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

Moderator/Presenter:
Jordan Paulus, FSA, MAAA

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

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

Equality

Equity
### What are social determinants of health?

#### Social Determinants of Health

<table>
<thead>
<tr>
<th>Economic Stability</th>
<th>Neighborhood and Physical Environment</th>
<th>Education</th>
<th>Food</th>
<th>Community and Social Context</th>
<th>Health Care System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>Housing</td>
<td>Literacy</td>
<td>Hunger</td>
<td>Social integration</td>
<td>Health coverage</td>
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<td>Income</td>
<td>Transportation</td>
<td>Language</td>
<td>Access to healthy options</td>
<td>Support systems</td>
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<td>Expenses</td>
<td>Safety</td>
<td>Early childhood education</td>
<td>Social integration</td>
<td>Community engagement</td>
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<td>Debt</td>
<td>Parks</td>
<td>Vocational training</td>
<td>Support systems</td>
<td>Discrimination</td>
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<td>Medical bills</td>
<td>Playgrounds</td>
<td>Higher education</td>
<td>Community engagement</td>
<td>Stress</td>
<td></td>
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<tr>
<td>Support</td>
<td>Walkability</td>
<td></td>
<td></td>
<td></td>
<td>Provider availability</td>
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<td></td>
<td>Zip code / geography</td>
<td></td>
<td></td>
<td></td>
<td>Provider linguistic and cultural competency</td>
</tr>
</tbody>
</table>

#### Health Outcomes
- Mortality
- Morbidity
- Life Expectancy
- Health Care Expenditures
- Health Status
- Functional Limitations

[Image of KFF logo]
You have probably seen these statistics…

<table>
<thead>
<tr>
<th>Cause</th>
<th>Estimated No.*</th>
<th>Percentage of Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>400 000</td>
<td>19</td>
</tr>
<tr>
<td>Diet/activity patterns</td>
<td>300 000</td>
<td>14</td>
</tr>
<tr>
<td>Alcohol</td>
<td>100 000</td>
<td>5</td>
</tr>
<tr>
<td>Microbial agents</td>
<td>90 000</td>
<td>4</td>
</tr>
<tr>
<td>Toxic agents</td>
<td>60 000</td>
<td>3</td>
</tr>
<tr>
<td>Firearms</td>
<td>35 000</td>
<td>2</td>
</tr>
<tr>
<td>Sexual behavior</td>
<td>30 000</td>
<td>1</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>25 000</td>
<td>1</td>
</tr>
<tr>
<td>Illicit use of drugs</td>
<td>20 000</td>
<td>&lt;1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 060 000</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

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

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


Figure 2: Impact of Different Factors on Risk of Premature Death
Why should we pay attention to SDOH?

OECD Life Expectancy and Health Expenditures, 2015

% of Gross Domestic Product (%)

Health Expenditures, % GDP

Life Expectancy, in Years

---

Why should we pay attention to SDOH?
2017 Diabetes prevalence (% of population ages 20 to 79)

- United Kingdom
- France
- Italy
- Sweden
- Australia
- Switzerland
- Japan
- European Union
- Canada
- High income
- OECD members
- Germany
- India
- United States
- Marshall Islands

10.4
10.8
30.5

Diabetes prevalence (% of population ages 20 to 79), 2017
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

<table>
<thead>
<tr>
<th>Assessment of diagnosis</th>
<th>Hypertension</th>
<th>Hyperlipidemia</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self-report,</td>
<td>Self-report,</td>
<td>Self-report,</td>
</tr>
<tr>
<td></td>
<td>Clinical,(^1)</td>
<td>Clinical,(^2)</td>
<td>Clinical,(^3)</td>
</tr>
<tr>
<td>Food secure</td>
<td>(n = 4957)</td>
<td>(n = 1930)</td>
<td>(n = 5089)</td>
</tr>
<tr>
<td>Unadjusted prevalence, %</td>
<td>20.2</td>
<td>33.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Food insecure</td>
<td>(n = 4627)</td>
<td>(n = 4559)</td>
<td>(n = 2239)</td>
</tr>
<tr>
<td>Unadjusted prevalence, %</td>
<td>24.6</td>
<td>43.3</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>CRR (95% CI)</strong>(^4)</td>
<td>(1.20 (1.06–1.38))</td>
<td>(1.31 (1.10–1.56))</td>
<td>(1.21 (0.92–1.59))</td>
</tr>
<tr>
<td><strong>ARR (95% CI)</strong>(^4)</td>
<td>(1.20 (1.04–1.38))</td>
<td>(1.30 (1.09–1.55))</td>
<td>(1.19 (0.89–1.58))</td>
</tr>
</tbody>
</table>

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

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

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 5, available online).

### Examples of savings and outcomes

<table>
<thead>
<tr>
<th>Program</th>
<th>Outcome</th>
<th>Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment support</td>
<td>18% reduction in ED use, 28% decreased OP spend, increased Rx adherence</td>
<td>Life Services / CareSource</td>
</tr>
<tr>
<td>Community based-programs and services (removing social barriers, coordinating support services)</td>
<td>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</td>
<td>WellCare CommUnity</td>
</tr>
<tr>
<td>Food access, education (Fresh Food Farmacy)</td>
<td>Reduced A1C (18%), glucose (27%), cholesterol (10%) BP and weight</td>
<td>Geisinger</td>
</tr>
<tr>
<td>Housing support, integrated services</td>
<td>$7,083 PMPM savings, 1.57 ROI</td>
<td>Health Plan of San Mateo Housing Pilot</td>
</tr>
<tr>
<td>Nutritional program for at risk employees</td>
<td>Reduced weight, blood pressure, BMI, cholesterol, triglycerides</td>
<td>Whole Foods</td>
</tr>
</tbody>
</table>
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
Risk adjustment incorporates homelessness and neighborhood stress in MCO payments

<table>
<thead>
<tr>
<th>Table 1: Variables Included in Massachusetts Medicaid Payment Model[^18]</th>
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<tr>
<td><strong>Diagnostic Risk Scores</strong></td>
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<tr>
<td><strong>Age</strong></td>
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<tr>
<td><strong>Additional Diagnostic Variables</strong></td>
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<tr>
<td><strong>State Agency Affiliation</strong></td>
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<tr>
<td><strong>Disability</strong></td>
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<tr>
<td><strong>Unstable Housing</strong></td>
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<tr>
<td><strong>Neighborhood Stress Score</strong></td>
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</tbody>
</table>

[^18]: Source information for variables
[^19]: Additional details for unstable housing criteria
SDoH in Medicaid Programs - Minnesota

- Adjustment in payments

- Population-based Payment Amount (PMPM)
- Clinical / Medical Risk (ACG)
- Individual Social Risk Factors
  - Substance use disorder
  - Serious mental illness (SMI & SPMI)
  - Housing Instability
  - Prior incarceration
  - Deep poverty
  - Child protection involvement

Social risk data
- Aggregate level / demographics
- Individual level *(when available)*
Relationships Between SDoH and Health Outcomes
Self-Reported SDoH and Health Concerns

- Lower HEDIS Rates
- Impacts Utilization
- Suboptimal resource deployment

**BARRIERS:**
- Discomfort
- Transportation
- Cost/Money
- No Doctor

**Concerns about LIFE NECESSITIES**
- Worry about having a place to LIVE, enough to EAT, SAFETY
- Poor OVERALL HEALTH in past month
- Social and Environment Factors
- Worse PHYSICAL HEALTH vs. last year
- Worse EMOTIONAL HEALTH vs. last year

**Worse SOCIAL HEALTH vs. last year**

**Worse EMOTIONAL HEALTH vs. last year**

**Worse PHYSICAL HEALTH vs. last year**

**Worse OVERALL HEALTH in past month**

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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
### 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

<table>
<thead>
<tr>
<th>Impact</th>
<th>% Diff</th>
<th>HEDIS %</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor OVERALL HEALTH</td>
<td></td>
<td>47.9%</td>
<td>476</td>
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<tr>
<td>Concern for LIFE NECESSITIES</td>
<td></td>
<td>5.1%</td>
<td>2,832</td>
</tr>
<tr>
<td>Change in PHYSICAL HEALTH</td>
<td></td>
<td>4.0%</td>
<td>309</td>
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Identifying Members with Barriers (Medicaid)

<table>
<thead>
<tr>
<th>Question</th>
<th>YES (%)</th>
<th>NO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sometimes forget to take meds?</td>
<td>37.70%</td>
<td>62.30%</td>
</tr>
<tr>
<td>Concerned about side effects?</td>
<td>29.22%</td>
<td>70.78%</td>
</tr>
<tr>
<td>Cost an issue?</td>
<td>23.17%</td>
<td>76.83%</td>
</tr>
<tr>
<td>Concerned flu shot causes flu?</td>
<td>36.89%</td>
<td>63.11%</td>
</tr>
<tr>
<td>Transportation an issue?</td>
<td>21.15%</td>
<td>78.85%</td>
</tr>
<tr>
<td>Have doctor you work well with?</td>
<td>17.43%</td>
<td>82.57%</td>
</tr>
<tr>
<td>Sometimes not take meds because feel better?</td>
<td>42.70%</td>
<td>57.30%</td>
</tr>
<tr>
<td>Think test will be uncomfortabile?</td>
<td>20.69%</td>
<td>79.31%</td>
</tr>
<tr>
<td>Confident meds will work?</td>
<td>10.71%</td>
<td>89.29%</td>
</tr>
<tr>
<td>Think child only needs to to to the doctor when sick?</td>
<td>10.54%</td>
<td>89.46%</td>
</tr>
<tr>
<td>Doctor tell you screening wasn’t necessary?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
<tr>
<td>Have trouble scheduling appointment time with doctor?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
<tr>
<td>Have dentist you like working with?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
<tr>
<td>Have a doctor you work well with?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
<tr>
<td>Need to find eye doctor?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
<tr>
<td>Feel you need to bring child to dentist / vaccines are necessary?</td>
<td>40.54%</td>
<td>59.46%</td>
</tr>
</tbody>
</table>

Immediate support through in-call education and immediate transfers
Matching Resources to Need

Care Management:
- Declining Health Concerns for Life Necessities
- Fear of discomfort, side effects, cost

Mobile Resources, Transport Vouchers, Incentives:
- Transportation, access, cost issues

Online:
- Doc find tools
- Wellness programs

Live Agent Transfer:
- Doctor find
- Appointment scheduling

Incentives:
- Transportation
- Access
- Cost issues
### Transferred in 2016 Report Improved Status in 2017

**Members in Both Years Who had a Successful Transfer in 2016 (1,240 Members)**

<table>
<thead>
<tr>
<th>Category</th>
<th>% of Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>% 1-3 to Overcome Problems of Answered ALL</td>
<td>21.3%</td>
</tr>
<tr>
<td>% 1-3 to Seek Help of Answered ALL</td>
<td>14.5%</td>
</tr>
<tr>
<td>% 5-7 to Emotion Effects of Answered ALL</td>
<td>55.0%</td>
</tr>
<tr>
<td>% 5-7 to Life Necessities of Answered ALL</td>
<td>49.3%</td>
</tr>
<tr>
<td>% 5-7 to Physical Effects of Answered ALL</td>
<td>63.3%</td>
</tr>
<tr>
<td>% Fair/Poor to Overall Health of Answered ALL</td>
<td>62.6%</td>
</tr>
<tr>
<td>% Somewhat/Much Worse to Emotional Health Change of Answered ALL</td>
<td>29.6%</td>
</tr>
<tr>
<td>% Somewhat/Much Worse to Physical Health Change of Answered ALL</td>
<td>39.2%</td>
</tr>
</tbody>
</table>
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 were not high cost in the prior year.

Do Life Concerns and SDoH Impact Utilization and Increase Costs?

**Study Overview**

**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

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

**Self-Reported Health Change**
- Health Status Change (Overall, Emotional & Physical)

---

* NIHCM Foundation analysis of data from 2009 Medical Expenditure Panel Survey.

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

**Education Decile by Avg PMPM**
- Avg. 2016 Cost PMPM
- Avg. 2016 AG Adj PMPM
- Avg. 2016 Risk Adjusted P.

**Education Decile by Avg. ER Count**
- Avg. 2016 Ercount
- Avg. AG_Adj_ERCount
- Avg. Risk_Adj_ERCount

Lower Education Level associated with Higher Avg. ER Utilization

N= 146,610

Lower Education associated with Higher Risk and AG Adj. PMPM
INCOME (decile) vs Avg. PMPM and Avg. ER Utilization

- Lower Income Level associated with Higher Avg. ER Utilization
- Lower Income associated with Higher Risk and AG Adj. PMPM

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 with 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 circumstance.

Z59 Claim Flag

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

<table>
<thead>
<tr>
<th>Z59 Claims</th>
<th>n</th>
<th>Avg_Init_MARA_Score</th>
<th>Avg_Init_MARA_Score</th>
<th>Avg_PMPM</th>
<th>AG_Adjust_PMPM</th>
<th>Avg_2016_Risk_Adjusted_PMPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2917</td>
<td>2.91</td>
<td>3.00</td>
<td>3.28</td>
<td>5.15</td>
<td>3.31</td>
</tr>
<tr>
<td>1</td>
<td>504</td>
<td>10.00</td>
<td>10.00</td>
<td>5.79</td>
<td>5.51</td>
<td>5.71</td>
</tr>
</tbody>
</table>

Grp 1 vs 0 sig @ P<0.001

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

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

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

<table>
<thead>
<tr>
<th>Dwelling Type</th>
<th>Avg. Concern for Life Necessities</th>
<th>N= 7,411</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Family &amp; Marginal Multi-Family</td>
<td>3.7525</td>
<td></td>
</tr>
<tr>
<td>Single Family</td>
<td>3.2729</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Dwelling Type</th>
<th>Avg. Concern for Life Necessities</th>
<th>N= 7,411</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Family &amp; Marginal Multi-Family</td>
<td>2.6467</td>
<td></td>
</tr>
<tr>
<td>Single Family</td>
<td>2.4406</td>
<td></td>
</tr>
</tbody>
</table>

### Overall PMPM spend by Dwelling Type

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Family &amp; Marginal Multi-Family</td>
<td>$1,389.46</td>
<td>$1,165.89</td>
<td>$536.20</td>
<td></td>
</tr>
<tr>
<td>Single Family</td>
<td>$1,070.35</td>
<td>$1,115.95</td>
<td>$515.07</td>
<td></td>
</tr>
</tbody>
</table>
Dwelling Type vs Avg. ER and OP Utilization

Dwelling Type by Avg. ER Visits

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

Dwelling Type by Avg. Outpatient Visits

Dwelling Type by Avg. Inpatient Days

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

N= 9,476

Welch’s two sample t-test P <=0.05

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

*Adjusted for Age, Gender and Morbidity

** Original Mara Scores Shown
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

* Primarily Well-child Programs
Concerns for Family Environment

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

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

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

0 = NO
1 = YES

* Primarily Well-child Programs

Welch's two sample t-test $P \leq 0.05$

N= 6,393
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

Welch’s two sample t-test p <=0.05

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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

Welch’s two sample t-test P <=0.05

N= 9,476

Concerns for Life Necessities associated with Lower HEDIS Outcomes for some measures
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

OVERALL HEALTH RATING

<table>
<thead>
<tr>
<th>Overall Health</th>
<th>n</th>
<th>Orig MARA</th>
<th>Age Gen Adj MARA</th>
<th>Orig Cost PMPM</th>
<th>AgeGen Adj PMPM</th>
<th>Avg Life Necessities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>1</td>
<td>868</td>
<td>2.52</td>
<td>1.65</td>
<td>1.394.03</td>
<td>2.63</td>
</tr>
<tr>
<td>Very Good</td>
<td>2</td>
<td>1.377</td>
<td>2.80</td>
<td>1.81</td>
<td>1.673.86</td>
<td>2.77</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
<td>2.407</td>
<td>3.85</td>
<td>2.07</td>
<td>2.241.67</td>
<td>3.24</td>
</tr>
<tr>
<td>Fair</td>
<td>4</td>
<td>2.746</td>
<td>6.09</td>
<td>2.98</td>
<td>3.412.70</td>
<td>3.72</td>
</tr>
<tr>
<td>Poor</td>
<td>5</td>
<td>1.193</td>
<td>8.48</td>
<td>3.91</td>
<td>4.827.13</td>
<td>4.42</td>
</tr>
</tbody>
</table>

N= 8,591

Welch’s Two Sample t-test(s) of Life Necessities reco by Overall Health reco

<table>
<thead>
<tr>
<th>Test</th>
<th>t-Statistic</th>
<th>Degrees of Freedom</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 vs 3</td>
<td>-14.1596</td>
<td>2393.8</td>
<td>9.04E-55</td>
</tr>
<tr>
<td>5 vs 4</td>
<td>-8.50525</td>
<td>2297.8</td>
<td>3.21E-17</td>
</tr>
<tr>
<td>5 vs 2</td>
<td>-10.0996</td>
<td>2480.3</td>
<td>7.15E-69</td>
</tr>
<tr>
<td>5 vs 1</td>
<td>-16.9865</td>
<td>1858.2</td>
<td>2.87E-56</td>
</tr>
</tbody>
</table>
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

People who self-report Poor Overall Health Status are 2x higher risk and 2x higher cost

N= 12,128

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**

Adjusted for Age, Gender and Morbidity

**NEXT YEAR**

Adjusted for Age, Gender and Morbidity

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

Emotional Health Change
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

Higher risk

Average Life Necessity Concerns vs Emo Health Change

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

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## 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

<table>
<thead>
<tr>
<th>Milliman Classification (..)</th>
<th>Less Concerned</th>
<th>Very Concerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoholism</td>
<td>45.45%</td>
<td>54.55%</td>
</tr>
<tr>
<td>Anorexia Nervosa &amp; Ano..</td>
<td>38.46%</td>
<td>61.54%</td>
</tr>
<tr>
<td>Bipolar Disorder</td>
<td>45.06%</td>
<td>54.94%</td>
</tr>
<tr>
<td>Bulimia</td>
<td>50.00%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Depression</td>
<td>47.13%</td>
<td>52.87%</td>
</tr>
<tr>
<td>Drug Abuse, Opioid</td>
<td>45.45%</td>
<td>54.55%</td>
</tr>
<tr>
<td>Drug Abuse, Specified &amp; ..</td>
<td>41.76%</td>
<td>58.24%</td>
</tr>
<tr>
<td>Emotional Disturbance</td>
<td>50.00%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Lifestyle Related</td>
<td>45.77%</td>
<td>54.23%</td>
</tr>
<tr>
<td>Nuerotic Disorders</td>
<td>47.69%</td>
<td>52.31%</td>
</tr>
<tr>
<td>Schizophrenia, Psychosis</td>
<td>48.16%</td>
<td>51.84%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>46.53%</td>
<td>53.47%</td>
</tr>
</tbody>
</table>

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

Grp 0 = 1-3 – No/Low Concern

Grp 1 = 4-7, Mod to High Concern
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

Age/Gender Adj Mara Score x Phy Health Change

Higher risk and cost

Age/Gender Adjusted PMPM

Grp 1 vs 0 sig @ P<0.05
N= 11,881
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

<table>
<thead>
<tr>
<th>Milliman Classification (group) 1</th>
<th>Not Concerned</th>
<th>Concerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF</td>
<td>44.76%</td>
<td>55.24%</td>
</tr>
<tr>
<td>COPD &amp; COPD Related</td>
<td>45.35%</td>
<td>54.65%</td>
</tr>
<tr>
<td>Cor Artery Disease &amp; Cor Artery Dis..</td>
<td>46.57%</td>
<td>53.43%</td>
</tr>
<tr>
<td>Diabetes Insipidus, Diabetes Relate..</td>
<td>49.08%</td>
<td>50.92%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>48.16%</td>
<td>51.84%</td>
</tr>
<tr>
<td>Lifestyle Related</td>
<td>45.77%</td>
<td>54.23%</td>
</tr>
<tr>
<td>Obesity</td>
<td>51.33%</td>
<td>48.67%</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>45.46%</td>
<td>54.54%</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>49.08%</td>
<td>50.92%</td>
</tr>
<tr>
<td>Renal Failure Stg 1, Renal Failure St..</td>
<td>49.85%</td>
<td>50.15%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>48.22%</td>
<td>51.78%</td>
</tr>
</tbody>
</table>
Enhanced Model: Predicting ER Visits MARA+ SDoH

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)

Regression Statistics

Next Year
Enhanced Model: Predicting Inpatient Days MARA+ SDoH

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)

Regression Statistics

| Variable       | Estimate | Confidence     | Std. Error | t value | Pr(>|t|) | df       |
|----------------|----------|----------------|------------|---------|---------|----------|
| (Intercept)    | 1.07e-03 | 8.07e-04       | 1.330      | 1.84e-01|         | 55713    |
| X2016_Age      | 3.54e-04 | 2.02e-05       | 17.508     | 1.91e-08|         |          |
| X2016_GenderM  | -4.81e-03| 6.60e-04       | -7.287     | 3.20e-13|         |          |
| X2016_lip      | 1.92e-02 | 2.15e-04       | 88.209     | 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-04 | 7.28e-04       | 2.533      | 1.13e-02|         |          |
| Urban_Flag1    | -1.73e-03| 2.30e-03       | -0.762     | 4.62e-01|         |          |

N= 6,054
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

Null deviance: 8769.2 on 6503 degrees of freedom
Residual deviance: 8019.7 on 6500 degrees of freedom
McFadden R-Squared: 0.08613, AIC: 8022

Accuracy: 0.656
Precision: 0.565
Recall: 0.633
F1: 0.597

Optimal Probability Cutoff: 0.359

<table>
<thead>
<tr>
<th>Actual</th>
<th>Actual Positive</th>
<th>Actual Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Positive</td>
<td>1650 (50.5%)</td>
<td>1277 (43.5%)</td>
</tr>
<tr>
<td>Predicted Negative</td>
<td>982 (27%)</td>
<td>2687 (71%)</td>
</tr>
</tbody>
</table>

N = 6,054
**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**

![Logistic Regression Model](image)
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

18% Improvement over base Model

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
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.
Discuss SDoH Program Evaluation
Actuaries and Healthcare Interventions
Population Segmentation

![Population Segmentation Diagram](image)
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

- Population (Problem)
- Intervention (Exposure)
- Comparison (Control)
- Outcome(s)
Designing Intervention Evaluations
Designing Intervention Evaluations

- Meta-analysis
- Systematic reviews
- Randomized controlled trial
- Non-randomized trial
- Cohort study
- Case-control study
- Before-after study
- Cross-sectional study
- Case series
- Case reports
- Qualitative studies
- Background information / expert opinions
Designing Intervention Evaluations
Discussion and Questions
Appendix
### Age/Gender Risk and PMPM Adjustments

#### Avg. Age/Gender PMPM

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2016 Gender</th>
<th>1-15</th>
<th>16-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Male</td>
<td>$420.24</td>
<td>$1,090.83</td>
<td>$1,499.94</td>
<td>$1,921.89</td>
<td>$2,772.79</td>
<td>$3,049.98</td>
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<tr>
<td></td>
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<td>$740.88</td>
<td>$1,198.03</td>
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<td>Grand Total</td>
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<td>$2,719.38</td>
<td>$3,012.34</td>
<td>$1,131.94</td>
</tr>
</tbody>
</table>

#### Avg. Age/Gender PMPM Ratio

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2016 Gender</th>
<th>1-15</th>
<th>16-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Male</td>
<td>0.37</td>
<td>0.96</td>
<td>1.32</td>
<td>1.69</td>
<td>2.44</td>
<td>2.68</td>
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<td>0.44</td>
<td>0.65</td>
<td>1.05</td>
<td>1.54</td>
<td>2.32</td>
<td>2.60</td>
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<td>0.82</td>
<td>1.24</td>
<td>1.64</td>
<td>2.39</td>
<td>2.65</td>
<td>1.00</td>
</tr>
</tbody>
</table>

#### Adjusted Age/Gender PMPM

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2016 Gender</th>
<th>1-15</th>
<th>16-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Male</td>
<td>$1,099.04</td>
<td>$1,135.98</td>
<td>$1,138.71</td>
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<tr>
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<tr>
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<td>$1,128.97</td>
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</table>

#### MARA Adjusted PMPM

<table>
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<th>Age Group</th>
<th>2016 Gender</th>
<th>1-15</th>
<th>16-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>56-65</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Male</td>
<td>$465.29</td>
<td>$661.60</td>
<td>$606.45</td>
<td>$533.27</td>
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<td>$530.35</td>
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<tr>
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<td>Female</td>
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<td>$471.80</td>
<td>$479.79</td>
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<td>$482.65</td>
<td>$482.59</td>
<td>$482.44</td>
</tr>
<tr>
<td>Grand Total</td>
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<td>$476.07</td>
<td>$577.15</td>
<td>$571.47</td>
<td>$517.23</td>
<td>$511.89</td>
<td>$510.07</td>
<td>$516.32</td>
</tr>
</tbody>
</table>
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| 0.031881   | 14.5790 | < 2.2e-16*** |
| X2016_Age     | -0.0003304| 0.0006933  | -0.4706 | 0.63369   |
| X2016_ER      | 1.0075884 | 0.1071603  | 9.4449  | < 2.2e-16*** |
| X2016_Hed     | 0.0002433 | 0.0021573  | 0.0120  | 0.10039   |

Significance codes: * p < 0.05, ** p < 0.01, *** p < 0.001

Residual standard error: 0.7423 on 6500 degrees of freedom
Multiple R-squared: 0.1075, Adjusted R-Squared: 0.1075
F-statistic: 302 on 3 and 6500 DF, p-value: < 2.2e-16

Type II ANOVA Analysis

Response: ER Use

<table>
<thead>
<tr>
<th>Sum Sq</th>
<th>DF</th>
<th>Mean Sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2016_Age</td>
<td>0.14</td>
<td>1</td>
</tr>
<tr>
<td>X2016_ER</td>
<td>218.24</td>
<td>1</td>
</tr>
<tr>
<td>X2016_Hed</td>
<td>1.63</td>
<td>1</td>
</tr>
<tr>
<td>Residuals</td>
<td>4980.69</td>
<td>6500</td>
</tr>
</tbody>
</table>

Significance codes: * p < 0.05, ** p < 0.01, *** p < 0.001

Accuracy: 0.656
Precision: 0.565
Recall: 0.633
F1: 0.597

Optimal Probability Cut-off: 0.359

Actual | Actual Positive | Actual Negative
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Positive</td>
<td>1050 (50.5%)</td>
<td>1277 (43.5%)</td>
</tr>
<tr>
<td>Predicted Negative</td>
<td>982 (27%)</td>
<td>1267 (37%)</td>
</tr>
</tbody>
</table>
Enhanced Model: SDoH + Health Status

Sample Characteristics:

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Limited to valid records containing
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Age
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Length of Residence (Int)

Removed:
Income Decile (correlated with Educ.)

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Next year ER Use >= 1 event

Regression Statistics

N= 6,054
Enhanced Model: Predicting ER Utilization Using MARA + SDoH + Health Status

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Regression Statistics

18% Improvement over base Model