



Optum Center for Health Equity

Maternal and infant health insights



The increased national attention on maternal health disparities has amplified the need for payers to better understand the driving forces behind inequitable maternal health outcomes within their member populations. Optum Advisory provided insights into disparate maternal and infant health outcomes between a Midwest health plan's commercial and Medicaid lines of business and identified specific factors driving these differences. With the actionable insights from Optum Advisory, the health plan identified the exact needs of their member population and accurately tailored strategic approaches to address the root causes of maternal health disparities.

Issue background

More mothers and infants die in the United States from [pregnancy and birth complications](#) than in any other high-income nation. Several clinical factors increase maternal health risk. Pre-pregnancy conditions such as cardiovascular disease, obesity, asthma and a compromised immune system can increase the risk of maternal morbidity or mortality. Other pregnancy-related clinical factors – advanced maternal age, pregnancy with multiple infants, preeclampsia, gestational diabetes – also contribute to increased risk.

[Social determinants of health \(SDOH\)](#) can significantly impact maternal morbidity and mortality rates. SDOH are conditions in the environments where people are born, live, work, learn and age that impact their health and quality of life. For example, a recent *New York Times* article on maternal and infant health inequality shows that the richest Black mothers and babies are twice as likely to die as the richest white mothers and babies. Other factors that increase maternal health risk include [ethnicity, built environment and access to health care](#).

Federal law mandates that Medicaid programs in each state extend coverage to all pregnant women with [incomes at or below 138%](#) of the national poverty line. This coverage extends until the mother is 60 days postpartum. In states that have expanded Medicaid eligibility under the Affordable Care Act, many of these mothers can retain their coverage past the 60-day postpartum timeline, up to a year in many cases. However, in states that have not expanded Medicaid eligibility, many of these mothers become [uninsured after 60 days postpartum](#) due to lower income eligibility requirements for parents. This presents a significant barrier to health care access for low-income mothers and contributes to disparate postpartum maternal health outcomes.

Use case background

A Midwest health plan serving Medicare, Medicaid and commercial members wanted to understand how maternal and infant health outcomes differed between their commercial and Medicaid lines of business and the factors driving those differences. With an increased national focus on maternal health, states are now implementing policies focused on addressing maternal morbidity and infant mortality. For example, one Midwestern state extended postpartum depression care for up to one year postpartum and increased the availability of doulas for prenatal and postpartum care. Considering these changes, the health plan wanted to understand if members were utilizing these expanded services and, if not, what factors influenced that choice.

The objective of this use case was to identify the clinical and nonclinical factors – like social isolation, housing insecurity and other social determinants of health – driving disparate maternal health outcomes within the plan's member population.

Study background

Given the importance of clinical and SDOH factors in driving maternal health outcomes, the foundational framework of this study used person-level data to develop a holistic view of the mother and their newborn in terms of both clinical and nonclinical data. Using a combination of self-reported and imputed person-level SDOH data, we linked the mother to their infant and examined the relationship between the mother's clinical and SDOH characteristics and the newborn's birth outcome. The process of integrating data from different available sources was meticulously carried out to accurately map the mother's data to that of their newborns. The framework below was applied to the data of more than 10,000 mothers and infants to identify the clinical and nonclinical factors impacting maternal health outcomes, which, in turn, impact the newborn's birth outcome. Condition groups were created to organize the newborn population into:

Baby condition levels

1. NAS: Newborn suffering from neonatal abstinence syndrome
2. Premature with complications (underweight)
3. Premature without complications (underweight)
4. Full term with complications
5. Full term without complications

Analytical delivery framework

This study used the following analytics framework to identify meaningful insights to drive actionable change within the health plan's ID/Strat and case management to reduce maternal and infant health disparities.

- 1. Integrated data:** at the individual mother level, Medicaid and commercial members' clinical, behavioral, utilization, care management and SDOH data combined and linked to their infant's clinical data to create an integrated and holistic data set
- 2. Descriptive analytics:** summary statistics of the Medicaid and commercial populations, including age distribution and baby condition level distribution segmented by available race, ethnicity and language data
- 3. Diagnostics and root cause:** quantitative approach to understanding the relationship that clinical and nonclinical factors have on specific health outcomes
 - Correlation analysis: correlational method to measure the strength of linear relationship between mother's and newborn's health outcomes
 - Logistic regression and odds ratio analysis: statistical technique that establishes a cause-and-effect relationship between multiple clinical conditions and a specific health outcome in mothers
 - Decision tree analysis: a tree-like graphical representation defines paths with multiple combinations of SDOH and clinical factors leading to a specific health outcome in mothers
- 4. Prescriptive analytics:** identify the specific changes that can be made within the health plan's ID/Strat methodology to reduce disparities and address a member's clinical and social needs

Figure 1 shows different levels of analyses performed on an integrated member-level data set to identify the mother's significant clinical and nonclinical conditions that may impact the health of a newborn baby.

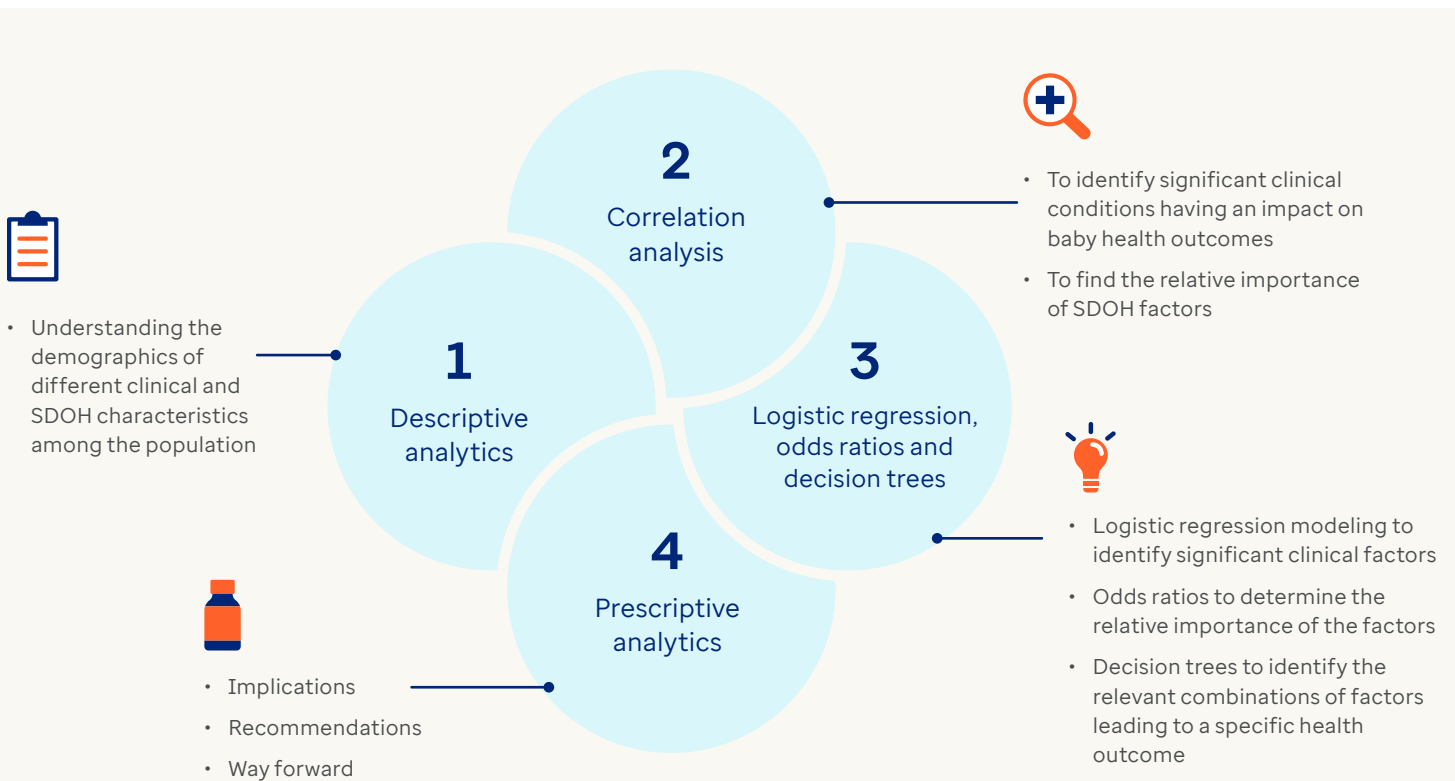


Figure 1

Integrated and descriptive analytics

Using the integrated data set, we can examine the population from a cost, utilization and SDOH perspective through descriptive analytics. Figure 2 below shows the population size by the line of business and baby condition levels included within this analysis. The timeframe included infants one-year-old or younger and their mothers from 2021-2022. The analysis also included one year of historical clinical data of the mother one year from the delivery date.

Moms having babies falling under condition level						
Line of business	Total population	NAS	Premature with complication	Premature without complication	Full term with complication	Full term without complication
Medicaid	2386	69 (0.3%)	148 (6.2%)	146 (6.1%)	381 (16%)	1642 (68.8%)
Commercial	9735	32 (0.3%)	438 (4.4%)	575 (6.0%)	1434 (15%)	7256 (74.5%)

Figure 2

Figures 3, 4 and 5 below showcase the strikingly different distribution of the various SDOH characteristics across commercial plan mothers and subsequently by baby condition level.

Figure 3 shows the total commercial population of moms distributed across various SDOH characteristics on a scale from 'very high' (most severe) to 'very low' (least severe).

Mothers (commercial line of business)					
	Food insecurity	Financial insecurity	Transportation insecurity	Housing insecurity	Social isolation
Very high	5.1%	30.2%	3.3%	6.2%	28.8%
High	8.2%	42.7%	41.3%	17.7%	41.6%
Moderate	10.6%	20.2%	43.6%	29.6%	23.4%
Low	23.7%	6.1%	10.6%	36.9%	4.9%
Very low	52.5%	0.8%	1.4%	9.6%	1.3%
Grand total	100%	100%	100%	100%	100%

Figure 3

Figure 4 shows the distribution of commercial plan mothers who scored 'low' or 'very low' for the various SDOH characteristics. Figure 5 shows the same characteristics for commercial plan mothers who scored 'high' or 'very high.'

Low/Very low					
	Food insecurity	Financial insecurity	Transportation insecurity	Housing insecurity	Social isolation
NAS	0.4%	0.3%	0.3%	0.3%	0.4%
Premature with complication	4.7%	4.9%	4.6%	4.8%	4.5%
Premature without complication	6.9%	5.5%	5.6%	5.4%	6.4%
Full term with complication	14.6%	15.4%	14.6%	15.2%	12.8%
Full term without complication	73.5%	73.8%	74.9%	74.3%	76.0%
Grand total	100%	100%	100%	100%	100%

Figure 4

High/Very high					
	Food insecurity	Financial insecurity	Transportation insecurity	Housing insecurity	Social isolation
NAS	0.5%	0.5%	0.8%	0.7%	0.5%
Premature with complication	4.7%	4.5%	5.2%	5.4%	4.5%
Premature without complication	6.1%	9.4%	7.5%	5.8%	5.4%
Full term with complication	14.4%	12.1%	14.8%	12.9%	15.6%
Full term without complication	74.3%	73.5%	71.7%	75.1%	74%
Grand total	100%	100%	100%	100%	100%

Figure 5

Diagnostic analytics

The purpose of the diagnostic analysis was to determine significant predictors of baby health outcomes. Outcomes included admission to neonatal intensive care unit (NICU) and the baby's health condition at birth. The methodology leveraged a prepared member-level data set of mothers and their newborns with variables including SDOH factors, lifestyle factors and the health outcomes for both mothers and their newborns. This study compared the results from the analysis of the 2 data sets representing the population of Medicaid and commercial lines of business.

As the first step of the diagnostic analytics, correlation values were derived to determine the relative impact of different clinical and SDOH factors of mothers on the health outcomes of the newborn.

Figure 6 shows the relationship between the most crucial mother's clinical conditions and the admission of the newborn to the neonatal intensive care unit (NICU), comparing the 2 lines of business. Hypertension is the most positively correlated clinical condition with NICU admission in both member populations. Pregnancy complications correlated more with NICU admission within commercial member populations than within Medicaid member populations. Chemical dependency and diabetes were more positively correlated with NICU admissions within the Medicaid member population than within the commercial member population. Within the commercial population, 3 conditions showed negative correlations with NICU admissions. This is likely due to the small counts of members with the conditions in the population.

Medicaid	Commercial
<p>Positive correlation*</p> <ul style="list-style-type: none"> • Hypertension • Premature rupture of membranes (PROM) • Chemical dependency • Diabetes (existing) • Multiple gestation • Anxiety/Depression • Serious mental illness (SMI) • Pregnancy complications • Gestational diabetes • Tobacco • STIs • COPD/Asthma • Renal failure • Epilepsy/Seizure • Neonatal aftercare • Weight/Nutrition/Obesity • SDOH psychological status or social concerns • Recurrent loss 	<p>Positive correlation*</p> <ul style="list-style-type: none"> • Renal failure/Hypertension • Pregnancy complications • Multiple gestation • Premature rupture of membranes (PROM) • Labor and delivery complications • Weight/Nutrition/Obesity • Anxiety/Depression • Diabetes • SMI • HIV • Chemical dependency • Tobacco • Recurrent loss • Epilepsy/Seizure • Neonatal aftercare <p>Negative correlation</p> <ul style="list-style-type: none"> • Sickle cell • COPD/Asthma • SDOH psychological status or social concerns

* Variables in Figure 6 are arranged in decreasing order of their values of correlation.

Figure 6

Figure 7 shows the relationship between the most important clinical conditions of the mother and the condition where newborns have some of the other complications (baby condition levels 1-4). Hypertension and chemical dependency were the clinical conditions most positively correlated with NICU admissions for the Medicaid population. Renal/Hypertension and multiple gestation were the most positively correlated clinical conditions with NICU admissions within the commercial population.

Medicaid	Commercial
<p>Positive correlation*</p> <ul style="list-style-type: none"> • Hypertension • Chemical dependency • Multiple gestation • Pregnancy complications • Tobacco • Premature rupture of membranes (PROM) • Anxiety/Depression • Diabetes (existing) • Serious mental illness (SMI) • Gestational diabetes • COPD/Asthma • Weight/Nutrition/Obesity • Neonatal aftercare • STIs • Renal failure • HIV • Epilepsy/Seizure • SDOH psychological status or social concerns • Recurrent loss <p>No correlation</p> <ul style="list-style-type: none"> • Sickle Cell • Infertility 	<p>Positive correlation*</p> <ul style="list-style-type: none"> • Renal/Hypertension • Multiple gestation • Premature rupture of membranes (PROM) • Pregnancy complications • Anxiety/Depression • SMI • Weight/Nutrition/Obesity • Tobacco • Diabetes • Chemical dependency • Sickle Cell • HIV • Recurrent loss <p>Negative correlation</p> <ul style="list-style-type: none"> • Epilepsy/Seizure • COPD/Asthma • SDOH psychological status or social concerns <p>No or weak correlation</p> <ul style="list-style-type: none"> • Gonorrhea • Chlamydia

Figure 7

* Variables in Figure 7 are arranged in decreasing order of their values of correlation.

Figure 8 shows the SDOH factors experienced by mothers that are most likely to lead to complications in newborns. “Propensity to engage” was shown as the most positively correlated factor with newborn complications within the Medicaid population. This indicates that if a mom displays a high program engagement propensity score, the likelihood of their newborn falling into baby condition levels (1-4) is increased. On the other hand, for the commercial population, “propensity to engage” and “health ownership” were shown as the most positively correlated factors. “Financial security” and “transportation security” showed a negative correlation for the commercial population.

Medicaid	Commercial
<p>Positive correlation*</p> <ul style="list-style-type: none"> • Propensity to engage (summary) • Propensity to engage (disease management) • Food security • Housing security • Chronic health ownership • Health ownership - overall • Propensity to engage (IB) • Transportation security • Financial security • Social isolation 	<p>Positive correlation*</p> <ul style="list-style-type: none"> • Propensity to engage (summary) • Health ownership (level) • Propensity to engage (programs) • Housing security (homelessness) • Chronic health ownership • Social isolation • Food security <p>Negative correlation</p> <ul style="list-style-type: none"> • Financial security • Transportation security

Figure 8



SDOH glossary

Health ownership

Identifies the member’s level of interaction with the health care system and personal health choices based on their health status. It is a measure of a member’s level of engagement with their own health.

Propensity to engage (disease management)

Predicts the likelihood for someone to engage in care and disease management programs.

Propensity to engage (inbound call)

Predicts the likelihood someone will use a specific communication channel such as a phone.

Propensity to engage (summary)

Combines both inbound call and program engagement propensity indices.

* Variables in Figure 8 are arranged in decreasing order of their values of correlation.

Predictive and prescriptive analytics

The diagnostic analysis identified hypertension (high blood pressure) as one of the most prominent clinical factors for the mother in determining the health outcome of the newborn. The next part of the analysis focused on identifying significant clinical factors that may cause the mother to develop hypertension. For this analysis, logistic regression models were trained on Medicaid and commercial data sets, and model coefficients were analyzed using odds ratios, a popular statistical concept used to check the effect of specific exposures on certain outcomes. The odds ratio, in this case, defines the odds that a mother will have hypertension given that she *is exposed* to a specific clinical condition, compared to the odds that she will still have hypertension if she *is not exposed* to that clinical condition.

The results for the 2 lines of business were compared to provide detailed insights into the clinical conditions leading to a woman developing hypertension during pregnancy.

Figure 9 highlights the importance of variables that affect hypertension in mothers in the Medicaid population. If a mother has diabetes, the odds of developing hypertension increase by 175.24%, compared to a nondiabetic mother developing hypertension, while other variables are held constant. In other words, the odds of a diabetic mother developing hypertension are approximately triple the odds of a nondiabetic mother developing the same condition. For age, the interpretation is such that the odds of hypertension increase by 8.33%, with every step transition in the age interval as per the quartile values.

Medicaid: Odds ratio analysis		
Variable	Odds ratio	Change in odds of hypertension
Diabetes (existing)	2.75	175.24%
Weight/Nutrition/Obesity	1.97	96.91%
COPD/Asthma	1.95	94.87%
Anxiety/Depression	1.66	65.49%
Tobacco	1.05	4.94%
Age	1.08	8.33%

Figure 9

Age distribution for mothers (Medicaid):

Minimum age: 15..... **25th percentile:** 25 (lower quartile)

Maximum age: 50 **50th Percentile:** 29 (median)

Average age: 29..... **75th Percentile:** 33 (upper quartile)

Figure 10 indicates the variables of weight, nutrition and obesity to be the most significant among clinical variables in the commercial population. In cases where a mother is obese, has weight issues or nutrition deficiency, the odds of developing hypertension increase by 207.41%, compared to a healthy mother developing hypertension while other variables are held constant. In the case of age, the odds increase by 3.55%, with every step transition in the age intervals as per the quartile values.

Commercial: Odds ratio analysis		
Variable	Odds ratio	Change in odds of hypertension
Weight/Nutrition/Obesity	3.07	207.41%
Diabetes (existing)	2.45	145.42%
Anxiety/Depression	1.66	66.43%
COPD/Asthma	1.62	62.04%
Tobacco	1.55	54.95%
Age	1.04	3.55%

Figure 10

Age distribution for mothers (Commercial):

Minimum age: 15..... **25th Percentile:** 29 (lower quartile)

Maximum age: 54..... **50th Percentile:** 32 (median)

Average age: 32..... **75th Percentile:** 35 (upper quartile)

Results from logistic regression models showed that Diabetes (existing) and Weight/Nutrition/Obesity concerns are the highest predictors for the diagnosis of hypertension.

The results showed that hypertension was one of the most prominent factors among mothers that indicate complications. High blood pressure can cause preterm delivery and low birth weight. It's hard for the baby to get enough oxygen and nutrition, which can cause preterm delivery.

Chemical dependency is the next most crucial factor. Heavy alcohol use during pregnancy has been associated with a range of adverse birth outcomes, including low birth weight, preterm delivery and stillbirth. Treatment for mothers with an alcohol use disorder includes counseling, therapy detoxification and medical devices to treat withdrawal symptoms. Treatment is also available for mothers affected by both mental illness and alcohol use disorders.

Results from analyses of the SDOH factors align with past research, which has proven that educational status and the risk of hypertension are inversely related. Education before, during and after pregnancy is essential for both the mother and baby.

Timely and regular prenatal care is essential. Participation in the prenatal Special Supplemental Nutrition Program for women, infants and children (WIC) results in longer pregnancies and fewer premature births. It also lowers incidences of moderately low and very low birth weight in infants and reduces infant deaths. The CDC also recommends pregnant mothers track their blood pressure using at-home monitors. Many of these risk factors are interconnected so early detection, prenatal planning and education help promote healthy moms and babies.

Decision tree analysis

The next part of the analysis used decision tree modeling – an advanced statistical technique – to identify the possible combinations of SDOH and clinical factors in mothers leading to hypertension development.

Figure 11 shows the decision tree analysis for mothers on commercial plans. The same model was developed for the Medicaid population. The decision points for 12,365 mothers along the continuum were funneled down to the ones most likely to develop hypertension. Starting from the left, Weight/Nutrition/Obesity was the most crucial predictor of hypertension. Next, it was whether a mother had very high economic instability followed by a high propensity to engage index (PEI) summary. A mother following this path had the highest chance of developing hypertension (70%). In figure 12, within the Medicaid population of 2,422 mothers, pregnancy with diabetes was the most crucial predictor, followed by COPD/Asthma and Weight/Nutrition/Obesity. A mother exhibiting all 3 conditions had the highest chance of developing hypertension (69%). Very high levels of food insecurity and homelessness significantly increased the risk of mothers in the Medicaid population developing this condition.

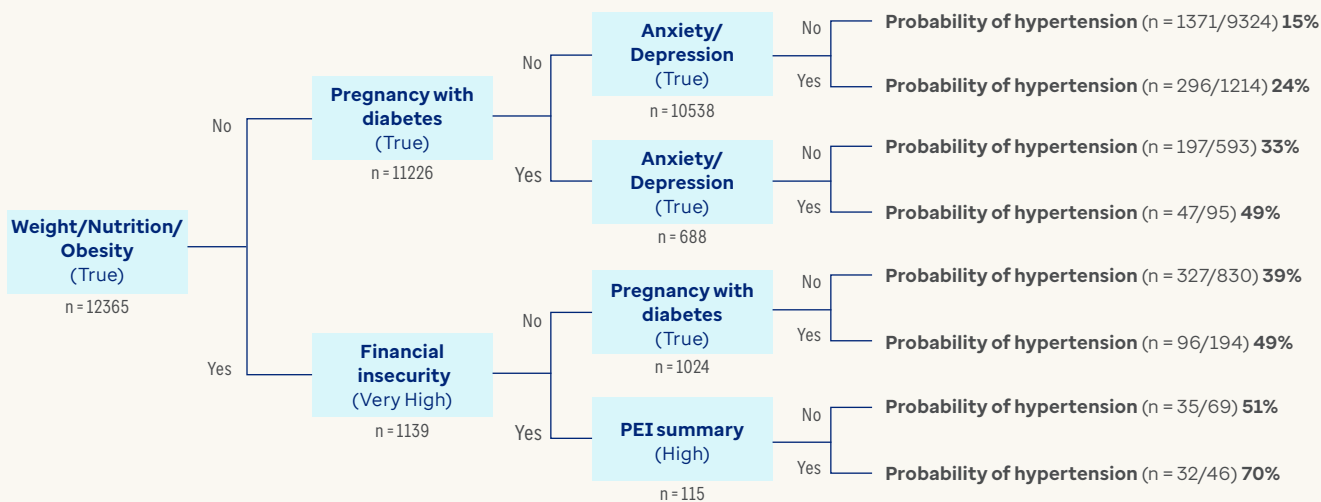


Figure 11: Decision tree analysis for commercial population

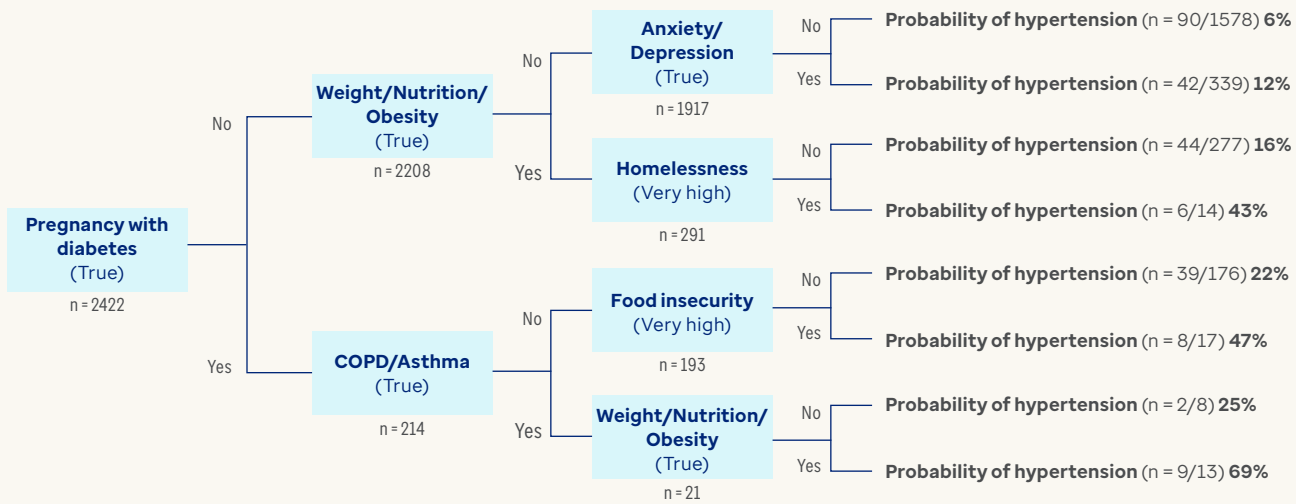


Figure 12: Decision tree analysis for Medicaid population

This analysis is powered by the detailed SDOH and clinical characteristics of mothers from 2 different sets of the population who are likely to develop hypertension.

Implications and recommendations

Statistics show that health plans do not identify 40% of at-risk mothers until the time of delivery. This means that almost half of at-risk pregnant women fall through the cracks of the legacy health care system. A predictive, advanced analytics platform that uses artificial intelligence (AI) and machine learning (ML), helps health plan case managers come closer to ensuring that every mother can access the best health care options available. Such a value-based framework can improve delivery outcomes and build healthier communities.

If health plans can identify the conditions and social determinants of health that are likely to lead to birth complications and poor maternal and infant health outcomes upfront, they can influence several key areas:

1. **Provider education:** Educate and incentivize health care providers to screen patients for social determinants of health and track responses using Z-codes. This allows better data collection and, ultimately, coordination of resources.
2. **Case management impact:** Identifying at-risk birthing persons sooner and engaging them in care or case management, including doula care, can positively impact maternal health outcomes.
3. **Refer patients to wraparound services:** Reviewing SDOH data can help providers connect patients with services that address their needs. They can also prioritize patient care. Patients whose health plans incorporate historical data will experience better health and birth outcomes than those that do not. This will eventually help reduce NICU admissions and duration of stay. These improvements lead to better health outcomes for patients and decrease costs for health plans.

4. **Strategic community partnerships:** Understanding that many of the factors that drive poor health outcomes are due to a member's social and built environment, health plans can identify strategic partnerships with community-based organizations to address areas of need within their member population, like food and housing insecurity. Understanding the factors that can lead to hypertension is also critical, so health plans can strategically look upstream to community partnerships that address the social and economic needs of mothers.

Conclusion

Optum Advisory health equity analytics capabilities provide insights into disparate maternal health outcomes and uncover what specific factors drive these differences within member populations. With these actionable insights, health plans can identify at-risk mothers, accurately tailor strategic approaches to combat maternal health inequity, improve value, and prevent at-risk members from falling through the cracks.

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