01396	*
Educ_Flag1	-0.185345	0.053163	-3.486	0.00049	***
Overall_Hlth_FLag1	0.500538	0.059622	8.395	< 2.2e-16	***
Emo_Chg_Flag1	0.299357	0.069871	4.284	2e-05	***
Phy_Chg_Flag1	0.373592	0.066290	5.636	1.74e-08	***
Dwelling_Flag1	0.379476	0.068058	5.576	2.46e-08	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Dispersion parameter for binomial taken to be 1)

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 8359.4 on 6494 degrees of freedom
McFadden R-Squared: 0.04673, AIC: 8379



ACCURACY **0.611**
PRECISION **0.515**
RECALL **0.609**
F1 **0.558**
OPTIMAL PROBABILITY CUTOFF **0.393**

Actual	Actual Positive	Actual Negative
Predicted Positive	1596 (51.5%)	1505 (48.5%)
Predicted Negative	1024 (30.1%)	2379 (69.9%)

N= 6,054

Enhanced Model: Predicting ER Utilization Using MARA + SDoH + Health Status

Sample Characteristics:

N= 6,528
Limited to valid records containing
- Life Necessity (1-7)
- Overall Health (1-5)
- Physical/Emotional Health (1-5)
- Education Decile (non null)
- Income Decile (non null)

Model Inputs
Prior Yr MARA 'ER' Score (unadjusted)
Age
Gender
Life Necessity (1-4) vs (5-7)
Overall Health (1-3) vs (4-5)
Physical/Emotional Health (1-3) vs (4-5)
Education Decile (0-3) vs (4-9)
Dwelling Type – Multi vs Single
Length of Residence (Int)

Removed:
Income Decile (correlated with Educ.)

Predicted Outcome
Next year ER Use >= 1 event

Regression Statistics

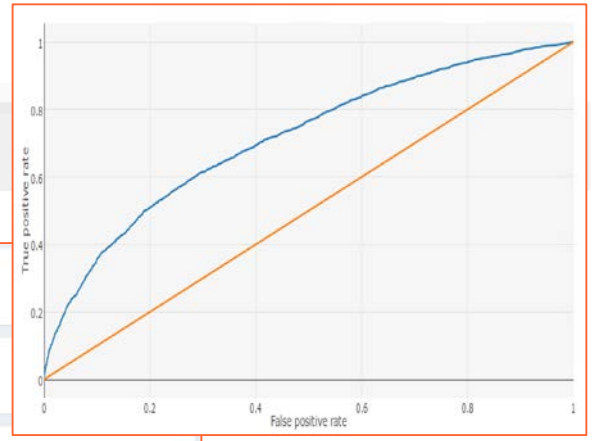
Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-0.779418	0.097196	-8.019	1.06e-15	***
X2016_Age	-0.006606	0.001967	-3.358	0.00079	***
X2016_ER	6.929124	0.381998	18.139	< 2.2e-16	***
X2016_GenderM	-0.209015	0.057213	-3.653	0.00026	***
First_LENGTH.OF.RESIDENCE	-0.007626	0.002350	-3.245	0.00118	**
Life_Nec_Flag1	0.132635	0.057396	2.311	0.02084	*
Educ_Flag1	-0.158430	0.055176	-2.871	0.00409	**
Overall_Hlth_FLag1	0.282612	0.062667	4.510	1e-05	***
Emo_Chg_Flag1	0.224720	0.073270	3.067	0.00216	**
Phy_Chg_Flag1	0.212776	0.069830	3.047	0.00231	**
Dwelling_Flag1	0.346193	0.070842	4.887	1.02e-06	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Dispersion parameter for binomial taken to be 1)

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 7866.7 on 6493 degrees of freedom
McFadden R-Squared: 0.1029, AIC: 7889

18% Improvement over base Model



ACCURACY
0.669

PRECISION
0.585

RECALL
0.61

F1
0.598

OPTIMAL PROBABILITY CUTOFF
0.386

Actual	Actual Positive	Actual Negative
Predicted Positive	1599 (58.5%)	1132 (41.5%)
Predicted Negative	1021 (27.1%)	2752 (72.9%)

N= 6,054